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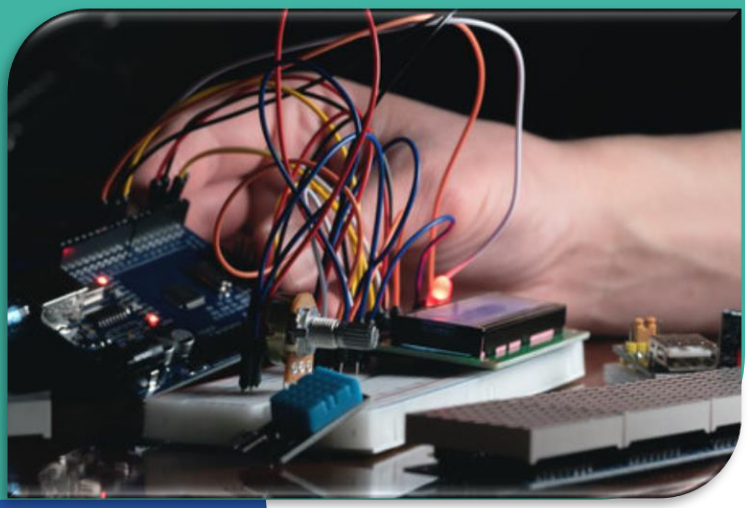

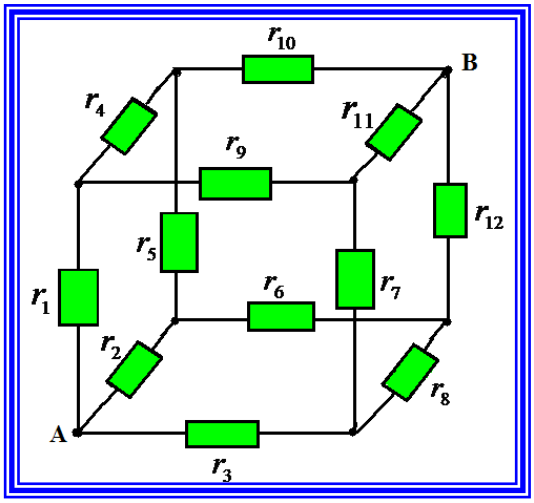

ELEKTR ZANJIR ELEMENTLARIGA DOIR MASALALAR YECHISH

O‘quv qo‘llanma

V.Sh. Fayziyev, H.O. Jo‘rayev, Sh.Sh. Fayziyev

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O‘quv qo‘llanma

“KAMOLOT” nashriyoti
Buxoro - 2024

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Ushbu o‘quv qo‘llanmada masalalar yechish namunalari keltirilgan bo‘lib, masalalarni yechishda har xil usullardan foydalanilgan, ya’ni masalalarni yechishda ularni sxemalarini murakkab ko‘rinishdan oddiy ko‘rinishga aylantirib, masalalar yechilgan.

O‘quv qo‘llanma yordamida o‘quvchilar o‘tkazgichlarni ketma-ket va parallel ulash usullarni hamda turli xil sxemalarni ulashni o‘rganishlari mumkin.

Ushbu o‘quv qo‘llanmada nazariy usul bilan bir qatorda amaliy (laboratoriya) usulida yechib ko‘rilgan masalalar ham joy olgan.

Uslubiy qo‘llanmada Kirxgofning 1-2-qoidalari va ularga doir masalalar yechimlari ham joy olgan.

Ushbu o‘quv qo‘llanmadan umumiy o‘rta talim maktabi, akademik litsey va kollejlar o‘qituvchilari o‘quvchilarni olimpiadalarga tayyorlash uchun foydalanishlari mumkin.

Taqrizchilar:

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M.Z.Sharipov – BuxMTI « Fizika » kefedrasi professori, fizika-matematika fanlari doktori.

Ushbu o‘quv qo‘llanma Oliy ta’lim, fan va innovatsiyalar vazirligining 2024-yil 4-martdagi 55-sonli buyrug‘iga asosan nashrga ruxsat berildi. Ro‘yxatga olish raqami 55-174.

MUNDARIJA

Kirish

O‘zbekiston Respublikasi Prezidentining 2021-yil 19-matrdagi PQ-5032-son Qarorida “Bugungi kunda ta’lim muassasalarida fizika fanini o‘qitish sifatini oshirish, ta’lim jarayoniga zamonaviy o‘qitish uslublarini joriy qilish, iqtidorli o‘quvchilarni saralash, mehnat bozoriga raqobatbardosh mutaxassislarni tayyorlash, ilmiy tadqiqot va innovatsiyalarni rivojlantirish hamda amaliy natijadorlikka yo‘naltirishga katta e’tibor qaratilayotganligi” ta’kidlangan.

Talabalarning fizikaning elektr va magnetizm kursidan nazariy bilimlarini o‘zlashtirishlari va ularni amaliy mashqlarda qo‘llay bilishlari uchun fizika o‘qituvchilarini tayyorlash sifatini oshiruvchi omillardan biri hisoblanadi. Masalalar yechish amaliy ko‘rsatmalarni rivojlantirishga yordam beradi. Ushbu to‘plamdagi masalalarni yechishda egallangan malakalar talabalarning kelgusi pedagogik faoliyatlari uchun foydalidir.

O‘quv qo‘llanmada masalalar yechish namunalari keltirilgan bo‘lib, masalalarni yechishda har xil usullardan foydalanilgan, ya’ni masalalarni yechishda ularni sxemalarini murakkab ko‘rinishdan oddiy ko‘rinishga aylantirib, masalalar yechilgan.

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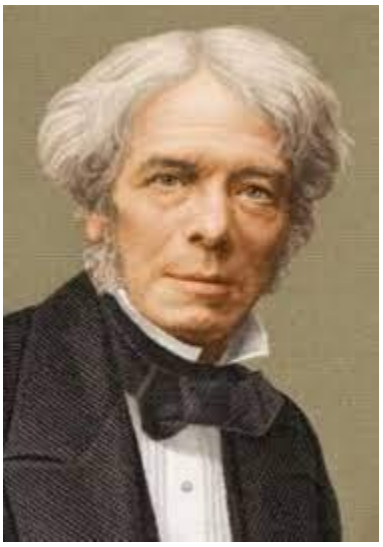
O‘quv qo‘llanmadan Oliy ta’lim muassasalarining Fizika yo‘nalishlarida foydalanish mumkin.

KONDENSATORLAR, KONDENSATORLARNI KETMA-KET VA PARALLEL ULASH



Yakkalangan o‘tkazgichning elektr sig‘imi.

Yakkalangan o‘tkazgich deb, elektr jihatidan izolyasiyalangan va boshqa o‘tkazgichlardan yetarlicha uzoqlikda joylashgan o‘tkazgichga aytiladi.

Agar yakkalangan o‘tkazgichga q zaryad berilsa, bu zaryad o‘tkazgichning sirti biror φ potensialli ekvipotensial sirtga aylanguncha o‘tkazgich sirti bo‘ylab tarqaladi. O‘tkazgich sirtining potensiali φ unga berilgan zaryad q ga proporsional ravishda o‘zgarar ekan.

O‘lchashlar natijasida ma’lum bo‘ldiki, o‘tkazgich zaryadini potensialga bo‘lgan nisbati, ya’ni $\frac{q}{\varphi}$ zaryadning katta-kichikligiga bog‘liq bo‘lmasdan, faqat o‘tkazgichning o‘lchami, shakli va o‘tkazgich atrofidagi dielektrikningxususiyatlariga bog‘liq bo‘lar ekan. Bu nisbatga yakkalangan o‘tkazgichning elektr sig‘imi deyiladi va C harfi bilan belgilanadi.

$$C = \frac{q}{\varphi} \qquad (1)$$

Yuqoridagi ifodaga asosan elektr sig‘imni quyidagicha tariflash mumkin:

Yakkalangan o‘tkazgichning elektr sig‘imi deb, uning potensialini bir birlikka o‘zgartirish uchun zarur bo‘lgan zaryadga miqdor jihatidan teng bo‘lgan fizik kattalikka aytiladi.

SI tizimida sig‘im birligi ingliz fizigi Maykl Faraday nomi bilan atalgan va farad (belgi:F) hisoblanadi. 1 faradli kondensator, 1 kulon elektr zaryadi bilan zaryadlanganida, uning plastinkalari orasidagi potentsiallar farqi 1 voltga teng bo‘ladi

$$1F = \frac{1kl}{1V}$$

Maykl Faradey *(inglizcha: Michael Faraday, 1791.22.9 London-1867.25.8) ingliz fizigi, kimyogari, elektromagnit maydoni ta’limoti asoschisi, London Qirollik jamiyati a’zosi (1824). Peterburg Fanlar akademiyasi a’zosi (1830). London Qirollik jamiyati institutida assistent (1913), laboratoriya direktori (1825), kimyo kafedrasining professor (1833—1862). Ilmiy ishlari elektr, magnitizm, magnitooptika va*

elektrokimyoga oid. Elektromagnit induksiya hodisasi (1831), elektroliz qonunlari (1833), diamagnetizm va para-magnetizm hodisasi (1845), yorug‘lik qutblanish tekisligining magnit maydonda burilishi (1845) va boshqalarni kashf etgan. Elektr zaryadining saqlanish qonunini eksperimental tasdiqlagan (1843). Faradey g‘oyalari va uning ilmiy yutuqlari fizika fanining rivojlanishida muhim o‘rin tutgan.

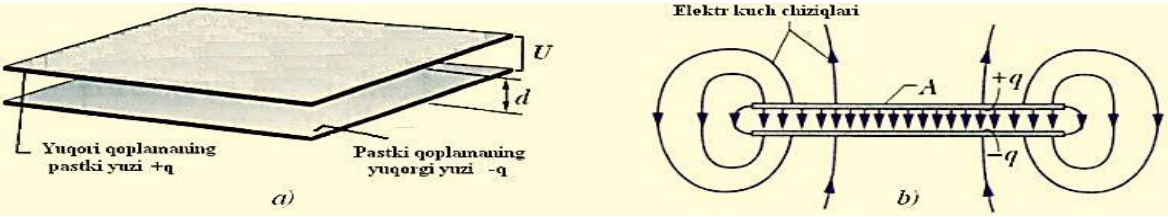
1C elektr zaryadi juda katta zaryad bo‘lgani uchun 1F elektr sig‘imi ham juda katta sig‘imdir. Amalda 1F elektr sig‘imiga umuman ishimiz tushmaydi. Shuning uchun, masalalarda bu sig‘imning ulushlari mikrofaradda (μF), nanofaradda (nF), pikofaradda (pF) lar bilan ish ko‘ramiz.

Agar +q va -q zaryadlar bilan zaryadlangan o‘tkazgichlar sistemasi orasida potensiallar ayirmasi (kuchlanish) $U=\varphi_1-\varphi_2$ bo‘lsa, bu ikki o‘tkazgichning o‘zaro elektr sig‘imi C quyidagicha bo‘ladi:

$$C=\frac{q}{\varphi_1-\varphi_2}=\frac{q}{U} \qquad (2)$$

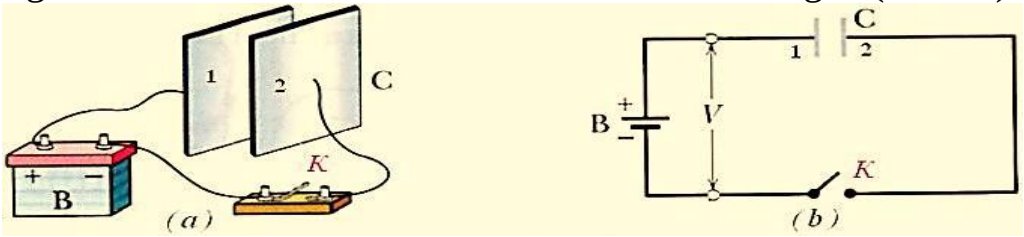
Yassi kondensator:

Qarama-qarshi ishorali zaryadlar bilan zaryadlangan, dielektrik bilan ajratilgan, bir-biriga yaqin turuvchi ikkita parallel o‘tkazgich plastinaga yassi kondensator deyiladi. Yassi kondensator zaryadlanganda har bir qoplamaning tashqi tomoni elektroneytral bo‘lib, bu qoplamalarning biri-biriga qaragan ichki yuzalarida qarama-qarshi ishorali va teng miqdorda +q va -q zaryadlar to‘planadi. Qoplamalar orasida bir jinsli elektr maydoni hosil bo‘ladi (1-rasm).



1-rasm. Yassi kondersatorning ko‘rinishi.

Quyidagi rasmda yassi kondensatorning o‘zgarmas tok manbaiga ulanish rasmiva sxematik ko‘rinishi tasvirlangan (2-rasm).



2-rasm. Yassi kondensatorning sxematik ko‘rinishi.

Yassi kondensatorning elektr sig‘imini hisoblash formulasini keltirib chiqaraylik. Buning uchun sig‘imning umumiy formulasi (2) dan foydalanamiz. Unga ko‘ra

$$C = \frac{q}{U} = \frac{q}{Ed} = \frac{q}{\frac{\sigma}{\varepsilon\varepsilon_0}d} = \frac{q}{\frac{q}{S\varepsilon\varepsilon_0}d} = \frac{\varepsilon\varepsilon_0 S}{d}$$ bo‘ladi.

Demak, yassi kondensatorning elektr sig‘imi quyidagicha bo‘lar ekan:

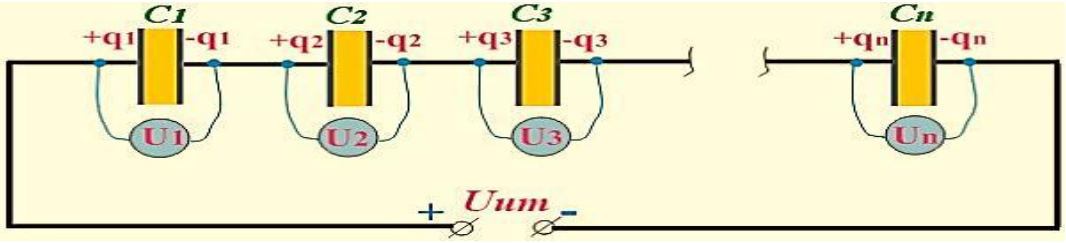
$$C = \frac{\varepsilon\varepsilon_0 S}{d} \qquad (3)$$

Bu yerda: S – bitta qoplamaning yuzi, d – qoplamalar orasidagi masofa.

Kondensatorlarni ketma-ket va parallel ulash:

Kondensatorlarni quyida rasmdagi kabi ulash ketma-ket ulash hisoblanadi.

Bunda 1-kondensatorning 2-qoplamasiga 2-kondensatorning 1-qoplamasi, 2- kondensatorning 2-qoplamasiga 3-kondensatorning 1-qoplamasi va hokozo ketma- ketlikda ulanadi (3-rasm).



3-rasm. Kondesatorlarni ketma-ket ulash sxemasi.

Kondensatorlarni ketma-ket ulaganda 1-kondensatorning 1-qoplamasi manbaning (+) qutbiga, oxirgi n-kondensatorning 2-qoplamasi esa manbaning (-) qutbiga ulangan bo‘ladi. Oradagi qoplama va kondensatorlar hech qanday manbaga ulanmagan bo‘lsa ham ular qanday zaryadlanadi degan savol tug‘ilishi tabiiy. Bunga sabab elektrostatika induksiya hodisasidir. Bu yerda oraliqda joylashgan qoplama va kodensatorlar manbaga ulangan ikki chetdagi qoplamalarning elektr maydonida turgani bois, ular elektr maydonga kiritilgan o‘tkazgich vazifasini o‘taydi. Har bir o‘tkazgichning (bir-biriga ulangan qo‘shni kondensator qoplamalarining) qarama-qarshi tomonida teng miqdordagi va qarama-qarshi ishorali zaryadlar to‘planadi. Natijada tok manbaiga ketma-ket ulangan kondensatorlarning har bir qoplamasi teng miqdorda +q va -q zaryadlarga ega bo‘ladi.

Shuning uchun ham $q_{um} = q_1 = q_2 = q_3 = ... = q_n$ bo‘ladi. Tashqaridan berilgan umumiy kuchlanish barcha kondensatorlarga taqsimlanib ketgani sababli $U_{um} = U_1 + U_2 + U_3 + ... + U_n$ bo‘ladi. Umumiy sig‘imni popish uchun (2) ifodadan U larni topib ushbu ifodaga qo‘yib chiqamiz.

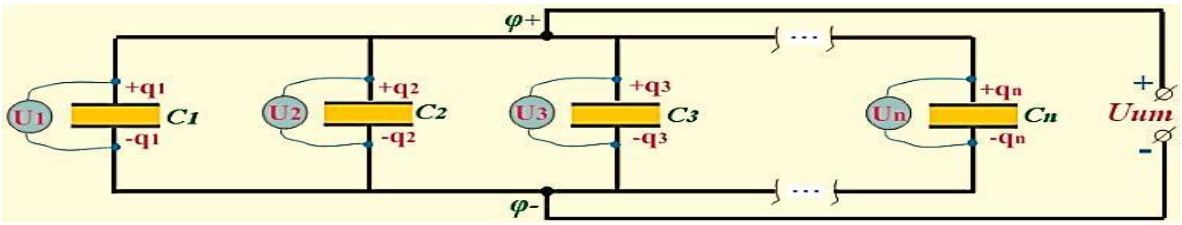
$$U_{um} = U_1 + U_2 + U_3 + ... + U_n; \rightarrow \frac{q_{um}}{C_{um}} = \frac{q_1}{C_1} + \frac{q_2}{C_2} + \frac{q_3}{C_3} + ... + \frac{q_n}{C_n}$$

Hosil bo‘lgan kasrni q ga bo‘lib yuborsak, kondensatorlar ketma-ket ulanganda zaryad bir xil ekanligini inobatga olamiz.

$$\frac{1}{C_{um}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ... + \frac{1}{C_n} \qquad (4)$$

Kondensatorlarni ketma-ket ulashda sig‘im formulasi hosil bo‘ladi.

Kondensatorlarni quyida 4-rasmdagidek qilib ulash parallel ulash hisoblanadi. Bunda hamma kondensatorlarning 1-qoplamasi manbaning (+) qutbiga, 2- qoplamasi esa manbaning (-) qutbiga ulanadi.



4-rasm. Kondesatorlarni paralell ulash sxemasi.

Hamma kondensatorlarning yuqorigi 1-qoplamalari to‘g‘ridan to‘g‘ri manbaning (+) qutbiga ulangan. Shuning uchun, bu qoplamalarning hammasida birxil manbaning (+) qutbining potensialiga teng bo‘lgan φ_+ potensial hosil bo‘ladi. Hamma kondensatorlarning pastki 2-qoplamalari to‘g‘ridan to‘g‘ri manbaning (-) qutbiga ulangan. Shuning uchun, bu qoplamalarning hammasida bir xil manbaning (-) qutbining potensialiga teng bo‘lgan φ_- potensial hosil bo‘ladi (4-rasm). Har bir qoplamadagi potensiallar farqi o‘zaro teng bo‘ladi va bu potensiallar farqi manbaning kuchlanishiga teng, ya’ni $\varphi_+ - \varphi_- = U$ bo‘ladi. Demak, kondensatorlarning hammasidagi kuchlanishlar bir xil va manbaning kuchlanishiga teng, ya’ni $U_{um} = U_1 = U_2 = U_3 = ... = U_n$ bo‘ladi. Kondensatorlar har biri zaryadlanish jarayonida zaryadni tok manbaidan olgani bois kondesatorlar sistemasining umumiy zaryadi barcha kodensatorlarda to‘plangan zaryadlar yig‘indisiga teng, ya’ni $q_{um} = q_1 + q_2 + q_3 + ... + q_n$ bo‘ladi.

Kondensatorlar sistemasining umumiy sig‘imni popish uchun (2) ifodadan q larni topib ushbu ifodaga qo‘yib chiqamiz

$$q_{um} = q_1 + q_2 + q_3 + ... + q_n \rightarrow C_{um}U_{um} = C_1U_1 + C_2U_2 + C_3U_3 + ... + C_nU_n$$

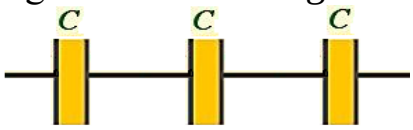
Kondensatorlar paralallel ulanganda kuchlanish tengligi uchun oxirgi tenglamani barcha hadini U ga bo‘lsak quyidagi natijaga erishamiz.

$$C_{um} = C_1 + C_2 + C_3 + ... + C_n \quad (5)$$

Kondensatorlarni paralell ulashda sig‘im formulasi hosil bo‘ladi.

KONDENSATORLARNI ARALASH ULASHGA DOIR MASALALAR

1. Sxemaning umumiy sig‘imini hisoblang.



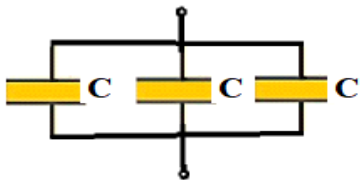
Har bir sig‘imlar ketma-ket ulanganligi uchun (4) formuladan foydalanamiz.

Uchala sig‘imlar ham C ekanligini inobatga oladigan bo‘lsak, umumiy sig‘im quyidagicha hisoblanadi.

$$\frac{1}{C_{Um}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots \frac{1}{C_n}; \quad \frac{1}{C_{Um}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} = \frac{3}{C}$$

$$C_{Um} = \frac{C}{3}$$

2. Sxemaning umumiy sig‘imini hisoblang



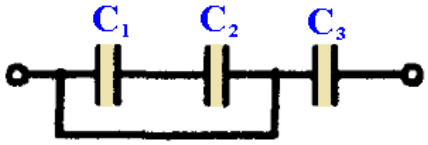
Har bir sig‘imlar paralel ulanganligi uchun (5) formuladan foydalanamiz..

Uchala sig‘imlar ham C ekanligini inobatga oladigan bo‘lsak, umumiy sig‘im quyidagicha hisoblanadi.

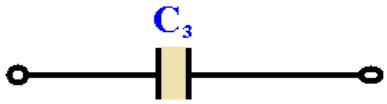
$$C_{Um} = C_1 + C_2 + C_3 + \ldots C_n$$

$$C_{Um} = C + C + C = 3C \rightleftarrows; C_{Um} = 3C$$

3. Sxemaning umumiy sig‘imini hisoblang.($C_1 = C_2 = C_3 = C$)

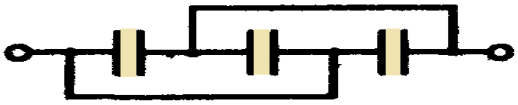


Sxemaning C_1 va C_2 sig‘imlar orqali tok o‘tmaydi,shuning uchun bu sig‘imlarni sxemadan olib tashlaymiz va quyidagi ko‘rinishga keladi.

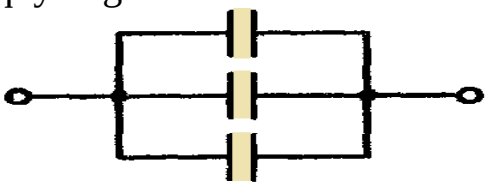


$$C_{Um} = C_3 = C$$

4. Sxemaning umumiy sig‘imini hisoblang.($C_1 = C_2 = C_3 = C$)



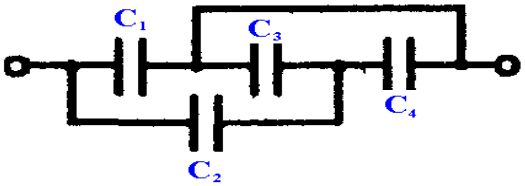
Sxemani quyidagi sodda ko‘rinishda ifodalaymiz.



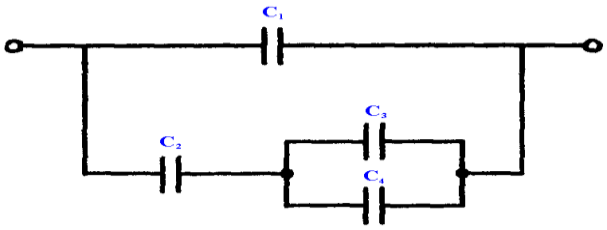
Sxemadan ko‘rinib turibdiki uchala sig‘imlar ham parallel ulangan (5) formuladan foydalanib, hisoblashlar olib boramiz.

$$C_{Um} = C + C + C = 3C \rightleftarrows; C_{Um} = 3C$$

5. Sxemaning umumiy sig‘imini hisoblang.($C_1 = C_2 = C_3 = C_4 = C$)



Sxemani quyidagi sodda ko‘rinishda ifodalaymiz



Sxemadan ko‘rinib turibdiki C_3 va C_4 sig‘imlar parallel ulangan

$$C_{34} = C_3 + C_4 = C + C = 2C$$

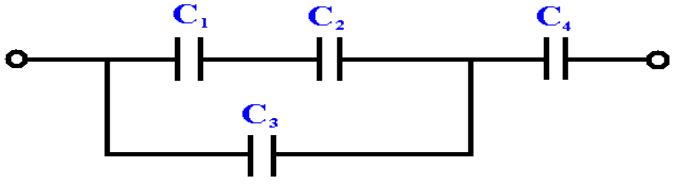
C_{34} sig‘im C_2 sig‘imga ketma-ket ulangan.

$$\frac{1}{C_{234}} = \frac{1}{C_2} + \frac{1}{C_{34}} = \frac{1}{C} + \frac{1}{2C} = \frac{3}{2C}; C_{234} = \frac{2}{3}C$$

C_{234} sig‘im C_1 sig‘imlar parallel ulangan

$$C_{Um} = C_1 + C_{234} = C + \frac{2}{3}C = \frac{5}{3}C; C_{Um} = \frac{5}{3}C$$

6. Sxemaning umumiy sig‘imini hisoblang. ($C_1 = C_2 = C_3 = C_4 = C$)



Sxemadan ko‘rinib turibdiki C_2 va C_2 sig‘imlar ketma-ket ulangan

$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}; C_{12} = \frac{C}{2}.$$

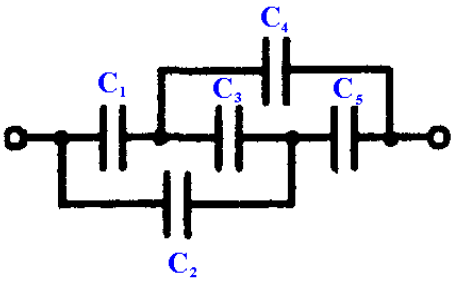
C_{12} sig‘im C_3 sig‘imlar parallel ulangan

$$C_{123} = C_{12} + C_3 = \frac{C}{2} + C = \frac{3}{2}C$$

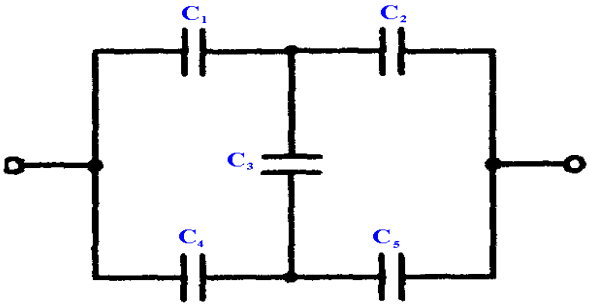
C_{123} sig‘im C_4 sig‘imga ketma-ket ulangan.

$$\frac{1}{C_{Um}} = \frac{1}{C_4} + \frac{1}{C_{123}} = \frac{1}{C} + \frac{2}{3C} = \frac{5}{3C} \rightarrow C_{Um} = \frac{3}{5}C$$

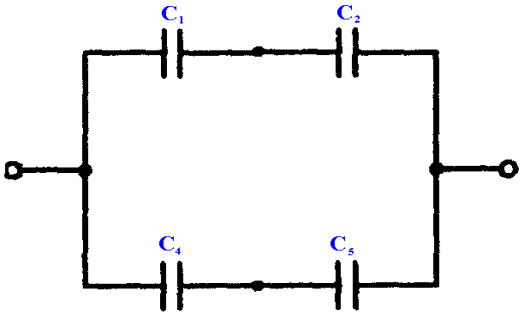
7. Sxemaning umumiy sig‘imini hisoblang.($C_1 = C_2 = C_3 = C_4 = C_5 = C$)



Ushbu sxemani quyidagi sodda ko‘rinishdagi sxema orqali ifodalaymiz



Shunga o‘xshash sxemalar uchun quyidagi formula doimo o‘rinlidir. Agar $\frac{C_1}{C_4} = \frac{C_2}{C_5}$ nisbat teng bo‘lganda C_3 sig‘imda potensiallar farqi 0 ga teng bo‘ladi. Shuning uchun C_3 sig‘imni sxemadan olib tashlaymiz.

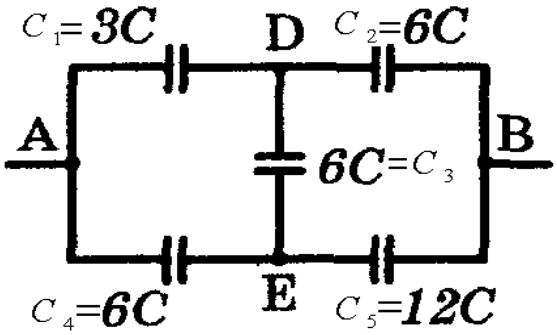


Sxemadan ko‘rinib turibdiki C_1 va C_2 sig‘imlar hamda C_4 va C_5 sig‘imlar ketma-ket ulangan. C_{12} sig‘im C_{45} sig‘imlar parallel ulangan.

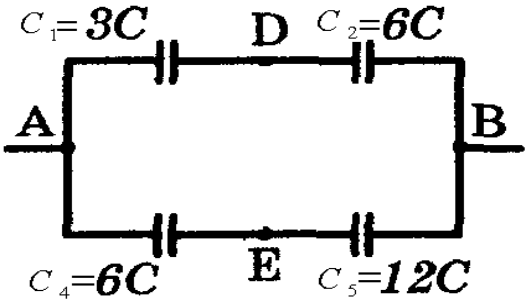
$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{12} = \frac{C}{2}; \frac{1}{C_{45}} = \frac{1}{C_4} + \frac{1}{C_5} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}$$

$$C_{45} = \frac{C}{2}: \quad C_{Um} = C_{12} + C_{45} = \frac{C}{2} + \frac{C}{2} = C \rightarrow C_{Um} = C$$

8. Sxemaning umumiy sig‘imini hisoblang.?



Oldingi masalada aytganimizdek. $\frac{C_1}{C_4}=\frac{C_2}{C_5}$ nisbat teng bo‘lgan hollarda C_3 sig‘imda potensiallar farqi 0 ga teng bo‘ladi. Shuning uchun C_3 sig‘imni sxemadan olib tashlaymiz.



Sxemadan ko‘rinib turibdiki C_1 va C_2 sig‘imlar hamda C_4 va C_5 sig‘imlar ketma-ket ulangan. C_{12} sig‘im C_{45} sig‘imlar parallel ulangan.

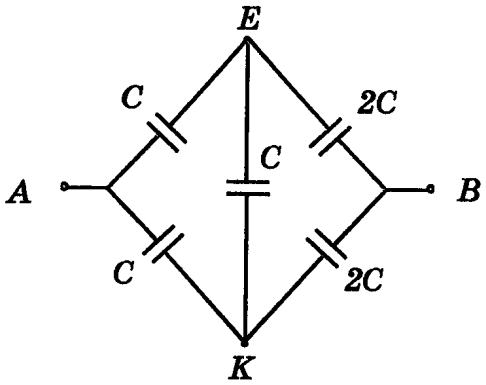
$$\frac{1}{C_{12}}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{3C}+\frac{1}{6C}=\frac{3}{6C}\rightarrow\ C_{12}=2C$$

$$\frac{1}{C_{45}}=\frac{1}{C_4}+\frac{1}{C_5}=\frac{1}{6C}+\frac{1}{12C}=\frac{3}{12C}$$

$$\rightarrow\ C_{45}=4C:\ C_{Um}=C_{12}+C_{45}=2C+4C=6C$$

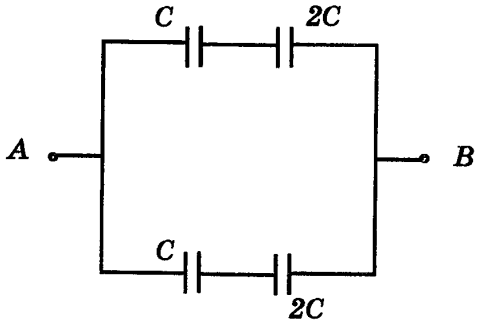
$$C_{Um}=6C$$

9. Sxemaning umumiy sig‘imini toping?



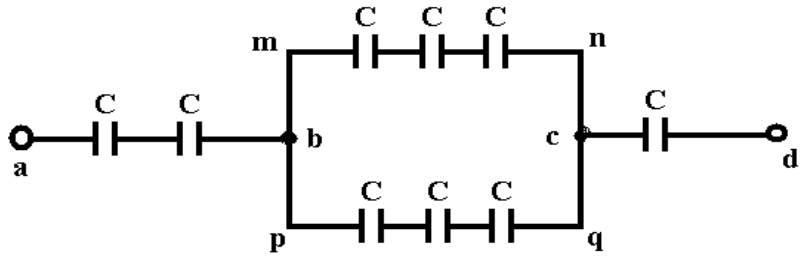
K va E nuqtalarda potensiallar farqi 0 ga tengligi uchun KE yo‘nalishda tok oqmaydi bu kondensator zaryadlanmaydi shuning uchun bu kondensatorni sxemadan olib tashlaymiz

($\frac{C}{C}=\frac{2C}{2C}$ teng bo‘lgani uchun ham yuqoridagi shart o‘rinlidir)



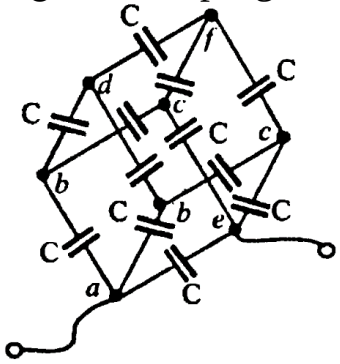
$$\frac{1}{C_{12}}=\frac{1}{C}+\frac{1}{2C}=\frac{3}{2C};C_{12}=\frac{2C}{3}:\frac{1}{C_{45}}=\frac{1}{C}+\frac{1}{2C}=\frac{3}{2C};$$
$$C_{45}=\frac{2C}{3}:\ C_{Um}=C_{12}+C_{45}=\frac{2C}{3}+\frac{2C}{3}=\frac{4C}{3};\ C_{Um}=\frac{4C}{3}$$

10. ad nuqta orasidagi umumiy sig‘imni toping?

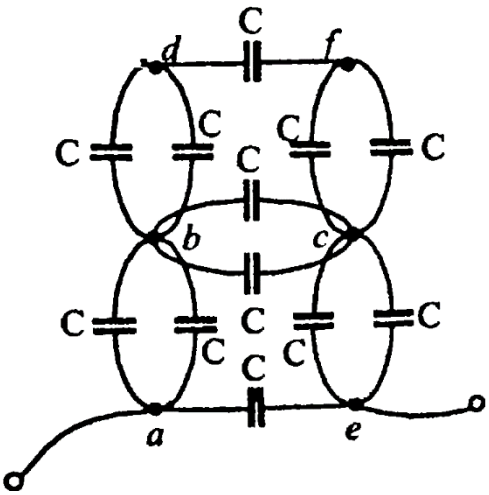


$$\frac{1}{C_{mn}}=\frac{1}{C}+\frac{1}{C}+\frac{1}{C}=\frac{3}{C}\rightarrow C_{mn}=\frac{C}{3}:\frac{1}{C_{pq}}=\frac{1}{C}+\frac{1}{C}+\frac{1}{C}=\frac{3}{C}\rightarrow C_{pq}=\frac{C}{3}:$$
$$C_{bc}=C_{mn}+C_{pq}=\frac{C}{3}+\frac{C}{3}=\frac{2C}{3};\frac{1}{C_{ab}}=\frac{1}{C}+\frac{1}{C}=\frac{2}{C}\rightarrow C_{ab}=\frac{C}{2}:$$
$$\frac{1}{C_{ad}}=\frac{1}{C_{ab}}+\frac{1}{C_{bc}}+\frac{1}{C_{cd}}=\frac{2}{C}+\frac{3}{2C}+\frac{1}{C}=\frac{9}{2C};C_{ad}=\frac{2C}{9}:$$

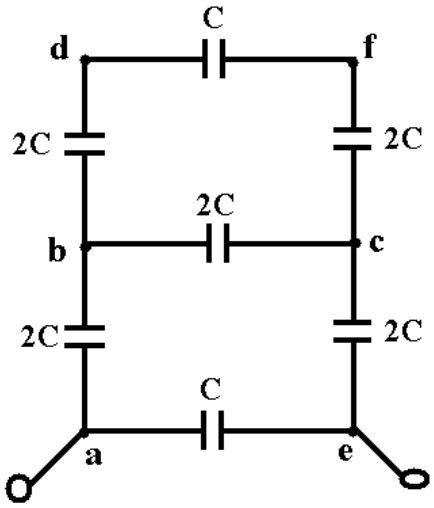
11. Sxemaning umumiy sig‘imini toping?



Sxemani quyidagicha soddalashtiramiz, ya’ni b va c nuqtalarni tutashtiramiz.



1-rasm.



1- rasmning soddalashgan ko‘rinishi.

$$\frac{1}{C_{bdfc}} = \frac{1}{2C} + \frac{1}{C} + \frac{1}{2C} = \frac{4}{2C}; C_{bdfc} = \frac{C}{2};$$

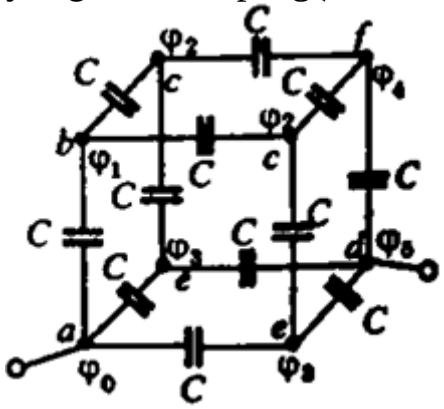
$$C_{bc} = C_{bdfc} + 2C = \frac{C}{2} + 2C = \frac{5C}{2}$$

$$\frac{1}{C_{abce}} = \frac{1}{C_{ab}} + \frac{1}{C_{bc}} + \frac{1}{C_{ce}} = \frac{1}{2C} + \frac{2}{5C} + \frac{1}{2C};$$

$$C_{abce} = \frac{10C}{14} = \frac{5C}{7}:$$

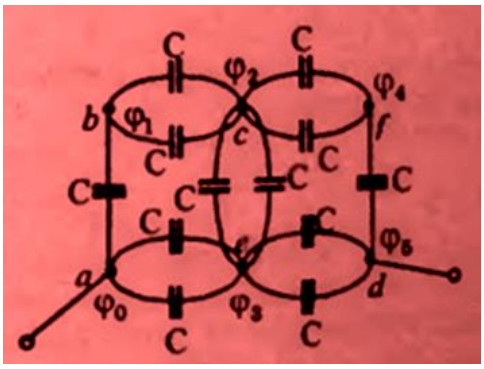
$$C_{ae} = C_{abce} + C = \frac{5C}{7} + C = \frac{12C}{7}$$

12. Sxemaning umumiy sig‘imini toping(1-rasm)?

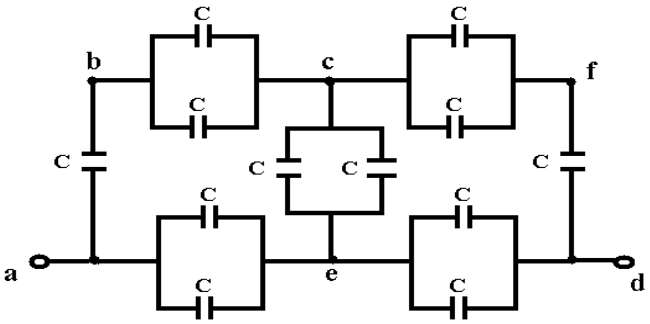


1-rasm.

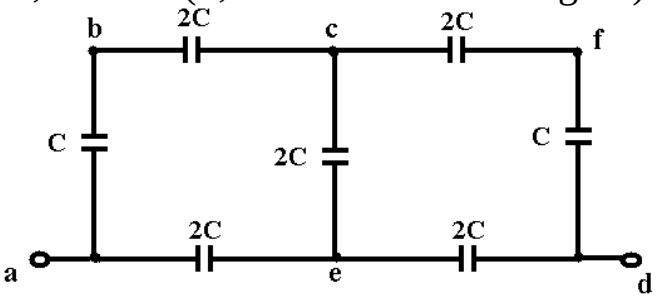
Sxemani quyidagicha soddalashtiramiz, ya’ni potensiallari bir xil bo‘lgan nuqtalarni ya’ni e va c nuqtalarni tutashtiramiz (1,1-rasm).



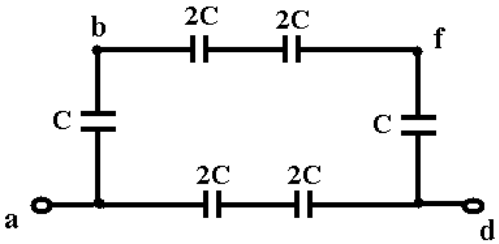
1,1-rasm.



1,2-rasm. (1,1-rasmni soddalashgani)



1,3-rasm. (1,2-rasmni soddalashgani)



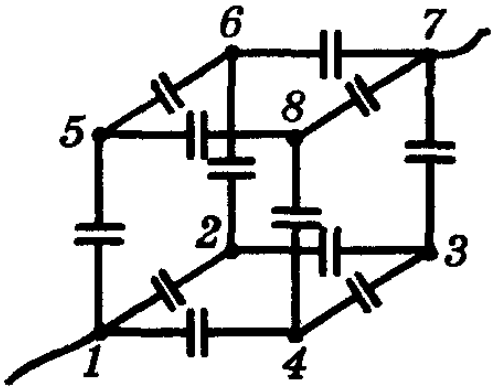
1,4-rasm. (1,3-rasmni soddalashgani)

1,3-rasmda $\frac{2C}{2C}=\frac{2C}{2C}$ nisbat teng bo‘lganligi uchun c va e nuqtalar potensiallari bir xil , potensiallar farqi 0 ga tengligi uchun ce nuqtalar orasidagi sig‘im orqali tok o‘tmaydi ya’ni bu sig‘im zaryadlanmaydi shuning uchun uni sxemadan olib tashladik(1,4-rasm).

$$\frac{1}{C_{bf}}=\frac{1}{2C}+\frac{1}{2C}=\frac{2}{2C};C_{bf}=C;\frac{1}{C_{abfd}}=\frac{1}{C}+\frac{1}{C}+\frac{1}{C}=\frac{3}{C};C_{abfd}=\frac{C}{3}$$

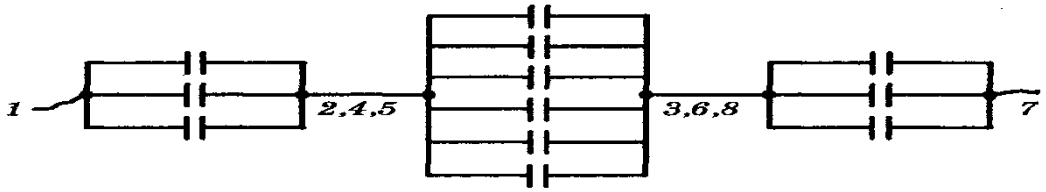
$$\frac{1}{C_{ad}}=\frac{1}{2C}+\frac{1}{2C}=\frac{2}{2C};C_{ad}=C;C_{um}=C_{abfd}+C_{ad}=\frac{C}{3}+C=\frac{4}{3}C,C_{um}=\frac{4}{3}C.$$

13. Sxemaning umumiy sig‘imini hisoblang.

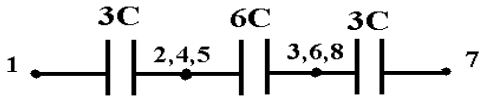


1-rasm.

Sxemani sodda ko‘rinishda ifodalaymiz ya’ni 2,4,5 va 3,6,8 nuqtalarni potensiallari bir xil bo‘lganligi uchun tutashtiramiz. (1,1-rasm).



1,1-rasm.

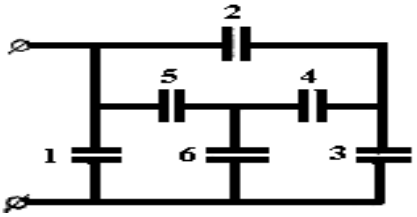


1,2-rasm.

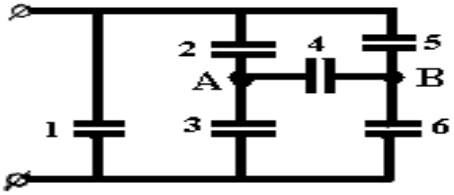
1,1-rasmdagi sxemaning parallel turgan sig‘imlarni hisoblasak, 1,2-rasmdagi sodda sxema hosil bo‘ladii.

$$\frac{1}{C_{Um}}=\frac{1}{3C}+\frac{1}{6C}+\frac{1}{3C}=\frac{5}{6C};C_{Um}=\frac{6}{5}C=1{,}2C.$$

14. Rasmda tasvirlangan sxemaning umumiy sig‘imini toping.Har bir kondensatorning sig‘imi C ga teng(1-rasm).



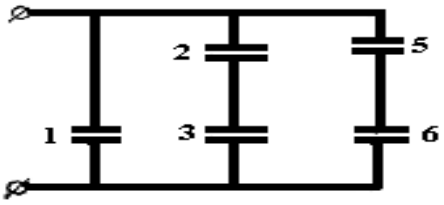
1-rasm.



1,1-rasm.

1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz.

Hamma kondensatorlarning sig‘imi birday bo‘lgani tufayli A va B nuqtalar orasidagi potensiallar farqi nolga teng, C_4 kondensator hamma vaqt zaryadlanmagan bo‘ladi va sxema ancha soddalashadi (1,2-rasm).

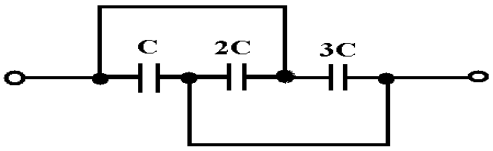


1,2-rasm.

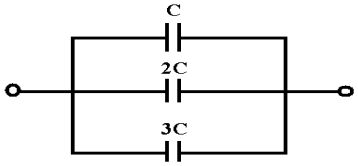
$$C_{23} = \frac{C_2 \cdot C_3}{C_2 + C_3} = \frac{C}{2}; C_{56} = \frac{C_5 \cdot C_6}{C_5 + C_6} = \frac{C}{2};$$

$$C_{Umum} = C_1 + C_{23} + C_{56} = C + \frac{C}{2} + \frac{C}{2} = 2C$$

15. Sxemalarning umumiy sig‘imini toping(1-rasm)?



1-rasm.

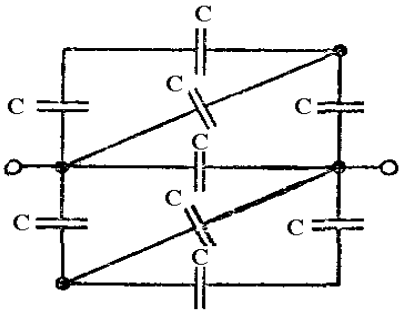


1,1-rasm.

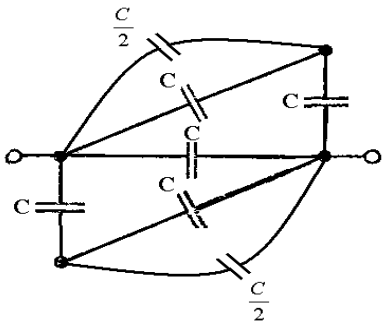
1-rasmni murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz(1,1-rasm) va hisoblaymiz.

$$C_{Um} = C + 2C + 3C = 6C$$

16. Sxemalarning umumiy sig‘imini toping(1-rasm)?

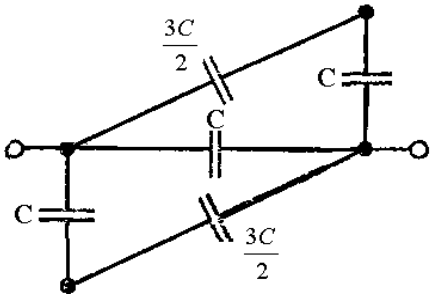


1-rasm.

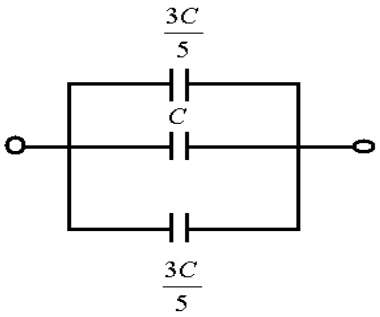


1,1-rasm.

1-rasmdagi sxemaning ikki burchagidagi sig‘imlarni ketma-ket ulasak sxemamiz 1,1-rasm kabi soddalashadi. 1,1-rasmdagi C va C/2 sig‘imlarni parallel ulasak, 1,2-rasmdagi sxema hosil bo‘ladi. 1,2-rasmdagi 3C/2 va C sig‘imni ketma-ket ulasak 1,3-rasm hosil bo‘ladi.



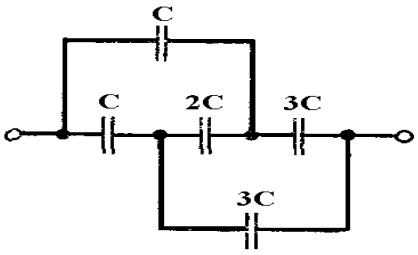
1,2-rasm.



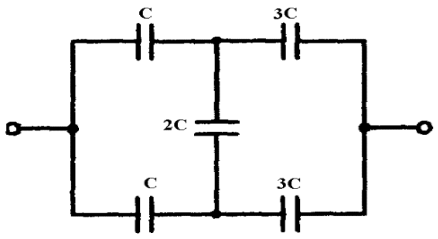
1,3-rasm.

1,3-rasmdan umumiy sig‘imni topamiz. $C_{Um} = \frac{3C}{5} + C + \frac{3C}{5} = \frac{11C}{5}$

17. Sxemalarning umumiy sig‘imini toping(1-rasm)?

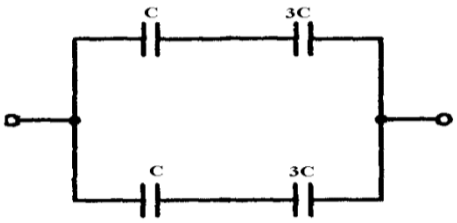


1-rasm.

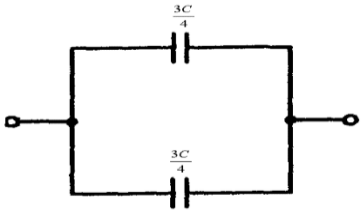


1,1-rasm.

1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz. $\frac{C}{C} = \frac{3C}{3C}$ Nisbatlar tengligi uchun 2C kondensator uchlaridagi potensiallar teng, potensiallar farqi esa nolga teng bo‘ladi va bu kondensator zaryadlanmaydi shuning uchun uni sxemadan olib tashlaymiz(1,2-rasm). 1,2-rasmdagi C va 3C kondensatorlarni ketma-ket ulasak 1,3-rasmdagi sxema hosil bo‘ladi.



1,2-rasm

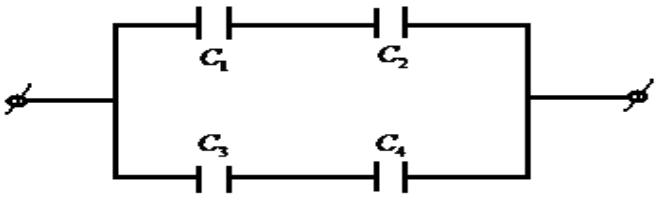


1,3-rasm

1,3-rasmdagi sxemadan umumiy qarshilikni topamiz.

$$C_{Um} = \frac{3C}{4} + \frac{3C}{4} = \frac{6C}{4} = 1{,}5C$$

18. Sig‘imlari $C_1\ 3mkF, C_2 = 5mkF, C_3 = 6mkF, va\, C_4 = 5mkF$ bo‘lgan to‘rtta kondensator rasmga ko‘rsatilgan sxema bo‘yicha ulangan. Hosil bo‘lgan kondensatorlar batareyasining sig‘imini anaqlang.



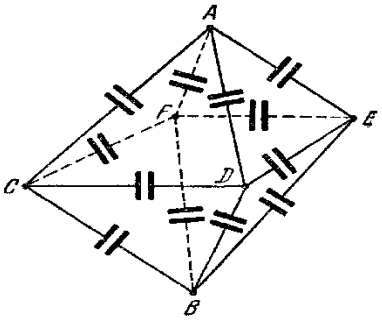
1 bilan 2, 3 bilan 4-kondensatorlar ketma-ket, chiqqan natija parallel ulasak umumiy sig‘im hosil bo‘ladi.

$$\frac{1}{C_{1.2}}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{3}+\frac{1}{6}=\frac{3}{6};\frac{1}{C_{1.2}}=\frac{3}{6}=\frac{1}{2}\rightarrow C_{1.2}=2mkF$$

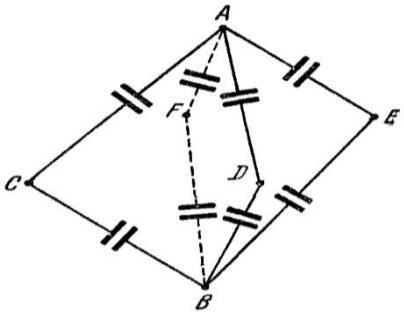
$$\frac{1}{C_{3.4}}=\frac{1}{C_3}+\frac{1}{C_4}=\frac{1}{5}+\frac{1}{10}=\frac{3}{10};\frac{1}{C_{3.4}}=\frac{3}{10}\rightarrow C_{3.4}=\frac{10}{3}mkF$$

$$C_{Um}=C_{1.2}+C_{3.4}=2+\frac{10}{3}=\frac{16}{3}mkF\rightarrow C_{Um}=\frac{16}{3}mkF$$

19. Har birining sig‘imi C bo‘lgan o‘n ikkita bir xil kondensator ACD EFB sakkiz yoq ko‘rinishida batareya qilib yig‘ilgan.Bu kondensatorlar batareyasining A va B nuqtalari orasidagi sig‘im qanday(1-rasm)?

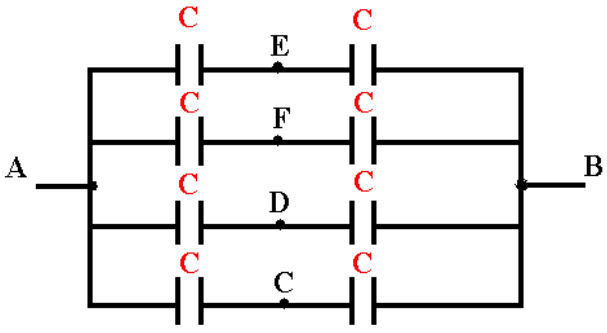


1-rasm.

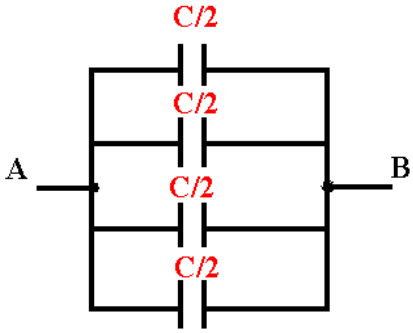


1,1-rasm.

C,D,E va F nuqtalarning potensiallari tengligi batareyaning simmetrikligidan ma’lum. Demak potensiallar farqi nolga teng,bu nuqtalar orasiga ulangan kondensatorlar zaryadlanmaydi . C,D,F,E nuqtalar orasidagi sig‘imini hisoblashda bu kondensatorlarni hisobga olmasa bo‘ladi. Unda batareya quyidagi ko‘rinishga keladi(1,1-rasm). 1,1-rasmdagi murakkab sxemani quyidagi sodda ko‘rinishga o‘tamiz(1,2-rasm)



1,2-rasm.

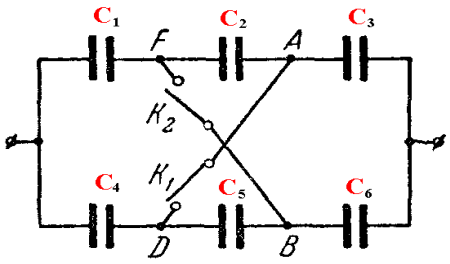


1,3-rasm.

1,2-rasmdagi C va C kondensatorlarni ketma-ket ulasak 1,3-rasm hosil bo‘ladi. 1,3-rasmdan umumiy sig‘imni topamiz.

$$C_{AB} = \frac{C}{2} + \frac{C}{2} + \frac{C}{2} + \frac{C}{2} = 2C; C_{AB} = 2C$$

20. Quyidagi sxemada tasvirlangan kondensatorlar batareyasi bir xil sig‘imli kondensatorlardan tuzilgan(1-rasm). Agar K_1 va K_2 kalitlar ulansa, batareyaning umumiy sig‘imi necha marta o‘zgaradi?($C_1 = C_2 = C_3 = C_4 = C_5 = C_6 = C$)



1-rasm.

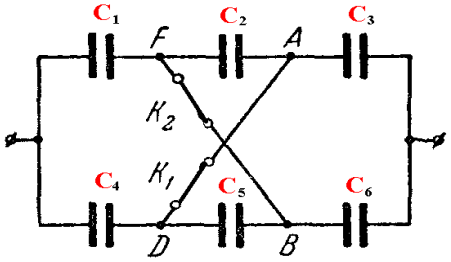
Kalit ulangunga qadar batareyaning umumiy sig‘imi

$$\frac{1}{C_{123}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} = \frac{3}{C}; C_{123} = \frac{C}{3}:$$

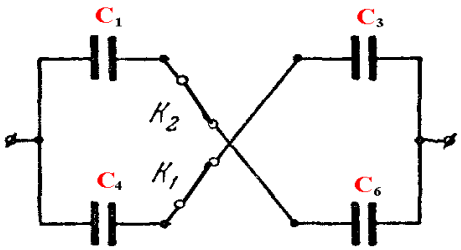
$$\frac{1}{C_{456}} = \frac{1}{C_4} + \frac{1}{C_5} + \frac{1}{C_6} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} = \frac{3}{C}; C_{456} = \frac{C}{3}:$$

$$C_{Um} = \frac{C}{3} + \frac{C}{3} = \frac{2C}{3}:$$

Kalitlar ulangunga qadar batareyaning umumiy sig‘imi $C_{Um} = \frac{2C}{3}$ ni tashkil qiladi.



2-rasm



2,1-rasm

Kalitlar ulangandan keyin hosil bo‘lgan sxemani ko‘ramiz(2-rasm). C_2 va C_5 kondensatorlarni ikki uchu sim bilan tutashtirib qo‘yilganligi uchun ular zaryadlanmaydi shuning uchun ularni sxemadan olib tashlaymiz(2,1-rasm).

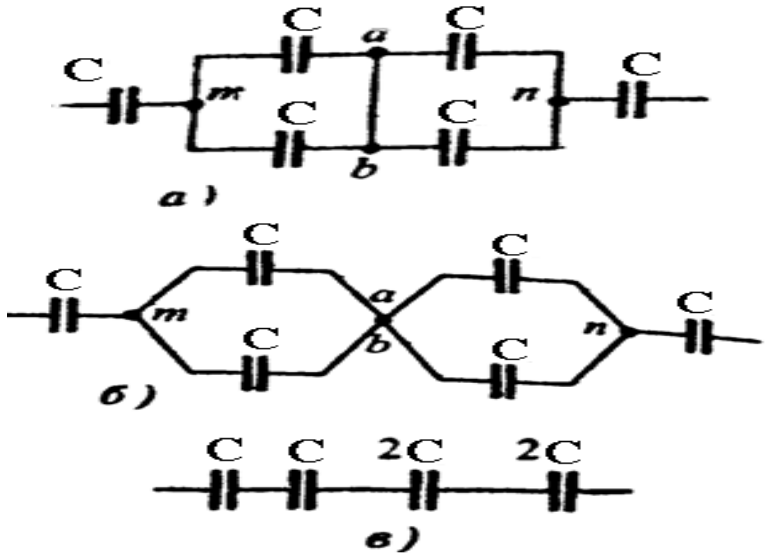
2,1-rasmdagi C_1 bilan C_4 va C_3 bilan C_6 ni parallel, chiqqan natijalarni ketma-ket ulaymiz.

$$C_{14} = C_1 + C_4 = 2C; C_{36} = C_3 + C_6 = 2C; \frac{1}{C_{Um}} = \frac{1}{C_{14}} + \frac{1}{C_{36}} = \frac{1}{2C} + \frac{1}{2C}; \rightarrow C_{Um} = C$$

Javob: 1,5marta ortadi

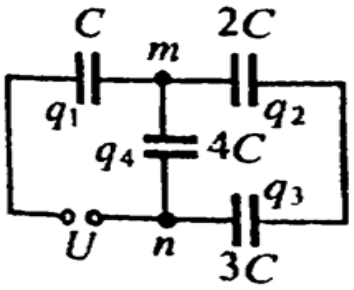
21. Sxemaning umumiy sig‘imini toping?

Masalani yechish uchun a rasmdagi sxemani ab nuqtalar orasida kondensator yo‘qligi uchun bu nuqtalarni birlashtirsak б rasm hosil bo‘ladi. б rasmdagi C va C kondensatorlarni parallel ulasak в rasmdagi soddalashgan sxema hosil bo‘ladi va umumiy sig‘imni topamiz.

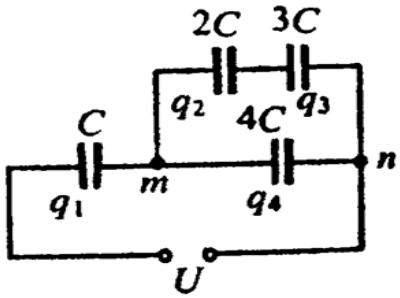


$$\frac{1}{C_{Um}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{2C} + \frac{1}{2C} = \frac{6}{2C} = \frac{3}{C}; C_{Um} = \frac{C}{3}$$

22. Berilgan sxemada C=0,2nF manbaning kuchlanishi 200V bo‘lsa har bir kondensatorda to‘planadigan zaryadni aniqlang. (1-rasm)



1-rasm.



1,1-rasm.

1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz. 1,1rasmdan ko‘rinib turibdiki 2C va 3C sig‘imli kondensatorlar o‘zaro ketma-ketligi uchun ulardagi zaryadlar bir-xil $q_2 = q_3$ birinchi kondensator manbaga ketma-ket ulanganligi uchun $q_1 = C_{Um} \cdot U = q_2 + q_4$

$$C_{23}=\frac{2C\cdot 3C}{2C+3C}=\frac{6C}{5};C_{234}=C_{23}+C_4=\frac{6C}{5}+4C=\frac{26C}{5};$$
$$\frac{1}{C_{Um}}=\frac{1}{C_{234}}+\frac{1}{C_1}=\frac{5}{26C}+\frac{1}{C}=\frac{31}{26C};C_{Um}=\frac{26C}{31};$$
$$q_1=C_{Um}\cdot U=\frac{26}{31}\cdot 0{,}2\cdot 10^{-9}\cdot 200=\frac{1040}{31}\cdot 10^{-9}=34\cdot 10^{-9}kl=34nkl$$

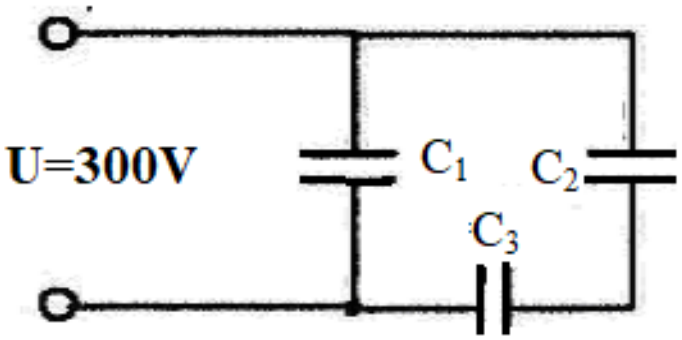
Parallel ulanganda kuchlanishlar tengligidan foydalanamiz

$$U_{23}=U_4;U_{23}=\frac{q_2}{C_{23}};(q_2=q_3)U_4=\frac{q_3}{C_4}$$
$$\frac{q_2}{C_{23}}=\frac{q_4}{C_4};\frac{5q_2}{6C}=\frac{q_4}{4C};\frac{5}{6}q_2=\frac{q_4}{4};q_4=\frac{10}{3}q_2$$

$q_1=C_{Um}\cdot U=q_2+q_4$ ushbu formulaga asosan

$$q_1=C_{Um}\cdot U=q_2+q_4=q_2+\frac{10}{3}q_2=\frac{13}{3}q_2;q_2=\frac{3}{13}q_1$$
$$q_2=\frac{3}{13}\cdot 34\cdot 10^{-9}=7{,}8\cdot 10^{-9}kl;q_3=q_2=7{,}8\cdot 10^{-9}kl=7{,}8nkl$$
$$q_4=\frac{10}{3}q_2=\frac{10}{3}\cdot 7{,}8\cdot 10^{-9}=26\cdot 10^{-9}kl=26nkl$$

23. Rasmda tasvirlangan zanjirda to‘plangan elektr energiyasi topilsin (J). $C_1=C_3=40$ μF, $C_2=20$ μF.



$$\frac{1}{C_{23}}=\frac{1}{C_2}+\frac{1}{C_3}=\frac{1}{20}+\frac{1}{40}=\frac{3}{40};C_{23}=\frac{40}{3}\mu F$$
$$C_{um}=C_1+C_{23}=40+\frac{40}{3}=\frac{160}{3}\mu F=\frac{160}{3}\cdot 10^{-6}F$$
$$W=\frac{C_{um}\cdot U^2}{2}=\frac{\frac{160}{3}\cdot 10^{-6}\cdot 300^2}{2}=\frac{160\cdot 10^{-6}\cdot 90000}{6}=2{,}4J$$

OLIY O‘QUV YURTLARIGA KIRUVCHILAR UCHUN VARIANT VA AXBOROTNOMALAR TO‘PLAMIDAN NAMUNALAR

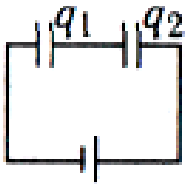
Kondensatorlarni ketma-ket ulash formulasi

$$\frac{1}{C_{Um}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots \frac{1}{C_n}$$

Kondensatorlarni parallel ulash formulasi

$$C_{Um} = C_1 + C_2 + C_3 + \ldots C_n$$

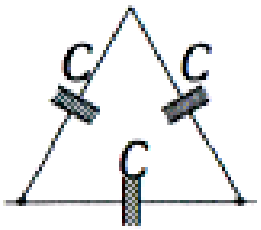
02/7-60. Sxemadagi kondensatorlar qoplamalaridagi zaryadlarning nisbati q_1/q_2 qanday?



Kondensatorlarni ketma-ket ulashda barcha kondensatordagi zaryadlar o‘zgarmas bo‘ladi ya’ni $q_{um} = q_1 = q_2 = q_3 = \ldots = q_n$ shuning uchun

$$q_1 = q_2; \quad \frac{q_1}{q_2} = 1$$

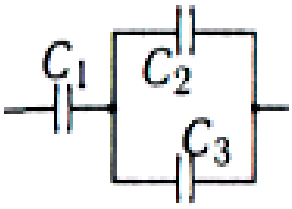
98/11-33. Rasmda tasvirlangan kondensatorlar batareyasining umumiy sig‘imini aniqlang.



1-ishimiz 2 ta kondensatorni ketma-ket ulaymiz, chiqqan natijani C ga parallel ulaymiz.

$$\frac{1}{C'} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}; C' = \frac{C}{2}; C_{um} = C' + C = \frac{C}{2} + C = \frac{3C}{2} = 1{,}5C.$$

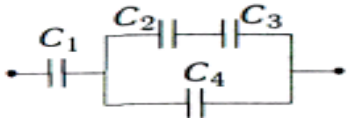
03/6-26. Sig‘imlari C_1=3 μF, C_2=12 μF va C_3=30 μF bo‘lgan uchta kondensator rasmdagi sxema bo‘yicha ulangan. Umumiy sig‘im qanday (μF)?



$$C_{23} = C_2 + C_3 = 12 + 30 = 42mkF;$$

$$\frac{1}{C_{um}}=\frac{1}{C_{23}}+\frac{1}{C_1}=\frac{1}{42}+\frac{1}{3}=\frac{1}{42}+\frac{14}{42}=\frac{15}{42}\rightarrow C_{um}=\frac{42}{15}=2{,}8mkF$$

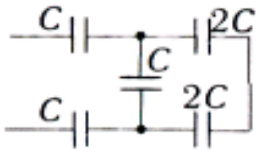
98/12-44. Kondensatorlar batareyasining umumiy sig‘imini toping. $C_1=C_2=C_3=C_4=C$.



$$\frac{1}{C_{23}}=\frac{1}{C_2}+\frac{1}{C_3}=\frac{1}{C}+\frac{1}{C}=\frac{2}{C}\rightarrow C_{23}=\frac{C}{2};C_{234}=C_{23}+C_4=\frac{C}{2}+C=\frac{3}{2}C$$

$$\frac{1}{C_{um}}=\frac{1}{C_1}+\frac{1}{C_{234}}=\frac{1}{C}+\frac{2}{3C}=\frac{5}{3C}\rightarrow C_{um}=\frac{3}{5}C=0{,}6C$$

98/7-37. Rasmda ko‘rsatilgan sxemadagi kondensatorlar batareyasining umumiy sig‘imini toping.

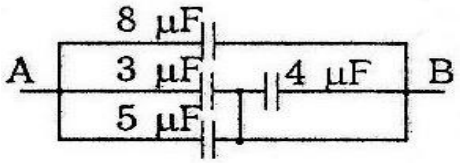


$$\frac{1}{C_{12}}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{2C}+\frac{1}{2C}=\frac{2}{2C}\rightarrow C_{12}=C;C_{123}=C_{12}+C_3=C+C=2C$$

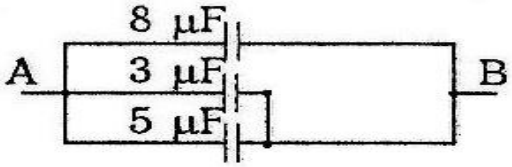
$$\frac{1}{C_{um}}=\frac{1}{C_{123}}+\frac{1}{C_4}+\frac{1}{C_5}=\frac{1}{2C}+\frac{1}{C}+\frac{1}{C}=\frac{5}{2C}\rightarrow C_{um}=\frac{2}{5}C=0{,}4C$$

96/15-94. A va B nuqtalar orasidagi umumiy sig‘im qanday (μF)?

$$C_1=8\mu F;C_2=3\mu F;C_3=5\mu F$$



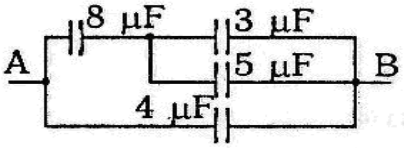
Sig‘imi $4\mu F$ bo‘lgan kondensator joylashgan tomonga tok o‘tmaydi.Shuning uchun $4\mu F$ kondensatorni inobatga olmaymiz.



$$C_{AB}=C_1+C_2+C_3;C_{AB}=8+3+5=16\mu F$$

96/3-25. A va B nuqtalar orasidagi umumiy sig im qanday (μF)?

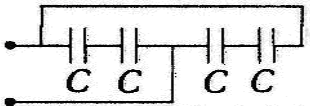
$C_1=3\mu F;C_2=5\mu F;C_3=8\mu F;C_4=4\mu F$



$$C_{12}=C_1+C_2=3+5=8\mu F;\frac{1}{C_{123}}=\frac{1}{C_{12}}+\frac{1}{C_3}=\frac{1}{8}+\frac{1}{8}=\frac{2}{8}$$

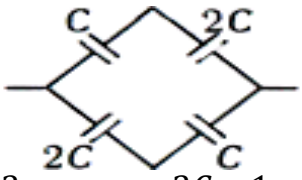
$$C_{123} = \frac{8}{2} = 4\mu F; C_{AB} = C_{123} + C_4 = 4 + 4 = 8\mu F$$

98/4-54. Keltirilgan sxemadagi kondensatorlar batareyasining umumiy sig‘imini aniqlang.



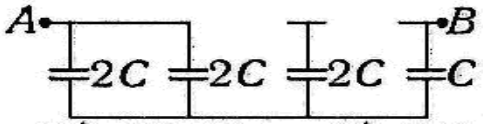
$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{12} = \frac{C}{2}; \frac{1}{C_{34}} = \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow$$
$$\rightarrow C_{34} = \frac{C}{2}; C_{AB} = C_{12} + C_{34} = \frac{C}{2} + \frac{C}{2} = C$$

96/3-90. Rasmda tasvirlangan kondensatorlar batareyasining umumiy sig‘imi qanday?

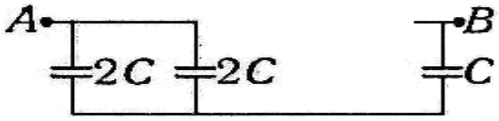


$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{2C} = \frac{3}{2C} \rightarrow C_{12} = \frac{2C}{3}; \frac{1}{C_{34}} = \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{2C} + \frac{1}{C} = \frac{3}{2C} \rightarrow$$
$$\rightarrow C_{34} = \frac{2C}{3}; C_{AB} = C_{12} + C_{34} = \frac{2C}{3} + \frac{2C}{3} = \frac{4C}{3}$$

97/9-30. Rasmda tasvirlangan kondensatorlar batareyasining umumiy sig‘imini aniqlang. $C_1 = C_2 = C_2 = 2C; C_3 = C$

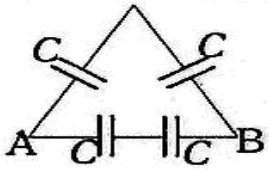


O‘rtadagi kondensatorning oxiri ochiq bo‘lganligi uchun undan tok o‘tmaydi shuning uchun sxemadan bu kondensatorni olib tashlaymiz va quyidagi ko‘rinishni egallaydi



$$C_{12} = C_1 + C_2 = 2C + 2C = 4C; \frac{1}{C_{AB}} = \frac{1}{C_{12}} + \frac{1}{C_3} = \frac{1}{4C} + \frac{1}{C} = \frac{5}{4C} \rightarrow C_{AB} = \frac{4}{5}C$$

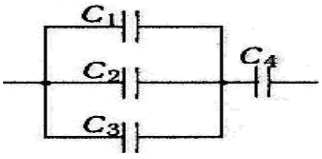
00/2-44. A va B nuqtalar orasidagi umumiy sig‘im qanday?



$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{12} = \frac{1}{2}C; \frac{1}{C_{34}} = \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}$$

$$C_{34} = \frac{1}{2}C; \quad C_{AB} = \frac{1}{2}C + \frac{1}{2}C = C$$

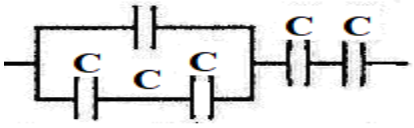
00/1-26. Rasmda ko‘rsatilgan konden satorlar batareyasining umumiy sig‘imi qanday (μF)? $C_1=C_2=C_3=2\mu F$, $C_4=3\mu F$.



$$C_{123} = C_1 + C_2 + C_3 = 2 + 2 + 2 = 6\mu F; \frac{1}{C_{um}} = \frac{1}{C_{123}} + \frac{1}{C_4} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{3}{6}$$

$$C_{um} = \frac{6}{3} = 2\mu F$$

96/10-37. Rasmda tasvirlangan elektr zanjirdagi kondensatorlarning umumiy sig‘imi qanday?

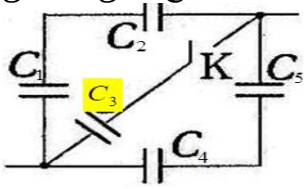


$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{12} = \frac{C}{2}; C_{123} = C_{12} + C_3 = \frac{C}{2} + C = \frac{3}{2}C$$

$$\frac{1}{C_{45}} = \frac{1}{C_4} + \frac{1}{C_5} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{45} = \frac{C}{2}; \frac{1}{C_{um}} = \frac{1}{C_{123}} + \frac{1}{C_{45}} = \frac{2}{3C} + \frac{2}{C} = \frac{8}{3C} \rightarrow$$

$$\rightarrow C_{um} = \frac{3}{8}C$$

98/6-41. Keltirilgan sxemadagi bir xil kondensatorlar batareyasining K kalit ulanmagandagi va ulangandagi sig‘imlari nisbatini toping.



a holat kalit ulanmagan bo‘lsa C_3 ni olib tashlaymiz

b holat kali

$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{12} = \frac{C}{2}; \frac{1}{C_{45}} = \frac{1}{C_4} + \frac{1}{C_5} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \rightarrow C_{45} = \frac{C}{2}$$

$$C_a = C_{12} + C_{45} = \frac{C}{2} + \frac{C}{2} = C$$

t ulangan bo‘lsa C_3 ni inobatga olamiz

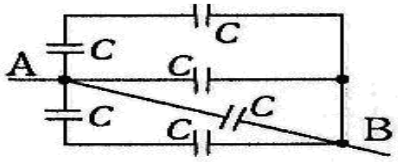
$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}; C_{12} = \frac{C}{2}$$

$$\frac{1}{C_{45}} = \frac{1}{C_4} + \frac{1}{C_5} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}; C_{45} = \frac{C}{2}$$

$$C_b = C_{12} + C_3 + C_{45} = \frac{C}{2} + C + \frac{C}{2} = 2C$$

$$\frac{C_a}{C_b} = \frac{C}{2C} = \frac{1}{2}$$

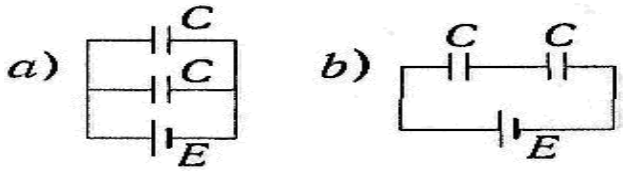
99/7-23. Quyidagi sxemaning umumiy sig‘imi qanday?



$$\frac{1}{C_{12}}=\frac{1}{C_1}+\frac{1}{C_2}=\frac{1}{C}+\frac{1}{C}=\frac{2}{C}\rightarrow C_{12}=\frac{C}{2};\frac{1}{C_{56}}=\frac{1}{C_5}+\frac{1}{C_6}=\frac{1}{C}+\frac{1}{C}=\frac{2}{C}\rightarrow C_{56}=\frac{C}{2}$$

$$C_{um}=C_{12}+C_3+C_4+C_{56}=\frac{C}{2}+C+C+\frac{C}{2}\rightarrow C_{um}=3C$$

98/6-39. a sxemadan b sxemaga o‘tganda, bitta kondensatordagi zaryad qanday o‘zgaradi?



Elektr zaryadni topish uchun bizga umumiy sig‘im va kuchlanish yoki kuchlanganlik kerak bo‘ladi.$C=\frac{q}{U}=\frac{q}{\varepsilon}$ formuladan zaryadni topsak $q=C\cdot\varepsilon$ formulaga ega bo‘lamiz . a-holat va b-holat uchun umumiy sig‘imlarni topib zaryadlar nisbatini olamiz.

a-holat sig‘imlarni parallel ulaymiz $C_{um}=C_1+C_2=C+C=2C;q_a=2C\cdot\varepsilon$

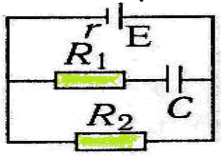
b-holat ketma-ket ulashda zaryad 1 va 2- kondensatorda ham bir xil bo‘ladi

$$q_{ket-ket}=q_1=q_2=q_3=\ldots=q_nq_b=C\cdot\varepsilon$$

Har ikkala holatda chiqqan natijalarni nisbat olamiz $\frac{q_b}{q_a}=\frac{C\cdot\varepsilon}{2C\cdot\varepsilon}$ bir xil hadlarni qisqartirsak $\frac{q_b}{q_a}=\frac{1}{2}$natijaga ega bo‘lamiz ya’ni b-holatga o‘tganida zaryad 2 marta kamayar ekan

01/2-45. Kondensator zaryadini toping. (μC)

$\varepsilon=2{,}2V,r=1\Omega,R_1=R_2=10\Omega,C=5\mu F$



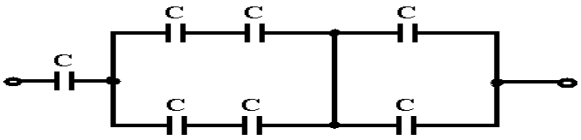
Kondensatorning zaryadini toppish uchun bizlarga kerakli kattaliklar yetarli emas ya’ni kuchlanish berilmagan.Kuchlanishni toppish uchun esa tok kuchi kerak bo‘ladi. Tok kuchini topishham, kuchlanishni topishdaham R_2 qarshilikni etiborga olmaymiz chunki kondensator R_1 qarshilik bilan ketma-ket ulangan.

$$I=\frac{\varepsilon}{R_1+r}=\frac{2{,}2}{10+1}=0{,}2A;U=I\cdot R_1=0{,}2\cdot 10=2V;$$

$$C=\frac{q}{U}\rightarrow q=C\cdot U=5\mu F\cdot 2V=10\mu C$$

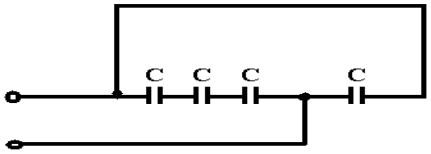
KONDENSATORLARNI ARALASH ULASHGA DOIR MUSTAQIL YECHISH UCHUN MASALALAR

1. Sxemalarning umumiy sig‘imini toping?



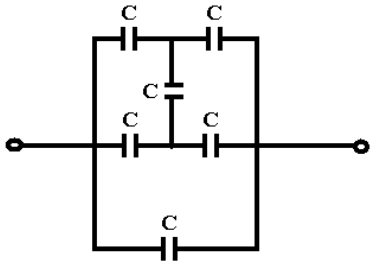
Javob: C_{Um}= 0,4C

2. Sxemalarning umumiy sig‘imini toping?



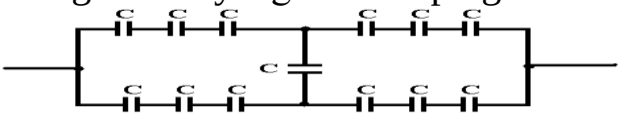
Javob: $C_{Um} = \frac{4}{3}C$

3. Sxemalarning umumiy sig‘imini toping?



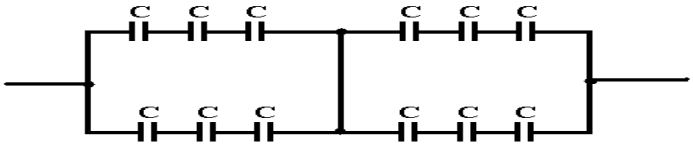
Javob: $C_{Um} = 2C$

4. Sxemalarning umumiy sig‘imini toping?



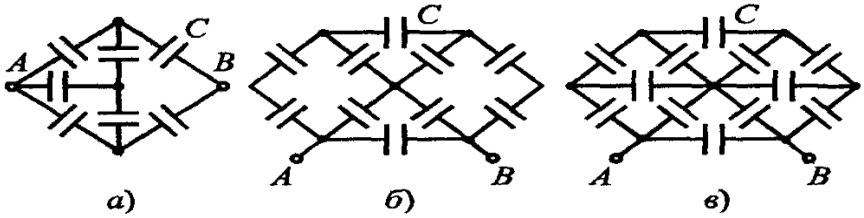
Javob: $C_{Um} = \frac{C}{3}$

5. Sxemalarning umumiy sig‘imini toping?



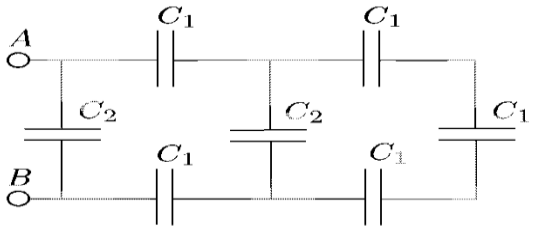
Javob: $C_{Um} = \frac{C}{3}$

6. A va B nuqta orasidagi umumiy sig‘imini toping?



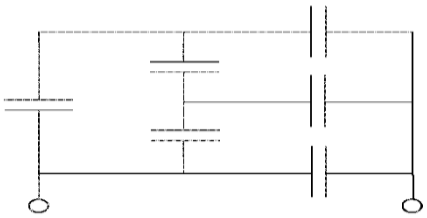
Javob: $arasmC_{AB} = \frac{8}{7}C; bvavrasmR_{AB} = \frac{12}{7}C$

7. Zanjirdagi umumiy sig‘imni toping? ($C_1 = 2mkF; C_2 = 1mkF$)



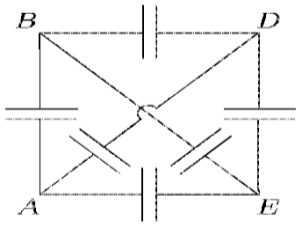
Javob: $C_{Um} = 1{,}62mkF$

8. Zanjirdagi umumiy sig‘imni toping? (Har-bir kondensator sig‘imi C)



Javob: $C_{Um} = 2C$

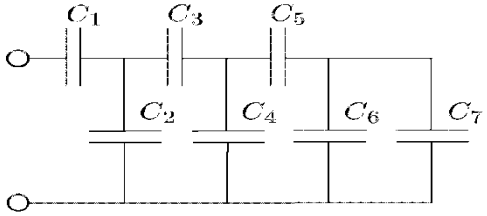
9. Rasmda berilgan sxemaning A, D va A, E nuqtalar orasidagi umumiy sig‘imni toping? (barcha kondensatorlarning sig;imi C)



Javob: $C_{AD} = C_{AE} = 2C$

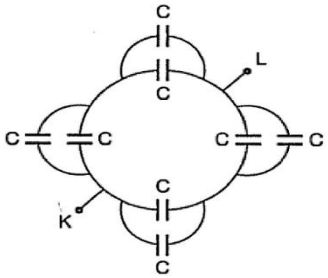
10. Sxemaning umumiy sig‘imini toping?

$$C_1 = C_2 = C_3 = C_4 = C_5 = C, C_6 = C_7 = C/2$$



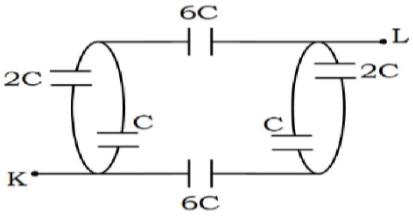
Javob: $C_{Um} = \frac{8}{13}C$

11. Quyidagi sxemaning K-L oraliqdagi umumiy sig‘im qanday?



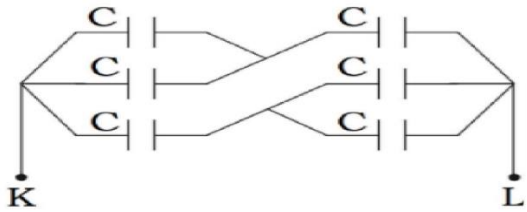
D) 2C. Javob: $C_{KL} = 2C$

12. Quyidagi sxemaning K-L oraliqdagi umumiy sig‘im qanday?



Javob: $C_{KL} = 4C$

13. Quyidagi sxemaning K-L oraliqdagi umumiy sig‘im qanday?



Javob: $C_{KL} = 4C/3$

ZANJIRNING BIR QISMI UCHUN VA TO‘LIQ ZANJIR UCHUN OM QONUNI, ELEKTR QARSHILIK, QARSHILIKLARNI KETMA-KET VA PARALLEL ULASH

Zanjirning bir qismi uchun Om qonuni:

O‘tkazgich bo‘ylab zaryadlarning harakatlanishi uchun o‘tkazgich uchlarida potensiallar farqining bo‘lishi, ya’ni o‘tkazgich ichida elektr maydon bo‘lishi kerak. O‘tkazgich uchlaridagi potensiallar farqi elektrostatikadan farqli ravishda kuchlanish deb ham yuritiladi va lotincha U harfi bilan belgilanadi.

O‘tkazgich uchlaridagi potensiallar ayirmasi yoki kuchlanish deb, bir birlik musbat zaryadni o‘tkazgich bo‘ylab ko‘chirishda o‘tkazgichdagi elektr maydoni kuchning bajargan ishiga miqdor jihatidan teng bo‘lgan fizik kattalikka aytiladi.

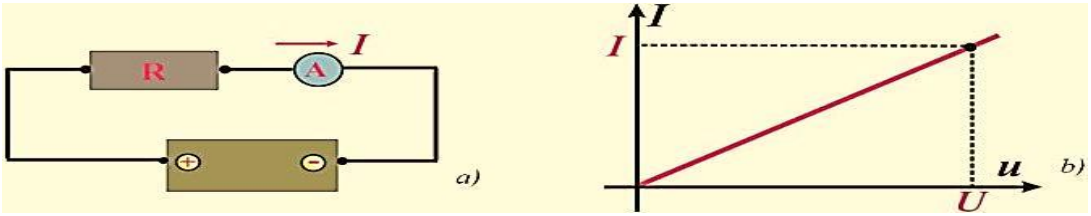
$$U = \frac{A}{q} \qquad (1)$$

O‘tkazgichdagi kuchlanish va tok kuchi orasidagi bog‘lanishni aniqlash bo‘yicha tajribalarni birinchi bo‘lib nemis fizigi 1826-yilda Om Georg Simono‘tkazgan.

Tajribagag ko‘ra o‘tkazgich qutblaridagi kuchlanishni asta-sekin oshirilganda tok kuchi ham kuchlanishga to‘g‘ri proporsional holda (I~U) oshib borgan (1- rasm). Shuning uchun koeffitsient kiritish orqali proporsionallikdan tenglikka o‘tildi.

$$I = GU \qquad (2)$$

Bu yerda: G- proporsionallik koeffitsienti bo‘lib, unga o‘tkazgichning o‘tkazuvchanligi deyiladi. O‘tkazuvchanlik qancha yaxshi bo‘lsa, ayni bir kuchlanishda o‘tkazgichdan shuncha katta tok o‘tadi.



1-rasm.

XBSda o‘tkazuvchanlikning birligi qilib simens (Sm) qa’bul qilingan. 1Sm o‘tkazuvchanlik deb, ushlarida 1V kuchlanish bo‘lganda 1A tok o‘tadigano‘tkazgichning o‘tkazuvchanligiga aytiladi. Odatda esa, amaliy hisoblashlarda o‘tkazuvchanlikka teskari bo‘lgan ifoda – o‘tkazgich qarshiligi ishlatiladi.

$$R = \frac{1}{G} \qquad (3)$$

Turli xil o‘tkazgichlar zanjirdan o‘tayotgan tokni turlicha cheklaydi yoki tokka turlicha qarshilik ko‘rsatadi. O‘tkazgich qarshiligi Om (Ω) larda o‘lchanadi. o‘tkazuvchanligi 1Sm bo‘lgano‘tkazgichning qarshiligi 1 Ω ga teng.

O‘tkazgichning zanjirdagi tokni cheklash xossasiga o‘tkazgich qarshiligi
deyiladi. O‘tkazgich qarshiligi R orqali tok kuchi I ning kuchlanish U ga bog‘liqligiquyidagicha bo‘ladi:

$$I = \frac{U}{R} \qquad (4)$$

Yuqoridagi bog‘lanishni birichi bo‘lib Georg Simon Om aniqlagani uchun bu bog‘lanish uning sharafiga zanjirning bir qismi uchun Om qonuni deb ataladi. Bu qonun quyidagicha ta’riflanadi:

Zanjirning bir qismidan o‘tayotgan tokning kuchi o‘tkazgich uchlaridagi kuchlanishga to‘g‘ri proporsional va o‘tkazgichning qarshiligiga teskariproporsionaldir. O‘tkazgich qarshiligi 1 Ω ni quyidagicha ta’riflash ham mumkin:

1 Ω qarshilik deb, uchlaridagi kuchlanish 1V bo‘lganda 1A tok o‘tkazadigan o‘tkazgichning qarshiligiga aytiladi.

O‘tkazgichning qarshiligi uning geometrik o‘lchamlariga va material turiga bog‘liq bo‘lgan kattalikdir. O‘tkazgichning ko‘ndalang kesim yuzasi qancha katta bo‘lsa, erkin elektronlar yugurishi uchun shuncha keng yo‘lakcha qilib qo‘yilganva bu elektronlar bir-biriga turtilmasdan shuncha bemalol yugurishadi deb fikr yuritsak, u holda qarshilik o‘tkazgichning ko‘ndalang kesim yuzasiga teskari proporsional degan xulosaga kelamiz. O‘tkazgich uzunligi qancha uzun bo‘lsa, erkin elektronlar bu uzun yo‘lda shuncha ko‘p kristal panjaralaridagi tugunlar bilan to‘qnashadi deb fikr

yuritsak, u holda qarshilik o‘tkazgichning uzunligiga to‘g‘ri proporsional degan xulosaga kelamiz.

O‘tkazgich qarshiligi o‘tkazgichning geometrik o‘lchamlariga va materila turiga quyidagicha bog‘langan:

$$R = \rho \frac{l}{RS} \qquad (5)$$

Bu yerda: ℓ – o‘tkazgich uzunligi; S – o‘tkazgichning ko‘ndalang kesim yuzasi; ρ –o‘tkazgichning solishtirma qarshiligi bo‘lib, har xil materiallar uchun uning son qiymati turlichadir. Solishtirma qarshilikning son qiymatlari har xil materiallar uchun ilovada berilgan. Solishtirma qarshilikning XBSdagi o‘lchov birligi $[\rho]=[\Omega \cdot m]$ bo‘lib, lekin ba’zida $\frac{[\Omega \cdot mm^2]}{m}$ o‘lchov birliklaridan ham foydalaniladi. Ular orasidagi bog‘lanish quyidagicha bo‘ladi:

$$1\frac{\Omega \cdot mm^2}{m} = 1 \cdot 10^{-6} \Omega \cdot m$$

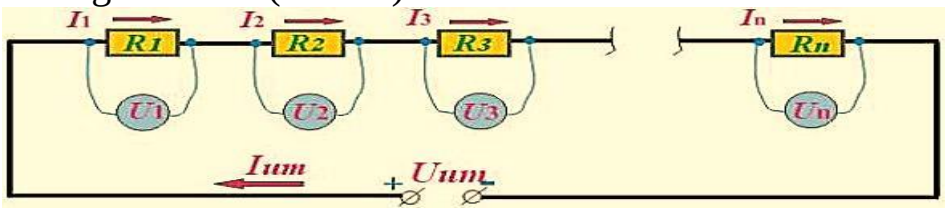
Om Georg Simon *1787-yil 16-mayda Bavariya qirolligining Erlangen shahrida dunyoga kelgan. U tok kuchi, kuchlanish va qarshilik orasidagi bog‘lanishni ifodalovchi qonunni fizikaga nazariy jihatdan kirgizdi va o‘z tajribalarida isbotladi. Hozirda elektr qarshiligining nomi uning nomi bilan “Om” deb va o‘tkazuvchanlikning birligi esa uning familiyasi bilan “Simon” deb nomlanadi. Om qonuni dunyo olimlari tomonidan tan olinadi va London qirollik jamiyatining 1841-yil 30-noyabrda yig‘ilishida Kopli medali bilan taqdirlanadi. U hayoti davmida qilgan ishlari, maqolalarini 1827-yilda bitta kitob (Dier galvanische Kette, mathematisch bearbeitet) qilib chop etadi, so‘ngra bu kitob 1841-yilda mnglizchaga, 1847-yil fransuzchaga, 1860-yil esa italyanchaga tarjima qilinadi. U Furening issiqlik tarqalish hodisalari bilan ham shug‘ullangan. U 1854-yil 6-iyulda Germaniyaning Myunxen shahrida 76 yoshida olamdan o‘tadi.*

Qarshiliklarni ulashning uch turi bor: 1) ketma-ket ulash; 2) parallel ulash. 3) aralash ulash. Bunday ulashlarda tok kuchi, kuchlanish va ummiy qarshilik qanday hisoblanishiniqarab ko‘raylik.

O‘tkazgichlarni ketma-ket ulash:

Qarshiliklarni quyida rasmdagidek ulash ketma-ket ulash hisoblanadi Bunda 1- qarshilikning iziga 2-qarshilik, 2-qarshilikning iziga 3-qarshilik va

hokoza ulanib, 1-va n- qarshiliklar o‘zgarmas tok manbaining mos holda (+) va (-) qutblariga ulanadi (2-rasm).



2-rasm.

Qarshiliklarni ketma-ket ulaganda 1-qarshilikning boshi (kirish nuqtasi) manbaning (+) qutbiga, oxirgi n-qarshilikning oxiri (chiqish nuqtasi) esa manbaning (-) qutbiga ulangan bo‘ladi (2-rasm). Manbaning (+) qutbidan chiqgan zaryad (aslida esa manbaning (-) qutbidan elektron chiqadi) 1-, 2-, 3-, ...n- qarshiliklar orqali o‘tib manbaning (-) qutbiga (aslida esa manbaning (+) qutbiga elektronlar yetib keladi) to‘la-to‘kis yetib keladi. Hech qanday tarmoqlanish bo‘lmagani sababli har bir qarshilikda vaqt birligi ichida teng miqdordagi zaryad oqib o‘tadi. Demak, ulardagi tok kuchlari teng, ya’ni

$$I_{um} = I_1 = I_2 = I_3 = ... = I_n \qquad \textbf{(6)}$$

bo‘lar ekan. Bunga har bir istemolchi qarshilikdan keyin ampermetr ulagandaularning ko‘rsatishlari bir xil chiqishidan ham bilib olish mumkin.

Tashqaridan berilgan umumiy kuchlanish barcha qarshiliklarga taqsimlanib,singib ketgani sababli

$$U_{um} = U_1 + U_2 + U_3 + ... + U_n \qquad \textbf{(7)}$$

bo‘ladi. Bunga har bir istemolchi qarshilikga parallel qilib ulangan volrmetrlar ko‘rsatishlari yig‘indisi tok manbaining kuchlanishiga teng chiqishidan ham bilib olish mumkin.

Umumiy qarshilik esa

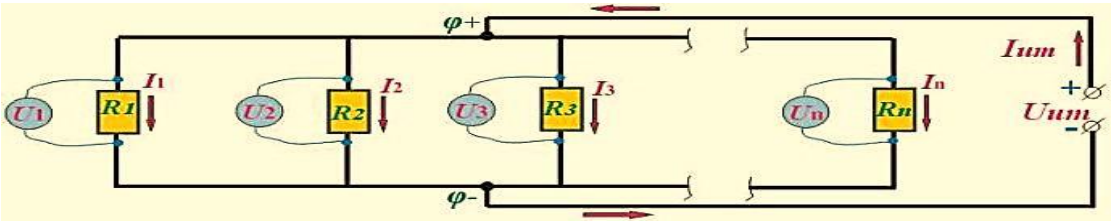
$$U_{um} = U_1 + U_2 + U_3 + ... + U_n \rightarrow I_{um} \cdot R_{um} = I_1 \cdot R_1 + I_2 \cdot R_2 + I_3 \cdot R_3 + ... + I_n \cdot R_n$$

Hosil bo‘lgan oxirgi tenglamadan toklarni qisqartirib yuborsak, umumiy qarshilik formulasi kelib chiqadi

$$R_{um} = R_1 + R_2 + R_3 + ... + R_n \qquad \textbf{(8)}$$

O‘tkazgichlarni parallel ulash:

Qarshiliklarni quyida rasmdagidek ulash parallel ulash hisoblanadi. Bunda hamma qarshiliklarning bir uchi manbaning (+) qutbiga, 2-uchlari esa manbaning (-) qutbiga to‘g‘ridan to‘g‘ri ulanadi.



3-rasm.

Hamma qarshiliklarning tepadagi 1-uchlari to‘g‘ridan to‘g‘ri manbaning (+) qutbiga ulangan. Shuning uchun, bu uchlarning hammasida bir xil manbaning (+) qutbining potensialiga teng bo‘lgan φ_+ potensial hosil bo‘ladi. Hamma qarshiliklarning pastki 2-uchlari to‘g‘ridan to‘g‘ri manbaning (-) qutbiga ulangan. Shuning uchun bu uchlarning hammasida bir xil manbaning (-) qutbining potensialiga teng bo‘lgan φ_- potensial hosil bo‘ladi (3-rasm). Har bir qarshilikdagi potensiallar farqi o‘zaro teng bo‘ladi va bu potensiallar farqi manbaning kuchlanishiga teng, ya’ni $\varphi_+ - \varphi_- = U$ bo‘ladi. Demak, qarshiliklarning hammasidagi kuchlanishlar bir xil va manbaning kuchlanishiga teng, ya’ni

$$U_{um} = U_1 = U_2 = U_3 = ... = U_n \quad \textbf{(9)}$$

bo‘ladi. Buni har bir istemolchi qarshilikga parallel qilib ulangan voltmeter ko‘rsatishlari bir xil chiqishidan ham bilib olish mumkin. Manbaning (+) qutbidan chiqqan zaryad (aslida manbaning (-) qutbidan elektronlar chiqadi) barcha qarshiliklarga bo‘linib tarqalib ketadi va qarshiliklarning pastki uchlaridan chiqgach qo‘shilib manbaning (-) qutbiga yetib boradi (aslida esa elektronlar manbaning (+) qutbiga yetib boradi). Demak, tarmoqlanmagan qismdagi zaryad barcha qarshiliklarga taqsimlanib ketgandan keyin tok kuchi

$$I_{um} = I_1 + I_2 + I_3 + ... + I_n \quad \textbf{(10)}$$

bo‘ladi. Buni har bir istemolchi qarshilikdan keyin ulangan volrmetrlar ko‘rsatishlari yig‘indisi tarmoqlanmagan qismiga ulangan ampermetr ko‘rsatishiga teng chiqishidan ham bilib olish mumkin. Bu zaryadning saqlanish qonuni natijasidir.

Qarshiliklar sistemasining umumiy qarshiligi

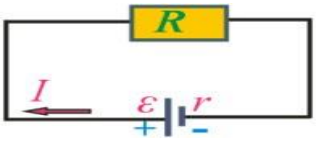
$$I_{um} = I_1 + I_2 + I_3 + ... + I_n \rightarrow \frac{U_{um}}{R_{um}} = \frac{U_1}{R_1} + \frac{U_2}{R_2} + \frac{U_3}{R_3} + ... + \frac{U_n}{R_n}$$

Parallel ulanganda kuchlanishlar tengligidan kuchlanishlarni qisqartirib yuborsak

$$\frac{1}{R_{um}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... + \frac{1}{R_n} \quad \textbf{(11)}$$

bo‘ladi.

To‘liq zanjir uchun Om qonuni.



4-rasm.

Tok manbaiga biror R rezistor ulab yopiq zanjir hosilqilaylik (4-rasm). Tok manbasining EYuK ε va ichki qarshiligi r bo‘lsin. Generatorlarda ichki qarshilik r deganda cho‘lg‘amlarning qarshiligi, galvanik elementlarda esa elektrolit eritmasi va elektrodlar qarshiligi tushuniladi. Yopiq zanjirda tarmoqlanish bo‘lmagani uchun berk zanjirda tashqi R va ichki r qarshiliklardan o‘tuvchi bitta I tok kuchi mavjud bo‘ladi.

Om qonunini yopiq zanjir uchun tatbiq qilganda yopiq zanjirdagi tok kuchi I ni EYuK ε va yopiq zanjirning to‘la qarshiligi (R+r) bilan bog‘laydi. Bunda zanjirning tashqi va ichki qismlaridagi kuchlanish tushuvlari yig‘indisi manbaning EYuKni beradi.

$$\varepsilon = U_R + U_r = IR + Ir$$

Yuqoridagi formuladan to‘liq zanjirning tashqi va ichki qismidagi kuchlanish

tushuvlarini yozishimiz mumkin.

$$U_R = IR, \quad U_r = Ir$$

Yopiq zanjirdagi tok kuchini aniqlashimiz mumkin.

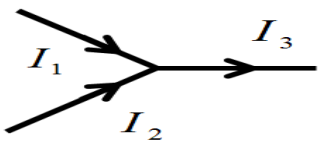
$$I = \frac{\varepsilon}{R + r} \qquad \textbf{(12)}$$

Yuqoridagi formula yopiq zanjir uchun Om qonunining matematik ifodasi bo‘lib, uni quyidagicha ta’riflash mumkin:

Yopiq zanjirdan o‘tayotgan tokning kuchi manbaning EYuKiga to‘g‘ri proporsional va zanjirning to‘la qarshiligiga teskari proporsionaldir.

TARMOQLANGAN ELEKLR ZANJIRI UCHUN KIRXGOF QOIDALARI

Kirxgofning birinchi qoidasi: Tarmoqlanish tugunida uchrashuvchi toklarning algebraik yig‘indisi nolga teng.



$$\sum I_k = 0 \qquad (1) \qquad\qquad I_1 + I_2 - I_3 = 0 \qquad (1{,}1)$$

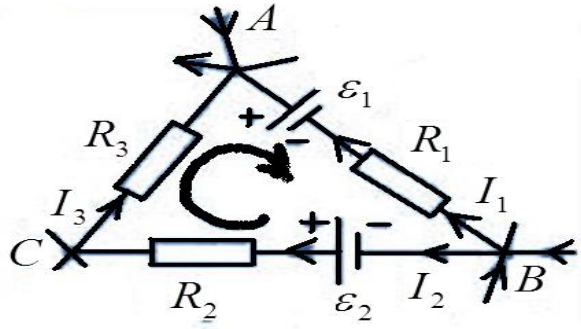
Kiruvchi toklar (+) ishorada(I_1;I_2), chiquvchi toklar (–) ishorada(I_3) olinadi.

Kirxgofning ikkinchi qoidasi: Tarmoqlangan zanjirning berk konturida uning qismlaridan oqayotgan tok kuchlarining tegishli qismlar qarshiliklariga ko‘paytmasining algebraik yig‘indisi konturdagi tok manbalari elektr yurituvchi kuchlarining algebraic yig‘indisiga teng bo‘ladi.

$$\sum I_k R_k = \sum \varepsilon_k \qquad (13)$$

Kirxgofning ikkinchi qoidasini tatbiq qilish shartlari

1. Elektr zanjiri qismlaridagi yo‘nalish aylanish yo‘nalishi bilan mos tushgan toklar musbat, teskari yo‘nalgan toklar manfiy.
2. Elektr zanjiridagi tok manbalarining manfiy qutbidan musbat qutbiga tomon yo‘nalishi konturning aylanishi bilan mos tushsa, manbaning EYK musbat, aks holda manfiy ishora bilan olinad



$$I_2 + I_3 - I_1 = 0; \quad \varepsilon = \varepsilon_2 - \varepsilon_1$$

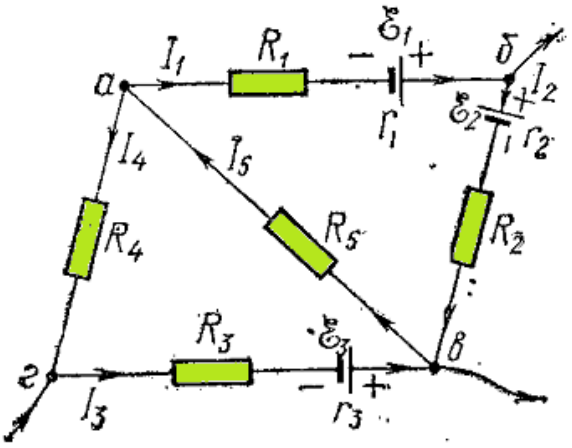
Kirxgofning ikkinchi qoidasi: Murakkab elektr zanjirdagi istalgan yopiq konturni aylanib chiqqanda barcha qarshiliklardagi (manbaning ichki qarshiligiham kiradi) kuchlanish tushishlarining algebraik yig‘indisi shu kontur E.Yu.K larning algebraic yig‘indisiga teng, ya’ni

$$I_1R_1 + I_2R_2 + \ldots + I_nR_n = \varepsilon_1 + \varepsilon_2 + \ldots + \varepsilon_n \qquad (14)$$

Har bir konturni aylanib chiqish yo‘nalishi (soat strelkasining harakat yo‘nalishi bo‘yicha yoki unga teskari) ixtiyoriy tanlanadi. Agar ikki tugun orasidagi uchastkada oldindan tanlangan tok yo‘nalishi konturni aylanib chiqish yo‘nalishi bilan mos tushsa, u holda kuchlanish tushishi musbat hisoblanadi, agar tok yo‘nalishi aylanib chiqish yo‘nalishiga teskari bo‘lsa, kuchlanish manfiy bo‘ladi.

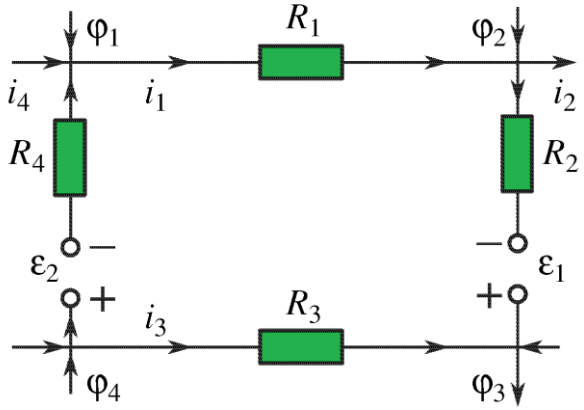
Agar kontur bo‘yicha aylanib chiqishda tok manbaini manfiy qutbidan musbat qutbiga tomon o‘tilsa, u holda E.Yu.K musbat hisoblanadi, aks holda E.Yu.K manfiy hisoblanadi.

Rasmda ko‘rsatilgan абвг kontur uchun soat strelkasining harakat yo‘nalishi bo‘yicha aylanishda 3-formula quyidagi ko‘rinishda yoziladi:



$$I_1(R_1+r_1)+I_2(R_2+r_2)-I_3(R_3+r_3)-I_4R_4=\varepsilon_1-\varepsilon_2-\varepsilon_3 \qquad (15)$$

Kirxgofning ikkinchi qoidasi quyidagi sxema misolida

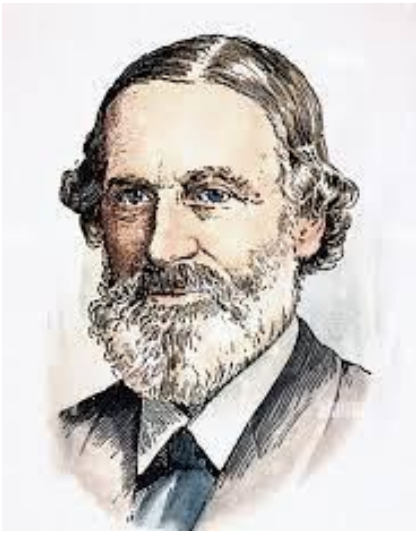


$$i_1R_1+i_2R_2-i_3R_3+i_4R_4=\varepsilon_1-\varepsilon_2$$

Har bir uchastkadagi potensiallar farqi quyidagicha

$$i_1R_1=\varphi_1-\varphi_2, \qquad i_2R_2=\varphi_2-\varphi_3+\varepsilon_1,$$
$$-i_3R_3=\varphi_3-\varphi_4, \qquad i_4R_4=\varphi_4-\varphi_1-\varepsilon_2,$$

Gustav Robert Kirxgof



(1824-yil 12-mart, Kenigsberg, – 1887-yil 17-oktabr, Berlin) — XIX asrning buyuk fiziklaridan biri, Berlin fanlar akademiyasi a'zosi (1874 yildan).

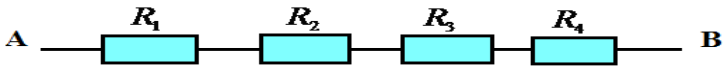
Kenigsberg universitetini tugatgan (1846). Ilmiy ishlari elektron optika va mexanikaga oid. Tarmoqlangan zanjirlar bo'ylab oquvchi elektr tokining taqsimlanish qonuniyatlari (qarang Kirxgof qoidalari)ni yaratgan va elektr potensiali tushunchasini fizikaga birinchi bo'lib kiritgan (1845–49), deformatsiya nazariyasi,

elastik jismlarning harakati va muvozanati hamda suyuqliklar oqimi masalalari bilan shug‘ullangan (1849–58).

Nemis kimyogari R.V. Bunzen bilan hamkorlikda spektral tahlil usuliga asos solgan (1854–59) va kimyoviy elementlardan seziy (1860) va rubidiy (1861)ni topgan. Mutlaq qora jism tushunchasini fanga kiritgan va o‘z nomi bilan atalgan nurlanish qonuni (qarang Kirxgof nurlanish qonuni) ni yaratgan.

REZISTORLARNI ARALASH ULASHGA DOIR MASALALAR

1.AB nuqta orasidagi umumiy qarshilikni toping?

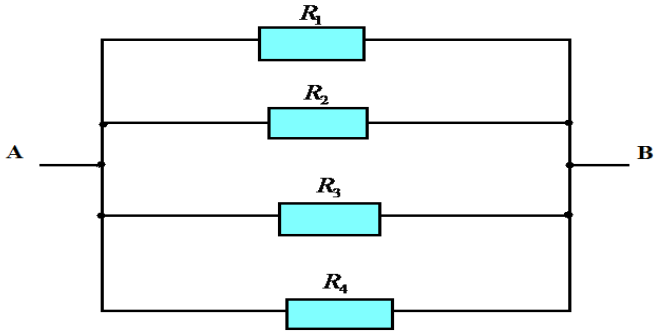


Ketma-ket ulashda qarshiliklar qo‘shiladi. Agar qarshiliklar har-xil bo‘lsa,

$R_{AB} = R_1 + R_2 + R_3 + R_4$. Agar qarshiliklar bir xil bo‘lsa,

$R_1 = R_2 = R_3 = R_4 = R;\ R_{AB} = R_1 + R_2 + R_3 + R_4 = R + R + R + R = 4R$

2. AB nuqta orasidagi umumiy qarshilikni toping?



Agar qarshiliklar har-xil bo‘lsa,

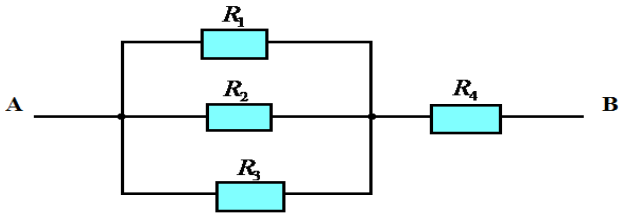
$$\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$R_{AB} = \frac{R_1 \cdot R_2 \cdot R_3 \cdot R_4}{R_2 \cdot R_3 \cdot R_4 + R_1 \cdot R_3 \cdot R_4 + R_1 \cdot R_2 \cdot R_4 + R_1 \cdot R_2 \cdot R_3}$$

Agar qarshiliklar bir xil bo‘lsa,

$$R_1 = R_2 = R_3 = R_4 = R; \frac{1}{R_{AB}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{4}{R} \rightarrow R_{AB} = \frac{R}{4}$$

3. AB nuqta orasidagi umumiy qarshilikni toping?



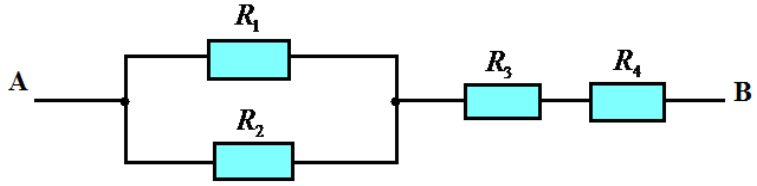
Agar qarshiliklar har-xil bo‘lsa,

$$\frac{1}{R_{123}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{R_2 \cdot R_3}{R_1 \cdot R_2 \cdot R_3} + \frac{R_1 \cdot R_3}{R_1 \cdot R_2 \cdot R_3} + \frac{R_1 \cdot R_2}{R_1 \cdot R_2 \cdot R_3} =$$
$$= \frac{R_2 \cdot R_3 + R_1 \cdot R_3 + R_1 \cdot R_2}{R_1 \cdot R_2 \cdot R_3}$$
$$R_{123} = \frac{R_1 \cdot R_2 \cdot R}{R_2 \cdot R_3 + R_1 \cdot R_3 + R_1 \cdot R_2};$$
$$R_{AB} = R_{123} + R_4$$

Agar qarshiliklar bir xil bo‘lsa

$$R_1 = R_2 = R_3 = R_4 = R$$
$$\frac{1}{R_{123}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}; R_{123} = \frac{R}{3}$$
$$R_{AB} = R_{123} + R_4 = \frac{R}{3} + R = \frac{4}{3}R$$

4. AB nuqta orasidagi umumiy qarshilikni toping?



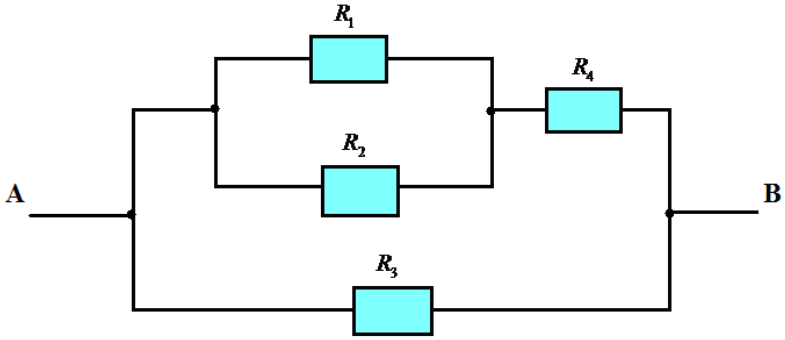
Agar qarshiliklar har-xil bo‘lsa

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1 + R_2}{R_1 \cdot R_2}; R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2}; R_{34} = R_3 + R_4; R_{AB} = R_{12} + R_{34}$$

Agar qarshiliklar bir xil bo‘lsa $R_1 = R_2 = R_3 = R_4 = R$

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}; R_{12} = \frac{R}{2}$$
$$R_{34} = R_3 + R_4 = R + R = 2R; R_{AB} = R_{12} + R_{34} = \frac{R}{2} + 2R = \frac{5}{2}R$$

5. AB nuqta orasidagi umumiy qarshilikni toping?



Agar qarshiliklar har-xil bo‘lsa,

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1 + R_2}{R_1 \cdot R_2}; R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2}; R_{124} = R_{12} + R_4;$$

$$\frac{1}{R_{AB}} = \frac{1}{R_{124}} + \frac{1}{R_3} = \frac{R_3 + R_{124}}{R_{124} \cdot R_3}; R_{AB} = \frac{R_{124} \cdot R_3}{R_3 + R_{124}}$$

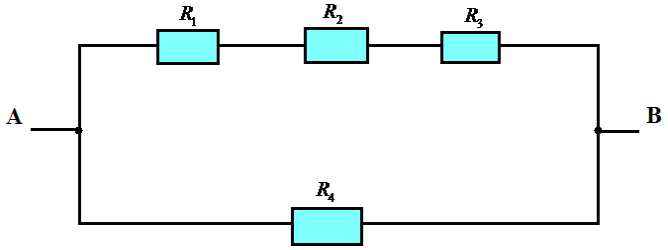
Agar qarshiliklar bir xil bo‘lsa,

$$R_1 = R_2 = R_3 = R_4 = R$$

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}; R_{12} = \frac{R}{2}; R_{124} = R_{12} + R_4 = \frac{R}{2} + R = \frac{3}{2}R$$

$$\frac{1}{R_{AB}} = \frac{1}{R_{124}} + \frac{1}{R_3} = \frac{2}{3R} + \frac{1}{R} = \frac{5}{3R} \rightarrow R_{AB} = \frac{3}{5}R$$

6. AB nuqta orasidagi umumiy qarshilikni toping?



Agar qarshiliklar har-xil bo‘lsa, $R_1; R_2; R_3$qarshiliklar ketma-ket ulanganligi uchun $R_{123} = R_1 + R_2 + R_3$ chiqqan natija esa R_4 ga parallel ulanganligi uchun umumiy qarshilik quyidagicha topiladi

$$\frac{1}{R_{AB}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{R_4 + R_{123}}{R_{123} \cdot R_4} \rightarrow R_{AB} = \frac{R_{123} \cdot R_4}{R_4 + R_{123}}$$

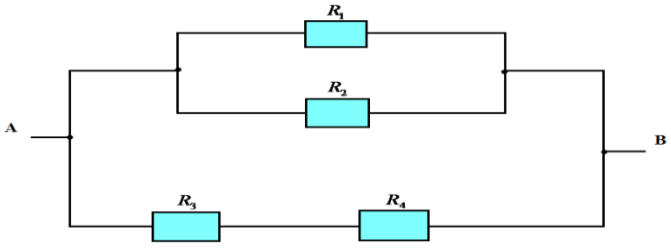
Agar qarshiliklar bir xil bo‘lsa, $R_1 = R_2 = R_3 = R_4 = R$

$$R_{123} = R_1 + R_2 + R_3 = R + R + R = 3R;$$

$$\frac{1}{R_{AB}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{1}{3R} + \frac{1}{R} = \frac{4}{3R}$$

$$R_{AB} = \frac{3R}{4}$$

7. AB nuqta orasidagi umumiy qarshilikni toping?



Agar qarshiliklar har-xil bo‘lsa R_1 va R_2 qarshiliklar parallel ulangan, R_3 va R_4 qarshiliklar ketma-ket ulanganligi uchun ularni quyidagicha hisoblaymiz.

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_2 + R_1}{R_1 \cdot R_2} \rightarrow R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2}; R_{34} = R_3 + R_4$$

Chiqqan natijalarni parallel ulaymiz

$$\frac{1}{R_{AB}}=\frac{1}{R_{12}}+\frac{1}{R_{34}}=\frac{R_{34}+R_{12}}{R_{12}\cdot R_{34}}\rightarrow R_{AB}=\frac{R_{12}\cdot R_{34}}{R_{34}+R_{12}}$$

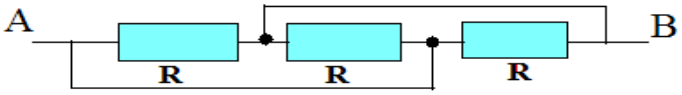
Agar qarshiliklar bir xil bo‘lsa,

$$R_1=R_2=R_3=R_4=R$$

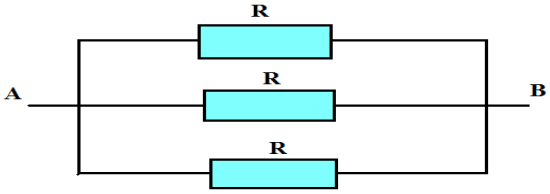
$$\frac{1}{R_{12}}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{12}=\frac{R}{2};R_{34}=R_3+R_4=R+R=2R$$

$$\frac{1}{R_{AB}}=\frac{1}{R_{12}}+\frac{1}{R_{34}}=\frac{1}{\frac{R}{2}}+\frac{1}{2R}=\frac{2}{R}+\frac{1}{2R}=\frac{5}{2R}\rightarrow R_{AB}=\frac{2R}{5}$$

8. Rasmda tasvirlangan sxemaning umumiy qarshiligini toping?

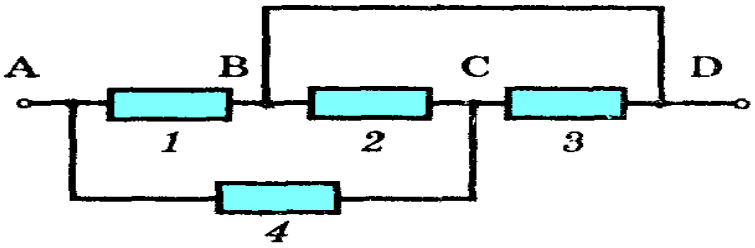


Bu zanjirni soddalashtiramiz

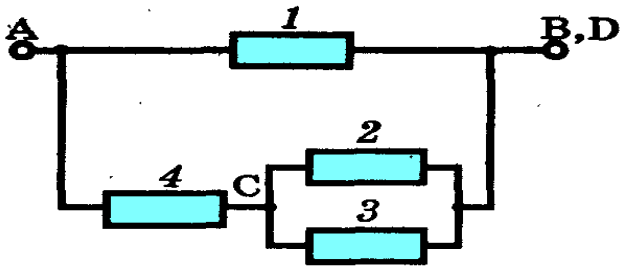


$$\frac{1}{R_{AB}}=\frac{1}{R}+\frac{1}{R}+\frac{1}{R}=\frac{3}{R}\rightarrow R_{AB}=\frac{R}{3}$$

9. Rasmda tasvirlangan sxemaning umumiy qarshiligini toping? (Barcha rezistorlarning qarshiligi R ga teng)



Sxemani soddalashtiramiz

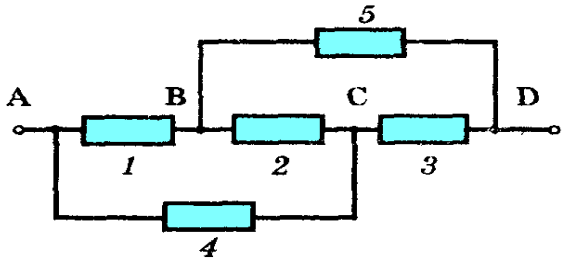


$$\frac{1}{R_{23}}=\frac{1}{R_2}+\frac{1}{R_3}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{23}=\frac{R}{2}:R_{234}=R_{23}+R_4=\frac{R}{2}+R=\frac{3}{2}R$$

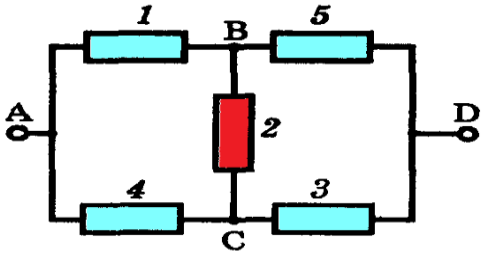
$$\rightarrow R_{234}=\frac{3}{2}R;\frac{1}{R_{Um}}=\frac{1}{R_{234}}+\frac{1}{R_5}=\frac{2}{3R}+\frac{1}{R}=\frac{5}{3R};R_{Um}=\frac{3}{5}R:$$

10. Rasmda tasvirlangan sxemaning umumiy qarshiligini toping (1-rasm)?

(Barcha rezistorlarning qarshiligi R ga teng)



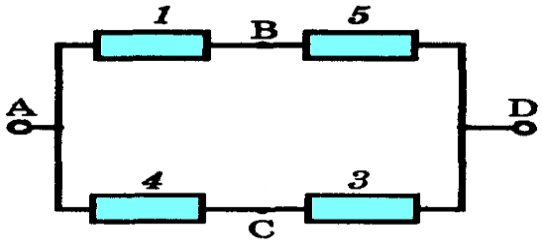
1-rasm.



1,1-rasm.

1-rasmdagi sxemani murakkab ko‘rinishidan sodda ko‘rinishga o‘tamiz (1,1-rasm)

$\frac{R_1}{R_4} = \frac{R_5}{R_3}$ nisbatlar tengligi uchun B va C nuqtalarda potensiyallai teng, potensiallar farqi nolga teng. Shuning uchun 2-rezistordan tok o‘tmayni . Tok o‘tmaganligi uchun 2-rezistorni sxemadan olib tashlaymiz(1,2-rasm).

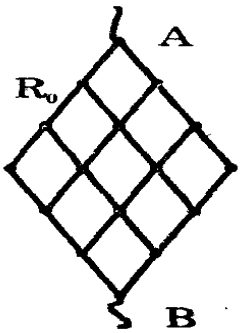


$$R_{15} = R_1 + R_5 = R + R = 2R \rightarrow R_{15} = 2R; R_{43} = R_4 + R_3 = R + R = 2R \rightarrow R_{43} = 2R$$

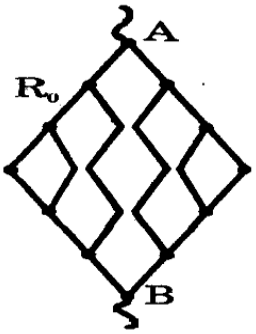
$$\frac{1}{R_{AB}} = \frac{1}{R_{15}} + \frac{1}{R_{43}} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \rightarrow R_{AB} = R:$$

11. AB nuqta orasidagi umumiy qarshilikni toping. (1-rasm)?

(Barcha qarshiliklar R)

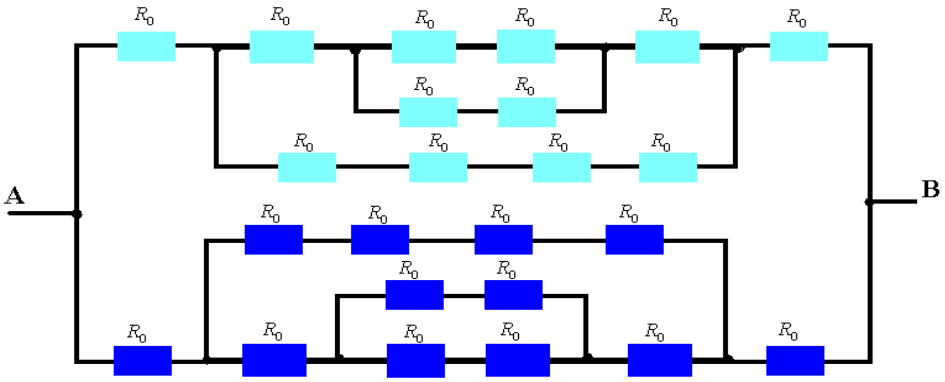


1-rasm.



1,1-rasm.

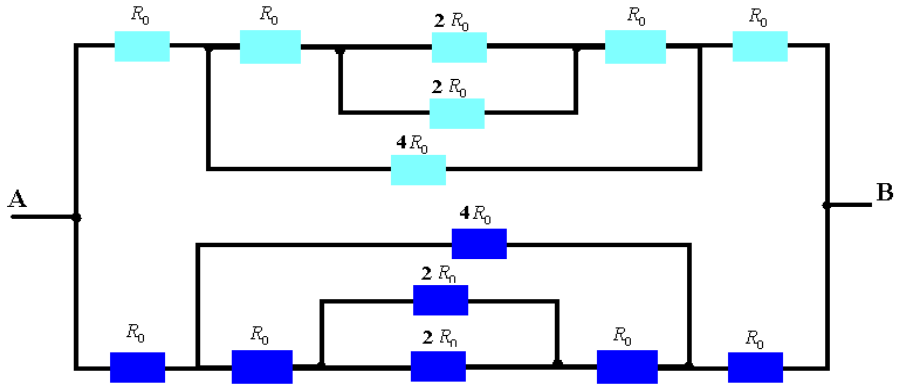
1-rasmdagi sxemaning potensiali teng bo‘lgan nuqtalarini ajratib chizamiz (1,1-rasm).1,1-rasmdagi murakkab sxemani 1,2-rasmdagi sodda ko‘rinishga o‘tamiz.



1,2-rasm.

1,2-rasmdagi sxemaning ketma-ket ulangan R_0 qarshiliklarni hisoblaymiz (1,3-rasm).

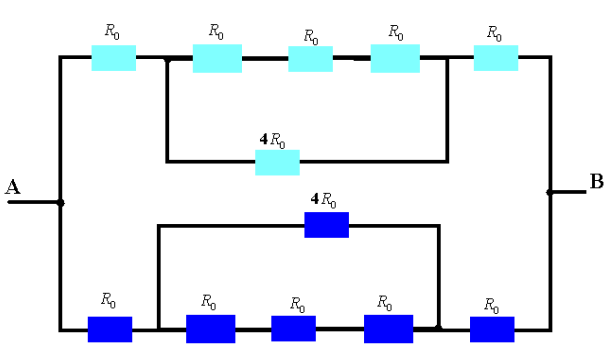
$$R_{k-k} = R_0 + R_0 = 2R_0$$



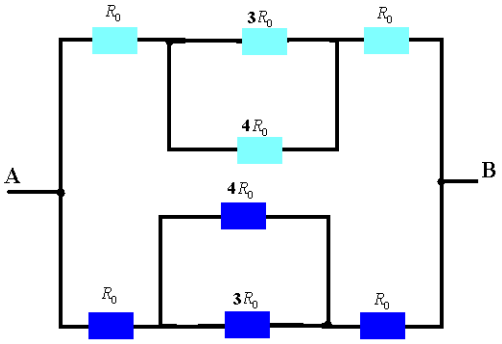
1,3-rasm.

1,3-rasmdagi $2R_0$ qarshiliklarni parallel ulab, 1,4-rasmdagi sxemani hosil qilamiz.

$$\frac{1}{R_{p-r}} = \frac{1}{2R_0} + \frac{1}{2R_0} = \frac{2}{2R_0} \rightarrow R_{p-r} = R_0$$



1,4-rasm.



1,5-rasm.

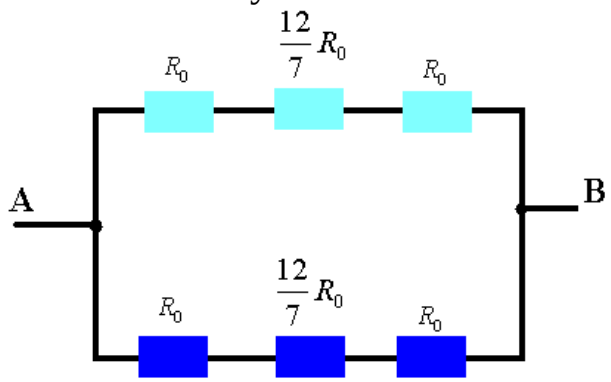
1,4-rasmdagi 3 ta R_0 qarshilikni ketma-ket ulab 1,5-rasmdagi sxemaniga kelamiz.

$$R_{k-k} = R_0 + R_0 + R_0 = 3R_0$$

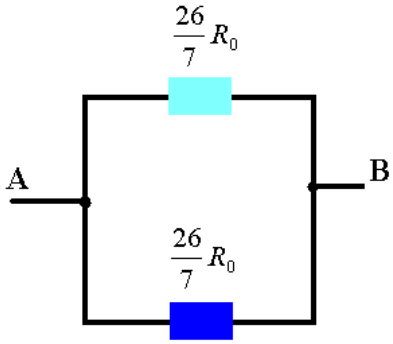
1,5-rasmdagi $3R_0$ va $4R_0$ qarshiliklarni parallel ulaymiz.

$$\frac{1}{R_{p-r}} = \frac{1}{4R_0} + \frac{1}{3R_0} = \frac{7}{12R_0} \rightarrow R_{p-r} = \frac{12R_0}{7}$$

va soddalashgan 1,6-1,7-rasmdagi sxemalar hosil bo‘ladi, ulardan umumiy qarshilikni hisoblaymiz



1,6-rasm.

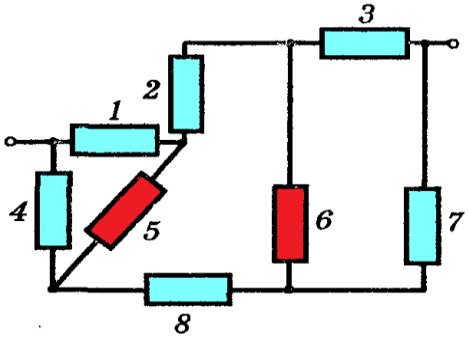


1,7-rasm.

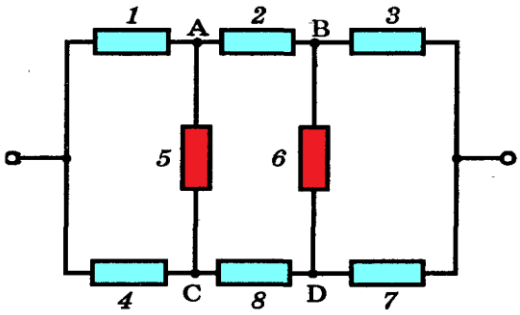
$$\frac{1}{R_{AB}} = \frac{7}{26R_0} + \frac{7}{26R_0} = \frac{14}{26R_0} = \frac{7}{13R_0} \rightarrow R_{AB} = \frac{13}{7}R_0$$

12. Zanjirning umumiy qarshiligini, har-bir rezistordan o‘tadigan tok kuchini toping? (1-rasm).

$U = 84V; R_1 = R_5 = R_8 = 12\Omega; R_2 = R_6 = R_7 = 6\Omega; R_4 = 24\Omega; R_3 = 3\Omega;$

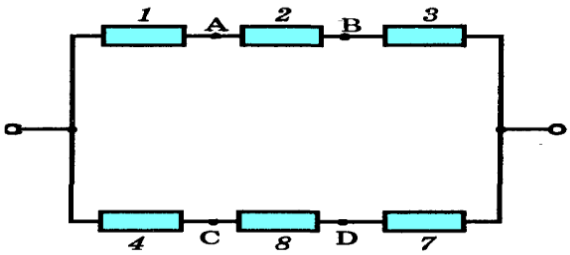


1-rasm.



1,1-rasm.

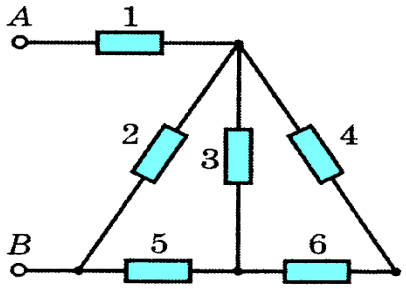
1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz. $R_1 : R_2 : R_3 = R_4 : R_8 : R_7$ qarshiliklar nisbati tengligi uchun A va C ;B va D nuqtalarda potensiallar teng, potensiallar farqi o ga teng. Shuning uchun R_5 va R_6 rezistor orqali tok o‘tmaydi va sxemamiz quyidagicha soddalashtirib umumiy qarshilikni topamiz. (1,2-rasm)



1,2-rasm.

$$R_{123} = R_1 + R_2 + R_3 = 12 + 6 + 3 = 21\Omega;$$
$$R_{487} = R_4 + R_8 + R_7 = 24 + 12 + 6 = 42\Omega$$
$$\frac{1}{R_{Um}} = \frac{1}{R_{123}} + \frac{1}{R_{487}} = \frac{1}{21} + \frac{1}{42} = \frac{3}{42} \rightarrow R_{Um} = 14\Omega$$
$$I_5 = 0; I_6 = 0; I_1 = I_2 = I_3 = \frac{U}{R_{123}} = \frac{84}{21} = 4A; I_4 = I_7 = I_8 = \frac{U}{R_{487}} = \frac{84}{42} = 2A$$

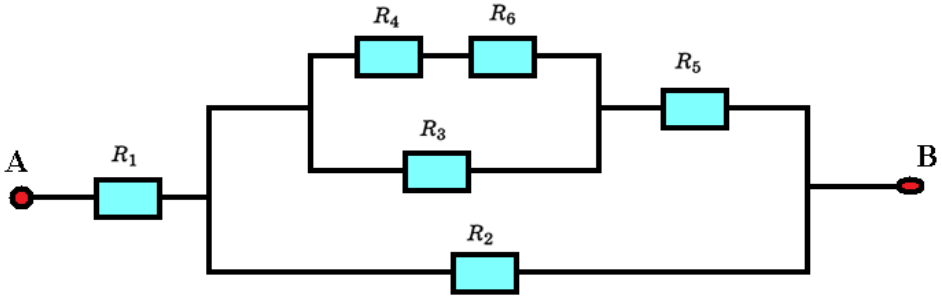
13. AB nuqta orasidagi umumiy qarshilikni va har bir rezistor orqali o‘tadigan tok kuchini toping. (1-rasm) A va B nuqta potensiallar farqi 12 V



$R_1 = 4$ Ом
$R_2 = 4$ Ом
$R_3 = 5$ Ом
$R_4 = 3$ Ом
$R_5 = 1{,}5$ Ом
$R_6 = 2$ Ом

1-rasm.

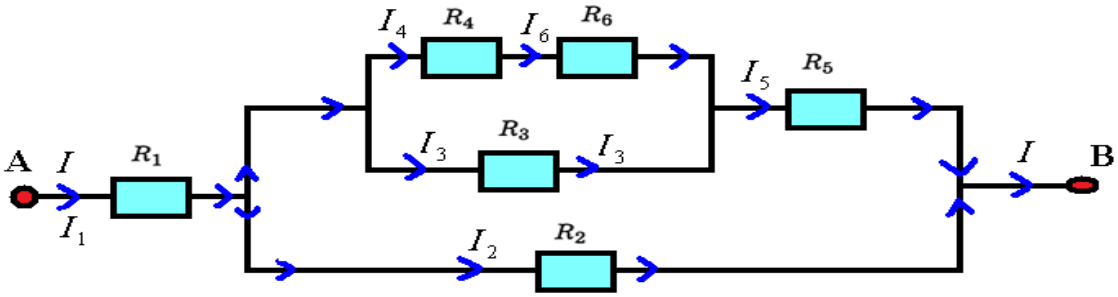
1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz.



1,1-rasm.

$$R_{46} = R_4 + R_6 = 3 + 2 = 5\Omega; \frac{1}{R_{346}} = \frac{1}{R_3} + \frac{1}{R_{46}} = \frac{1}{5} + \frac{1}{5} = \frac{2}{5}; R_{346} = 2{,}5\Omega$$
$$R_{3465} = R_{346} + R_5 = 2{,}5 + 1{,}5 = 4\Omega; \frac{1}{R_{34652}} = \frac{1}{R_{3465}} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4};$$
$$R_{34652} = 2\Omega; R_{AB} = R_{34652} + R_1 = 2 + 4 = 6\Omega; I = \frac{U}{R_{AB}} = \frac{12}{6} = 2A$$

Demak A nuqtadan I tok kuchi kirib B nuqtadan chiqib ketadi deb 1,1-rasmdagi sxemani 1,2-rasmdagi kabi o‘zgartiramiz.



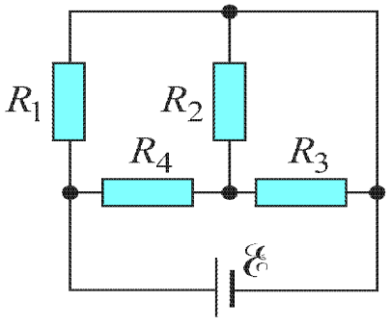
1,2-rasm.

Kirxgov 1-qoidasiga ko‘ra $\begin{cases} I = I_1 = I_2 + I_5 \\ I_5 = I_3 + I_6 \end{cases}$ R_4 va R_6 ketma ketligi uchun $I_4 = I_6$ Kirxgov 2-qoidasiga ko‘ra $\begin{cases} I_4 \cdot R_4 + I_6 \cdot R_6 - I_3 \cdot R_3 = 0 \\ I_3 \cdot R_3 + I_5 \cdot R_5 - I_2 \cdot R_2 = 0 \end{cases}$. Bu ikki tenglamalar sistemasidan toklarni topsak $I_1 = I = 2A; I_2 = I_5 = 0{,}5A$

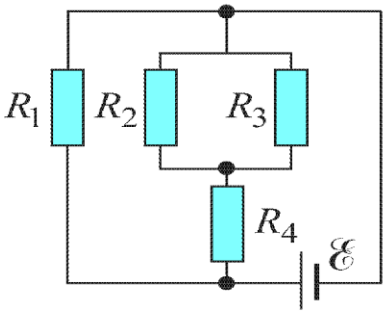
$$I_4 = I_6 = I_3 = 0{,}25A$$

14. Manbadan chiquvchi tok kuchini va R_1 rezistordagi tok kuchini aniqlang.

(1-rasm). ($\varepsilon = 1{,}5V; r = 0{,}5\Omega; R_1 = 5\Omega; R_2 = 9\Omega; R_3 = 3\Omega; R_4 = 2{,}75\Omega$)



1-rasm.



1,1-rasm.

1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz va hisoblaymiz.

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} \rightarrow R_{23} = \frac{9}{4}\Omega; \quad R_{234} = R_{23} + R_4 = 5\Omega; \frac{1}{R_{Um}} = \frac{1}{R_{234}} + \frac{1}{R_1}$$

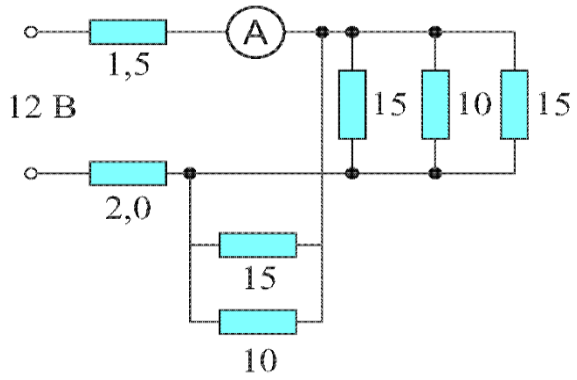
$$R_{Um} = 2{,}5\Omega$$

$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{1{,}5}{2{,}5 + 0{,}5} = 0{,}5A$$

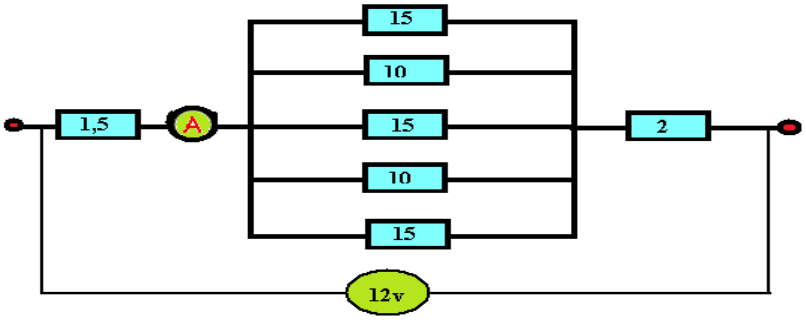
$$U_1 = U_{234} \rightarrow I_1 \cdot R_1 = I_{234} \cdot R_{234} \rightarrow I_1 \cdot 5 = I_{234} \cdot 5; I_1 = I_{234}$$

$$I = I_1 + I_{234} = 0{,}5A \rightarrow I_1 = I_{234} = \frac{I}{2} = \frac{0{,}5}{2} = 0{,}25A$$

15. Zanjirdagi ampermetr necha amperni ko‘rsatadi(1-rasm)?

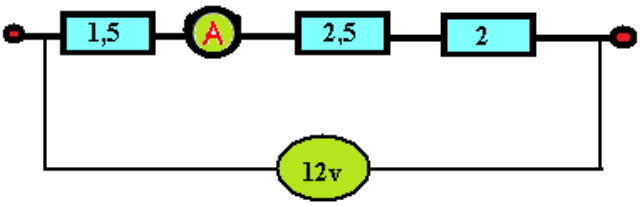


1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz.



1,1-rasm

1,1-rasmdagi qarshiliklarni parallel ulasak sxema yanada soddalashadi. (1,2-rasm)



1,2-rasm.

$$R_{Um} = 1{,}5 + 2{,}5 + 2 = 6\Omega; I = \frac{U}{R_{Um}} = \frac{12}{6} = 2A$$

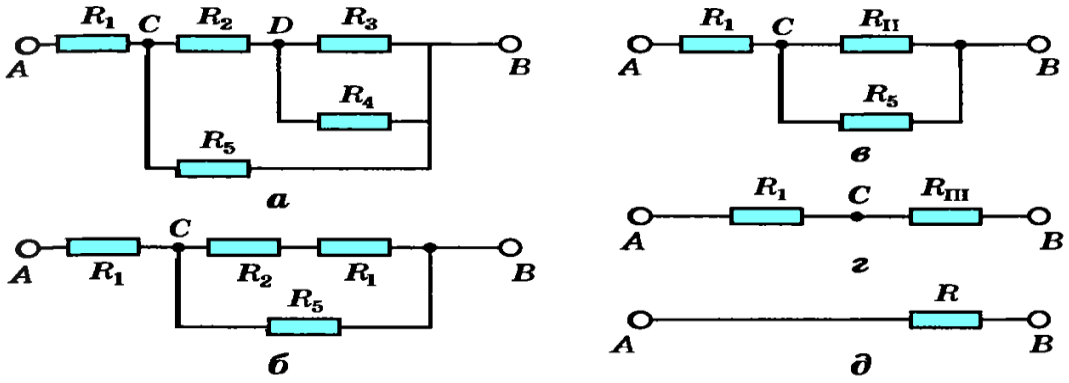
16. Rasmda tasvirlangan har-bir rezistordan o‘tadigan tok kuchini va umumiy qarshilikni toping. (a-rasm) ?

$R_1 = 6\Omega; R_2 = 5\Omega; R_3 = 4\Omega; R_4 = 12\Omega; R_5 = 8\Omega; U_{AB} = 20V$

Sxemani quyidagicha parallel va ketma-ket ulash formulalaridan foydalanib
hisoblab soddalashtiramiz chiqamiz.

$$R_I = \frac{R_3 \cdot R_4}{R_3 + R_4} = \frac{4 \cdot 12}{4 + 12} = \frac{48}{16} = 3\Omega; R_{II} = R_2 + R_I = 5 + 3 = 8\Omega;$$

$$R_{III} = \frac{R_{II} \cdot R_5}{R_{II} + R_5} = \frac{8 \cdot 8}{8 + 8} = \frac{64}{16} = 4\Omega; R_{AB} = R_1 + R_{III} = 6 + 4 = 10\Omega$$



$$I = I_1 = \frac{U_{AB}}{R_{AB}} = \frac{20}{10} = 2A; U_{CB} = I_1 \cdot R_{III} = 2 \cdot 4 = 8V; I_2 = \frac{U_{CB}}{R_{II}} = \frac{8}{8} = 1A;$$

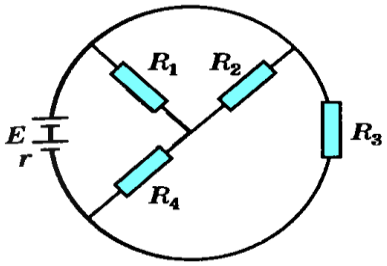
$$I_5 = \frac{U_{CB}}{R_5} = \frac{8}{8} = 1A; R_{II} = R_5 tengligidan I_{II} = I_5 = \frac{I}{2} = 1A;$$

$$DBuchastkauchun U_{DB} = I_3 R_3 = I_4 R_4 = I_2 R_I; U_{DB} = 1 \cdot 3 = 3V$$

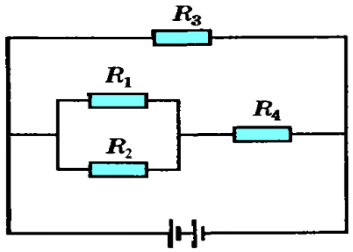
$$I_3 = \frac{U_{DB}}{R_3} = \frac{3}{4} = 0{,}75A, I_4 = \frac{U_{DB}}{R_4} = \frac{3}{12} = 0{,}25A.$$

17. Rasmda tasvirlangan sxema manbasini tok kuchini toping. (1-rasm)?

($R_1 = 1\Omega; R_2 = 3\Omega; R_3 = 1{,}5\Omega; R_4 = 0{,}75\Omega; \varepsilon = 3V; r = 0{,}25\Omega$)



1-rasm.



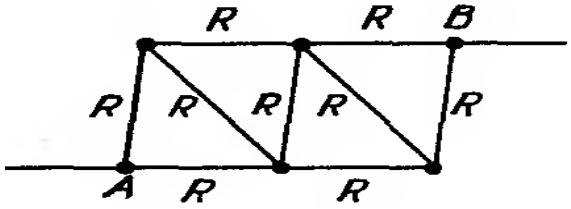
1,1-rasm.

1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz.

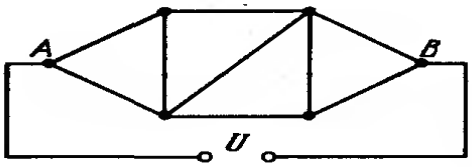
$$R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{1 \cdot 3}{1 + 3} = \frac{3}{4} = 0{,}75\Omega;\ R_{124} = R_{12} + R_4 = 0{,}75 + 0{,}75 = 1{,}5\Omega$$

$$R_{Um} = \frac{R_{124} \cdot R_3}{R_{124} + R_3} = \frac{1{,}5 \cdot 1{,}5}{1{,}5 + 1{,}5} = \frac{2{,}25}{3} = 0{,}75\Omega;\ I = \frac{\varepsilon}{R + r} = \frac{3}{0{,}75 + 0{,}25} = 3A$$

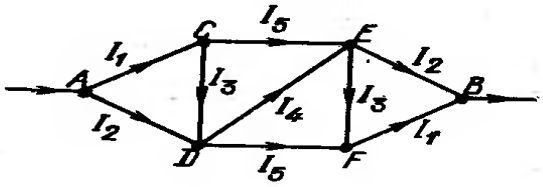
18. AB nuqta orasidagi umumiy qarshilikni toping?



Sxemaning umumiy qarshiligini toppish uchun uning A va B nuqtalari potensiallar farqini U bilian belgilaymiz(1-rasm), 2-rasmda esa sxemadagi rezistorlardagi toklarning harakat yo‘nalishlari ko‘rsatilgan.



1-rasm.



2-rasm.

Krixgovning 1-qoidasiga ko‘ra

$$I = I_1 + I_2; I_2 + I_3 = I_4 + I_5;$$

Krixgovning 2-qoidasiga ko‘ra

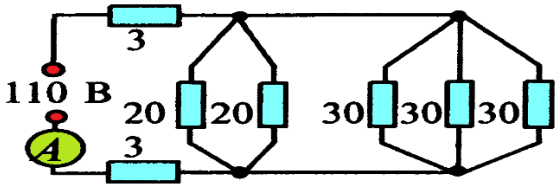
$$(I_2 + I_5 + I_1)R = U; (I_3 + I_4)R = I_5R; (I_1 + I_3)R = I_2R$$

Krixgovning 1-2-qoidalaridan chiqqan natijalardan

$$I_2 = \frac{6}{5}I_1, I_3 = \frac{I_1}{5}, I_4 = \frac{3}{5}I_1, I_5 = \frac{4}{5}I_1. U = (I_1 + \frac{4}{5}I_1 + \frac{6}{5}I_1)R. \frac{U}{I_1} = 3R.$$

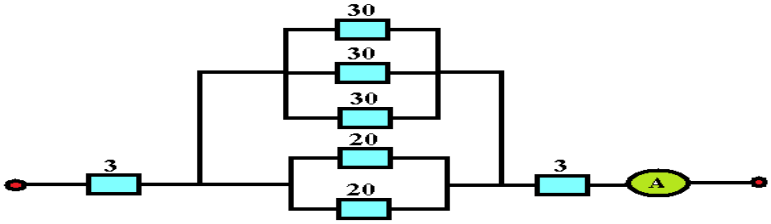
$$R_{AB} = \frac{U}{I} = \frac{U}{I_1 + I_2} = \frac{U}{I_1 + \frac{6}{5}I_1} = \frac{5}{11} \cdot \frac{U}{I_1} = \frac{5}{11} \cdot \frac{3 \cdot R \cdot I_1}{I_1} = \frac{15}{11}R$$

19. Sxemaning umumiy qarshiligini va Ampermetr ko‘rsatgichini aniqlang (1-rasm).



1-rasm.

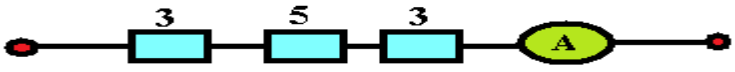
1-rasmdagi murakkab sxemani 1,1-rasmdagi sodda ko‘rinishga o‘tamiz.



1,1-rasm.

$$\frac{1}{R} = \frac{1}{30} + \frac{1}{30} + \frac{1}{30} + \frac{1}{20} + \frac{1}{20} R = 5\Omega$$

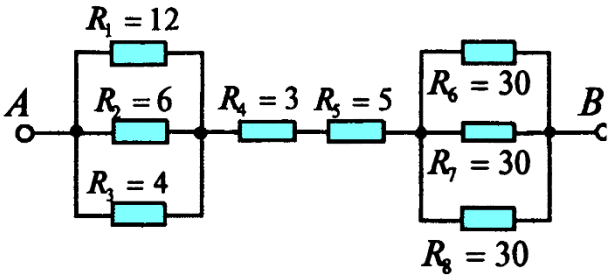
1,1-rasmda parallel ulangan qarshiliklarni hisoblasak 1,2-rasmdagi sxema hosil bo‘ladi.



1,2-rasm.

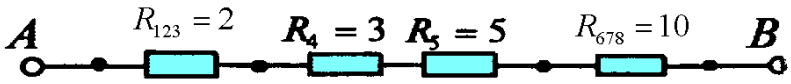
$$R_{Um} = 3 + 5 + 3 = 11\Omega; I = \frac{U}{R_{Um}} = \frac{110}{11} = 10A$$

20. AB nuqta orasidagi umumiy qarshilikni toping?



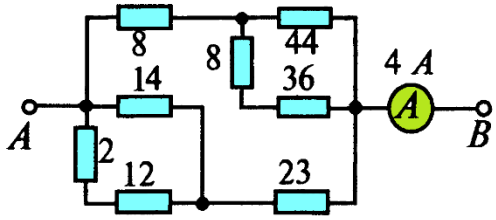
$$\frac{1}{R_{123}}=\frac{1}{12}+\frac{1}{6}+\frac{1}{4}\rightarrow R_{123}=2\Omega;\frac{1}{R_{678}}=\frac{1}{30}+\frac{1}{30}+\frac{1}{30}\rightarrow R_{123}=10\Omega$$

Sxemadagi parallel joylashgan qarshiliklarni hisoblasak sxema quyidagicha soddalashadi

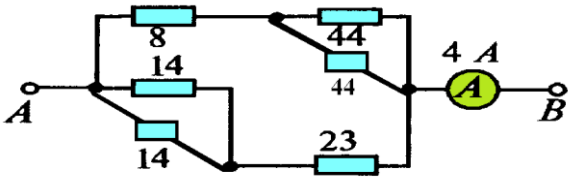


$$R_{Um}=R_{123}+R_4+R_5+R_{678}=2+3+5+10=20\Omega$$

21. AB nuqta orasidagi umumiy qarshilikni va AB nuqta urasidagi potensiallar farqini toping(1-rasm)?

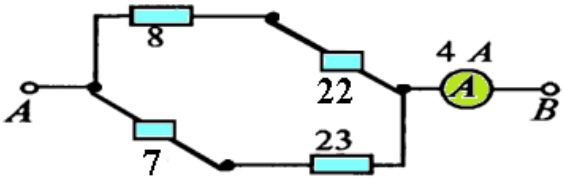


1-rasm

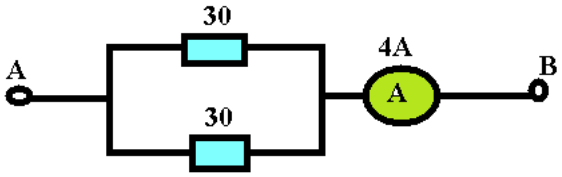


1,1-rasm

1-rasmdagi sxemadagi 8Ω va 36 Ω, 2 Ω va 12 Ω qarshiliklarni ketma-ket ulasak 1,1-rasm hosil bo‘ladi.1,1-rasmdagi 44 Ω va 44 Ω, 14 Ω va 14 Ω parallel ulasak sxema 1,2 rasm ko‘rinishiga keladi. 1,2-rasmdagi 8 Ω va 22 Ω, 7 Ω va 23 Ω qarshiliklarni ketma-ket ulasak sxemamiz 1,3-rasm ko‘rinishni egallaydi va bu sxemadan R_{Um} qarshilikni topamiz.



1,2-rasm.

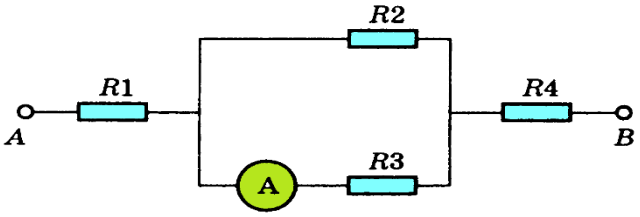


1,3-rasm.

$$R_{Um}=\frac{30\cdot 30}{30+30}=15\Omega;U=I\cdot R_{Um}=4\cdot 15=60v$$

22. Rasmda tasvirlangan sxemaning barcha rezistorlaridagi tok kuchi va kuchlanishni toping. (3-rezistordan o‘tadigan tok kuchi 2A)

$$R_1 = 2\Omega; R_2 = 10\Omega; R_3 = 15\Omega; R_4 = 4\Omega; I_3 = 2A$$



2- va 3- rezistorlar parallel ulanganligi uchun

$$U_2 = U_3 \to R_2 \cdot I_2 = R_3 \cdot I_3 \to I_2 = I_3 \frac{R_3}{R_2} = 2 \cdot \frac{15}{10} = 3A;$$

$$U_3 = U_2 = R_2 \cdot I_2 = 10 \cdot 3 = 30V$$

Krixgovning 1-qoidasiga ko‘ra

$$I = I_1 = I_4 = I_2 + I_3 = I_3 \frac{R_2 + R_3}{R_2} = 2\frac{10 + 15}{10} = 5A$$

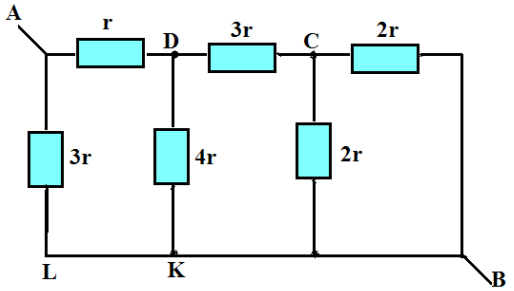
Om qonunidan kuchlanishni topamiz

$$U_1 = R_1 I_1 = I_3 \frac{R_1(R_2 + R_3)}{R_2} = 2\frac{2(10 + 15)}{10} = 10V$$

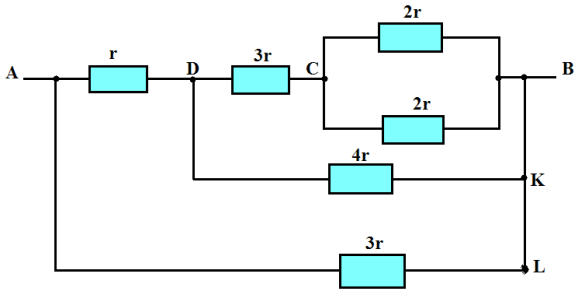
$$U_4 = R_4 I_4 = I_3 \frac{R_4(R_2 + R_3)}{R_2} = 2\frac{4(10 + 15)}{10} = 20V$$

$$U_{AB} = U_1 + U_4 + U_3 = 10 + 20 + 30 = 60V$$

23. Ava B nuqtalar orasidagi umumiy qarshilikni toping.



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz.



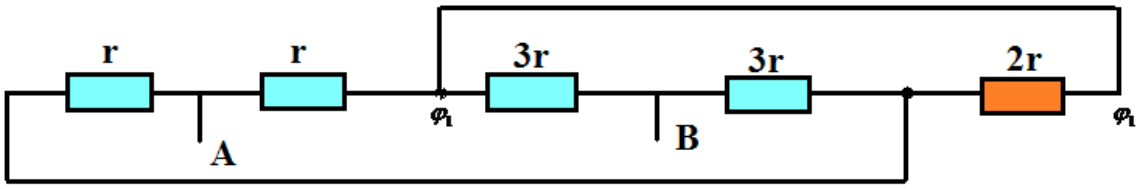
$$\frac{1}{R_{BS}} = \frac{1}{2r} + \frac{1}{2r} = \frac{1}{r} \to R_{BS} = r; R_{BD} = r + 3r = 4r$$

$$\frac{1}{R_{BDK}}=\frac{1}{R_{KD}}+\frac{1}{R_{BD}}=\frac{1}{4r}+\frac{1}{4r}=\frac{2}{4r}\rightarrow R_{BDK}=2r$$

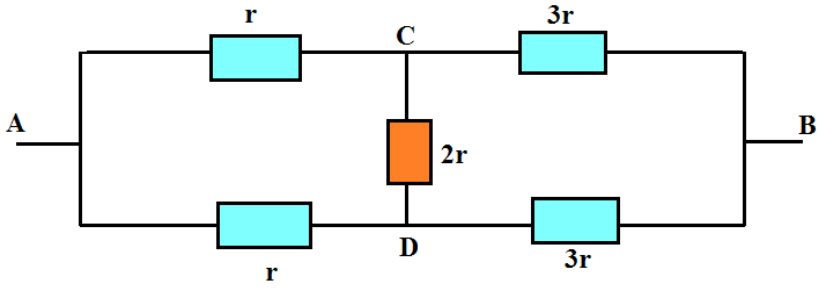
$$R_{BDKA}=R_{BDK}+R_{DA}=2r+r=3r;\frac{1}{R_{AB}}=\frac{1}{R_{BDKA}}+\frac{1}{R_{LA}}=\frac{1}{3r}+\frac{1}{3r}=\frac{2}{3r}$$

$$R_{AB}=1{,}5r$$

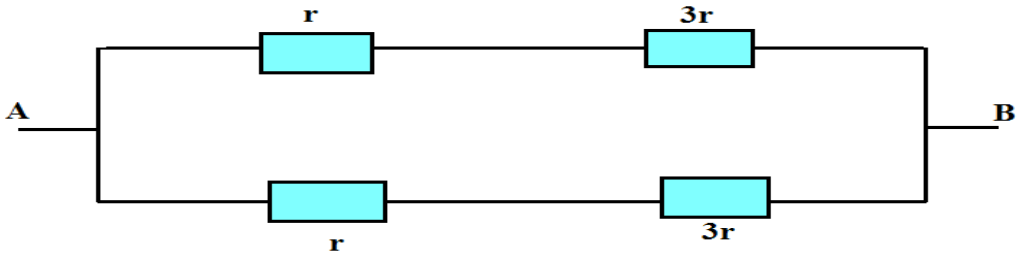
24. Rasmda tasvirlangan sxemaning umumiy qarshiligni hisobang?



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz

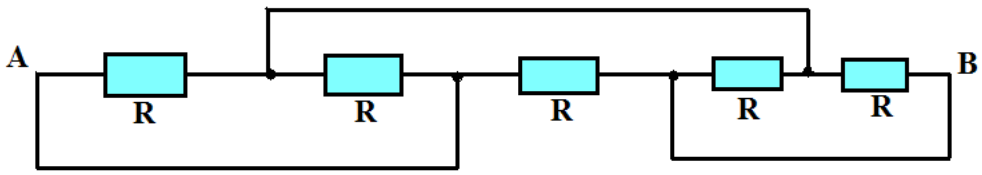


$\frac{r}{r}=\frac{3r}{3r}$ nisbat tenglagi uchun C va D nuqtalarda potensial bir xil, potensiallar farqi esa nolga teng. Demak 2r qarshilikdan tok o‘tmaydi, shuning uchun olib tashlaymiz.

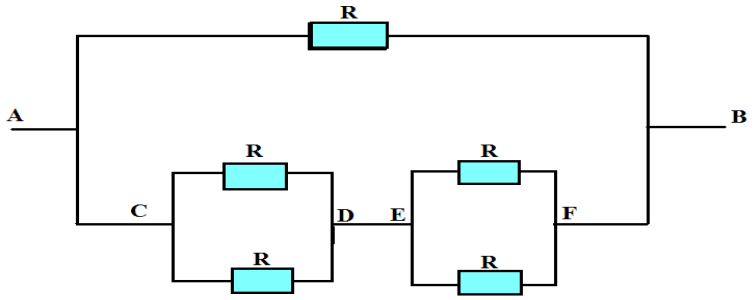


$$R'=r+3r=4r;\ \ R''=r+3r=4r;\ \ \frac{1}{R_{AB}}=\frac{1}{R'}+\frac{1}{R''}=\frac{1}{4r}+\frac{1}{4r}\rightarrow R_{AB}=2r$$

25. Har bir qarshilik R bo‘lsa umumiy qarshilikni toping. R_{AB}=?



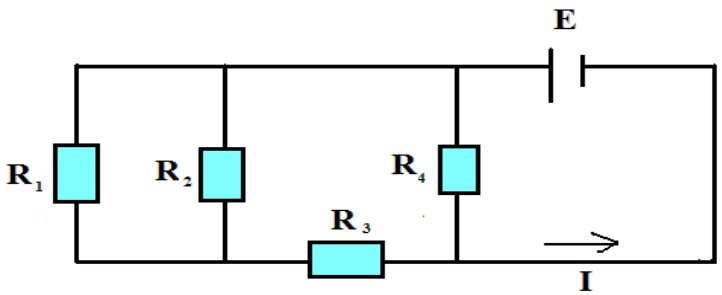
Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz



$$\frac{1}{R_{CD}}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R};R_{CD}=\frac{R}{2};\frac{1}{R_{EF}}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}R_{EF}=\frac{R}{2}$$

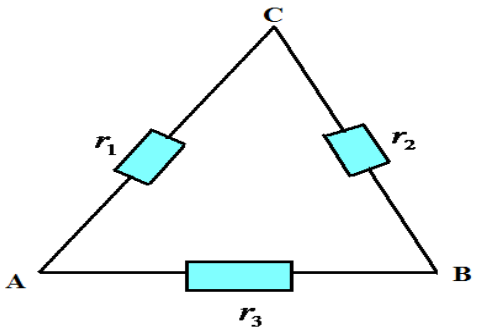
$$R_{CF}=R_{CD}+R_{EF}=\frac{R}{2}+\frac{R}{2}=R;\frac{1}{R_{AB}}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{AB}=\frac{R}{2}$$

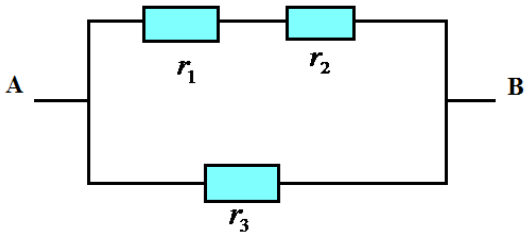
26. Quyidagi shaklda tasvirda manbaning ichki qarshiligini toping?



Berilgan:	Formula:	Yechilishi:
I=4A E=12V R=4 om	$I=\frac{E}{R_u+r}$	$\frac{1}{R^*}=\frac{1}{4}+\frac{1}{4}=\frac{2}{4}\rightarrow R^*=2\Omega$
r-?	$IR_u+Ir=E$	$R^{**}=2+4=6\Omega$
	$r=\frac{E}{I}-R_u$	$\frac{1}{R_u}=\frac{1}{6}+\frac{1}{4}=\frac{5}{12}\rightarrow R_u=2{,}4\Omega$
	$\frac{1}{R^*}=\frac{1}{R_1}+\frac{1}{R_2}$	$r=\frac{12}{4}-2{,}4=3-2{,}4=0{,}6\Omega$
	$R^{**}=R^*+R_3$	$Javob: r=0{,}6\Omega$
	$\frac{1}{R_u}=\frac{1}{R^{**}}+\frac{1}{R_4}$	

27. Uchta qarshilik rasmda ko‘rsatilgan sxema bo‘yicha ulangan. Qarshiliklar zanjirning AB nuqtalariga ulangan bo‘lsa,tutashmaning qarshiligini toping. (R_{AB}=?)

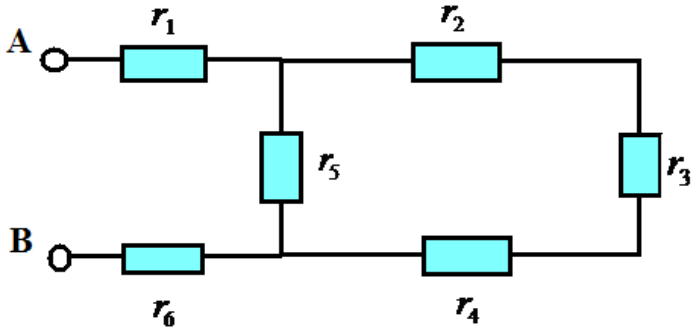




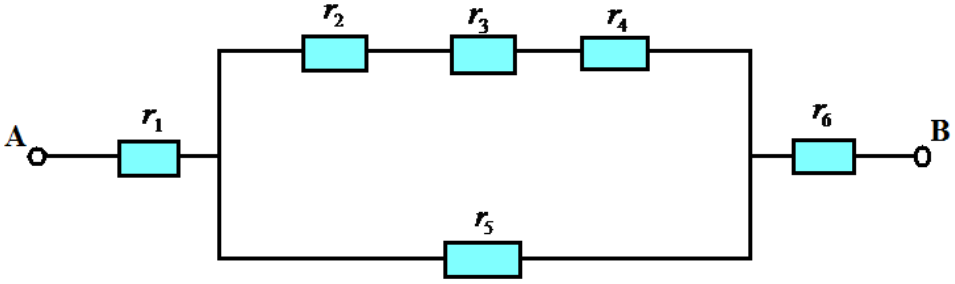
Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

Berilgan:	Formula:	Yechilishi:
$r_1 = 20\Omega$ $r_2 = 30\Omega$ $r_3 = 50\Omega$	Qarshiliklarni parallel ulash: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_n}$	$R^* = r_1 + r_2 = 20 + 30 = 50\Omega$ $\frac{1}{R_{AB}} = \frac{1}{R^*} + \frac{1}{r_3}$ $= \frac{1}{50} + \frac{1}{50}$ $= \frac{2}{50}$
R_{AB}-?	Qarshiliklarni ketma-ket ulash $R_K = R_1 + R_2 + R_3 + \ldots R_n$	$R_{AB} = 25\Omega$

28. Rasmda ko‘rsatilgan zanjirning umumiy qarshiligini hisoblang? (R_{AB}=?)

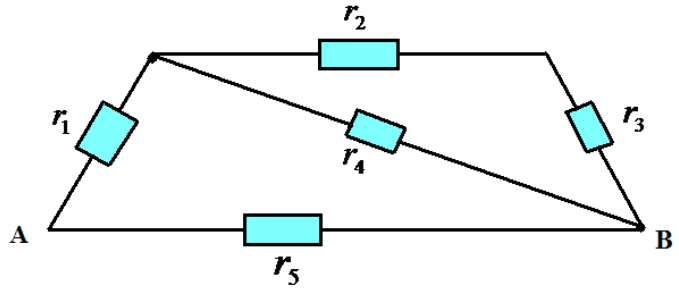


Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz.

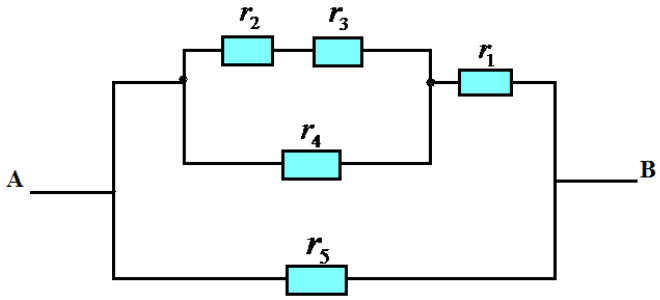


Berilgan:	Formula:	Yechilishi:
$r_1 = 4\Omega$ $r_2 = 5\Omega$ $r_3 = 5\Omega$ $r_4 = 5\Omega$ $r_5 = 10\Omega$ $r_6 = 10\Omega$ R_{AB}-?	Qarshiliklarni parallel ulash: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_n}$ Qarshiliklarni ketma-ket ulash $R_K = R_1 + R_2 + R_3 + \ldots R_n$	$R^* = r_2 + r_3 + r_4 = 5 + 5 + 5 = 15\Omega$ $\frac{1}{R^{**}} = \frac{1}{R^*} + \frac{1}{r_5} = \frac{1}{15} + \frac{1}{10}$; $R^{**} = 6\Omega$ $R_{AB} = r_1 + R^{**} + r_6 = 6 + 4 + 10 == 20\Omega$ *Javob*: $R_{AB} = 20\Omega$

29. Rasmda ko‘rsatilgan zanjirning umumiy qarshiligini hisoblang ? (R_{AB}=?)

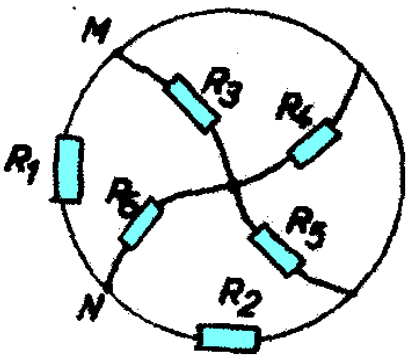


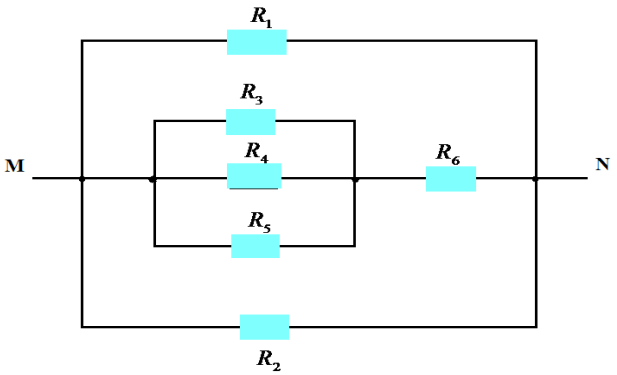
Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz



Berilgan:	Formula:	Yechilishi:
$r_1 = 2\Omega$ $r_2 = 3\Omega$ $r_3 = 5\Omega$ $r_4 = 8\Omega$ $r_5 = 6\Omega$ R_{AB}-?	Qarshiliklarni parallel ulash: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_n}$ Qarshiliklarni ketma-ket ulash $R_K = R_1 + R_2 + R_3 + \ldots R_n$	$R^* = r_2 + r_3 = 3 + 5 = 8\Omega$ $\frac{1}{R^{**}} = \frac{1}{R^*} + \frac{1}{r_4} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8}$; $R^{**} = 4\Omega$ $R^{***} = r_1 + R^{**} = 2 + 4 = 6\Omega$ $\frac{1}{R_{AB}} = \frac{1}{R^{***}} + \frac{1}{r_5}$ $R_{AB} = \frac{R^{***} \cdot r_5}{R^{***} + r_5} = \frac{6 \cdot 6}{6 + 6} = 3\ \Omega$ *Javob*: $R_{AB} = 3\Omega$

30. Rasmda tasvirlangan sxemaning M va N nuqtalari orasidagi qarshilikni aniqlang?





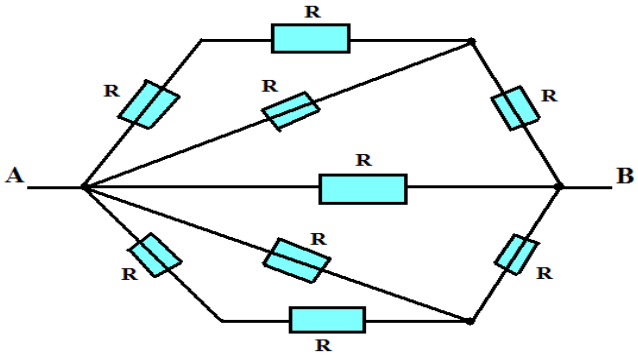
Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

Berilgan: $R_1 = R_3 = R_4 = R_5 = 3R; R_2 = 6R, R_6 = R$

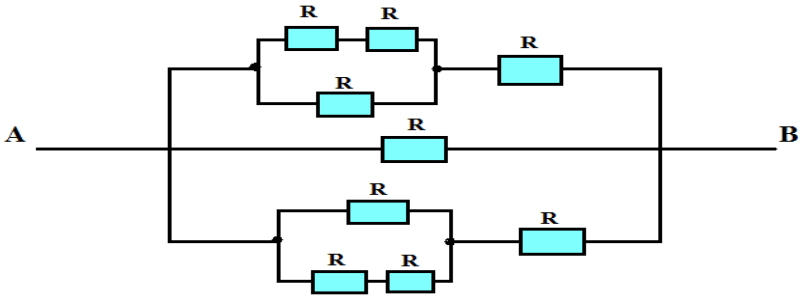
$$\frac{1}{R_{345}} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}; R_{345} = R;\ \ R_{3456} = R_{345} + R_6 = R + R = 2R$$

$$\frac{1}{R_{MN}} = \frac{1}{R_1} + \frac{1}{R_{3456}} + \frac{1}{R_2} = \frac{1}{3R} + \frac{1}{2R} + \frac{1}{6R}; R_{MN} = R$$

31. Agar har bir o‘tkazgichning qarshiligi R bo‘lsa. Zanjirning A va B nuqtalar orasidagi qismining umumiy qarshiligini toping.



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

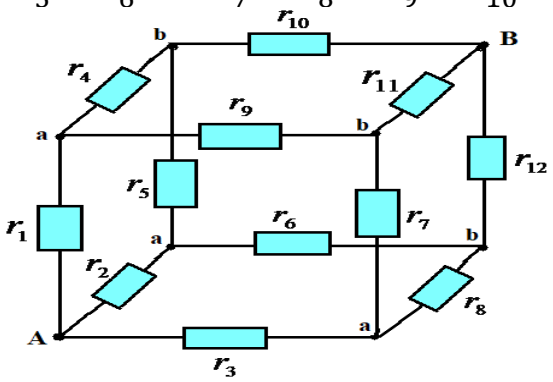


$$R_1 = R + R = 2R;\ \frac{1}{R_2} = \frac{1}{R_1} + \frac{1}{R} \rightarrow R_2 = \frac{3}{2}R;\ R_3 = R_2 + R = \frac{3}{2}R + R = \frac{5}{2}R$$

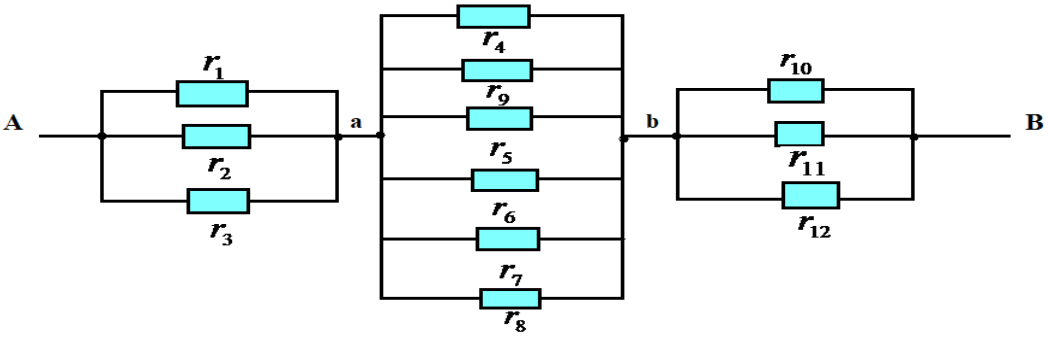
$$R_3 = R_6;\quad \frac{1}{R_{AB}} = \frac{1}{R_3} + \frac{1}{R} + \frac{1}{R_6} \rightarrow R_{AB} = \frac{5}{11}R$$

32.Agar har bir o‘tkazgichning qarshiligi R bo‘lsa. Zanjirning A va B nuqtalar orasidagi qismining umumiy qarshiligini toping.

$r_1 = r_2 = r_3 = r_4 = r_5 = r_6 == r_7 = r_8 = r_9 = r_{10} = r_{11} = r_{12} = R$



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz, buning uchun potensiallari bir xil bo‘lga a va b nuqtalarni tutashtiramiz



$$\frac{1}{R_1} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}; R_1 = \frac{R}{3}$$

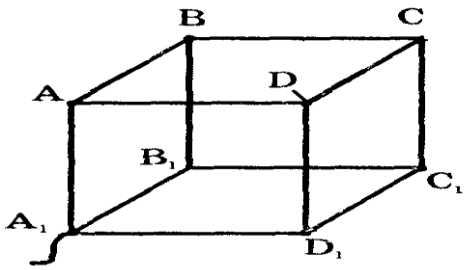
$$\frac{1}{R_2} = \frac{1}{r_4} + \frac{1}{r_9} + \frac{1}{r_5} + \frac{1}{r_6} + \frac{1}{r_7} + \frac{1}{r_8} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{6}{R}; R_2 = \frac{R}{6}$$

$$\frac{1}{R_3} = \frac{1}{r_{10}} + \frac{1}{r_{11}} + \frac{1}{r_{12}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}; R_3 = \frac{R}{3}$$

$$R_{AB} = R_1 + R_2 + R_3 = \frac{R}{3} + \frac{R}{6} + \frac{R}{3} = \frac{5R}{6}; Javob: R_{AB} = \frac{5}{6}R$$

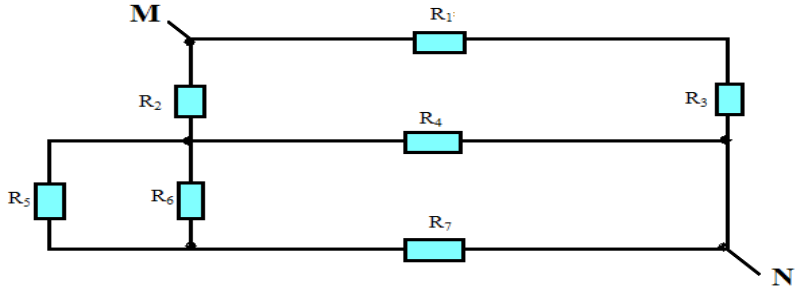
33.Agar har bir o‘tkazgichning qarshiligi R bo‘lsa. Zanjirning A_1 va D va A_1va D_1 nuqtalar orasidagi qismining umumiy qarshiligini toping.

$r_1 = r_2 = r_3 = r_4 = r_5 = r_6 == r_7 = r_8 = r_9 = r_{10} = r_{11} = r_{12} = R$

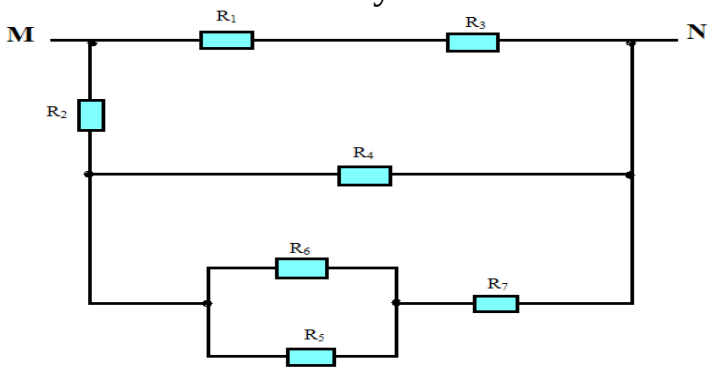


Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tish kondensatorlarga doir sxemalarning 11-12-13-masalalariga qarang.

34. Rasmda tasvirlangan zanjirning M va N nuqtalari orasidagi umumiy elektr qarshilikni aniqlang?

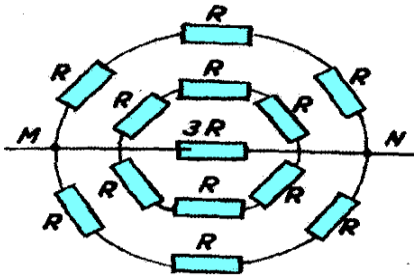


Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

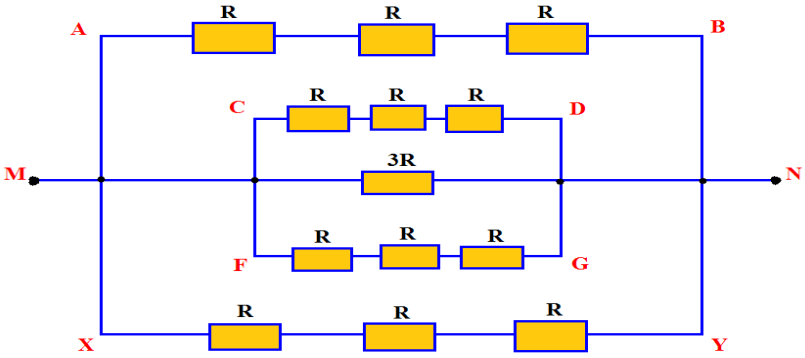


Berilgan:	Formula:	Yechilishi:
$R_1=R_2=R_3=$ $=R_5=R_6=R_7$ $==2R$ $R_4=6R$	Qarshiliklarni parallel ulash: $\frac{1}{R_P}=\frac{1}{R_1}+\frac{1}{R_2}+\ldots\frac{1}{R_n}$ Qarshiliklarni ketma-ket ulash $R_K=R_1+R_2+\ldots R_n$	$\frac{1}{R_{56}}=\frac{1}{R_5}+\frac{1}{R_6}: R_{56}=R$ $R_{567}=R_{56}+R_7=R+2R$ $=3R$ $\frac{1}{R_{5674}}=\frac{1}{R_{567}}+\frac{1}{R_4}; R_{5674}$ $=2R$ $R_{56742}=R_{5674}+R_2=4R$ $R_{12}=R_1+R_2=2R+2R$ $=4R$ $\frac{1}{R_{MN}}=\frac{1}{R_{12}}+\frac{1}{R_{56742}}$ $=\frac{1}{4R}+\frac{1}{4R}$ $R_{MN}=2R$ $R_{MN}=2R$
R_{MN}-?		

35. Rasmda tasvirlangan elektr zanjirining M va N nuqtalari orasidagi qarshilikni aniqlang?

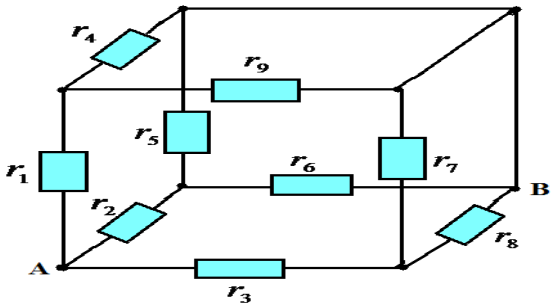


Bu zanjirni soddalashtiramiz va o‘zimizdan belgilash kiritamiz

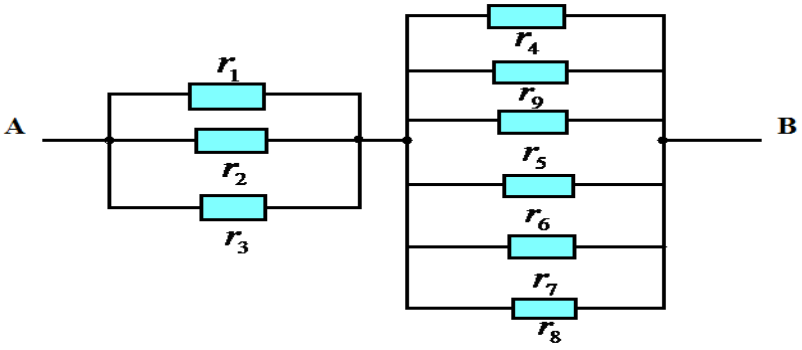


$$R_{AB} = R + R + R = 3R; R_{CD} = R + R + R = 3R; R_{FG} = R + R + R = 3R;$$
$$R_{XY} = R + R + R = 3R; \frac{1}{R_{MN}} = \frac{1}{3R} + \frac{1}{3R} + \frac{1}{3R} + \frac{1}{3R} + \frac{1}{3R} = \frac{5}{3R} \rightarrow R_{MN} = \frac{3}{5}R$$

36. Rasmda tasvirlangan elektr zanjirining A va B nuqtalari orasidagi qarshilikni aniqlang?



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz



Berilgan:

$$r_1 = r_2 = r_3 = r_4 = r_5 = r_6 = r_7 = r_8 = r_9 = R$$

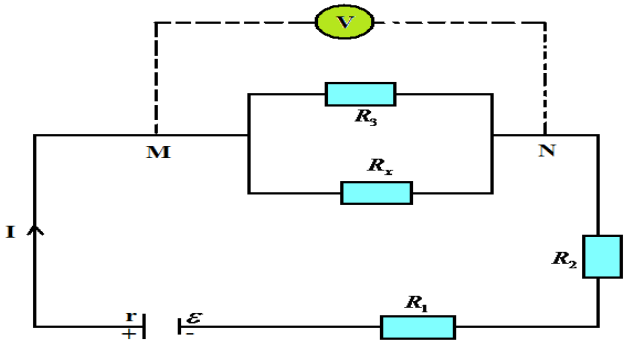
Yechilishi:

$$\frac{1}{R_1} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}; R_1 = \frac{R}{3}$$

$$\frac{1}{R_2} = \frac{1}{r_4} + \frac{1}{r_9} + \frac{1}{r_5} + \frac{1}{r_6} + \frac{1}{r_7} + \frac{1}{r_8} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{6}{R}; R_2 = \frac{R}{6}$$

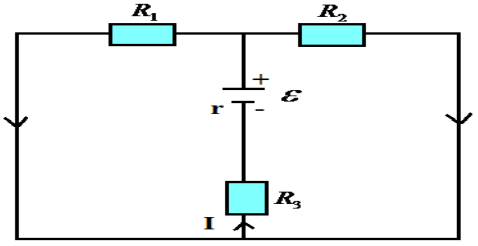
$$R_{AB} = R_1 + R_2 = \frac{R}{3} + \frac{R}{6} = \frac{3R}{6}; Javob: R_{AB} = \frac{1}{2}R$$

37. Elektr zanjir tarkibidagi R_x qarshilikni toping



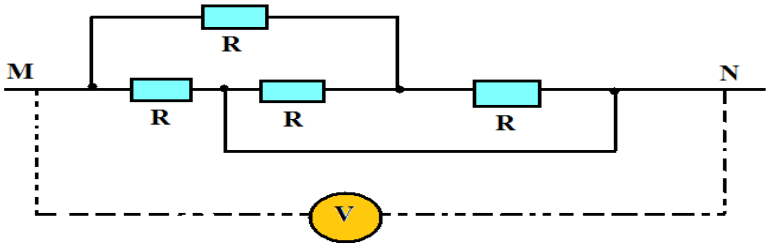
Berilgan:	Yechilishi:
$r = R_1 = 1\Omega;$ $R_2 = 2\Omega;$ $R_3 = 3\Omega$ $U_{MN} = 6v;$ $\varepsilon = 18v;$	Zanjirning bir qismi uchun va to‘liq zanjir uchun Om qonunini tenglashtiramiz. $I = \frac{U}{R_{MN}} \to I = \frac{\varepsilon}{R_{umumiy} + r} \to \frac{U}{R_{MN}} = \frac{\varepsilon}{R_{umumiy} + r}$ $R_{umumiy} = R_{MN} + R_1 + R_2$ $\frac{U}{R_{MN}} = \frac{\varepsilon}{R_{MN} + R_1 + R_2 + r}; \frac{6}{R_{MN}} = \frac{18}{R_{MN} + 1 + 2 + 1};$ $18R_{MN} = 6R_{MN} + 24; 12R_{MN} = 24; R_{MN} = 2;$ $R_{MN} = \frac{R_3 \cdot R_x}{R_3 + R_x} = 2; 3R_x = 6 + 2R_x; R_x = 6\Omega$
R_x-?	

38. Elektr zanjiridagi tok kuchini aniqlang ?

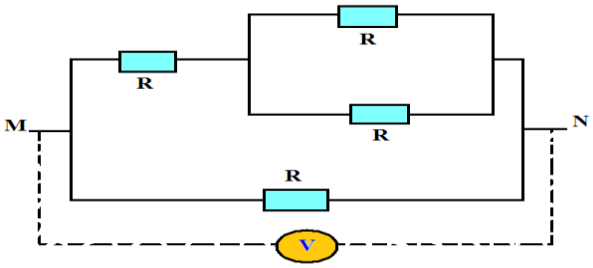


Berilgan:	Formula:	Yechilishi:
$R_1 = R_2 = 4\Omega$ $R_3 = 5\Omega$ $r = 1\Omega;$ $\varepsilon = 16V$	Qarshiliklarni parallel ulash: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}$	$I = \frac{\varepsilon}{R_{umum} + r}; \frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2};$ $R_{12} = 2\Omega; R_{umum} = R_{12} + R_3 = 2 + 5 = 7\Omega;$ $I = \frac{16}{7+1} = \frac{16}{8} = 2A$
I-?	Qarshiliklarni ketma-ket ulash $R_K = R_1 + R_2 + \ldots R_n$	

39. Elektr zanjiridagi tok kuchini aniqlang ? $R = 1\Omega;\ U = 3v$

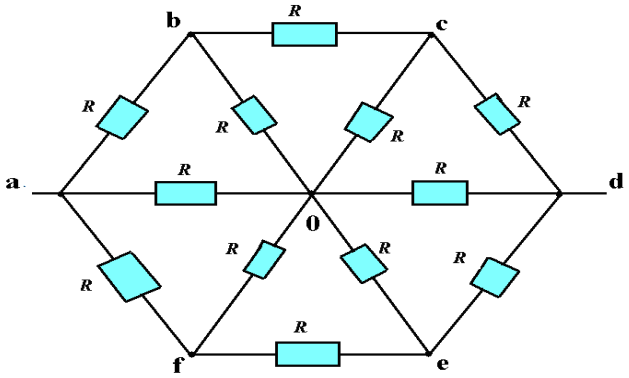


Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

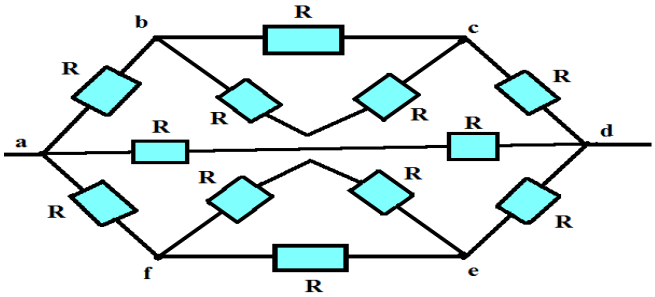


Formula:	Yechilishi:
Qarshiliklarni parallel ulash: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}$ Qarshiliklarni ketma-ket ulash $R_K = R_1 + R_2 + \ldots R_n$	$I = \frac{U}{R_{umum}};$ $\frac{1}{R_{12}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}; R_{12} = 0{,}5\Omega;$ $R_{123} = R_{12} + R_3 = 0{,}5 + 1 = 1{,}5\Omega$ $\frac{1}{R_{MN}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{1}{1{,}5} + \frac{1}{0{,}5}; R_{MN} = \frac{1{,}5}{4}\Omega;$ $I = \frac{3}{\frac{1{,}5}{4}} = \frac{12}{1{,}5} = 8A$

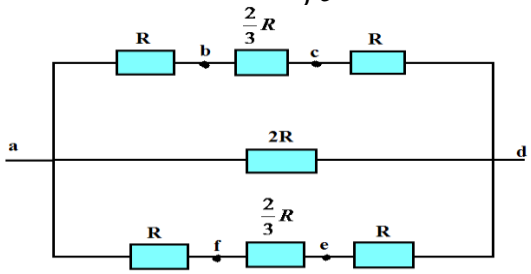
40. Rasmda tasvirlangan zanjir R bo‘lgan qarshilikdan tuzilgan zanjirning AB nuqta orasidagi qarshiligini hisoblab toping?



Barcha qarshiliklar bir xil bo‘lganligi uchun o nuqtani uzamiz va quyidagicha chizmaga ega bo‘lamiz.



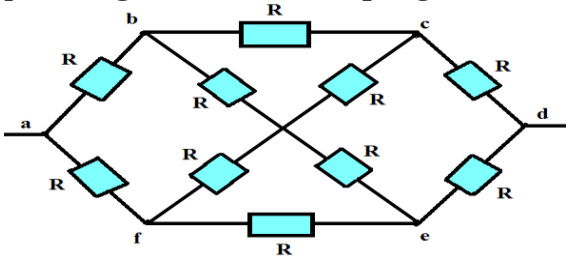
$$\frac{1}{R_{bc}}=\frac{1}{R}+\frac{1}{2R}=\frac{3}{2R}\rightarrow R_{bc}=\frac{2}{3}R;\frac{1}{R_{fe}}=\frac{1}{R}+\frac{1}{2R}=\frac{3}{2R}\rightarrow R_{fe}=\frac{2}{3}R$$



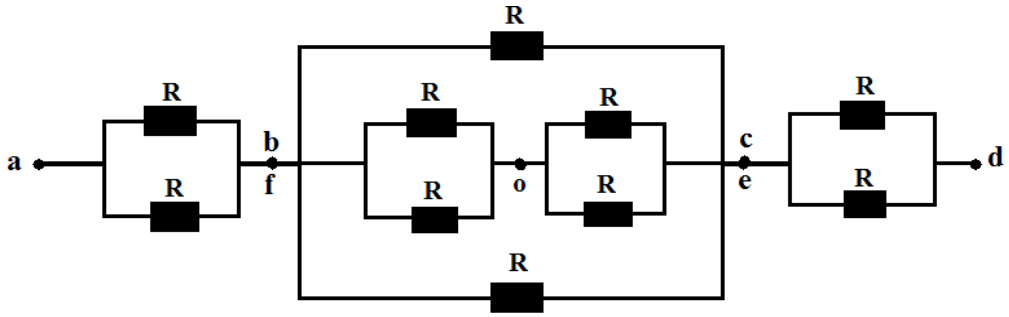
$$R_{abcd}=R+\frac{2}{3}R+R=\frac{8}{3}R;R_{afed}=R+\frac{2}{3}R+R=\frac{8}{3}R$$

$$\frac{1}{R_{ad}}=\frac{1}{R_{abcd}}+\frac{1}{R_{afed}}+\frac{1}{2R}=\frac{3}{8R}+\frac{3}{8R}+\frac{1}{2R}=\frac{10}{8R}\rightarrow R_{ad}=\frac{8R}{10}=\frac{4R}{5}$$

41. Rasmda tasvirlangan zanjir R bo‘lgan qarshilikdan tuzilgan zanjir qismining umumiy qarshiligini hisoblab toping?



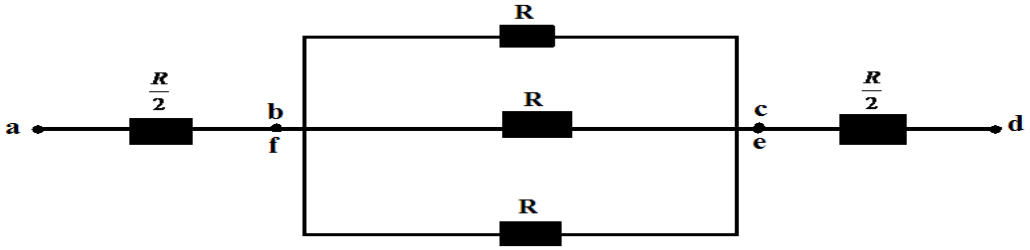
1-usul: Zanjirning bf va ce nuqtalarning potensiallari tengligi uchun ularni tutashtiramiz.Bu zanjirni tushunarli bo‘lishi uchun quyidagicha soddalashtiramiz:



Berilganlardan foydalanib qarshiliklarni parallel ulash formulasidan foydalanib hisoblaymiz va sxemamiz yanada soddalashadi

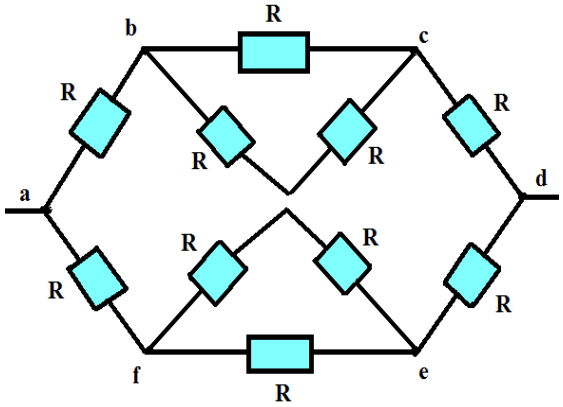
$$\frac{1}{R_{ab}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{ab}=\frac{R}{2};\frac{1}{R_{bo}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{bo}=\frac{R}{2};\frac{1}{R_{oc}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{oc}=\frac{R}{2};$$

$$R_{bc}=R_{bo}+R_{oc}=\frac{R}{2}+\frac{R}{2}=R;\frac{1}{R_{cd}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{cd}=\frac{R}{2}$$

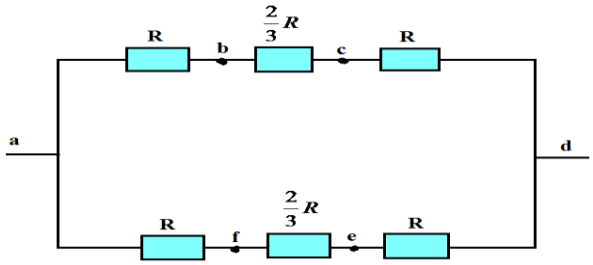


$$\frac{1}{R_{bc}}=\frac{1}{R}+\frac{1}{R}+\frac{1}{R}\rightarrow R_{bc}=\frac{R}{3};R_{ad}=\frac{R}{2}+\frac{R}{3}+\frac{R}{2}=\frac{4R}{3}$$

2-usul: Barcha qarshiliklar bir xil bo‘lganligi uchun o nuqtani uzamiz va quyidagicha chizmaga ega bo‘lamiz.



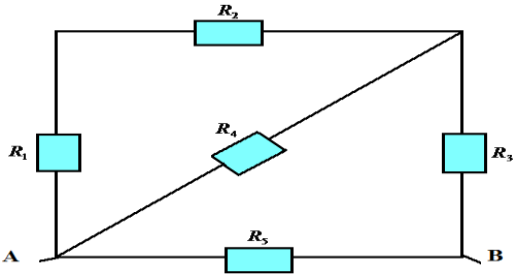
$$\frac{1}{R_{bc}}=\frac{1}{R}+\frac{1}{2R}=\frac{3}{2R}\rightarrow R_{bc}=\frac{2}{3}R;\frac{1}{R_{fe}}=\frac{1}{R}+\frac{1}{2R}=\frac{3}{2R}\rightarrow R_{fe}=\frac{2}{3}R$$



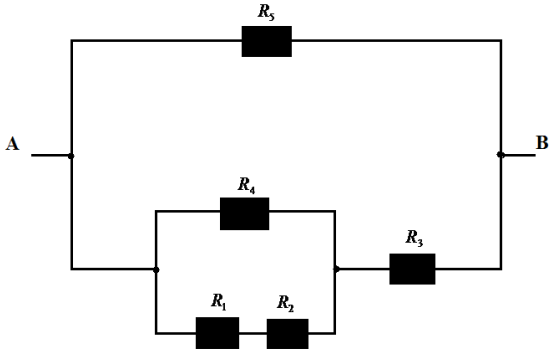
$$R_{abcd} = R + \frac{2}{3}R + R = \frac{8}{3}R \rightarrow R_{afed} = R + \frac{2}{3}R + R = \frac{8}{3}R$$

$$\frac{1}{R_{ad}} = \frac{1}{R_{abcd}} + \frac{1}{R_{afed}} = \frac{3}{8R} + \frac{3}{8R} = \frac{6}{8R}; R_{ad} = \frac{8R}{6} = \frac{4R}{3}$$

42. Rasmda tasvirlangan qarshiliklari R ga teng.Zanjir umumiy qarshiligini hisoblab toping? $R_1 = R_2 = R_3 = R_4 = R_5 = R$



Bu sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz va hisoblaymiz

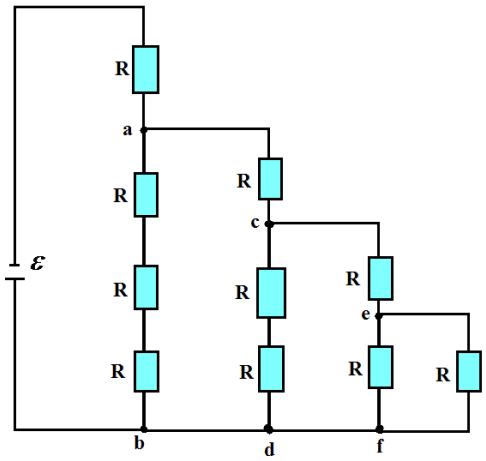


$$R_{12} = R_1 + R_2 = R + R = 2R; \frac{1}{R_{124}} = \frac{1}{R_{12}} + \frac{1}{R_4} = \frac{1}{2R} + \frac{1}{R} = \frac{3}{2R} \rightarrow R_{124} = \frac{2}{3}R$$

$$R_{1243} = R_{124} + R_3 = \frac{2}{3}R + R = \frac{5}{3}R; \frac{1}{R_{AB}} = \frac{1}{R_{1243}} + \frac{1}{R_5} = \frac{3}{5R} + \frac{1}{R} = \frac{8}{5R} \rightarrow$$

$$\rightarrow R_{AB} = \frac{5}{8}R$$

43. Rasmda tasvirlangan sxemadagi tok manbai orqali o‘tuvchi I tokni aniqlang. Sxemaning hamma qarshiligi birday va $R = 68\Omega$ gat eng,manbaning E.Yu.K esa $\varepsilon = 14V$ .Manbaning ichki qarshiligini hisobga olmang.



$$\frac{1}{R_{ef}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{ef}=\frac{R}{2};R_{efc}=\frac{R}{2}+R=\frac{3}{2}R\rightarrow R_{cd}=R+R=2R\frac{1}{R_{fecd}}$$

$$=\frac{2}{3R}+\frac{1}{2r}\rightarrow R_{fecd}=\frac{6}{7}R;R_{fecda}=R_{fecd}+R=\frac{6}{7}R+R=\frac{13}{7}R$$

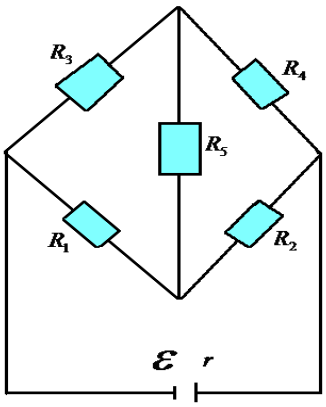
$$R_{ba}=R+R+R=3R;\frac{1}{R_{fecdab}}=\frac{1}{R_{fecda}}+\frac{1}{R_{ba}}=\frac{7}{13R}+\frac{1}{3R};R_{fecdab}=\frac{39}{34}R$$

$$R_{Umumiy}=R_{fecdab}+R=\frac{39}{34}R+R=\frac{73}{34}R$$

$$R_{Umumiy}=\frac{73}{34}R=\frac{73}{34}\cdot 68=146\Omega;I=\frac{\varepsilon}{R}=\frac{14}{146}\approx 0{,}1A$$

44. Rasmda tasvirlangan sxema qanday quvvat istemol qiladi.Elementning E.Yu.K $\varepsilon=12V$, ichki qarshiligi $r=0{,}4\Omega;R_1=2\Omega;R_2=4\Omega;R_3=3\Omega;R_4=6\Omega;$

$$R_5=10\Omega$$



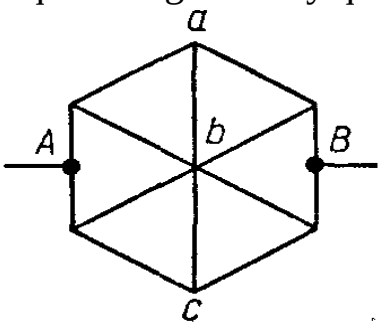
$\frac{R_1}{R_3}=\frac{R_2}{R_4}$shartdan R_5 qarshilikdan tok o‘tmaganligi kelib chiqadi(isbot 48-masalada). Shuning uchun zanjirning to‘la R qarshiligi R_1, R_2 va R_3, R_4 qarshiliklardan tuzilgan ikki parallel zanjir qarshiligi va elementning r ichki qarshiligi yig‘indisidan iborat bo‘ladi.

$$R_{34}=R_3+R_4=3+6=9\Omega;R_{12}=R_1+R_2=2+4=6\Omega$$

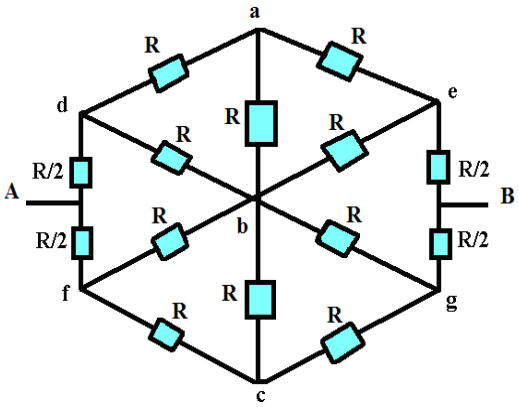
$$\frac{1}{R}=\frac{1}{R_{34}}+\frac{1}{R_{12}}=\frac{1}{9}+\frac{1}{6}=\frac{2}{18}+\frac{3}{18}=\frac{5}{18};R=\frac{18}{5}=3{,}6\Omega$$

$$N = I \cdot \varepsilon = \frac{\varepsilon}{R+r} \cdot \varepsilon = \frac{\varepsilon^2}{R+r} = \frac{144}{3{,}6+0{,}4} = \frac{144}{4} = 36W$$

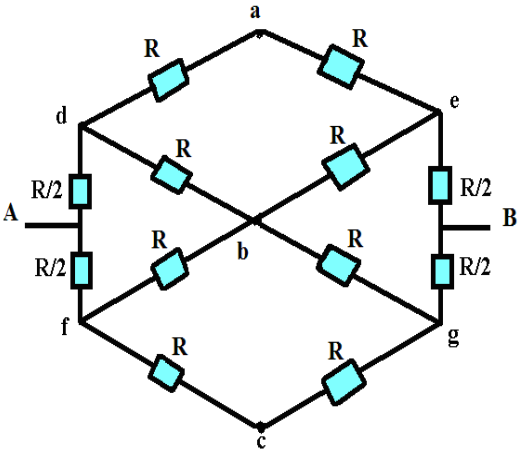
45. Rasmda tasvirlangan sxemaning har bir qismining qarshiligi R bo‘lgan qarshilikdan tuzilgan zanjir qismining umumiy qarshiligini hisoblab toping?



Sxemadagi qarshiliklarni tushunarli bo‘lishi uchun uni quyidagicha tasvirlaymiz

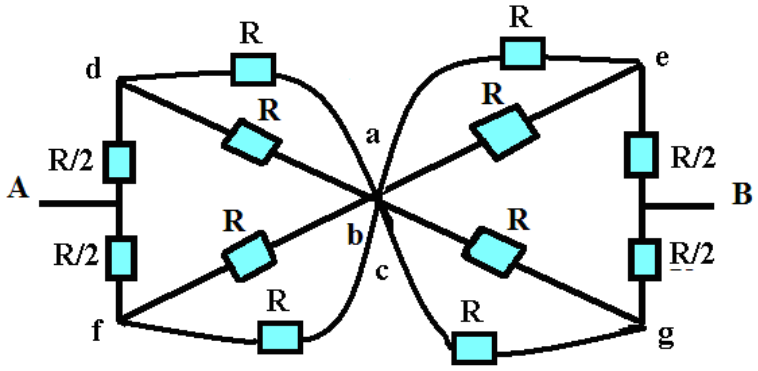


Sxemaning qarshiliklari bir-xil bo‘lganligi uchun a ,b,c nuqtalarda potensial bir xil $\varphi_a = \varphi_b = \varphi_c$ bo‘lganligi uchun potensiallar farqi $\varphi_a - \varphi_b = \varphi_c - \varphi_b = 0$ ga teng bo‘ladi va abva bc qismdan tok o‘tmaydi(Isbot 48-masalada) . Shuning uchun ab va bc qarshiliklarni olib tashlaymiz va sxema quyudagi ko‘rinishga ega bo‘ladi.



Bu sxema 2-xil usulda bajariladi

1-Usul: abc nuqtalarni potensiali bir xil bo‘lganligi uchun tutashtiramiz



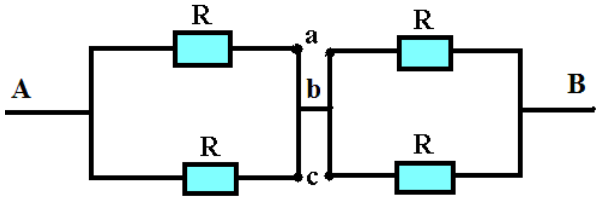
$$\frac{1}{R_{da}}=\frac{1}{R}+\frac{1}{R};R_{da}=\frac{R}{2};R_{Aa}=\frac{R}{2}+R_{da}=\frac{R}{2}+\frac{R}{2}=R$$

$$\frac{1}{R_{fc}}=\frac{1}{R}+\frac{1}{R};R_{fc}=\frac{R}{2};R_{Ac}=\frac{R}{2}+R_{dc}=\frac{R}{2}+\frac{R}{2}=R$$

$$\frac{1}{R_{ea}}=\frac{1}{R}+\frac{1}{R};R_{ea}=\frac{R}{2};R_{Ba}=\frac{R}{2}+R_{ea}=\frac{R}{2}+\frac{R}{2}=R$$

$$\frac{1}{R_{gc}}=\frac{1}{R}+\frac{1}{R};R_{gc}=\frac{R}{2};R_{Bc}=\frac{R}{2}+R_{gc}=\frac{R}{2}+\frac{R}{2}=R$$

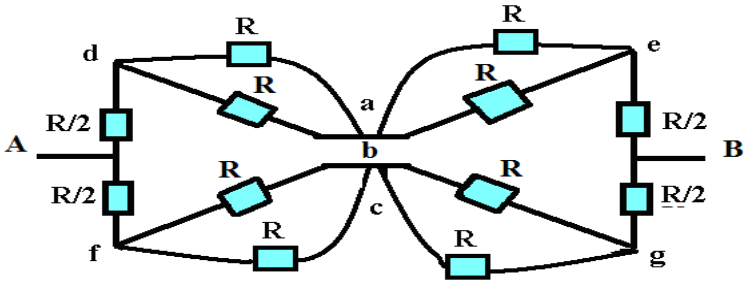
Ushbu hisoblashdan so‘ng sxema quyidagicha sodda holga keladi.



$$\frac{1}{R_{Ab}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{Ab}=\frac{R}{2};\frac{1}{R_{bB}}=\frac{1}{R}+\frac{1}{R}\rightarrow R_{bB}=\frac{R}{2}$$

$$;R_{AB}=R_{Ab}+R_{bB}=\frac{R}{2}+\frac{R}{2}=R$$

2-Usul sxemani b nuqtadan kesamiz va sxema quyidagi holga keladi



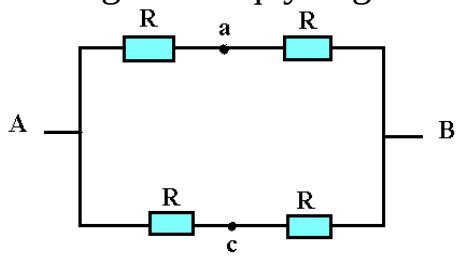
$$\frac{1}{R_{da}}=\frac{1}{R}+\frac{1}{R};R_{da}=\frac{R}{2};R_{Aa}=\frac{R}{2}+R_{da}=\frac{R}{2}+\frac{R}{2}=R$$

$$\frac{1}{R_{fc}}=\frac{1}{R}+\frac{1}{R};R_{fc}=\frac{R}{2};R_{Ac}=\frac{R}{2}+R_{dc}=\frac{R}{2}+\frac{R}{2}=R$$

$$\frac{1}{R_{ea}}=\frac{1}{R}+\frac{1}{R};R_{ea}=\frac{R}{2};R_{Ba}=\frac{R}{2}+R_{ea}=\frac{R}{2}+\frac{R}{2}=R$$

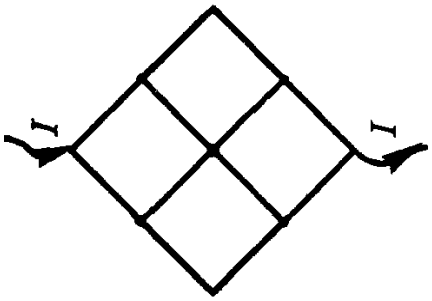
$$\frac{1}{R_{gc}}=\frac{1}{R}+\frac{1}{R};R_{gc}=\frac{R}{2};R_{Bc}=\frac{R}{2}+R_{gc}=\frac{R}{2}+\frac{R}{2}=R$$

Ushbu hisoblashdan so‘ng sxema quyidagicha sodda holga keladi.



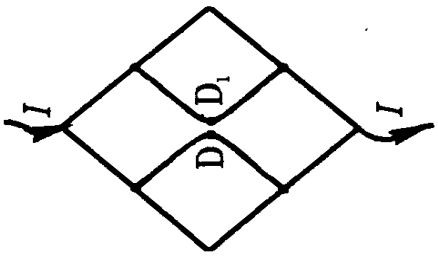
$$\frac{1}{R_{AB}}=\frac{1}{2R}+\frac{1}{2R};\rightarrow\quad R_{AB}=R$$

46. Quyidagi sxemaning umumiy qarshiligini toping

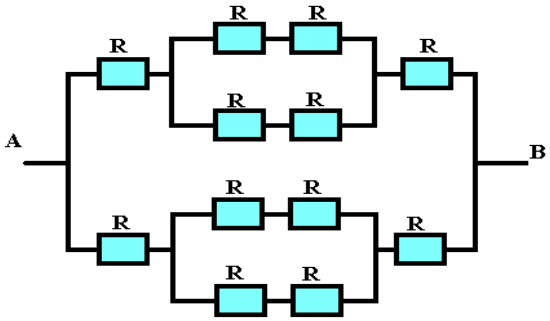


Bu masala ikki usulda yechiladi

1-Usul:Markazidan ikkiga ayiramiz

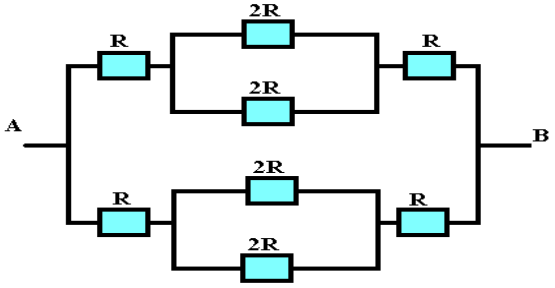


1-rasm

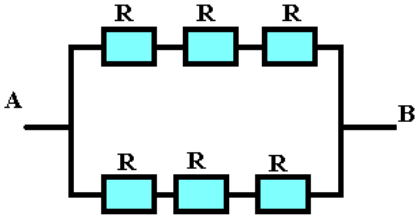


2-rasm (1-rasmning sodda ko‘rinishi)

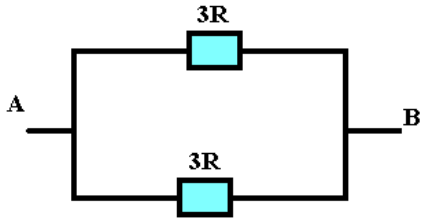
2-rasmdagi ketma-ket joylashgan qarshiliklar hisoblansa 3-rasmdagi sxema hosil bo‘ladi.



3-rasm

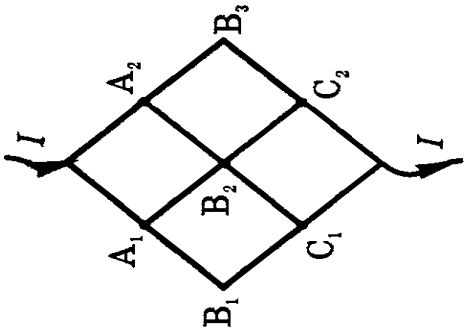


4-rasm (3-rasmni sodda ko‘rinishi)

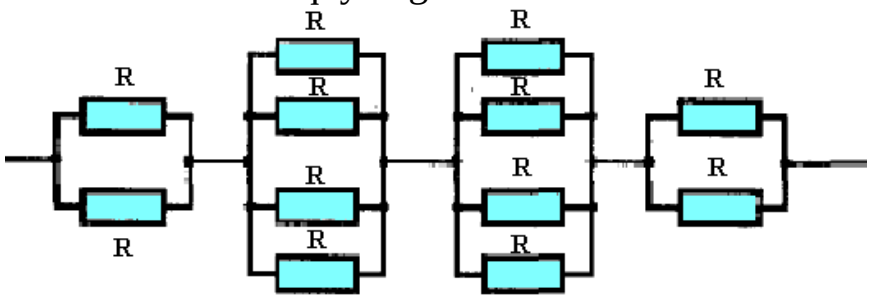


$$\frac{1}{R_{AB}} = \frac{1}{3R} + \frac{1}{3R}; R_{AB} = \frac{3}{2}R$$

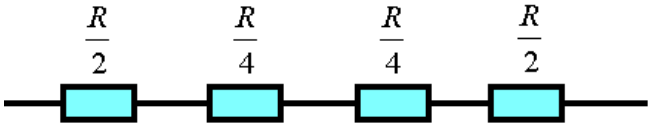
2-Usul: Sxemaning A_1 va A_2; B_1 ,B_2 va B_3; C_1 va C_2 nuqtalarni potensiali tengligi uchun ularni tutashtiramiz.



Sxemani quyidagicha soddalashadi.

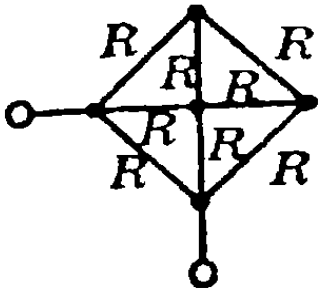
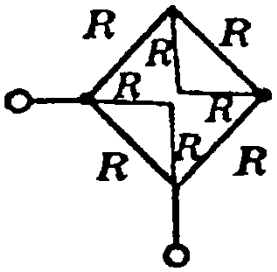


Yuqoridagi sxemadagi qarshiliklarni parallel ulasak quyidagicha soddalashadi

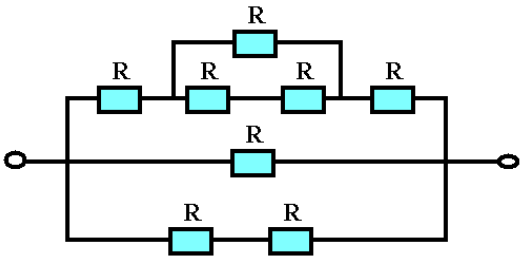


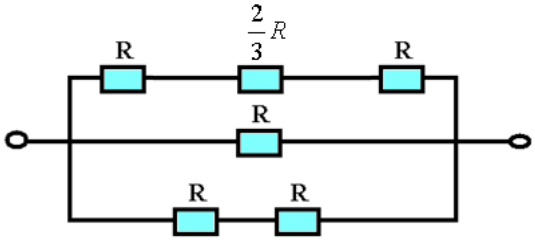
$$R_{Um} = \frac{R}{2} + \frac{R}{4} + \frac{R}{4} + \frac{R}{2} = \frac{3R}{2} \rightarrow R_{Um} = \frac{3R}{2}$$

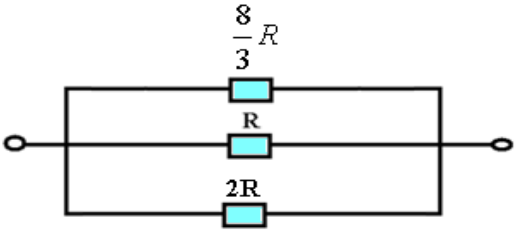
47. Zarjirning umumiy qarshiligini toping

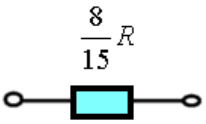



Sxemani soddalashtirish uchun markazni ikki qismga ajratamiz va ikkinchi sxemani murakkabdan sodda ko‘rinishga o‘tamiz.

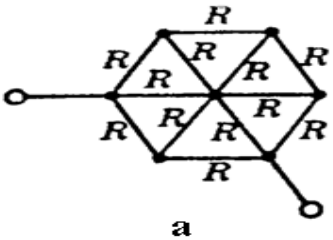

1-rasm

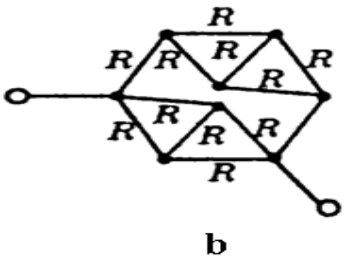

2-rasm (1-rasmning hisoblangan holati)

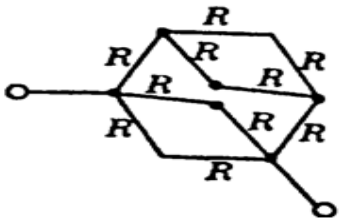

3-rasm (2-rasmning hisoblangan holati)


4-rasm Natija

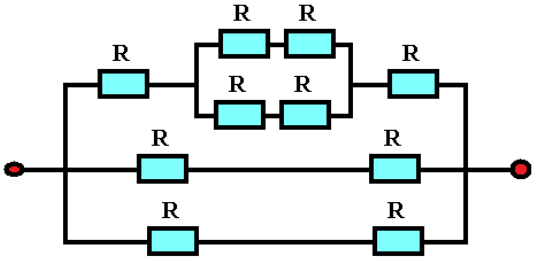
48. Zarjirning umumiy qarshiligini toping(a-rasm)

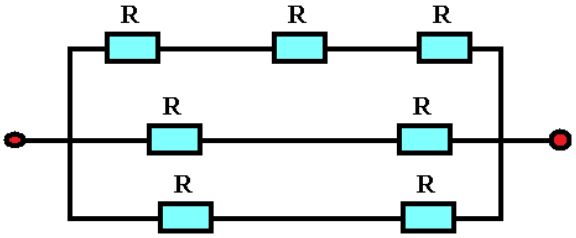

a

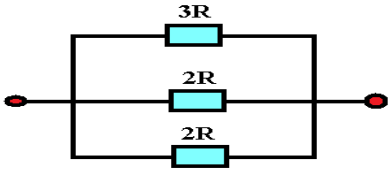

b


c

Zanjirning umumiy qarshiligini topish uchun b va c rasmlar kabi soddalashtiramiz va c rasmni quyidagi tushunarli sodda holga keltiramiz.


1-rasm

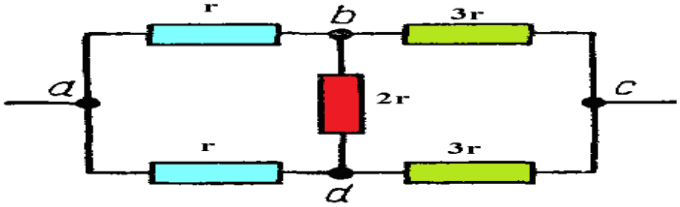

2-rasm (1-rasmning hisoblangan holati)



3-rasm. (2-rasmning hisoblangan holati)

$$\frac{1}{R_{Um}} = \frac{1}{3R} + \frac{1}{2R} + \frac{1}{2R} = \frac{8}{6R} \rightarrow R_{Um} = \frac{3R}{4}$$

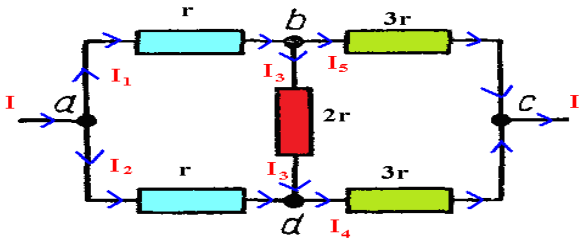
48. Rasmdagi sxemaning ac nuqta orasidagi umumiy qarshilikni toping



b va d nuqtalarda potensiallari bir xil $\varphi_b = \varphi_d$ bo‘lganligi uchun bd nuqtalar orasidagi potensiallar farqi $U_{bd} = \varphi_b - \varphi_d = 0$ ga teng ya’ni bd yo‘nalishda tok o‘tmaydi

ISBOT

Tok o‘tmasligini isbotlash uchun sxemaga tok kuchini joylashtirib chiqamiz yo‘nalishi bilan



Kirxgofning 1-qoidasiga ko‘ra

$$\begin{cases} I_3 + I_5 = I_1 \\ I_3 + I_2 = I_4 \end{cases} \qquad (1)$$

Kirxgofning 2-qoidasiga ko‘ra $\sum IR = \sum \varepsilon$

$$\begin{cases} I_1 r + I_3 2r - I_2 r = 0 \\ I_5 3r - I_4 3r - I_3 2r = 0 \end{cases} \rightarrow \begin{cases} I_1 + 2I_3 = I_2 \\ 3I_5 = 3I_4 + 2I_3 \end{cases} \qquad (2)$$

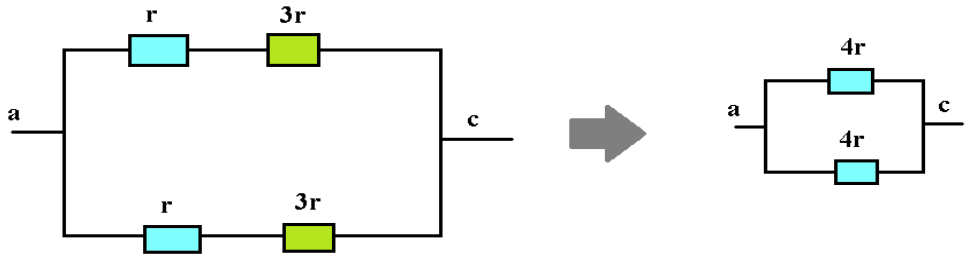
(1)-tenglamani qo‘shib tok kuchilar o‘rniga (2) tenglamalardan toklarni keltirib qo‘ysak

$$+\begin{cases} I_3 + I_5 = I_1; \\ I_3 + I_2 = I_4 \end{cases} \quad 2I_3 + I_5 + I_2 = I_1 + I_4$$

$$2I_3 + I_5 - I_4 = I_1 - I_2 \quad \begin{cases} I_1 + 2I_3 = I_2 \\ 3I_5 = 3I_4 + 2I_3 \end{cases} \rightarrow \begin{cases} I_1 - I_2 = -2I_3 \\ I_5 - I_4 = \frac{2}{3} I_3 \end{cases}$$

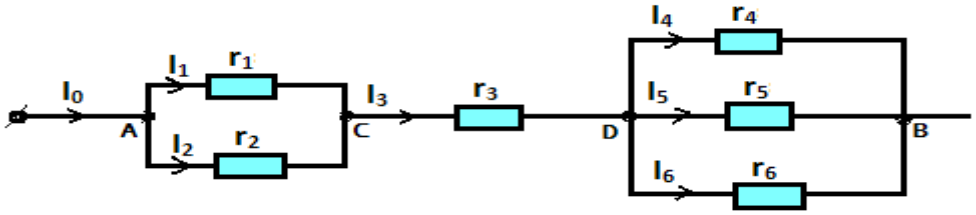
$$2I_3 + I_5 - I_4 = I_1 - I_2 \rightarrow 2I_3 + \frac{2}{3} I_3 = -2I_3 \rightarrow I_3 = 0$$

Bu natijalardan ko‘rinadiki 3-rezistordan tok o‘tmas ekan.Shuning uchun bd rezistorni olib tashlaymiz va sxemamiz quyidagi soda holga keladi



$$\frac{1}{R_{ab}}=\frac{1}{4r}+\frac{1}{4r}\rightarrow R_{ab}=2r$$

49. Agar kuchlanish U_{AB} =48v, r_1= r_3=3Ω; r_2=6 Ω, r_4=5 Ω ,r_5=10 Ω va r_6=30 Ω bo‘lsa. Zanjirdagi har bir qarshilikdan o‘tayotgan toklarni $I_1;I_2;I_3;I_4;I_5;I_6$ kuchlari va zanjirning AC ,CD, DB qismlaridagi U_{AC} ,U_{CD} ,U_{DB} kuchlanishlarni toping.



Berilgan: U_{AB} =48v, r_1= r_3=3Ω; r_2=6 Ω, r_4=5 Ω ,r_5=10 Ω va r_6=30 Ω

Topish kerak: $I_1;I_2;I_3;I_4;I_5;I_6$? U_{AC} =? U_{CD} =? U_{DB}?

Yechish:

Berilgan sxemada tarmoqlangan nuqtalari A,C,D va B harflar bilan belgilaymiz.Zanjirning AC,CD,DB qismlari o‘zaro ketma-ket ulanganligi sababli zanjirning umumiy qarshiligi $R_{AB}=R_{AC}+R_{CD}+R_{DB}$ bo‘ladi.

Zanjirning AC va DB qismlarida rezistorlar o‘zaro parallel ulangan.Shuning uchun:

$$\frac{1}{R_{AC}}=\frac{1}{r_1}+\frac{1}{r_2};R_{AC}=\frac{r_1r_2}{r_1+r_2}=\frac{3\cdot6}{3+6}=\frac{18}{9}=2\Omega$$

$$\frac{1}{R_{DB}}=\frac{1}{r_4}+\frac{1}{r_5}+\frac{1}{r_6};\frac{1}{R_{DB}}=\frac{1}{5}+\frac{1}{10}+\frac{1}{30};R_{DB}=3\Omega$$

$R_{CD}=r_3=3\Omega$ Endi R_{AB} ni topamiz $R_{AB}=2+3+3=8\Omega$

Om qonuniga binoan zanjirdan o‘tayotgan tokning kuchi I_0 resistor r_3 dan o‘tayotgan tokning kuchi I_3 ga teng, ya’ni

$$I_0=I_3=\frac{U_{AB}}{R_{AB}}=\frac{48}{8}=6A$$

Zanjir qismlaridagi $U_{AC};U_{CD};U_{DB}$ kuchlanishlar quyidagiga teng bo‘ladi:

$$U_{AC}=I_0\cdot R_{AC}=6\cdot2=12v$$
$$U_{CD}=I_0\cdot R_{CD}=6\cdot3=18v$$

$$U_{DB} = I_0 \cdot R_{BD} = 6 \cdot 3 = 18v$$

Parallel ulashda kuchlanishlar nengligidan

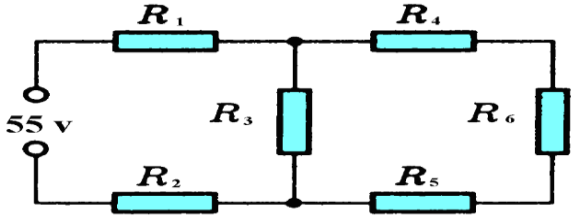
$$U_1 = U_2 = U_{AC} = 12V$$
$$U_3 = U_{CD} = 18V$$
$$U_4 = U_5 = U_6 = U_{DB} = 18V$$

Har bir rezistorlardagi kuchlanishlarni topdik.

Endi rezistorlardan o‘tayotgan tok kuchi quyidagilarga teng bo‘ladi:

$$I_1 = \frac{U_1}{r_1} = \frac{12}{3} = 4A; I_2 = \frac{U_2}{r_2} = \frac{12}{6} = 2A; I_4 = \frac{U_4}{r_4} = \frac{18}{5} = 3{,}6A;$$
$$I_5 = \frac{U_5}{r_5} = \frac{18}{10} = 1{,}8A; I_6 = \frac{U_6}{r_6} = \frac{18}{30} = 0{,}6A$$

50. Sxemada tasvirlangan zanjirda hamma rezistorlarning qarshiligi bir xil bo‘lib , har biri 2Ω gat eng .tok va kuchlanishlarning taqsimlanishini toping.



Zanjirning umumiy qarshiligini hisoblaymiz

$R_4; R_5; R_6$ qarshiliklar ketma-ket ulangan R_3–esa ularga parallel ulanganligi uchun ularning umumiy qarshiligi quyidagicha topiladi.

$$R_{456} = R_4 + R_5 + R_6 = 2 + 2 + 2 = 6\Omega$$
$$\frac{1}{R_{3456}} = \frac{1}{R_3} + \frac{1}{R_{456}} = \frac{1}{2} + \frac{1}{6} = \frac{4}{6}; R_{3456} = 1{,}5\Omega$$
$$R_{umum} = R_1 + R_{3456} + R_2 = 2 + 1{,}5 + 2 = 5{,}5\Omega$$

Zanjirning umumiy tok kuchi om qonuniga ko‘ra

$$I = \frac{U}{R_{um}} = \frac{55}{5{,}5} = 10A$$

R_1 va R_2 rezistorning qarshiligi tengligi uchun va I_1 va I_2 ketma-ket ulanganligi uchun

$$I = I_1 = I_2 = 10A$$
$$U_1 = U_2 = I_1 \cdot R_1 = 10 \cdot 2 = 20V$$

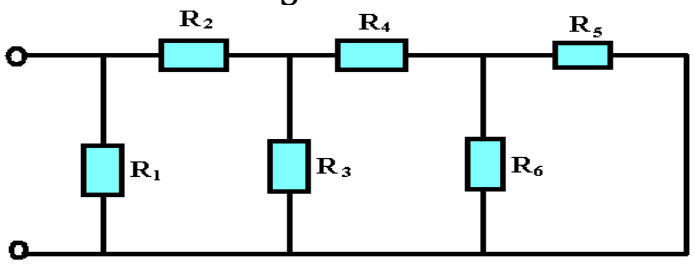
R_1 , R_2 va R_3 rezistorlar ketma-ket ulanganligi uchun

$U = U_1 + U_2 + U_3; U_3 = U - U_1 - U_2 = 55 - 20 - 20 = 15V$ bundan $I_3 = \frac{U_3}{R_3} = \frac{15}{2} = 7{,}5A$ natijaga ega bo‘lamiz.va yana R_4 , R_5 va R_6 rezistorlar ketma-ket ulanganligi uchun$I_4 = I_5 = I_6 = I_1 - I_3 = 10 - 7{,}5 = 2{,}5A$ natijaga ega bo‘lamiz topilgan natijalardan

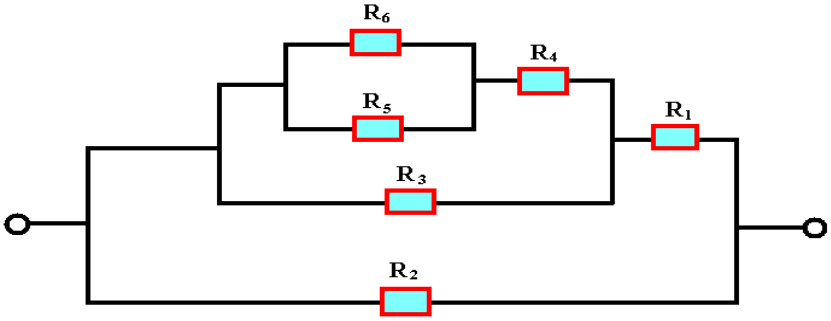
$$U_4 = U_5 = U_6 = I_4 \cdot R_4 = 2{,}5 \cdot 2 = 5V$$

51. Sxemaning umumiy qarshiligini toping

$$R_1 = R; R_2 = 2R; R_3 = \frac{4}{3}R; R_4 = 3R; R_5 = 2R; R_6 = 2R$$



Sxemani quyidagicha soddalashtiramiz



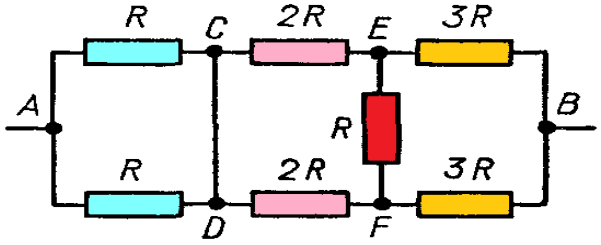
$$\frac{1}{R_{56}} = \frac{1}{R_5} + \frac{1}{R_6} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \rightarrow R_{56} = R; R_{456} = R_{56} + R_4 = R + 3R = 4R$$

$$\frac{1}{R_{3456}} = \frac{1}{R_3} + \frac{1}{R_{456}} = \frac{3}{4R} + \frac{1}{4R} = \frac{4}{4R} \rightarrow R_{3456} = R;$$

$$R_{13456} = R_1 + R_{3456} = R + R = 2R$$

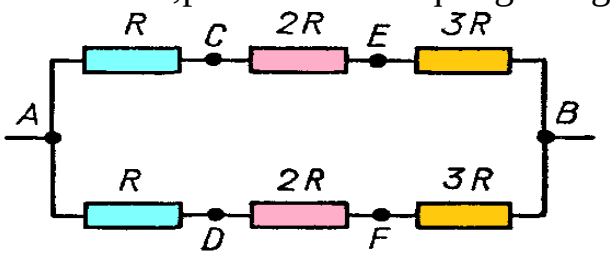
$$\frac{1}{R_{umu}} = \frac{1}{R_{13456}} + \frac{1}{R_2} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R}; R_{umum} = R.$$

52. Zanjirning AB; CD va EF nuqtalar orasidagi umumiy qarshilikni toping.



1-hol. (R_{AB} =?)

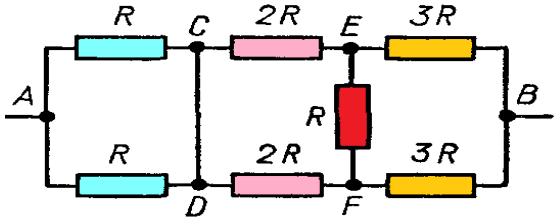
Zanjirning AB qismidagi umumiy qarshilikni topish uchun sxemaning CD va EF qismini olib tashlaymiz sababi bu yo‘nalishda tok oqmaydi.CD va EF nuqtalarda potensiallar bir xil,potensiallar farqi o ga teng



$$R_{ACEB} = R + 2R + 3R = 6R;\ R_{ADFB} = R + 2R + 3R = 6R$$

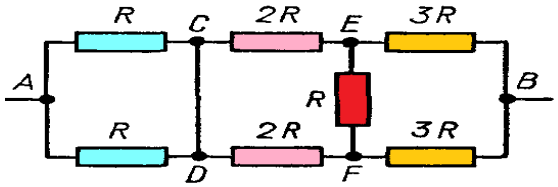
$$\frac{1}{R_{Umum}} = \frac{1}{6R} + \frac{1}{6R} = \frac{2}{6R} \rightarrow R_{Umum} = 3R$$

2-HOL($R_{CD} = ?$)

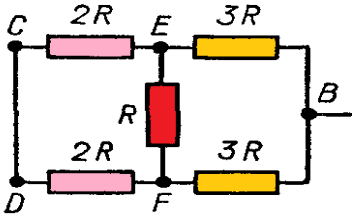


Cxemaning CD nuqtalar orasida qarshilik yo‘qligi uchun $R_{CD} = 0$ ga teng.

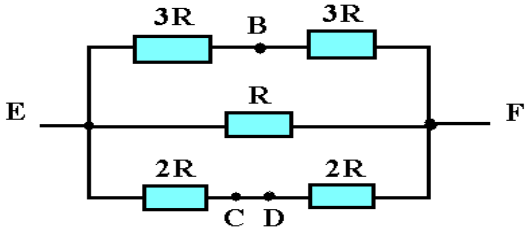
3-HOL($R_{EF} = ?$)



Sxemaning CA va AD qarshiliklari orqali tok o‘tmaydi shuning uchun ularni sxemadan olib tashlaymiz va sxemamiz quyidagi ko‘rinishga kelada



Sxemaning EC va DF qarshiliklari ketma-ket ulanganligi uchun va CD nuqta orasida qarshilik yo‘qligi uchun sxemani quyidagi sodda holga keltiramiz

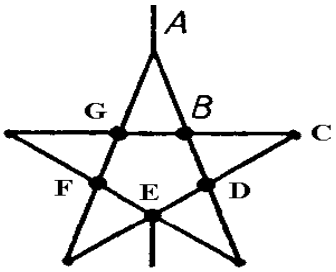


$$R_{EBF} = 3R + 3R = 6R;\ R_{ECDF} = 2R + 2R = 4R$$

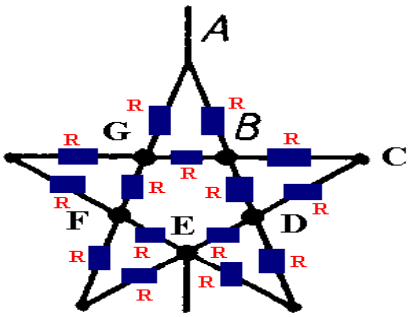
$$\frac{1}{R_{EF}} = \frac{1}{R_{EBF}} + \frac{1}{R} + \frac{1}{R_{ECDF}} = \frac{1}{6R} + \frac{1}{R} + \frac{1}{4R} = \frac{2}{6R} + \frac{12}{12R} + \frac{3}{12R}$$

$$R_{EF} = \frac{12}{17}R$$

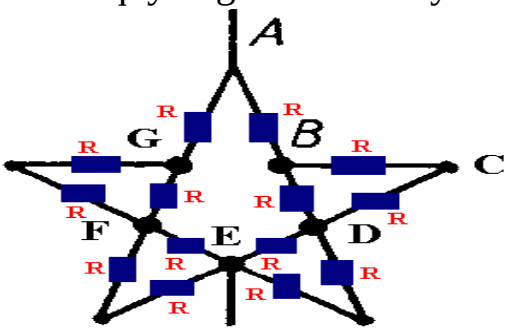
53. Sxemaning AE nuqtalari orasidagi umumiy qarshiliklarni toping? (Har bir nuqtalar orasidagi qarshilik R ga teng)



Bu sxema tushinarliroq bo‘lishi uchun quyidagicha tasvirlaymiz



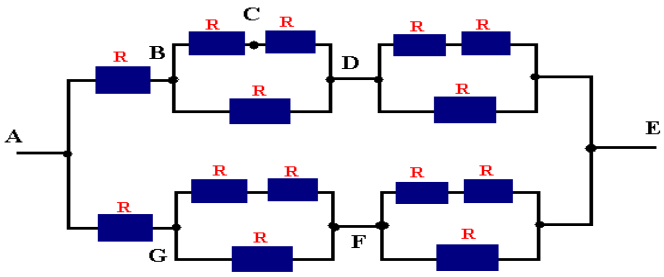
1-rasm



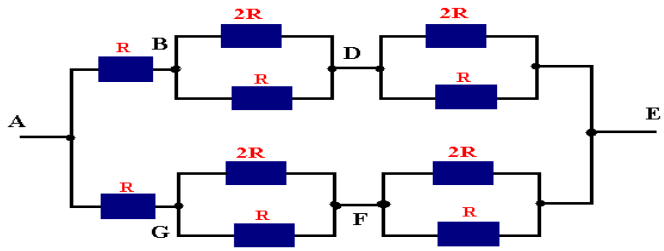
1,1-rasm

AE nuqta orasidagi qarshilikni topamiz.

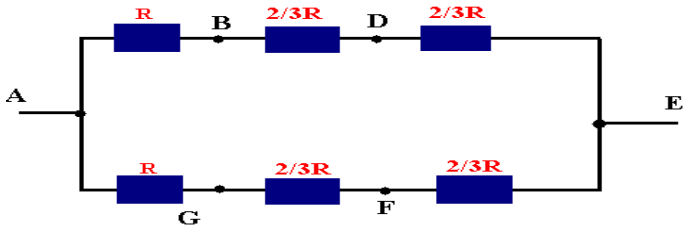
Rezistorlarning qarshiliklari bir-xil bo‘lganligi uchun1-rasmdagi G va B nuqtalarda potensiallar bir xil GB nuqtalar orasidagi potensiallar farqi esa 0 ga teng. Shuning uchun GB nuqta orasidagi qarshilikni olib tashlaymiz va sxemamiz quyidagi ko‘rinishga keladi(1,1-rasm). 1,1-rasm yanada tushunarli bo‘lishi uchun uni sodda ko‘rinishga o‘tamiz(1,2-rasm). 1,2-rasmdagi BD,GD,DE,FE nuqtalar orasidagi qarshiliklarni ketma-ket ulasak (R+R=2R) sxemamiz yangi ko‘rinishni egallaydi(1,3-rasm). 1,3-rasmdagi BD,DE,GF,FE nuqtalar orasidagi 2R va R qarshiliklarni parallel ulasak ($\frac{1}{R_{p-r}} = \frac{1}{2R} + \frac{1}{R} \rightarrow R_{p-r} = \frac{2}{3}R$) 1,4-rasm hosil bo‘ladi va bu sxemadan umumiy qarshilikni hisoblaymiz.



1,2-rasm



1,3-rasm

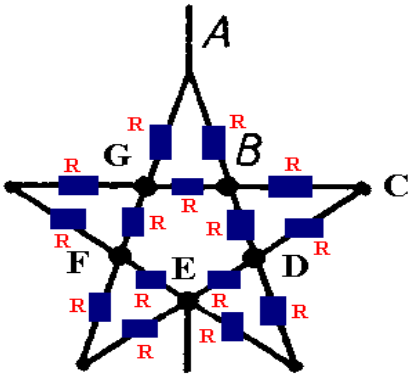


1,4-rasm

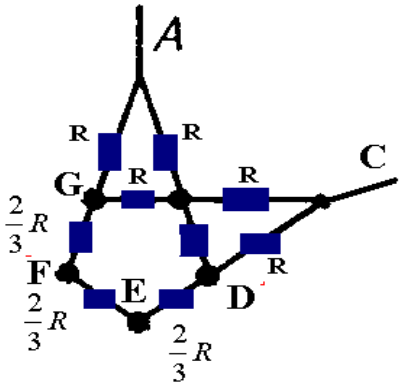
$$R_{ABDE} = R + {}^{2}/_{3}\,R + {}^{2}/_{3}\,R = {}^{7}/_{3}\,R; R_{AGFE} = R + {}^{2}/_{3}\,R + {}^{2}/_{3}\,R = {}^{7}/_{3}\,R$$

$$\frac{1}{R_{AE}} = \frac{1}{R_{ABDE}} + \frac{1}{R_{AGFE}} = \frac{1}{{}^{7}/_{3}\,R} + \frac{1}{{}^{7}/_{3}\,R} = \frac{3}{7R} + \frac{3}{7R} = \frac{6}{7R} \rightarrow R_{AE} = \frac{7}{6}R$$

54. Sxemaning AC nuqtalari orasidagi umumiy qarshiliklarni toping? (Har bir nuqtalar orasidagi qarshilik R ga teng)



1-rasm

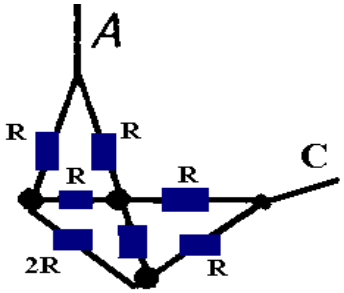


1,1-rasm

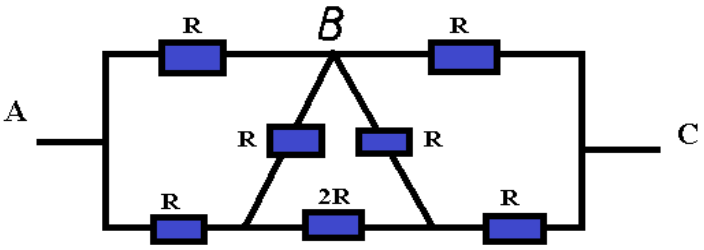
1-rasmdagi GF va FE nuqtalar orasidagi qarshiliklarni soddalashtirsak 1,1-rasm ko‘rinishidagi sxema hosil bo‘ladi.

$$\frac{1}{R_{GF}} = \frac{1}{2R} + \frac{1}{R} \rightarrow R_{GF} = \frac{2}{3}R; \frac{1}{R_{FE}} = \frac{1}{2R} + \frac{1}{R} \rightarrow R_{FE} = \frac{2}{3}R.$$

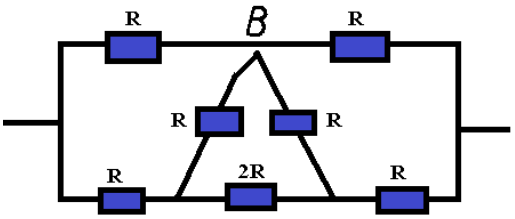
Hosil bo‘lgan 1,1-rasmning GD nuqtalar orasidagi qarshiliklarni ketma-ket ulasak sxema 1,2-rasmdagi ko‘rinishga keladi. $R_{GD} = {}^{2}/_{3}\,R + {}^{2}/_{3}\,R + {}^{2}/_{3}\,R = 2R$

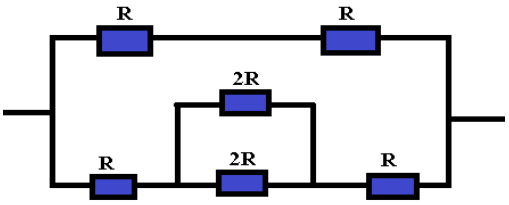


1,2-rasm

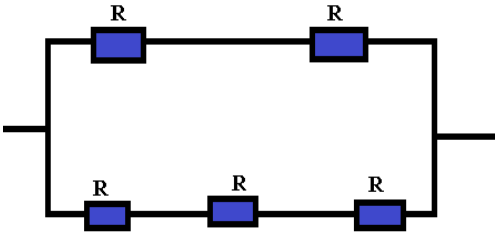


1,3-rasm (1,2-rasmning sodda ko‘rinishi)



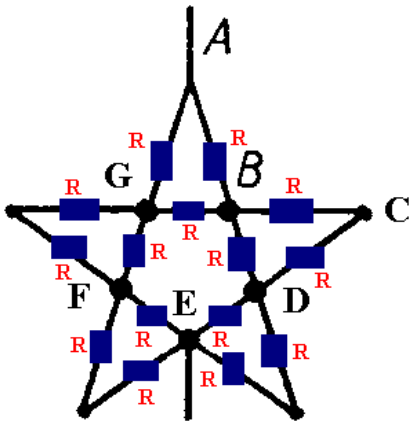


1,3-rasmni yuqoridagi sodda ko‘rinishlarga o‘tib soddalashtiramiz.

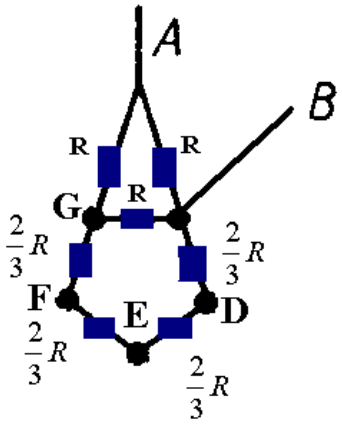


$$\frac{1}{R_{AC}} = \frac{1}{2R} + \frac{1}{3R} = \frac{5}{6R}; R_{AC} = \frac{6}{5}R$$

55. Sxemaning AB nuqtalari orasidagi umumiy qarshiliklarni toping? (Har bir nuqtalar orasidagi qarshilik R ga teng)



1-rasm



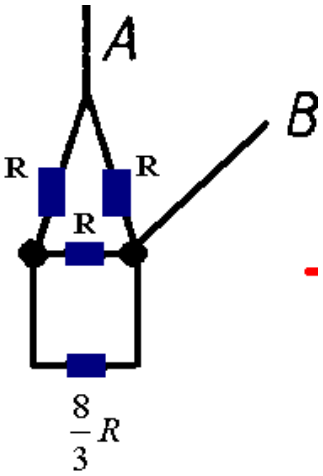
1,1-rasm

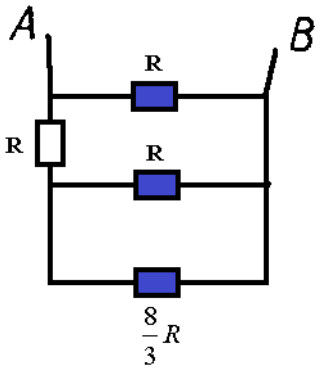
1-rasmdagi GF, FE,ED va DB nuqtalar orasidagi qarshiliklarni soddalashtirsak 1,1-rasm ko‘rinishidagi sxema hosil bo‘ladi.

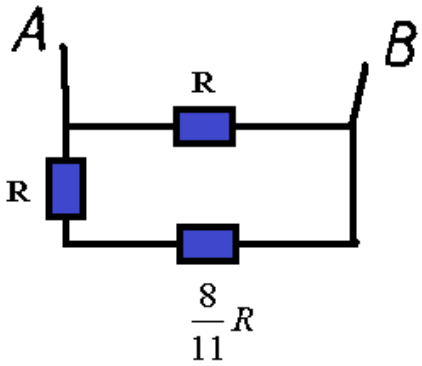
$$\frac{1}{R_{GF}} = \frac{1}{2R} + \frac{1}{R} \to R_{GF} = \frac{2}{3}R; \frac{1}{R_{FE}} = \frac{1}{2R} + \frac{1}{R} \to R_{FE} = \frac{2}{3}R;$$
$$\frac{1}{R_{ED}} = \frac{1}{2R} + \frac{1}{R} \to R_{ED} = \frac{2}{3}R; \frac{1}{R_{DB}} = \frac{1}{2R} + \frac{1}{R} \to R_{DB} = \frac{2}{3}R.$$

Hosil bo‘lgan 1,1-rasmning GB nuqtalar orasidagi qarshiliklarni ketma-ket ulasak sxema 1,2-rasmdagi ko‘rinishga keladi

$$R_{GD} = {}^{2}/_{3}\,R + {}^{2}/_{3}\,R + {}^{2}/_{3}\,R + {}^{2}/_{3}\,R = {}^{8}/_{3}\,R.$$





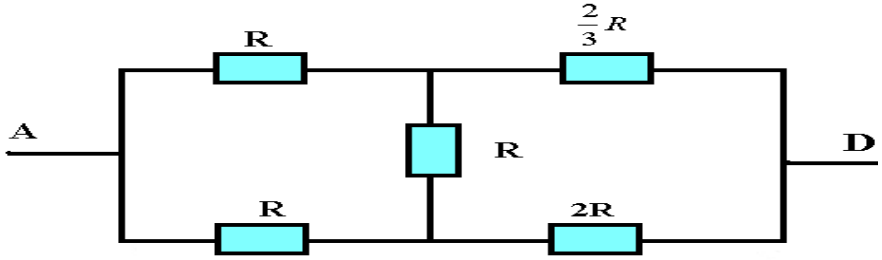


1,2-rasm 1,3-rasm 1,4-rasm

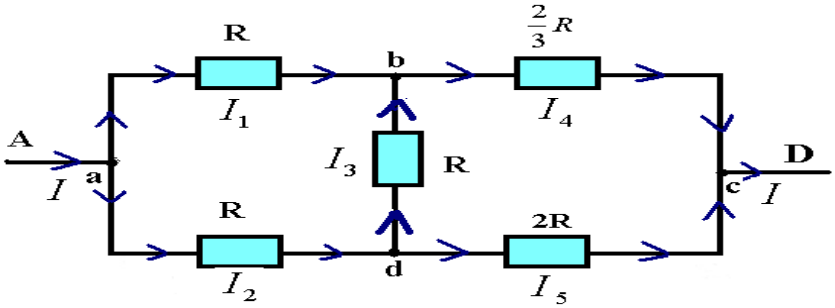
1,2-rasmni soddlashtirib, 1,3-1,4-rasmlarga aylantirib umumiy qarshilikni topamiz.

$$\frac{1}{R_{AB}} = \frac{1}{R} + \frac{1}{R + \frac{8}{11}R} = \frac{30}{19R}; R_{AB} = \frac{19}{30}R$$

56. Sxemaning AD nuqtalari orasidagi umumiy qarshiliklarni toping? (Har bir nuqtalar orasidagi qarshilik R ga teng)



Sxemaning umumiy qarshiligini toppish uchun rezistorlarda toklarni harakat yo‘nalishini yozib chiqamiz.



Krixgovning 1-qoidasidan quyidagi natijaga ega bo‘lamiz

$$I = I_1 + I_2; (a)$$
$$I_4 = I_1 + I_3; (b)$$
$$I_2 = I_3 + I_5; (c)$$
$$I = I_4 + I_5; (d)$$

Elektr zaryadi A nuqtadan D nuqtaga 4-xil yo‘l orqali harakatlanadi. Ya’ni (abc,adc,adbc va abdc).Zaryadning umumiy bajargan ishi har-bir rezistordagi ishlar yig‘indisiga teng

abc kontur uchun

$$A = A_1 + A_4; qU = qU_1 + qU_4; U = U_1 + U_4;$$

$$I \cdot R_{AB} = I_1 \cdot R + I_4 \cdot \frac{2}{3}R \qquad (1)$$

adc kontur uchun

$$A = A_2 + A_5; qU = qU_2 + qU_5; U = U_2 + U_5;$$

$$I \cdot R_{AB} = I_2 \cdot R + I_5 \cdot 2R \qquad (2)$$

adbc kontur uchun

$$A = A_2 + A_3 + A_4; qU = qU_2 + qU_3 + qU_4; U = U_2 + U_3 + U_4;$$

$$I \cdot R_{AB} = I_2 \cdot R + I_3 \cdot R + I_4 \cdot \frac{2}{3}R \qquad (3)$$

abdc kontur uchun

$$A = A_1 + A_3 + A_5; qU = qU_1 + qU_3 + qU_5; U = U_1 + U_3 + U_5;$$

$$I \cdot R_{AB} = I_1 \cdot R - I_3 \cdot R + I_2 \cdot 2R \qquad (4)$$

1 va 2, 1 va 4 natijalarni tenglashtiramiz

$$I_1 + \frac{2}{3}I_4 = I_2 + 2I_5\ ;\ I_3 + \frac{2}{3}I_4 = 2I_5 \qquad (4.1)$$

$$I_1 + \frac{2}{3}I_4 = I_1 - I_3 + 2I_5;\ \ I_3 + \frac{2}{3}I_4 = 2I_5 \qquad (4.2)$$

4.1 va 4.2 tenglamalarni sistema qilamiz

$$-\begin{cases} I_1 + \frac{2}{3}I_4 = I_2 + 2I_5 \\ I_3 + \frac{2}{3}I_4 = 2I_5 \end{cases} \rightarrow I_1 - I_3 = I_2; I_1 = I_2 + I_3$$

(b) natijaga etib qo‘yamiz

$$I_4 = I_1 + I_3 \qquad (b)$$

$$I_4 = I_2 + I_3 + I_3 = I_2 + 2I_3 \leftarrow I_2 = I_3 + I_5$$

$$I_4 = I_3 + I_5 + 2I_3 = 3I_3 + I_5 \qquad (4{,}3)$$

4.2 va 4.3 natijalarni sistema qilib oddalashtirsak quyidagi natijaga ega bo‘lamiz

$$\begin{cases} I_3 + \frac{2}{3}I_4 = 2I_5 \\ I_4 = 3I_3 + I_5; \end{cases} - \begin{cases} I_3 + \frac{2}{3}I_4 = 2I_5 \\ 2I_4 - 6I_3 = 2I_5; \end{cases} ; 7I_3 - \frac{4}{3}I_4 = 0;$$

$$I_3 = \frac{4}{21}I_4; I_4 = \frac{21}{4}I_3 \qquad (4{,}4)$$

$$I_3 + \frac{2}{3}I_4 = 2I_5 \rightarrow \frac{4}{21}I_4 + \frac{2}{3}I_4 = 2I_5; I_5 = \frac{3}{7}I_4;$$

$$I_2 = I_3 + I_5 \rightarrow I_2 = \frac{4}{21}I_4 + \frac{3}{7}I_4; I_2 = \frac{13}{21}I_4; I_4 = I_1 + I_3 \rightarrow$$

$$I_1 = I_4 - I_3 = I_4 - \frac{4}{21}I_4 = \frac{17}{21}I_4$$

$$I_1 = \frac{17}{21}I_4; I = I_4 + I_5 \to I = I_4 + \frac{3}{7}I_4 = \frac{10}{7}I_4$$

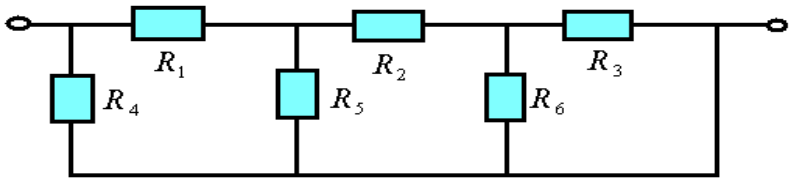
Bu natijalarni 1-formulaga etib qo‘ysak

$$I \cdot R_{AD} = I_1 \cdot R + I_4 \cdot \frac{2}{3}R \to \frac{10}{7}I_4 \cdot R_{AD} = \frac{17}{21}I_4 \cdot R + I_4 \cdot \frac{2}{3}R$$

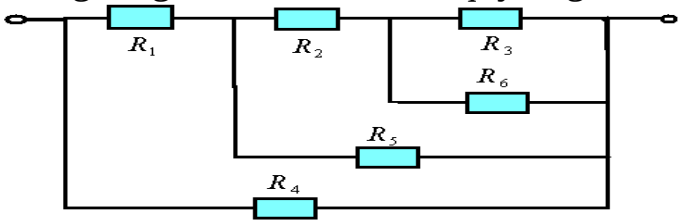
$$\frac{10}{7}R_{AD} = \frac{17}{21}R + \frac{14}{21}R = \frac{31}{21}R \to R_{AD} = \frac{31}{30}R;$$

57. Zanjirning umumiy qarshiligini toping?

$$(R_1 = \frac{1}{2}\Omega; R_2 = \frac{3}{2}\Omega; R_3 = R_4 = R_6 = 1\Omega; R_5 = \frac{2}{3}\Omega.)$$



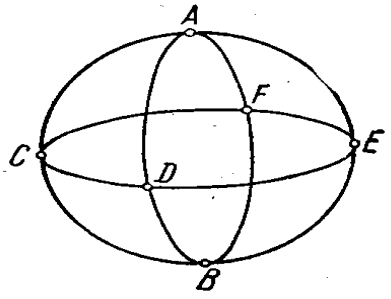
R_3 va R_6 qarshiliklar parallel ulangan, so‘ngra bu qarshiliklarga ketma-ket qilib R_2 qarshilik ulangan,bu uchta qarshilikka parallel qilib R_5 qarshilik ulangan,yana R_1 qarshilik ketma-ket ulangan va nihoyat,butun zanjirga parallel qilib R_4 ulanganligi uchun chizmani quyidagicha o‘zgartiramiz.



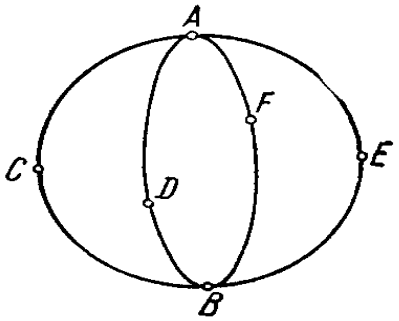
$$R_{36} = \frac{R_3 \cdot R_6}{R_3 + R_6} = \frac{1}{2}\Omega; R_{362} = R_{36} + R_2 = 2\Omega; R_{3625} = \frac{R_{362} \cdot R_5}{R_{362} + R_5} = \frac{1}{2}\Omega$$

$$R_{36251} = R_{3625} + R_1 = 1\Omega; R_{Umum} = R_{362514} = \frac{R_{36251} \cdot R_4}{R_{36251} + R_4} = \frac{1}{2}\Omega$$

58. Radiusi a bo‘lgan uchta bir xil mis halqa o‘zaro 1-rasmda ko‘rsatilgandek ulangan. Agar tashqi potensiallar farqi A va B nuqtalarga keltirilgan bo‘lsa, shunday tarzda olingan figura qarshiligini aniqlang. Simning diametri d.Misning solishtirma qarshiligi ρ,$\cup CD = \cup DE = \cup EF = \cup FC$.

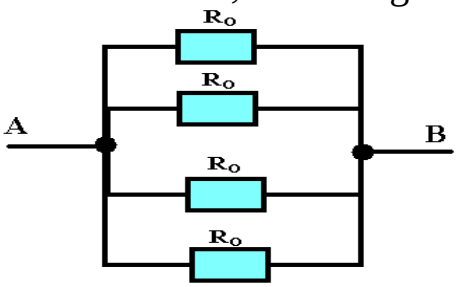


1-rasm



1,1-rasm

1-rasmning CDFE nuqtalaridagi potensiallar teng, potensiallar farqi esa nol bo‘lgani uchun ularni olib tashlasak 1,1-rasmdagi ko‘rinishni egallaydi.



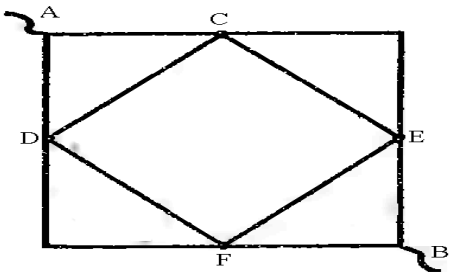
1,2-rasmdagi

1,1-rasmni murakkab ko‘rinishdan oddiy 1,2-rasmdagi ko‘rinishda ifodalab ularni umumiy qarshiligini topamiz. Sxema to‘rtta parallel ulangan yarim halqalar (ACB, ADB,AEB va AFB) dan iborat. Bitta yarim halqaning qarshiligi

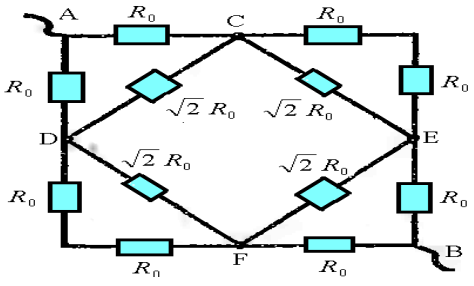
$$R_0 = \rho\frac{l}{S} = \rho\frac{\pi\cdot a}{\frac{\pi\cdot d^2}{4}} = \frac{4\rho\cdot a}{d^2}$$

Ravshanki, umumiy qarshilik $\frac{1}{R_{Um}} = \frac{1}{R_0}+\frac{1}{R_0}+\frac{1}{R_0}+\frac{1}{R_0} \rightarrow R_{Um} = \frac{R_0}{4} = \frac{\rho\cdot a}{d^2}$

59. Quyidagi simli ramkaning umumiy qarshiligini toping(1-rasm).(Simning solishtirma qarshiligi ρ yuzasi S) $AC = AD = l; DC = \sqrt{2}l$



1-rasm

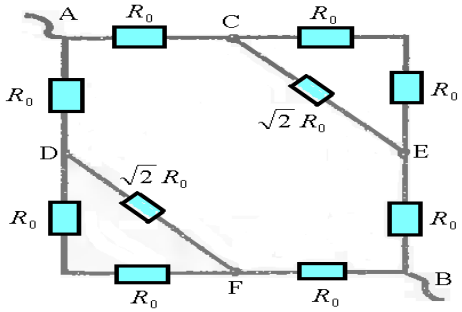


1,1-rasm

Masala tushinarli bo‘lishi uchun har-bir nuqtalar orasidagi qarshiliklarni topamiz. $R_{AC} = R_{AD} = \rho\frac{l}{S} = R_0; R_{DC} = \rho\frac{\sqrt{2}l}{S} = \sqrt{2}R_0$

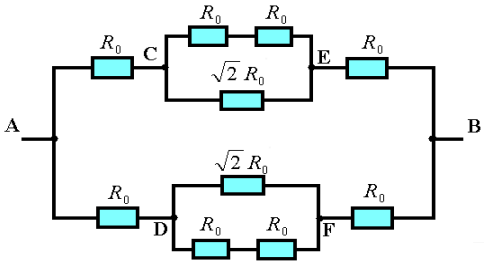
Ushbu natijalardan sxemamiz quyidagi sxemaga aylanadi(1,1-rasm).

Sxemaning D, C va F,E nuqtalarida potensial bir xil DC, FE nuqtalar orasida potensiallar farqi 0 ga teng bo‘lganligi uchun DC, FE nuqta orqali tok o‘tmaydi DC, FE nuqta orasidagi qarshilikni olib tashlasak ham bo‘ladi va sxemamiz quyidagi ko‘rinishga keladi.

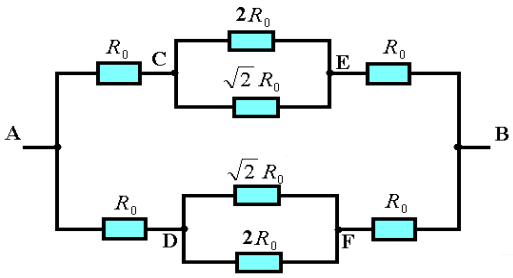


1,2-rasm

1,2-rasmdagi sxemani murakkab ko‘rinishdan 1,3-rasmdagi sodda ko‘rinishga o‘tamiz.

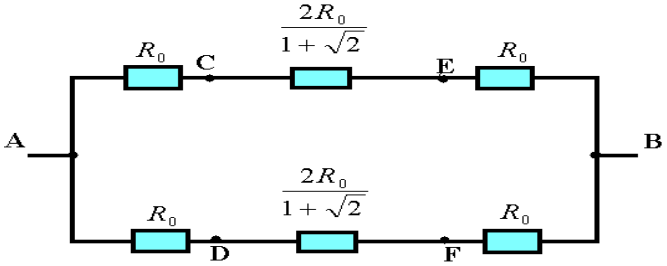


1,3-rasm

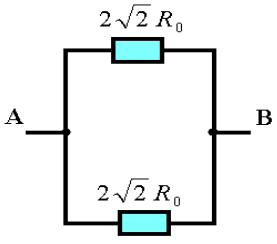


1,4-rasm

1,3-rasmdagi ketma-ket turgan 2 ta R_0 qarshilikni ketma-ket ulasak 1,4-rasm hosil bo‘ladi.1,4-rasmdagi qarshiliklarni parallel ulasak 1,5-rasm hosil bo‘ladi.



1,5-rasm

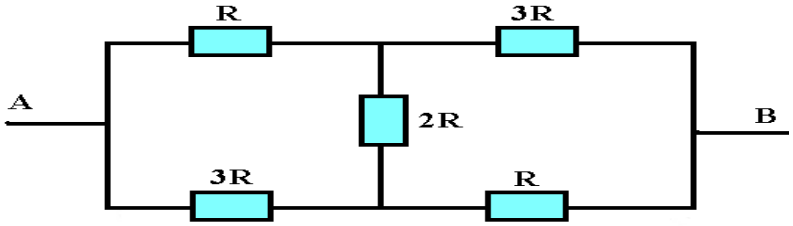


1,6-rasm

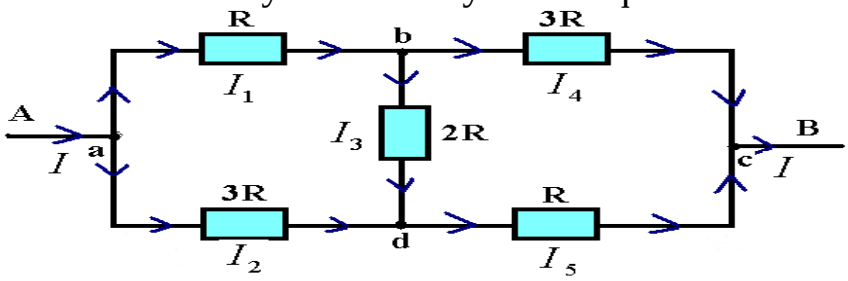
1,5-rasmdagi qarshiliklarni ketme-ket ulab(1,6-rasm) hosil bo‘lgan natijani parallel ulasak umumiy qarshilik kelib chiqadi.

$$\frac{1}{R_{AB}} = \frac{1}{2\sqrt{2}R_0} + \frac{1}{2\sqrt{2}R_0} = \frac{2}{2\sqrt{2}R_0} \rightarrow R_{AB} = \sqrt{2}R_0$$

60. AB nuqta orasidagi umumiy qarshilikni toping ?



Sxemaning umumiy qarshiligini toppish uchun rezistorlarda toklarni harakat yo‘nalishini yozib chiqamiz.



Krixgovning 1-qoidasidan quyidagi natijaga ega bo‘lamiz

$$\begin{cases} I = I_1 + I_2 \\ I_1 = I_3 + I_4 \\ I_5 = I_2 + I_3 \\ I = I_4 + I_5 \end{cases}$$

Elektr zaryadi q A nuqtadan B nuqtaga 4-xil yo‘l orqali harakatlanadi. Ya’ni (abc,adc,abdc va adbc). Zaryadning umumiy bajargan ishi har-bir rezistordagi ishlar yig‘indisiga teng abc kontur uchun

$$A = A_1 + A_4; qU = qU_1 + qU_4; U = U_1 + U_4;$$
$$I \cdot R_{AB} = I_1 \cdot R + I_4 \cdot 3R \qquad (1)$$

adc kontur uchun $A = A_2 + A_5; qU = qU_2 + qU_5; U = U_2 + U_5;$
$I \cdot R_{AB} = I_2 \cdot 3R + I_5 \cdot R \qquad (2)$

abdc kontur uchun $A = A_1 + A_3 + A_5; qU = qU_1 + qU_3 + qU_5; U = U_1 + U_3 + U_5; I \cdot R_{AB} = I_1 \cdot R + I_3 \cdot 2R + I_5 \cdot R \qquad (3)$

adbc kontur uchun $A = A_2 + A_3 + A_4; qU = qU_2 + qU_3 + qU_4; U = U_2 + U_3 + U_4; I \cdot R_{AB} = I_2 \cdot 3R - I_3 \cdot 2R + I_4 \cdot 3R \qquad (4)$

1 va 2 formulalarni tenglashtiramiz $I_1 \cdot R + I_4 \cdot 3R = I_2 \cdot 3R + I_5 \cdot R;$
$I_1 + 3I_4 = 3I_2 + I_5 \qquad (4.1)$

3 va 4 formulalarni tenglashtiramiz $I_1 + 4I_3 + I_5 = 3I_2 + 3I_4 \quad (4.2)$

4.1 va 4.2 formulalarni sistema qilib soddalashtiramiz.

$$\begin{cases} I_1 + 3I_4 = 3I_2 + I_5 \\ I_1 + 4I_3 + I_5 = 3I_2 + 3I_4 \end{cases}$$

I_1 o‘rniga (b) formulani keltirib qo‘yamiz

$$\begin{cases} I_3 + I_4 + 3I_4 = 3I_2 + I_5 \\ I_3 + I_4 + 4I_3 + I_5 = 3I_2 + 3I_4 \end{cases}$$

Sistemani ayiramiz

$$-4I_3 + 3I_4 - I_5 = I_5 - 3I_4;\ 6I_4 = 2I_5 + 4I_3;\ 3I_4 = I_5 + 2I_3$$

Oxirgi natijaga (c) natijani etib qo‘yamiz

$$3I_4 = I_2 + I_3 + 2I_3;\ 3I_4 = I_2 + 3I_3 \qquad (6)$$

1 va 4 formulalarni tenglashtiramiz

$$I_1 + 3I_4 = 3I_2 - 2I_3 + 3I_4;\ I_1 = 3I_2 - 2I_3$$

Oxirgi natijaga (b) natijani etib qo‘yamiz

$$I_3 + I_4 = 3I_2 - 2I_3;\ 3I_3 + I_4 = 3I_2 \qquad (6.5)$$

6 va 6.5 natijalarni sistema qilib soddalashtiramiz

$$\begin{cases} 3I_3 + I_4 = 3I_2 \\ 3I_4 - 3I_3 = I_2 \end{cases}$$

Sistemani qo‘shmiz $4I_4 = 4I_2; I_4 = I_2$ b va c natijalarni sistema qilib oxirgi natijani etib qo‘ysak

$$-\begin{cases} I_1 = I_3 + I_4 \\ I_5 = I_2 + I_3 \end{cases}$$

$$I_1 - I_5 = I_4 - I_3$$

$$(I_4 = I_2) \text{ dan } I_1 = I_5$$

6-formulaga ushbu natijalarni etib qo‘ysak $3I_4 = I_2 + 3I_3;\ 3I_4 - I_2 = 3I_3;$

$$(I_4 = I_2)\ ;\ 2I_4 = 3I_3;\ I_3 = \frac{2}{3}I_4$$

Ushbu natijalarni 4.1 formulaga etib qo‘yamiz

$$I_1 + 4I_3 + I_5 = 3I_2 + 3I_4;\ (I_1 = I_5); (I_2 = I_4) \rightarrow$$

$$2I_1 + 4I_3 = 6I_4; (I_3 = \frac{2}{3}I_4);\ 2I_1 + 4 \cdot \frac{2}{3}I_4 = 6I_4;\ I_1 = \frac{5}{3}I_4; I_4 = \frac{3}{5}I_1$$

a formulaga oxirgi natijani etib qo‘yamiz

$$I = I_1 + I_2 \qquad (a)$$

$$I = I_1 + I_2; (I_2 = I_4) \rightarrow I = I_1 + I_4 \Rightarrow I = I_1 + \frac{3}{5}I_1 = \frac{8}{5}I_1 \Rightarrow I_1 = \frac{5}{8}I;$$

$$I_4 = \frac{3}{5}I_1 \Rightarrow I_4 = \frac{3}{5} \cdot \frac{5}{8}I = \frac{3}{8}I$$

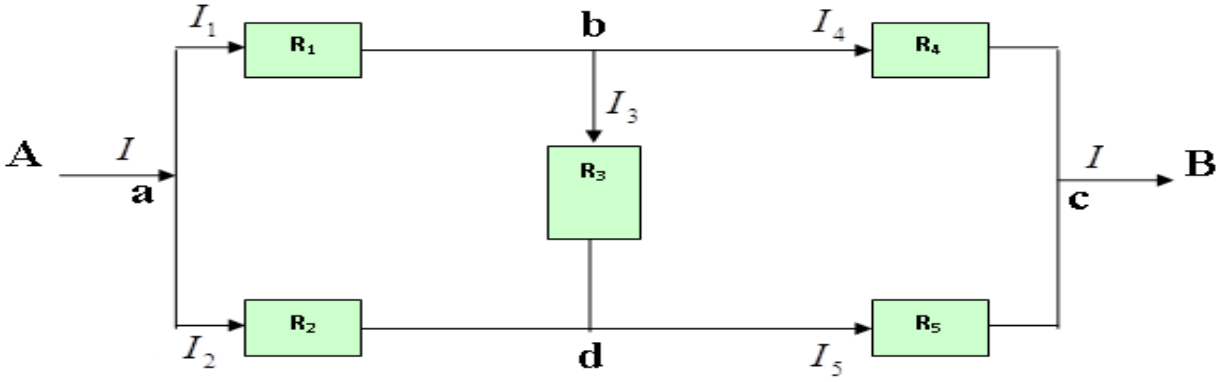
1-formula

$$I \cdot R_{AB} = I_1 \cdot R + I_4 \cdot 3R; I \cdot R_{AB} = \frac{5}{8}I \cdot R + \frac{3}{8}I \cdot 3R$$

$$R_{AB} = \frac{5}{8} \cdot R + \frac{9}{8} \cdot R; R_{AB} = \frac{14}{8}R = \frac{7}{4}R \rightarrow R_{AB} = \frac{7}{4}R$$

MURAKKAB TUZILISHGA EGA BO‘LGAN ZANJIR ELEMENTLARIDAGI TOK KUCHI, KUCHLANISH VA UMUMIY QARSHILIKNI HISOBLASH

Quyidagi masalani umumiy holda yechamiz



Berilgan: $R_1, R_2, R_3, R_4, R_5, I$

$$I_1, I_2, I_3, I_4, I_5, R_{AB} - ?$$

Kirxkofning 1-2 qonunlaridan foydalanib, quyidagi tenglamalar sistemasini hosil qilamiz.

$$\begin{cases} I = I_1 + I_2 \\ I_1 = I_3 + I_4 \\ I_5 = I_2 + I_3 \\ I_1R_1 + I_3R_3 = I_2R_2 \\ I_5R_5 + I_3R_3 = I_4R_4 \end{cases} \quad (1)$$

Bu sistemani yechish uchun quyidagilarni topib o‘rniga qo‘yamiz.

$$\begin{cases} I_2 = I - I_1 \\ I_5 = I - I_1 + I_3 \\ I_4 = I_1 - I_3 \end{cases} \qquad \begin{cases} I_1(R_1 + R_2) + I_3R_3 = IR_2 \\ IR_5 - I_1R_5 + I_3(R_3 + R_5) = I_4R_4 \end{cases}$$

$$\begin{cases} I_1(R_1 + R_2) + I_3R_3 = IR_2 \\ IR_5 - I_1R_5 + I_3(R_3 + R_5) = I_1R_4 - I_3R_4 \end{cases}$$

Olingan natijalarni ixchamlab quyidagi sistemani hosil qilamiz. Bu sistemani yechish uchun 2- formuladan foydalanib 3-tenglamani hosil qilamiz.

$$\begin{cases} I_1(R_1 + R_2) + I_3R_3 = IR_2 \\ I_1(R_4 + R_5) - I_3(R_3 + R_4 + R_5) = IR_5 \end{cases} \qquad I_3 = \frac{IR_2 - I_1(R_1 + R_2)}{R_3}$$

(2)

$$I_1(R_4+R_5)-\frac{IR_2-I_1(R_1+R_2)}{R_3}\cdot(R_3+R_4+R_5)=IR_5$$

(3)

Tenglamani ishlab chiqamiz

$$I_1(R_4+R_5)-\frac{IR_2}{R_3}\cdot(R_3+R_4+R_5)+I_1\frac{(R_1+R_2)}{R_3}(R_3+R_\$+R_5)=IR_5$$

$$I_1(R_4+R_5)+I_1\frac{R_1+R_2}{R_3}(R_3+R_4+R_5)=IR_5+I\frac{R_2}{R_3}(R_3+R_4+$$

$$R_5)I_1\frac{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}{R_3}=I\frac{R_3R_5+R_2(R_3+R_4+R_5)}{R_3}$$

3-tenglamadan quyidagi natijani olamiz

$$I_1=\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}I \qquad (4) \qquad U_1=I_1\cdot R_1$$

1-formuladan 1-tenglamani olib, 4-tenglamaga qo‘yib natijani olamiz

$$I_2=I-I_1=I\left(1-\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4=R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}\right)$$

$$I_2=I\frac{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)-R_3R_5-R_2(R_3+R_4+R_5)}{(R_5=R_5)R_3=(R_1+R_2)(R_3+R_4+R_5)}$$

$$I_2=I\frac{R_3R_4+R_3R_5+R_1(R_3+R_4+R_5)-R_3R_5}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}$$

$$I_2=\frac{R_3R_4+R_1(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}I \qquad (5) \qquad U_2=I_2\cdot R_2$$

4-formulani 2-formula yordamida hisoblaymiz quyidagi 6-formula hosil bo‘ladi.

$$I_3=\frac{IR_2-I_1(R_1+R_2)}{R_3}=\frac{R_2}{I_3}I-\frac{R_1+R_2}{R_3}I_1$$

$$I_3=\frac{R_2}{R_3}\cdot I-\frac{R_1+R_2}{R_3}\cdot\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)\cdot(R_3+R_4+R_5)}\cdot I$$

$$I_3=\left(\frac{R_2}{R_3}-\frac{R_1+R_2}{R_3}\cdot\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)\cdot(R_3+R_4+R_5)}\right)\cdot I$$

$$I_3=\left(\frac{R_3(R_2R_4-R_1R_5)}{(R_4+R_5)R_3+(R_1+R_2)\cdot(R_3+R_4+R_5)}\right)\cdot\frac{I}{R_3} \qquad (6) \qquad U_3=I_3\cdot R_3$$

4va 6 tenglamalar yordamida 7-formulani keltirib chiqaramiz

$$I_4=I_1-I_3=\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}I-I_3$$

$$I_4=\frac{R_3R_5+R_2(R_3+R_4+R_5)}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}I-\left(\frac{R_3(R_2R_4-R_1R_5)}{(R_4+R_5)R_3+(R_1+R_2)\cdot(R_3+R_4+R_5)}\right)\cdot\frac{I}{R_3}$$

$$I_4=\frac{R_3^2(R_2+R_5)+R_3R_5(R_1+R_2)}{(R_4+R_5)R_3+(R_1+R_2)(R_3+R_4+R_5)}\cdot\frac{I}{R_3} \qquad (7) \quad U_4=I_4\cdot R_4$$

5-6 formulalardan foydalanib 8-natijani hosil qilamiz

$$I_5 = I_2 + I_3$$

$$I_5 = \frac{R_3R_4 + R_1(R_3 + R_4 + R_5)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} I + \left(\frac{R_3(R_2R_4 - R_1R_5)}{(R_4 + R_5)R_3 + (R_1 + R_2)\cdot(R_3 + R_4 + R_5)} \right) \cdot \frac{I}{R_3}$$

$$I_5 = \frac{R_3^2(R_4 + R_1) + R_3R_4(R_1 + R_2)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} \cdot \frac{I}{R_3} \qquad (8) \quad U_5 = I_5 \cdot R_5$$

1-sistemani ishlab kerak bo‘lgan 4-5-6-7-8 tenglama natijalarini hosil qildik. Murakkab ko‘rinishdagi zanjir elementlaridagi tok kuchi va kuchlanishlarni topdik.Endi zanjirning umumiy qarshiligini hisoblaymiz.

Elektr zaryadi q A nuqtadan B nuqtaga 4-xil yo‘l orqali harakatlanadi. Ya’ni (abc,adc,abdc va adbc).Zaryadning umumiy bajargan ishi har-bir rezistordagi ishlar yig‘indisiga teng

abc kontur uchun

$$A = A_1 + A_4; \Rightarrow qU = qU_1 + qU_4; \Rightarrow U = U_1 + U_4$$

$$I \cdot R_{AB} = I_1 \cdot R_1 + I_4 \cdot R_4 \qquad (1.1)$$

adc kontur uchun

$$A = A_2 + A_5; \Rightarrow qU = qU_2 + qU_5; \Rightarrow U = U_2 + U_5$$

$$I \cdot R_{AB} = I_2 \cdot R_2 + I_5 \cdot R_5 \qquad (1.2)$$

abdc kontur uchun

$$A = A_1 + A_3 + A_5; \Rightarrow qU = qU_1 + qU_3 + qU_5; \Rightarrow U = U_1 + U_3 + U_5$$

$$I \cdot R_{AB} = I_1 \cdot R_1 + I_3 \cdot R_3 + I_5 \cdot R_5 \qquad (1.3)$$

adbc kontur uchun

$$A = A_2 + A_3 + A_4; \Rightarrow qU = qU_2 + qU_3 + qU_4; \Rightarrow U = U_2 + U_3 + U_4$$

$$I \cdot R_{AB} = I_2 \cdot R_2 - I_3 \cdot R_3 + I_4 \cdot R_4 \ (1.4)$$

Ushbu chiqarilgan natijalarning ixtiyoriy biriga yuqorida topilgan tok kuchilarini etib qo‘ysak umumiy qarshilik kelib chiqadi.

Masalan (1.1) formuladagi I_1 va I_4 tok kuchilar o‘rniga (4) va (7) natijalarni keltirib qo‘yamiz

$$I \cdot R_{AB} = I_1 \cdot R_1 + I_4 \cdot R_4$$

$$I \cdot R_{AB} = \frac{R_3R_5 + R_2(R_3 + R_4 + R_5)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} I \cdot R_1 +$$

$$+ \frac{R_3^2(R_2 + R_5) + R_3R_5(R_1 + R_2)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} \cdot \frac{I}{R_3} \cdot R_4$$

Tenglikni ikkala qismidan I larni qisqartiramiz

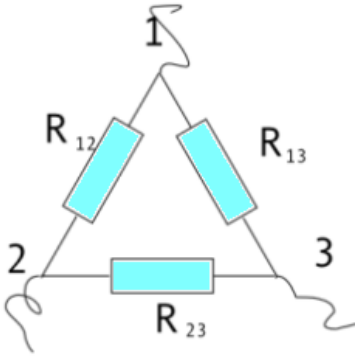
$$R_{AB} = \frac{R_3R_5 + R_2(R_3 + R_4 + R_5)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} \cdot R_1 +$$

$$+ \frac{R_3^2(R_2 + R_5) + R_3R_5(R_1 + R_2)}{(R_4 + R_5)R_3 + (R_1 + R_2)(R_3 + R_4 + R_5)} \cdot \frac{R_4}{R_3}$$

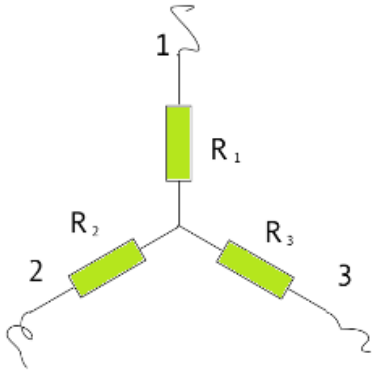
FIZIKA FANIDA MURAKKAB TUZILISHGA EGA BO‘LGAN ZANJIR ELEMENTLARI UCHUN “UCHBURCHAK-YULDUZCHA” USULINI QO‘LLANILISHI

Murakkab sxemalarni soddalashtirish uchun ishlatiladigan “Yulduzcha-uchburchak” usuli quyidagi sxemalarda ko‘rsatilgan bo‘lib ularni biridan ikkinchisiga o‘tish uchun formulalarni keltirib chiqaramiz.

Uchburchakdan-yulduzchaga o‘tish uchun, 1-2,1-3 va 2-3 nuqta orasidagi umumiy qarshilikni 1- va 2-sxemalar uchun keltirib chiqaramiz.



1-rasm. Uchburchak sxema.



2-rasm. Yulduzcha sxema.

1-sxema uchun 1-2 nuqta orasidagi umumiy qarshilikni hisoblashda R_{13} va R_{23}ni ketma-ket ulab, chiqqan natijani R_{12} qarshilikka parallel ulaymiz.

$$R_{13,23} = R_{13} + R_{23}\ ; \frac{1}{R_{Um(1-2)}} = \frac{1}{R_{12}} + \frac{1}{R_{13,23}}\ ;$$

$$\frac{1}{R_{Um(1-2)}} = \frac{1}{R_{12}} + \frac{1}{R_{13}+R_{23}} \rightarrow R_{Um(1-2)} = \frac{R_{12}\cdot(R_{23}+R_{13})}{R_{12}+R_{23}+R_{13}}$$

2-sxema uchun 1-2 nuqta orasidagi umumiy qarshilikni hisoblasak $R_{Um(1-2)} = R_1 + R_2$.

1-sxema uchun 1-3 nuqta orasidagi umumiy qarshilikni hisoblashda R_{12} va R_{23}ni ketma-ket ulab, chiqqan natijani R_{13}qarshilikka parallel ulaymiz.

$$R_{12,23} = R_{12} + R_{23}; \frac{1}{R_{Um(1-3)}} = \frac{1}{R_{13}} + \frac{1}{R_{12,23}}\ ;\ \frac{1}{R_{Um(1-3)}} = \frac{1}{R_{13}} + \frac{1}{R_{12}+R_{23}} \rightarrow R_{Um(1-3)} = \frac{R_{13}\cdot(R_{23}+R_{12})}{R_{12}+R_{23}+R_{13}}$$

2-sxema uchun 1-3 nuqta orasidagi umumiy qarshilikni hisoblasak $R_{Um(1-3)} = R_1 + R_3$. 1-sxema uchun 2-3 nuqta orasidagi umumiy qarshilikni hisoblashda R_{12} va R_{13}ni ketma-ket ulab, chiqqan natijani R_{23}qarshilikka parallel ulaymiz.

$$R_{12,13} = R_{12} + R_{13}; \frac{1}{R_{Um(2-3)}} = \frac{1}{R_{23}} + \frac{1}{R_{12,13}}\ ;\ \frac{1}{R_{Um(2-3)}} = \frac{1}{R_{23}} + \frac{1}{R_{12}+R_{13}} \rightarrow R_{Um(2-3)} = \frac{R_{23}\cdot(R_{12}+R_{13})}{R_{12}+R_{23}+R_{13}}$$

2-sxema uchun 2-3 nuqta orasidagi umumiy qarshilikni hisoblasak $R_{Um(2-3)} = R_2 + R_3$.

1-sxema uchun va 2-sxema uchun hisoblangan natijalarni tenglashtiramiz.

$$\begin{cases} R_1 + R_2 = \dfrac{R_{12}\cdot(R_{23}+R_{13})}{R_{12}+R_{23}+R_{13}}; \quad R_1 + R_3 = \dfrac{R_{13}\cdot(R_{23}+R_{12})}{R_{12}+R_{23}+R_{13}}; \; R_2 + R_3 = \dfrac{R_{23}\cdot(R_{12}+R_{13})}{R_{12}+R_{23}+R_{13}} \end{cases}$$

Tenglamalar sistemasi hosil bo‘ladi.

Yuqoridagi tenglamalar sistemasidan R_1, R_2 va R_3 topsak quyidagi natijaga erishamiz.

$$R_1 = \frac{R_{12}\cdot R_{13}}{R_{12}+R_{23}+R_{13}}; R_2 = \frac{R_{12}\cdot R_{23}}{R_{12}+R_{23}+R_{13}}; R_3 = \frac{R_{23}\cdot R_{13}}{R_{12}+R_{23}+R_{13}} \qquad (1)$$

Topilgan formulalar uchburchakdan yulduzchaga o‘tishda foydalaniladi.

Endi aksincha hol uchun ya’ni **yulduzchadan-uchburchakka** o‘tish kerak bo‘lsa yuqoridagi tenglamalar sistemasidan R_{12}, R_{13} va R_{23}ni topsak quyidagi natijaga eri-shamiz.

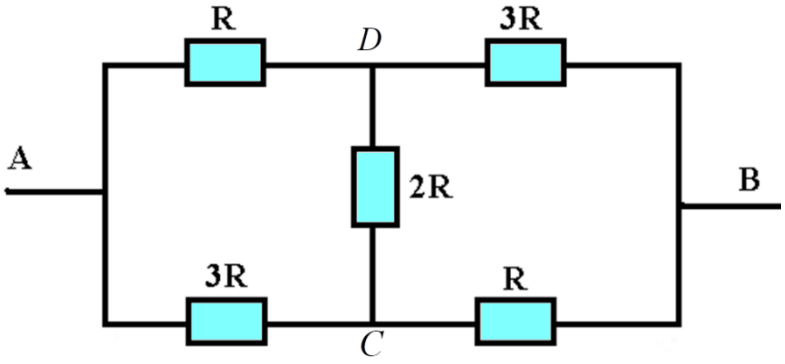
$$R_{12} = R_1 + R_2 + \frac{R_1\cdot R_2}{R_3}; R_{13} = R_1 + R_3 + \frac{R_1\cdot R_3}{R_2}; R_{23} = R_2 + R_3 + \frac{R_2\cdot R_3}{R_1}$$

(2)

Keltirib chiqarilgan (1) va (2) formulalardan foydalanib murakkab sxemalarni soddalashtirib hisoblaymiz. Yuqorida keltirib chiqarilgan formulalardan foydalanib quyidagi 3-rasmdagi sxemani umumiy qarshiligini yisoblaymiz. Sxemaning umumiy qarshiligini topish uchun ketma-ket, parallel ulashni amalga oshirib bo‘lmaydi. Bu sxemani yechishning ikki yo‘li bor.

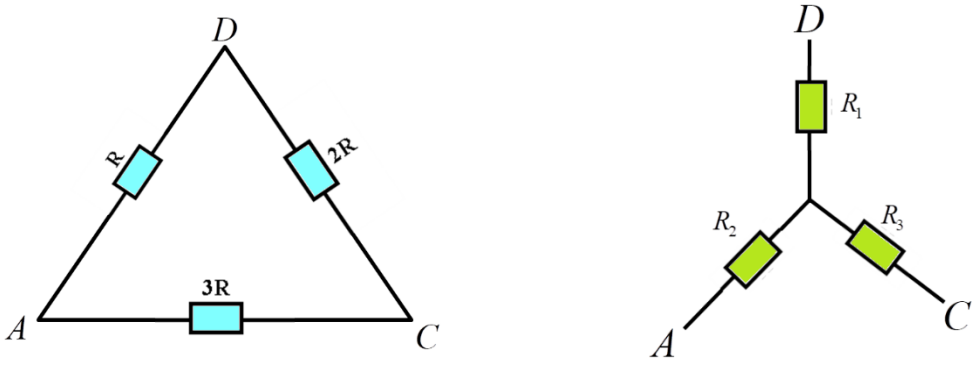
1-yo‘l: Kirxgof qoidalaridan foydalanib yechiladi, lekin bu yo‘l juda ko‘p tenglamalar talab qiladi.

2-yo‘l: Sxemani sodda holatga o‘tishning juda qulay yo‘li “Uchburchak-yulduzcha” yoki “Yulduzcha-uchburchak” usullaridir.

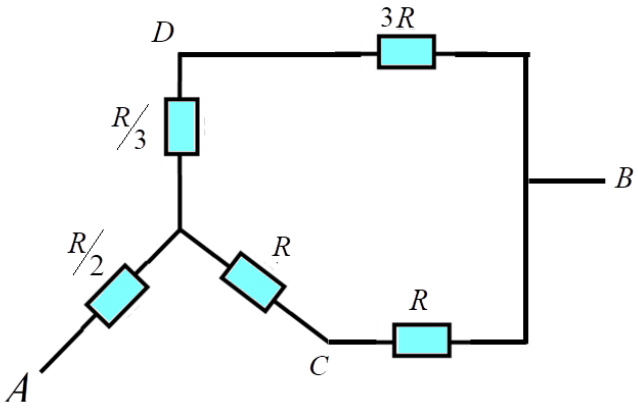


3-rasm. O‘rganilayotgan sxema.

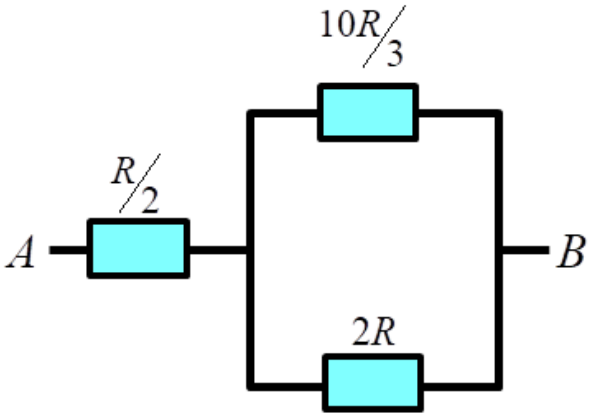
1-usul**: “Uchburchak-yulduzcha”** usuli. 3-rasmning ADC qismini uchburchak-dan yulduzchaga aylantiramiz.



(1) formulalardan foydalanib R_1, R_2, R_3 topsak $R_1 = R/3; R_2 = R/2; R_3 = R$ natijaga erishamiz. Asosiy sxemamizning ADC qismi o‘rniga yulduzchani etib qo‘ysak quyidagi sxema hosil bo‘ladi.

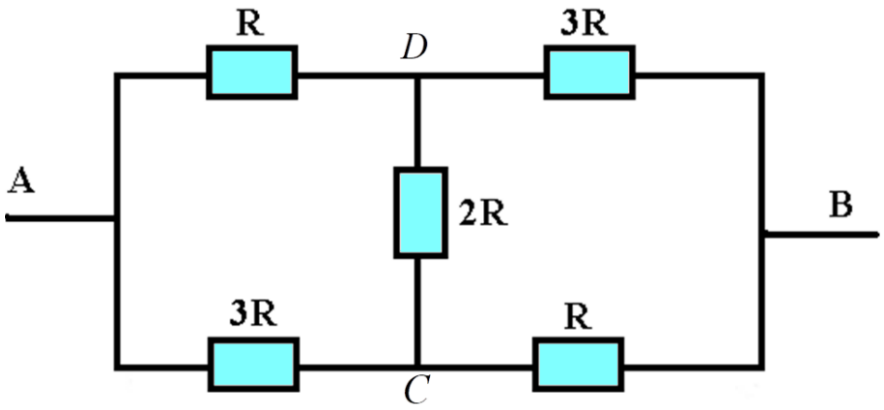


R/3 bilan 3R ni, R bilan R ni ketma-ket ulasak sxema quyidagicha soddalashadi.



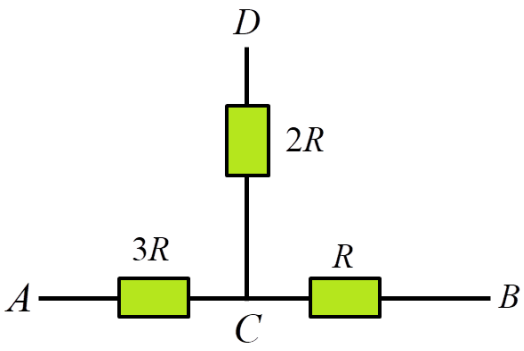
10R/3 bilan 2R ni parallel,natijani R/2 ga ketma-ket ulasak AB nuqta orasidagi umumiy qarshilik kelib chiqadi R_{AB}=7/4R

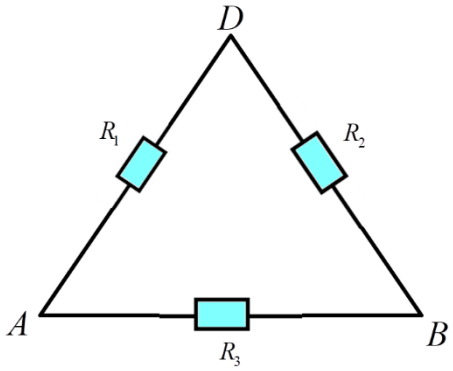
2-usul**: “Yulduzcha uchburchak”** usuli



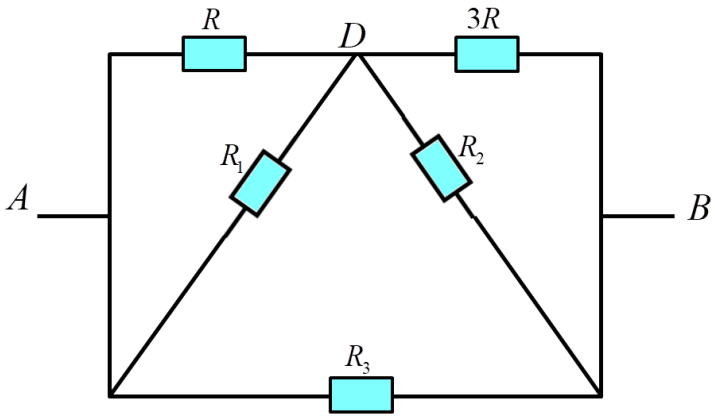
4-rasm. O‘rganilayotgan sxema.

4-rasmning AC, CD, CB qismini yulduzchadan ADB uchburchakka aylantiramiz.

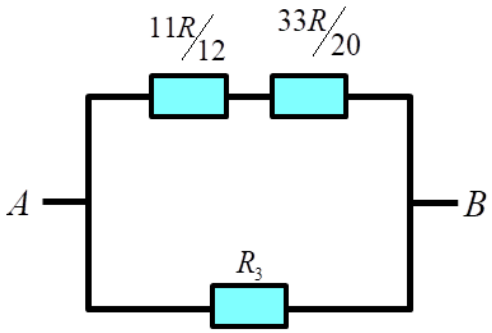




(2) formulalardan foydalanib R_1, R_2, R_3 topsak $R_1 = 11R; R_2 = 11R/3; R_3 = 5{,}5R$ natijaga erishamiz. Asosiy sxemamizning ACDB qismi o‘rniga ABD uchburchakni etib qo‘yamiz va sxemamiz quyidagi ko‘rinishga keladi.



R bilan R_1 ni, 3R bilan R_2 ni parallel ulasak sxema yanada soddalashadi.



Oxirgi qiladigan amalimiz 11R/12 ni 33R/20 qarshiliklarni ketma-ket ulab, chiqqan natijani R_3 ga parallel ulasak natija $R_{AB}=7/4R$ umumiy qarshilik kelib chiqadi.

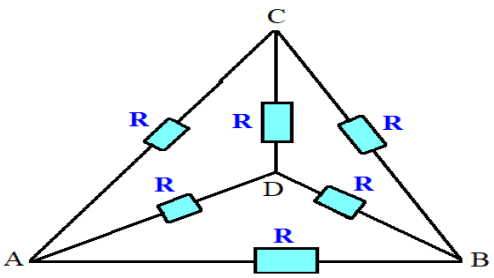
“Yulduzcha-uchburchak” va “Uchburchak-yulduzcha” usullari murakkab tuzilishga ega bo‘lgan sxemalarni yechishning eng sodda yechimi bo‘lib, o‘quvchilar murakkab sxemalarni yechishda Kirxgov qoidalarini qo‘llab juda ko‘b tenglamalarni keltirib chiqarmasdan, yuqoridagi usullardan foydalansa sxemalar murakkab ko‘rinishdan sodda ko‘rinishga o‘tadi. Sodda ko‘rinishdagi sxemalarni o‘quvchi ketma-ket va parallel ulash yordamida osongina natija chiqaradi.

NAZARIY YECHILGAN MASALALARNING AMALIY ISBOTI

Fizikadan masalalarni biz doimo nazariy yo‘l bilan ya’ni kerakli formulalar yordamida yechamiz, yechilgan masalalarni javobini laboratoriyada qilib ko‘rsak o‘quvchining bilim, ko‘nikmasi yanada oshadi.

Quyidagi masalalarni ham nazariy ham amaliy ya’ni laboratoriyada bajarib, har ikkala holatdaham javoblari bir-xil chiqishi isbotlangan.

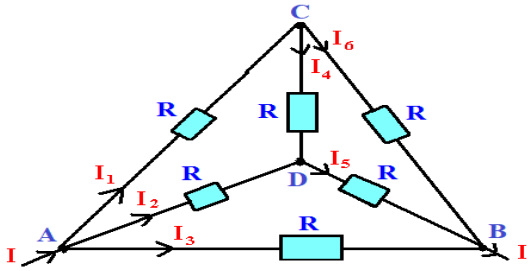
1. Uchburchakli piramidaning barcha tomonlarining qarshiligi R=20Ω ga teng, sxemaning AB nuqtalar orasidagi umumiy qarshiligini toping(1-sxema)?



1-sxema. Zanjir sxemasi.

AB nuqtalar orasidagi umumiy qarshilikni hisoblash uchun biz avval har bir rezistor orqali o‘tadigan toklarni topib chiqamiz. Demak A va B nuqta

orasidagi qarshilikni toping deyilgani uchun A nuqtadan I tok kirib B nuqtadan chiqib ketadi deb faraz qilib masalani ishlaymiz va sxemada tok kuchlarini quyidagicha joylashtirib chiqamiz(2-sxema).



2-sxema. Sxemada toklarning taqsimlanishi.

Kirxgofning 1-qoidasiga ko‘ra tugunlarga kiruvchi va chiquvchi toklar tengligidan quyidagi tenglamaga ega bo‘lamiz.

$$I = I_1 + I_2 + I_3$$
$$I_6 + I_5 + I_3 = I$$
$$I_4 + I_2 = I_5$$
$$I_4 + I_6 = I_1 \qquad (1)$$

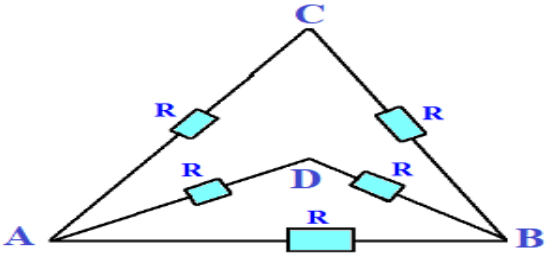
Kirxgofning 2-qoidasiga ko‘ra ACD, ADB va CBD yopiq kontur uchun quyidagi tenglamaga ega bo‘lamiz.

$$I_1 \cdot R + I_4 \cdot R - I_2 \cdot R = 0$$
$$I_2 \cdot R + I_5 \cdot R - I_3 \cdot R = 0$$
$$I_6 \cdot R - I_5 \cdot R - I_4 \cdot R = 0 \qquad (2)$$

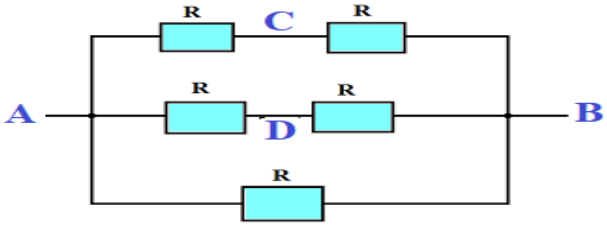
(1) va (2) tenglamalarni soddalashtirsak $I_3 = 2I_1 = 2I_2 = 2I_5 = 2I_6; I_4 = 0$ quyidagi natijaga erishamiz.

Demak CD yo‘nalishda tok harakatlanmaydi potensiallar farqi $\varphi_C - \varphi_D = U_{CD} = 0$ bo‘ladi. Shuning uchun CD rezistorni sxemadan olib tashlaymiz va sxemamiz quyidagi ko‘rinishga keladi(3-sxema). 3-sxemani quyidagi sodda ko‘rinishdagi 4-sxema ko‘rinishiga o‘tib uni hisoblaymiz.

$$\frac{1}{R_{AB}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{R}; R_{AB} = 0{,}5R = 0{,}5 \cdot 20 = 10\Omega$$

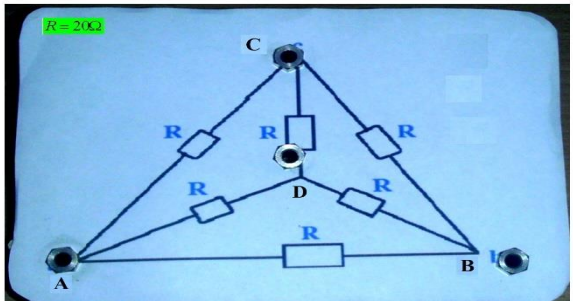


3-sxema. CD qarshilik olib tashlanadi.



4-sxema. Soddalashgan sxema.

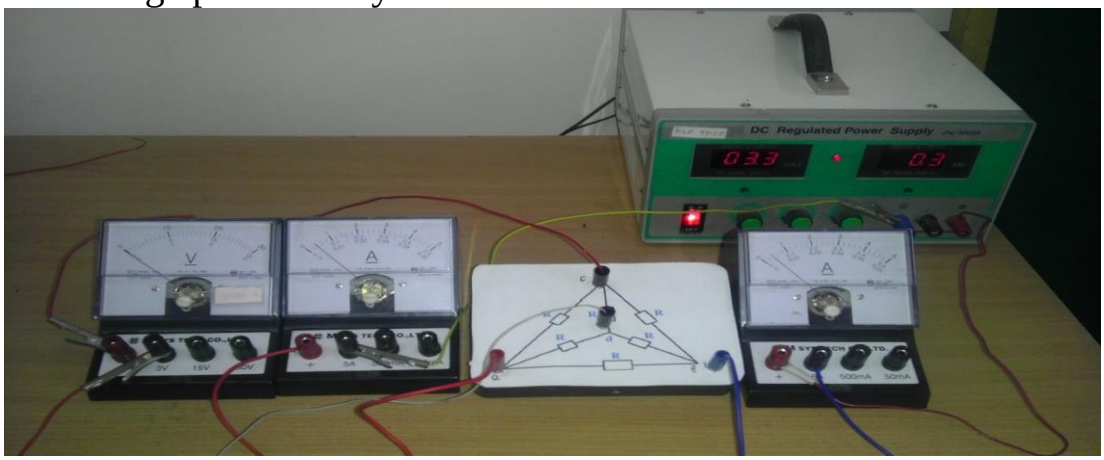
Endi nazariy yo‘l bilan isbotlab chiqarilgan natijalarni amalda bajaramiz. $\varphi_C - \varphi_D = U_{CD} = 0$ ushbu natijani amalda isbotlaymiz. Buning uchun quyidagi sxemani yig‘amiz



1-rasm. Zanjirning yig‘ilishi.
Old ko‘rinishi


1-rasm. Zanjirning yig‘ilishi.
Orqa ko‘rinishi

Sxemamizni A va B nuqtasini tok manbaiga ketma-ket, C va D nuqtalarni esa voltmetrga parallel ulaymiz.

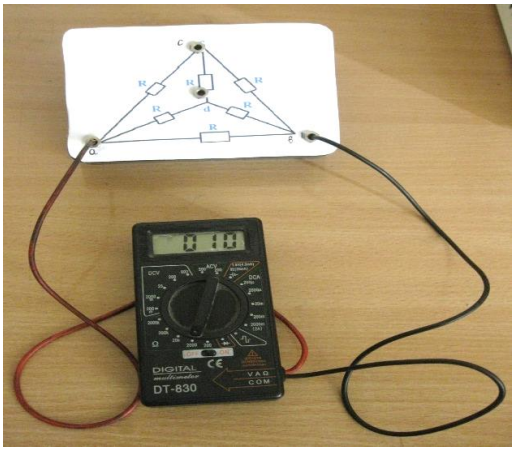


2-rasm. Tajriba qurilmalari.

Tajribadan ko‘rinib turibdiki, voltmetr 0 ni ko‘rsatmoqda demak C va D nuqtalarda potensiallar farqi 0 ga teng ekan.

Endi umumiy qarshilikni hisoblaymiz, buning uchun qarshilik o‘lchaydigan asbob ommetrdan foydalanamiz(3-rasm).

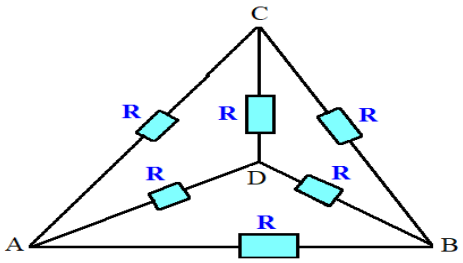
Bizga nazariy yo‘l bilan $R_{AB} = 10\Omega$ javob chiqqan edi, amalda ham shunday chiqdi.



3-rasm. O‘lchash natijasi.

Nazariy yo‘llar bilan topilgan barcha natijalar amaliy yo‘llar bilan o‘z isbotini topdi. Bunday amaliy tajribalar o‘quvchilarning nazariy bilimlarini amaliyotda qo‘llashga o‘rgatadi va nazariy bilimlarini mustahkamlaydi.

2. Uchburchakli piramidaning barcha tomonlarining qarshiligi R=20Ω ga teng, sxemaning AD nuqtalar orasidagi umumiy qarshiligini toping(1-rasm)?



1-sxema. Zanjir sxemasi.

Sxemaning qarshiliklari bir-xil bo‘lganligi uchun va c va b nuqtalarga potensiallar tengligi uchun, potensiallar farqi cb rezistorda 0 ga teng shuning uchun cb rezistordan tok o‘tmaydi.

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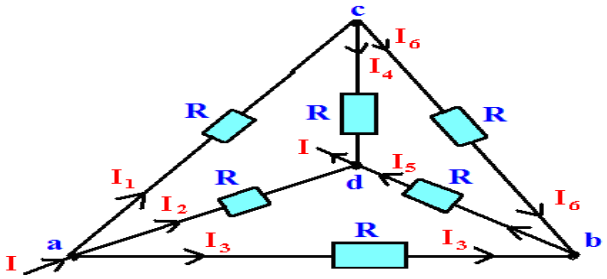
ad nuqtalar orasidagi umumiy qarshilikni hisoblash uchun biz avval har bir rezistor orqali o‘tadigan toklarni topib chiqamiz. Demak a va d nuqta orasidagi qarshilikni toping deyilgani uchun a nuqtadan I tok kirib d nuqtadan chiqib ketadi deb faraz qilib masalani ishlaymiz va sxemada tok kuchlarini quyidagicha joylashtirib chiqamiz (1,1-rasm).



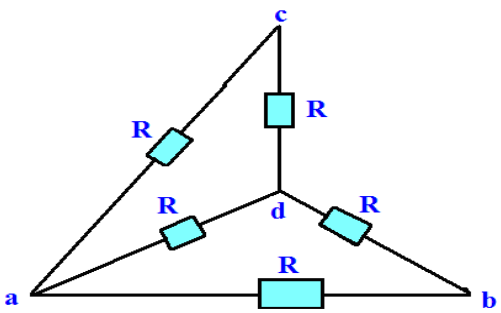
1,1-rasm.

Kirxgofning 1-2-qoidasidan foydalansak quyidagi (1) va (2) tenglamalar kelib chiqadi.

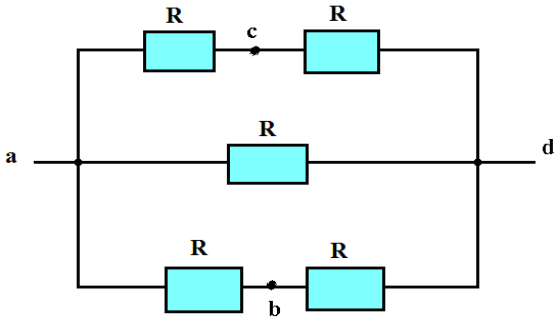
$$I = I_1 + I_2 + I_3\ ;\ I_2 + I_4 + I_5 = I;\qquad I_3 + I_6 = I_5 \qquad (1)$$

$$I_1R + I_4R - I_2R = 0;\ I_2R - I_5R - I_3R = 0;\ I_6R + I_5R - I_4R = 0 \qquad (2)$$

(1) va (2) formulalarni soddalashtirsak I_6=0 natija kelib chiqadi. Demak cb yo‘nalishda tok harakatlanmaydi potensiallar farqi $\varphi_c - \varphi_b = U_{cb} = 0$ bo‘ladi. Shuning uchun cb rezistorni sxemadan olib tashlaymiz va sxemamiz quyidagi ko‘rinishga keladi(1,2-rasm).



1,2-rasm.



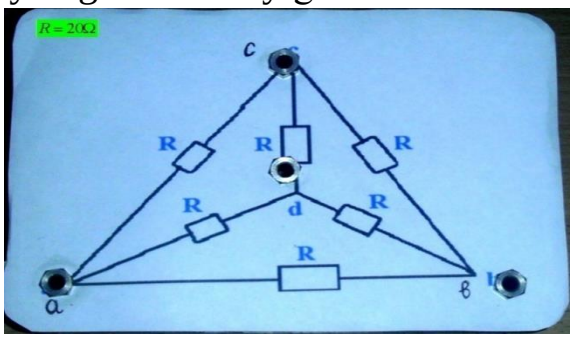
1,3-rasm.

1,2-rasmdagi sxemani murakkab ko‘rinishdan sodda ko‘rinishga o‘tamiz(1,3-rasm) va hisoblaymiz.

$$\frac{1}{R_{ad}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{R}; R_{ad} = 0{,}5R$$

Endi nazariy yo‘ bilan isbotlab chiqarilgan natijalarni amalda bajaramiz.

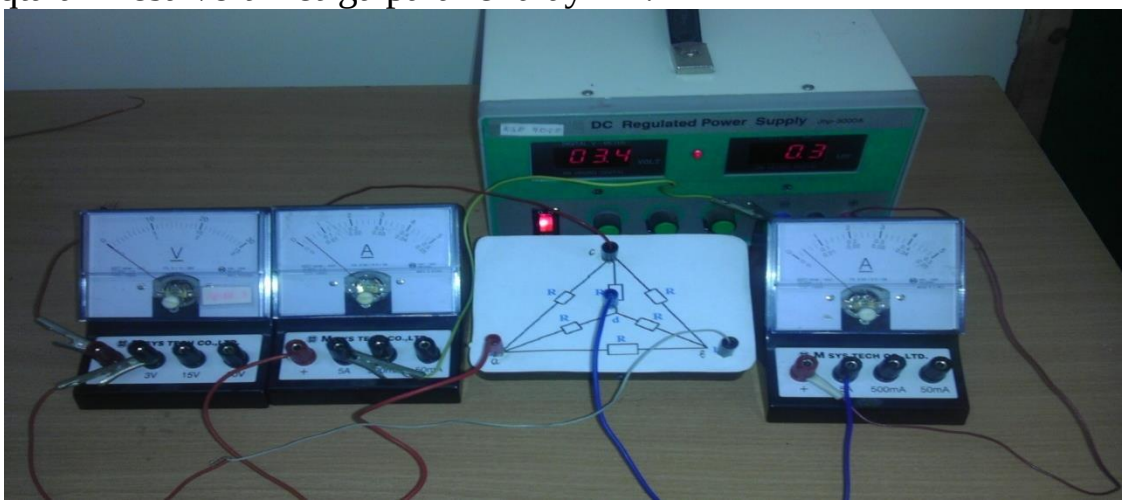
$\varphi_c - \varphi_b = U_{cb} = 0$ ushbu formulani amalda isbotlaymiz .Buning uchun quyidagi sxemani yig‘amiz



Old ko‘rinishi.

Orqa ko‘rinishi.

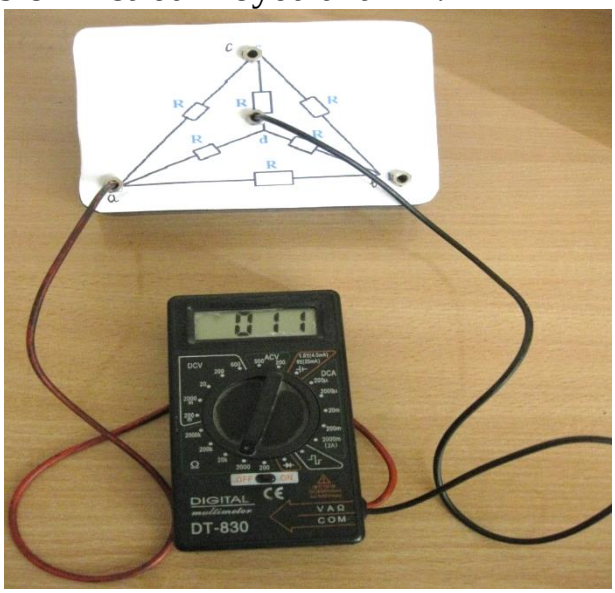
Sxemamizni a va d nuqtasini tok manbaiga ketma-ket, c va b nuqtalarni esa voltimetrga parallel ulaymiz.



Tajribadan ko‘rinib turibdiki voltimetr 0 ni ko‘rsatmoqda demak c va b nuqtalarda potensiallar farqi o ga teng ekan.

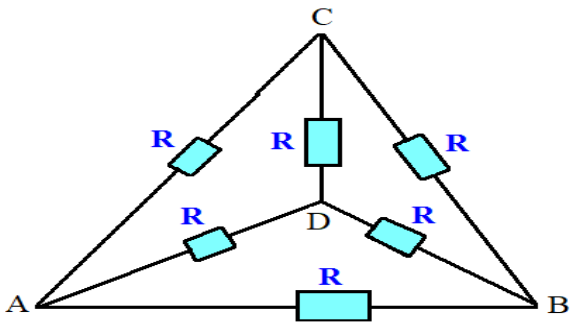
Tajribadan ya’na shunday xulosa chiqarish mumkinki Kirxgofning 1-qoidasida: Tugunlarga kiruvchi va chiquvchi toklar teng deyilgan edi yaqiqatdan ham a nuqtaga ulangan ampermetr ham d nuqtaga ulangan ampermetrham bir xil tokni ko‘rsatmoqda.

Endi umumiy qarshilikni hisoblaymiz buning uchun qarshilik o‘lchaydigan asbob ommetrdan foydalanamiz.



Bizga nazariy yo‘l bilan $R_{ad} = 0{,}5R$ javob chiqqan edi, biz qarshiligi $R = 20\Omega$ bo‘lgan qarshiliklardan foydalanganimiz uchun javob $R_{ad} = 0{,}5 \cdot 20 = 10\Omega$ chiqishi kerak edi lekin ulash simlarining qarshiligi borligi uchun $R_{ad} = 11\Omega$ chiqdi.

3. Uchburchakli piramidaning barcha tomonlarining qarshiligi R=20Ω ga teng, sxemaning AC nuqtalar orasidagi umumiy qarshiligini toping(1-rasm)?

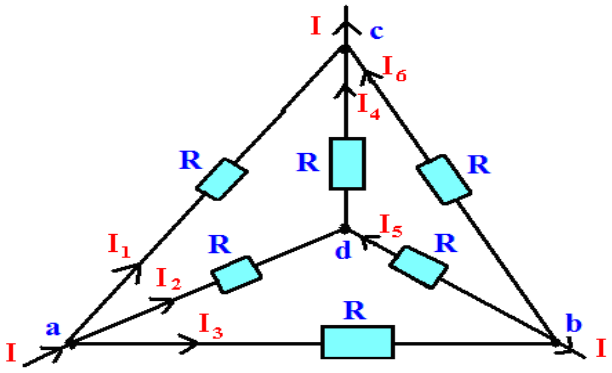


1-rasm

Sxemaning qarshiliklari bir-xil bo‘lganligi uchun va b va d nuqtalarga potensiallar tengligi uchun,potensiallar farqi bd rezistorda 0 ga teng shuning uchun bd rezistordan tok o‘tmaydi.

ISBOT

ac nuqtalar orasidagi umumiy qarshilikni hisoblash uchun biz avval har bir rezistor orqali o‘tadigan toklarni topib chiqamiz. Demak a va c nuqta orasidagi qarshilikni toping deyilgani uchun a nuqtadan I tok kirib c nuqtadan chiqib ketadi deb faraz qilib masalani ishlaymiz va sxemada tok kuchlarini quyidagicha joylashtirib chiqamiz(1,1-rasm).



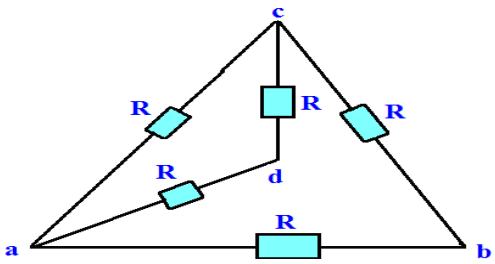
1,1-rasm

Kirxgofning 1-qoidasiga ko‘ra tugunlarga kiruvchi va chiquvchi toklar tengligidan quyidagi natijaga ega bo‘lamiz.

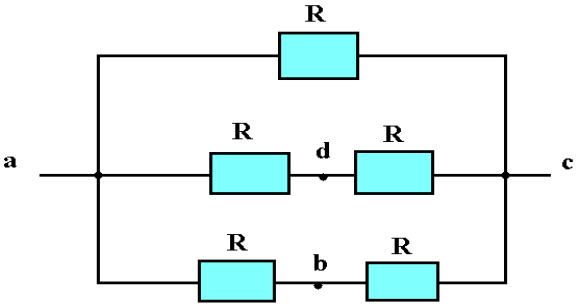
$I = I_1 + I_2 + I_3;\ I_1 + I_4 + I_6 = I;\ I_2 + I_5 = I_4$ (1)

$I_1R - I_4R - I_2R = 0;\ I_2R - I_5R - I_3R = 0;\ I_4R - I_6R - I_5R = 0$ (2)

(1) va (2) formulalarni soddalashtirsak $I_5=0$ natija kelib chiqadi. Demak db yo‘nalishda tok harakatlanmaydi potensiallar farqi $\varphi_b - \varphi_d = U_{bd} = 0$ bo‘ladi. Shuning uchun db rezistorni sxemadan olib tashlaymiz va sxemamiz quyidagi ko‘rinishga keladi(1,2-rasm).



1,2-rasm



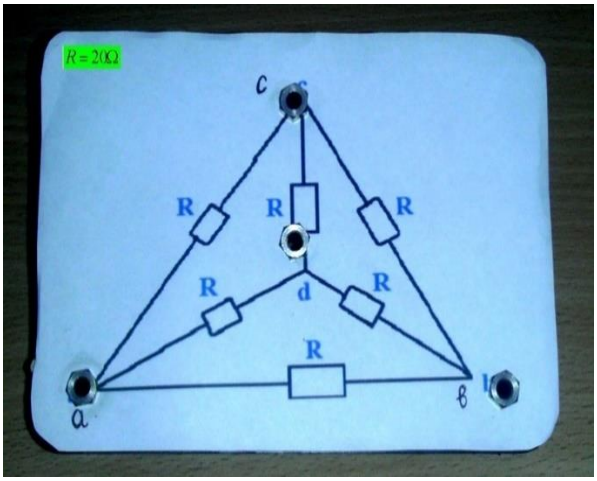
1,3-rasm

1,2-rasmdagi sxemani quyidagi sodda ko‘rinishda o‘tamiz(1,3-rasm) va hisoblaymiz.

$$\frac{1}{R_{ac}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{R};\ R_{ac} = 0{,}5R$$

Endi nazariy yo‘ bilan isbotlab chiqarilgan natijalarni amalda bajaramiz.

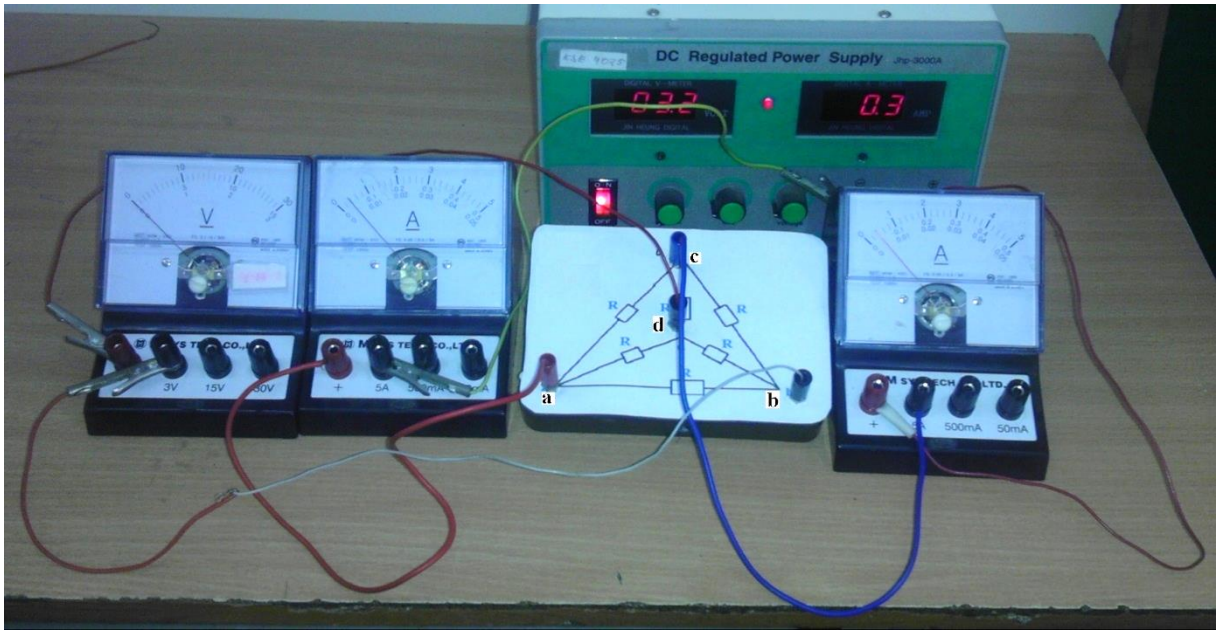
$\varphi_d - \varphi_b = U_{db} = 0$ ushbu formulani amalda isbotlaymiz .Buning uchun quyidagi sxemani yig‘amiz



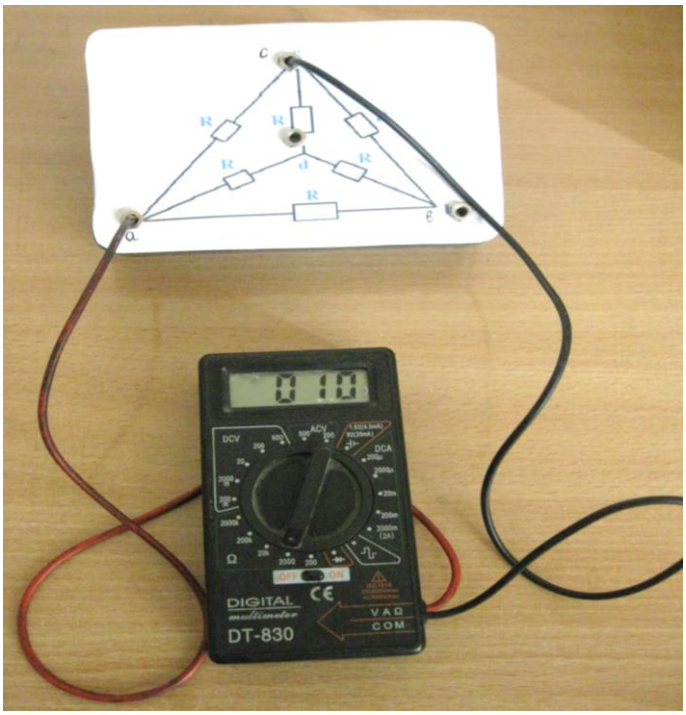
Old ko‘rinishi.

Orqa ko‘rinishi.

Sxemamizni a va c nuqtasini tok manbaiga ketma-ket, d va b nuqtalarni esa voltimetrga parallel ulaymiz.



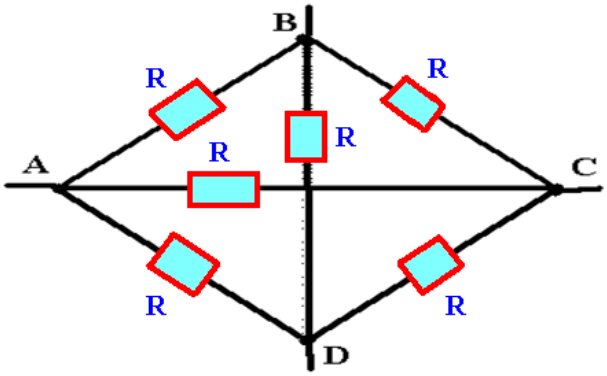
Tajribadan ko‘rinib turibdiki voltimetr 0 ni ko‘rsatmoqda demak d va b nuqtalarda potensiallar farqi o ga teng ekan. Tajribadan ya’na shunday xulosa chiqarish mumkinki Kirxgofning 1-qoidasida: Tugunlarga kiruvchi va chiquvchi toklar teng deyilgan edi yaqiqatdan ham a nuqtaga ulangan ampermetr ham c nuqtaga ulangan ampermetrham bir xil tokni ko‘rsatmoqda. Endi umumiy qarshilikni hisoblaymiz buning uchun qarshilik o‘lchaydigan asbob ommetrdan foydalanamiz.



Bizga nazariy yo‘l bilan $R_{ac} = 0{,}5R$ javob chiqqan edi, biz qarshiligi $R = 20\Omega$ bo‘lgan qarshiliklardan foydalanganimiz uchun javob $R_{ac} = 0{,}5 \cdot 20 = 10\Omega$ chiqdi.

3. Simdan yasalgan ABCD rombning AC nuqtalari orasidagi qarshilikni toping.Rombning tomonlari va diagonallarining qarshiligi R ga teng(1-rasm).

(AC va BD diaganallar kesishmagan)



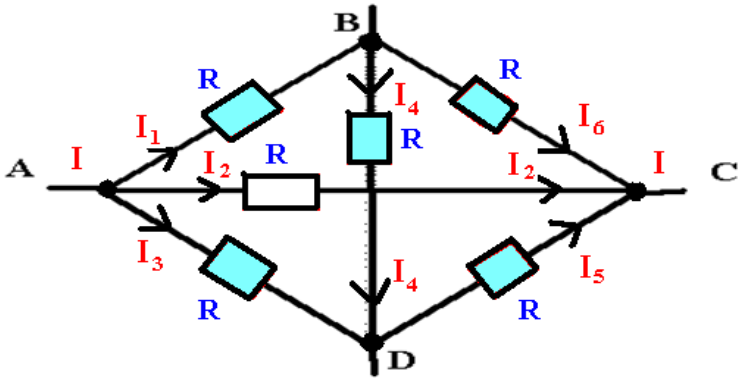
1-rasm

B va D nuqtalarda potensiallari teng $\varphi_B = \varphi_D$ Potensiallar farqi $\varphi_B - \varphi_D = U_{BD} = 0$ bo‘lganligi uchun BD nuqta orqali tok o‘tmaydi.

ISBOT:

AC nuqtalar orasidagi umumiy qarshilikni hisoblash uchun biz avval har bir rezistor orqali o‘tadigan toklarni topib chiqamiz. Demak A va C nuqta orasidagi qarshilikni toping deyilgani uchun A nuqtadan I tok kirib C

nuqtadan chiqib ketadi deb faraz qilib masalani ishlaymiz.Va sxemada tok kuchlarini quyidagicha joylashtirib chiqamiz(1,1-rasm).



1,1-rasm

Kirxgofning 1-2-qoidalariadan foydalanib quyidagi tenglamalarni tuzamiz.

$I = I_1 + I_2 + I_3;\ I_2 + I_5 + I_6 = I;\ I_4 + I_6 = I_1; I_3 + I_4 = I_5$ (1)

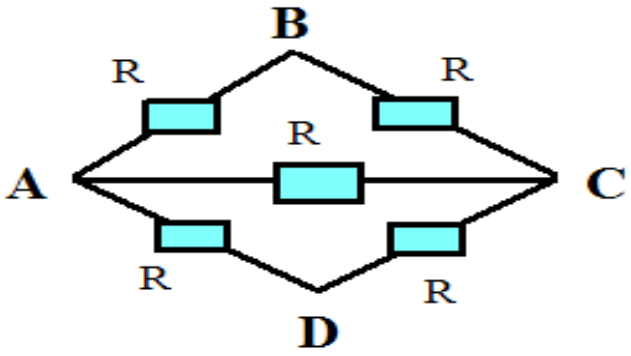
$I_1R - I_4R - I_3R = 0; I_2R - I_5R - I_3R = 0; I_6R - I_5R - I_4R = 0;$

$I_1R - I_6R - I_5R - I_3R = 0$ (2)

(1) va (2) formulalarni soddalashtirsak $I_4=0$ natija kelib chiqadi. Shuning uchun BD diagonalni olib tashlaymiz(1,2-rasm) va quyidagi 2-usulda ishlaymiz

1-Usul

Bu sxemani tushunarliroq bo‘lishi uchun quyidagicha soddalashtiramiz



1,2-rasm

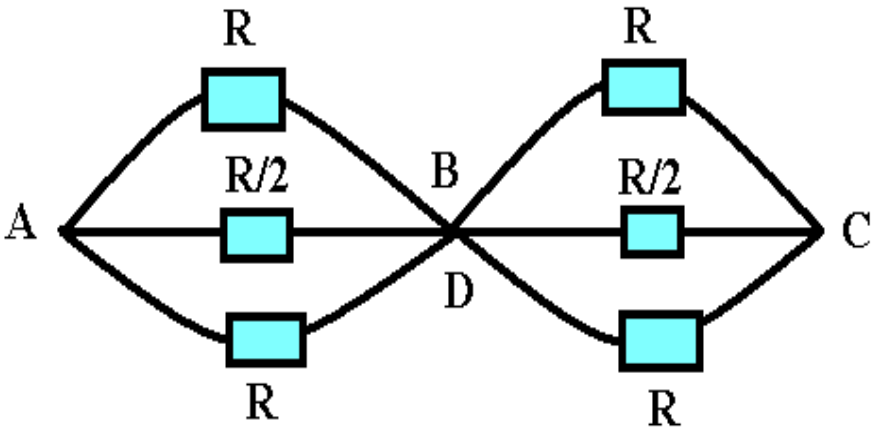
$$R_{ABC} = R + R = 2R; R_{ADC} = R + R = 2R; \frac{1}{R_{AC}} = \frac{1}{R_{ABC}} + \frac{1}{R} + \frac{1}{R_{ADC}}$$

$$= \frac{1}{2R} + \frac{1}{R} + \frac{1}{2R} = \frac{4}{2R}$$

$$R_{AC} = \frac{2R}{4} = \frac{R}{2}$$

2-Usul

B va D nuqtalarda potensiallar farqi o bo‘lganligi uchun BD nuqta orqali tok o‘tmaydi shuning uchun BD nuqtalarni birlashtiramiz va u quyidagi holga keladi

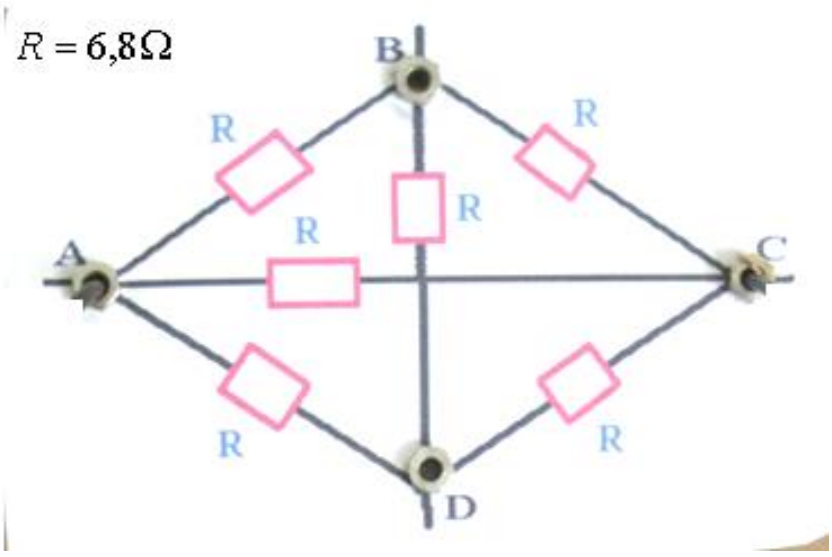


$$\frac{1}{R_{AB}} = \frac{1}{R} + \frac{1}{\frac{R}{2}} + \frac{1}{R} = \frac{1}{R} + \frac{2}{R} + \frac{1}{R} = \frac{4}{R} \rightarrow R_{AB} = \frac{R}{4};$$

$$\frac{1}{R_{BC}} = \frac{1}{R} + \frac{1}{\frac{R}{2}} + \frac{1}{R} = \frac{1}{R} + \frac{2}{R} + \frac{1}{R} = \frac{4}{R} \rightarrow R_{BC} = \frac{R}{4}$$

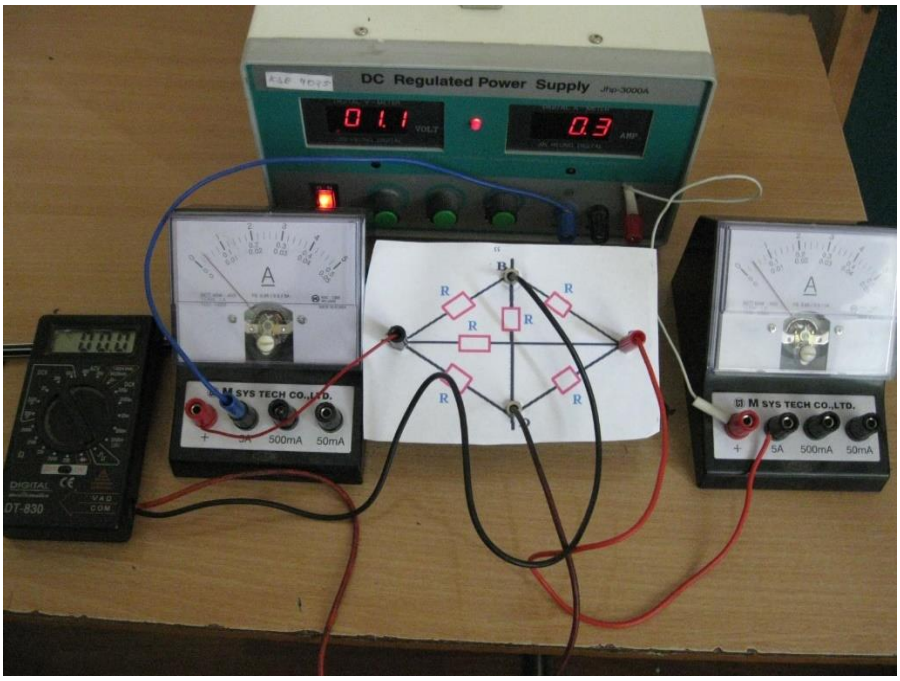
$$R_{AC} = \frac{R}{4} + \frac{R}{4} = \frac{R}{2}$$

Endi nazariy yo‘ bilan isbotlab chiqarilgan natijalarni amalda bajaramiz. $\varphi_B - \varphi_D = U_{BD} = 0$ ushbu formulani amalda isbotlaymiz .Buning uchun quyidagi sxemani yig‘amiz.



Old ko‘rinishi

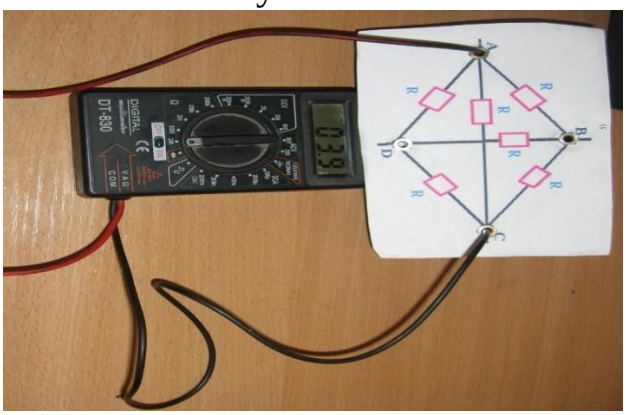
Sxemamizni A va C nuqtasini tok manbaiga ketma-ket, B va D nuqtalarni esa voltimetrga parallel ulaymiz.



Tajribadan ko‘rinib turibdiki voltimetr 0 ni ko‘rsatmoqda demak B va D nuqtalarda potensiallar farqi o ga teng ekan.

Tajribadan ya’na shunday xulosa chiqarish mumkinki Kirxgofning 1-qoidasida: Tugunlarga kiruvchi va chiquvchi toklar teng deyilgan edi yaqiqatdan ham A nuqtaga ulangan ampermetr ham C nuqtaga ulangan ampermetrham bir xil tokni ko‘rsatmoqda.

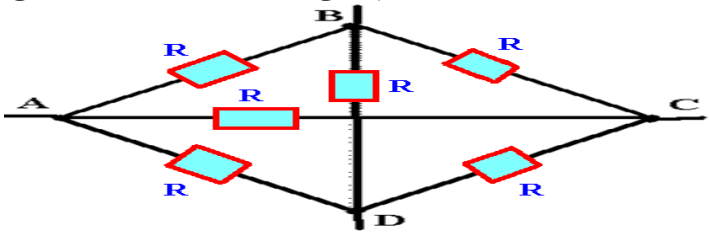
Endi umumiy qarshilikni hisoblaymiz buning uchun qarshilik o‘lchaydigan asbob ommetrdan foydalanamiz.



Bizga nazariy yo‘l bilan $R_{AC} = 0{,}5R$ javob chiqqan edi, biz qarshiligi $R = 6{,}8\Omega$ bo‘lgan qarshiliklardan foydalanganimiz uchun javob $R_{AC} = 0{,}5 \cdot 6{,}8 = 3{,}4\Omega$ chiqishi kerak edi lekin simlarning qarshiligi borligi uchun $R_{AC} = 3{,}9\Omega$ chiqdi.

4. Simdan yasalgan ABCD rombning AB nuqtalari orasidagi qarshilikni toping.Rombning tomonlari va diagonallarining qarshiligi R ga teng(1-rasm)

(AC va BD diaganallar kesishmagan)

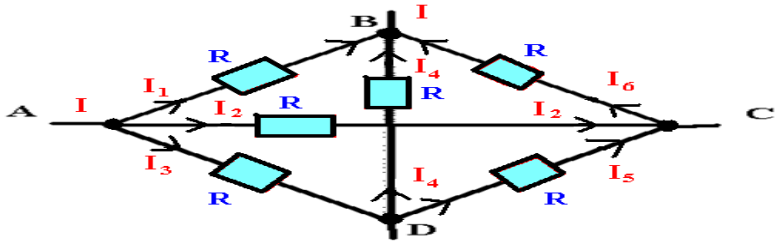


1-rasm.

D va C nuqtalarda potensiallari teng $\varphi_B = \varphi_D$ Potensiallar farqi $\varphi_B - \varphi_D = U_{BD} = 0$ bo‘lganligi uchun DC nuqta orqali tok o‘tmaydi.

ISBOT:

AB nuqtalar orasidagi umumiy qarshilikni hisoblash uchun biz avval har bir rezistor orqali o‘tadigan toklarni topib chiqamiz. Demak A va B nuqta orasidagi qarshilikni toping deyilgani uchun A nuqtadan I tok kirib B nuqtadan chiqib ketadi deb faraz qilib masalani ishlaymiz.Va sxemada tok kuchlarini quyidagicha joylashtirib chiqamiz(1,1-rasm).



1,1-rasm

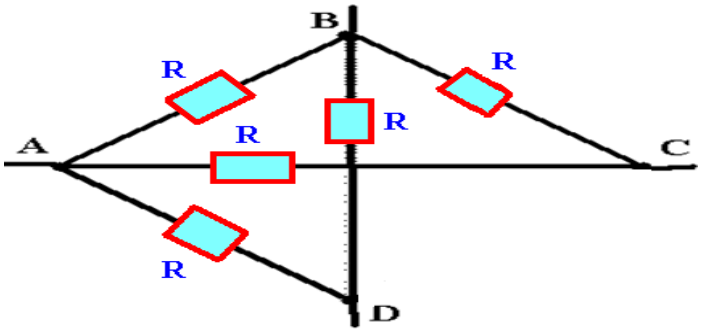
Kirxgofning 1-2-qoidalariadan foydalanib quyidagi tenglamalarni tuzamiz.

$$I = I_1 + I_2 + I_3;\ I_1 + I_4 + I_6 = I;\ I_4 + I_5 = I_3;\ I_2 + I_5 = I_6 \qquad (1)$$

$$I_1R - I_4R - I_3R = 0;\ I_2R - I_5R - I_3R = 0;\ -I_6R - I_5R + I_4R = 0$$

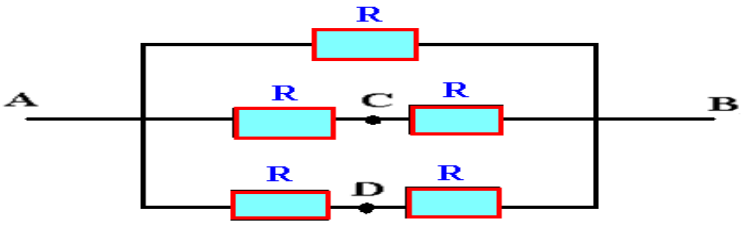
$$I_1R - I_6R - I_5R - I_3R = 0 \qquad (2)$$

(1) va (2) formulalarni soddalashtirsak $I_5=0$ natija kelib chiqadi.shuning uchun DC diagonalni olib tashlaymiz va quyidagicha ishlaymiz



1,2-rasm

AC va CB rezistorlar va AD va DB rezistorlarham ketma-ket ulanganligi uchun quyidagicha soddalashtiramiz(1,3-rasm).



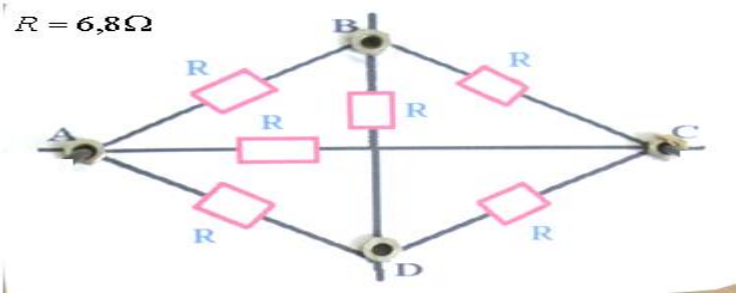
1,3-rasm

$$R_{ACB} = R + R = 2R; R_{ADB} = R + R = 2R;$$

$$\frac{1}{R_{AB}} = \frac{1}{R_{ACB}} + \frac{1}{R_{ADB}} + \frac{1}{R} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{R} = \frac{4}{2R} \rightarrow R_{AB} = \frac{R}{2}$$

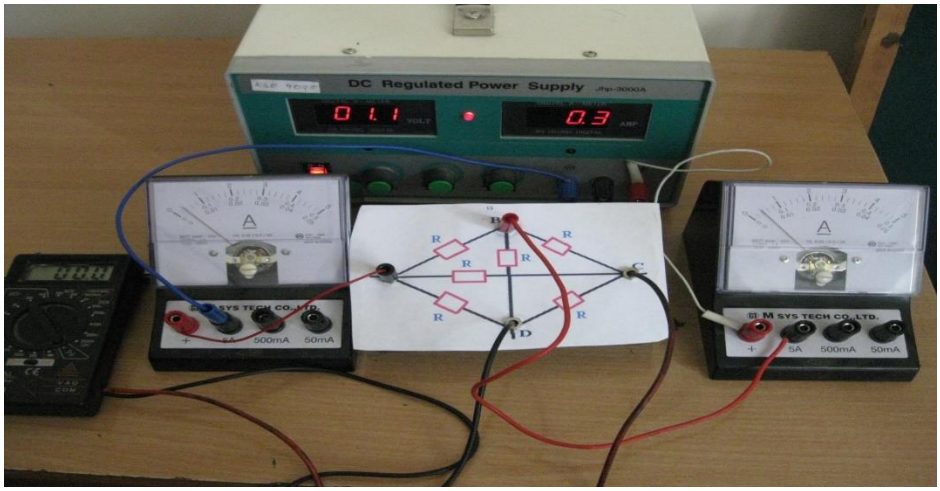
Endi nazariy yo‘ bilan isbotlab chiqarilgan natijalarni amalda bajaramiz.

$\varphi_D - \varphi_C = U_{DC} = 0$ ushbu formulani amalda isbotlaymiz .Buning uchun quyidagi sxemani yig‘amiz



Old ko‘rinishi

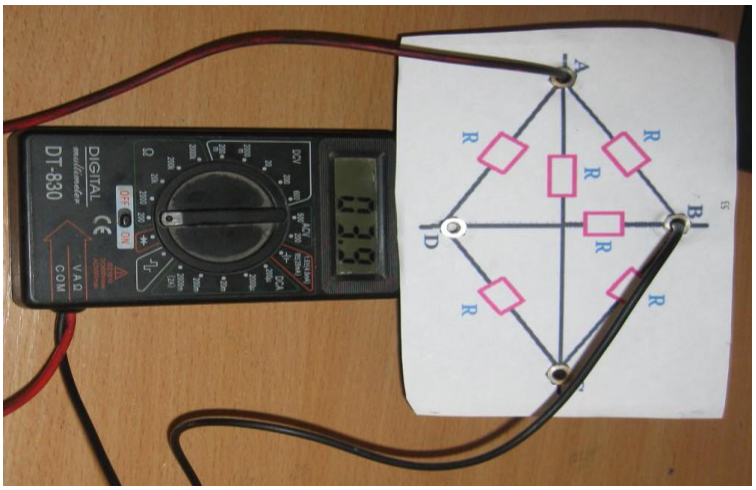
Sxemamizni A va B nuqtasini tok manbaiga ketma-ket, D va C nuqtalarni esa voltimetrga parallel ulaymiz.



Tajribadan ko‘rinib turibdiki voltimetr 0 ni ko‘rsatmoqda demak D va C nuqtalarda potensiallar farqi o ga teng ekan. Tajribadan ya’na shunday xulosa chiqarish mumkinki Kirxgofning

1-qoidasida: Tugunlarga kiruvchi va chiquvchi toklar teng deyilgan edi yaqiqatdan ham A nuqtaga ulangan ampermetr ham B nuqtaga ulangan ampermetrham bir xil tokni ko‘rsatmoqda.

Endi umumiy qarshilikni hisoblaymiz buning uchun qarshilik o‘lchaydigan asbob ommetrdan foydalanamiz.



Bizga nazariy yo‘l bilan $R_{AB}=0{,}5R$ javob chiqqan edi, biz qarshiligi $R=6{,}8\Omega$ bo‘lgan qarshiliklardan foydalanganimiz uchun javob $R_{AB}=0{,}5\cdot 6{,}8=3{,}4\Omega$ chiqishi kerak edi lekin simlarning qarshiligi borligi uchun $R_{AB}=3{,}9\Omega$ chiqdi.

OLIY O‘QUV YURTLARIGA KIRUVCHILAR UCHUN VARIANT VA AXBOROTNOMALAR TO‘PLAMIDAN NAMUNALAR

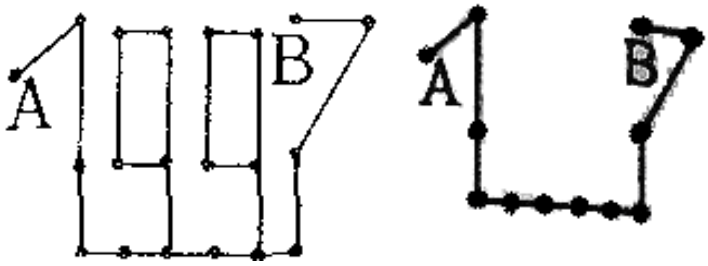
REZISTORLARNI KETMA-KET ULASH FORMULASI:

$$R_{Um} = R_1 + R_2 + R_3 + \dots R_n$$

REZISTORLARNI PARALLEL ULASH FORMULASI:

$$\frac{1}{R_{Um}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \frac{1}{R_n}$$

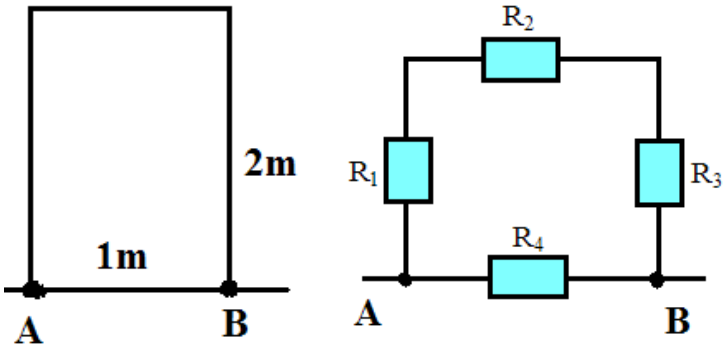
98/11-43. Rasmda ko‘rsatilgan A ya B nuqtalar orasidagi to‘liq qarshilikni toping. Har bir qismning qarshiligi R ga teng.



Sxemani soddalashtiramiz ya’ni tok o‘tmaydigan qismlarni olib tashlaymiz.Rasmda tasvirlangan barcha qismlarning qarshiligi R va ular ketma-ket ulangan 11 ta qismdan tashkil topgan

$R_{um} = R + R + R + R + R + R + R + R + R + R + R = 11R$

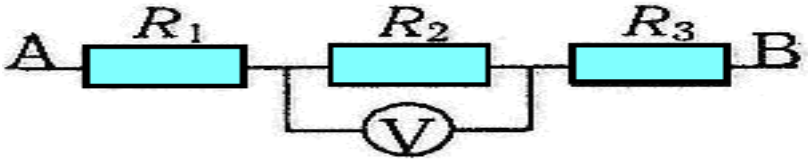
98/8-59. Kesimi yuzi 1 mm^2 bo‘lgan po‘lat o‘tkazgichdan tayyorlangan, tomoni 1m va 2m bo‘lgan to‘g‘ri to‘rtburchak shaklidagi elektr zanjning A va B nuqtalar orasidagi to‘liq qarshilikni toping (Ω).Po‘latning solishtirma qarshiligi $1{,}2 \cdot 10^{-7}\,\Omega \cdot m$



Bu sxemani har-bir uzunlikdagi simning qarshiligini topamiz. So‘ngra qarshilikni ketma-ket va parallel ulash formulalaridan foydalanib umumiy qarshilikni topamiz.bu sxemani quyidagi ko‘rinishda keltirsak bo‘ladi

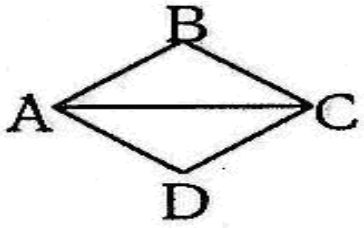
Berilgan:	Yechilishi:
$S = 1mm^2 = 1 \cdot 10^{-6}m^2$ $l_1 = 2m$ $l_2 = 1m$ $l_3 = 2m$ $l_4 = 1m$ $\rho = 1{,}2 \cdot 10^{-7}\Omega \cdot m$	$R_1 = \rho\frac{l_1}{S} = 1{,}2 \cdot 10^{-7}\frac{2}{1 \cdot 10^{-6}} = 0{,}24\Omega$ $R_2 = \rho\frac{l_2}{S} = 1{,}2 \cdot 10^{-7}\frac{1}{1 \cdot 10^{-6}} = 0{,}12\Omega$ $R_3 = \rho\frac{l_3}{S} = 1{,}2 \cdot 10^{-7}\frac{2}{1 \cdot 10^{-6}} = 0{,}24\Omega R_4 = \rho\frac{l_4}{S} = 1{,}2 \cdot 10^{-7}\frac{1}{1 \cdot 10^{-6}} = 0{,}12\Omega$ $R_{123} = R_1 + R_2 + R_3 = 0{,}24 + 0{,}12 + 0{,}24 = 0{,}6\Omega$ $\frac{1}{R_{AB}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{1}{0{,}6} + \frac{1}{0{,}12} = \frac{1}{0{,}6} + \frac{5}{0{,}6} = \frac{6}{0{,}6}$ $R_{AB} = \frac{0{,}6}{6} = 0{,}1\Omega$
$R_{AB} = ?$ Formula: $R = \rho\frac{l}{S}$	

96/7-37. A va B nuqtalar orasidagi kuchlanish qanday (V)?
R_1 = 10 Ω, R_2=5 Ω, R_3=20 Ω, U_2= 10 V

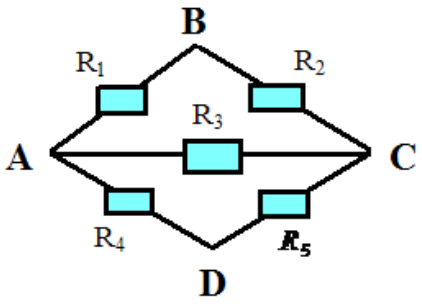


Ketma-ket ulashda sistemaning tok kuchi bir xil bo‘ladi $I_2 = \frac{U_2}{R_2} = \frac{10}{5} = 2A$ Demak bundan kelib chiqadiki $I_1 = I_2 = I_3 = 2A$ har bir qarshilikdagi kuchlanishni topamiz. $U_1 = I_1 \cdot R_1 = 2 \cdot 10 = 20V; U_3 = I_3 \cdot R_3 = 2 \cdot 20 = 40V;$ Ketma-ket ulashda kuchlanishlar qo‘shiladi:$U = U_1 + U_2 + U_3 = 20 + 10 + 40 = 70V.$

96/3-92. Simdan yasalgan ABCD rombning (rasmga q.) A va C nuqtalari orasidagi qarshilikni toping. Rombning tomonlari va AC diagonalming qarshiliklari bir xil bo‘lib R ga teng.



Bu sxemani tushunarliroq bo‘lishi uchun quyidagicha soddalashtiramiz

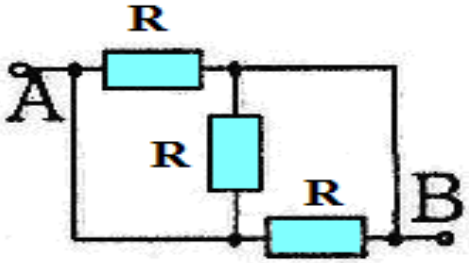


$R_1 = R_2 = R_3 = R_4 = R_5 = R; R_{12} = R_1 + R_2 = R + R = 2R$

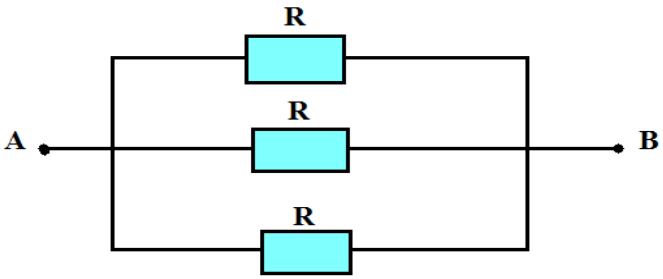
$R_{45} = R_4 + R_5 = R + R = 2R; \frac{1}{R_{AC}} = \frac{1}{R_{12}} + \frac{1}{R_3} + \frac{1}{R_{45}} = \frac{1}{2R} + \frac{1}{R} + \frac{1}{2R} = \frac{4}{2R}$

$R_{AC} = \frac{2R}{4} = \frac{R}{2}$

00/3-34. Rasmda tasvirlangan elektr zanjirning A va B nuqtalari orasidagi qarshilik necha Ω? Rezistorlardan har birining qarshiligi 30 Ω ga teng.

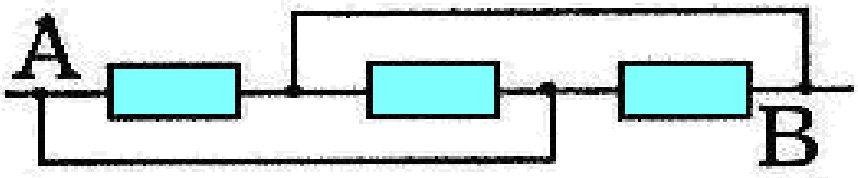


Bu sxemani tushunarliroq bo‘lishi uchun quyidagicha soddalashtiramiz

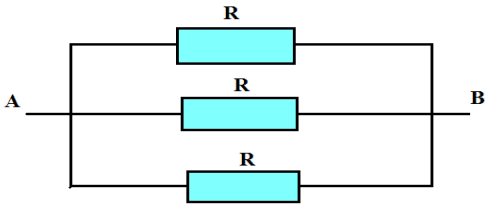


$$\frac{1}{R_{AB}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R} \rightarrow R_{AB} = \frac{R}{3} = \frac{30}{3} = 10\Omega$$

99/9-36. Har birining qarshiligi 3 Ω dan bo‘lgan qarshiliklar rasmda ko‘rsatilgan-dek ulangan bo‘lsa, A va B nuqtalar orasidagi umumiy qarshilik necha Ω?

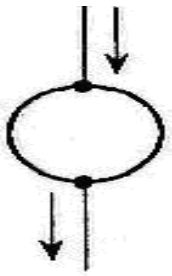


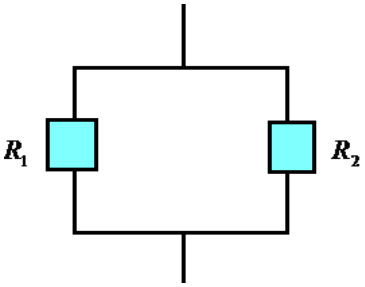
Bu zanjirni soddalashtiramiz



$$\frac{1}{R_{AB}}=\frac{1}{R}+\frac{1}{R}+\frac{1}{R}=\frac{3}{R}R_{AB}=\frac{R}{3}=\frac{3}{3}=1\Omega$$

98/4-56. Solishtirma qarshiligi ρ va ko‘ndalang kesim yuzi S bo‘lgan bir jinsli simdan radiusi r bo‘lgan halqa yasalgan va u diametral qarama-qarshi ikki nuqtasidan zanjirga ulangan. Shu nuqtalar orasidagi qarshilikni aniqlang.



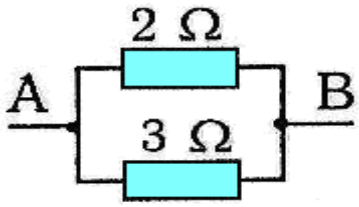


Halqaning ikki tomonini qarshiligini topamiz va quyidagicha soddalashgan holga keltiramiz.Yalqaning yarmining uzunligi bu aylana yarmi

$$l_1=l_2=\frac{2\pi r}{2}=\pi r;R_1=\rho\frac{l_1}{S}=\rho\frac{\pi r}{S};R_2=\rho\frac{l_2}{S}=\rho\frac{\pi r}{S};$$

$$\frac{1}{R_{um}}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{\rho\frac{\pi r}{S}}=\frac{S}{\rho\pi r}+\frac{S}{\rho\pi r}=\frac{2S}{\rho\pi r};R_{um}=\frac{\rho\pi r}{2S}$$

03/8-4. Sxemadagi qarshiligi 3 Ω bo‘lgan tarmoqdan o’tayotgan tokning kuchi 2 A. Qarshiligi 2 Ω bo‘lgan tarmoqdan o‘tayotgan tok kuchi qanday (A)?

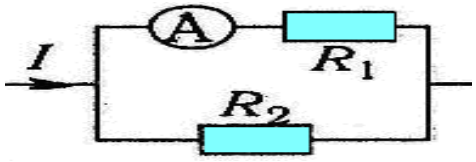


Ikkita qarshilik parallel ulangan, parallel ulashda tarmoqning kuchlanishlari bir xil bo‘ladi shuning uchun bu sxemaning kuchlanishlarini tenglashtiramiz.

Berilgan:	Yechilishi:
$I_2=2A$ $R_2=3\Omega$ $R_1=2\Omega$	$I=\frac{U}{R}$ Formuladan U ni topsak $U=I\cdot R$ formula kelib chiqadi

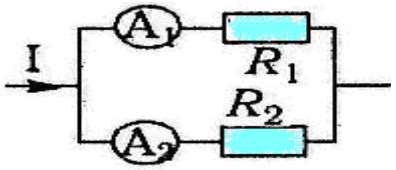
$I_1 = ?$ Formula: $U_1 = U_2$	$U_1 = I_1 \cdot R_1; U_2 = I_2 \cdot R_2; U_1 = U_2$ kuchlanishlarni tenglashtirsak $I_1 \cdot R_1 = I_2 \cdot R_2$ natijaga ega bo‘lamiz $I_1 = \frac{I_2 \cdot R_2}{R_1} = \frac{2 \cdot 3}{2} = 3A$

99/1-31. Quyidagi sxemada R_2=4 Ω, I=5 A, I_1=2 A bo‘lsa, umumiy qarshilik necha Ω bo‘ladi?



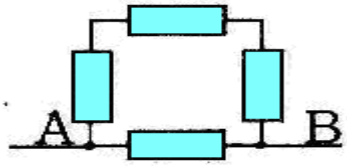
Berilgan: $I = 5A$ $I_1 = 2A$ $R_2 = 4\Omega$ $R_{um} = ?$ Formula: $U_1 = U_2$	Yechilishi: I tok kuchi 2 ga bo‘linadi$I = I_1 + I_2$ bundan $I_2 = I - I_1 = 5 - 2 = 3A$ sxemadagi qarshiliklar parallel ulangan, parallel ulashda kuchlanish bir xil $U_1 = U_2; U_1 = U_2; U_1 = I_1 \cdot R_1; U_2 = I_2 \cdot R_2$ kuchlanishlarni tenglashtirsak $I_1 \cdot R_1 = I_2 \cdot R_2$ bu yerdan R_1 ni topamiz $R_1 = \frac{I_2 \cdot R_2}{I_1} = \frac{3 \cdot 4}{2} = 6\Omega$ $\frac{1}{R_{um}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{4} = \frac{5}{12}; R_{um} = \frac{12}{5} = 2{,}4\Omega$

99/9-38. A_1 ampermetr 2,5 A, A_2 ampermetr 5 A tokni ko‘rsatmoqda. Agar R_1=4 Ω bo‘lsa, R_2 qarshilik necha Ω bo‘ladi?



Berilgan: $I_1 = 2{,}5A$ $I_2 = 5A$ $R_1 = 4\Omega$ $R_2 = ?$ Formula: $U_1 = U_2$	Yechilishi: $I = \frac{U}{R}$ formuladan U ni topsak $U = I \cdot R$ formula kelib chiqadi $U_1 = I_1 \cdot R_1; U_2 = I_2 \cdot R_2; U_1 = U_2$ kuchlanishlarni tenglashtirsak $I_1 \cdot R_1 = I_2 \cdot R_2$ natijaga ega bo‘lamiz $R_2 = \frac{I_1 \cdot R_1}{I_2} = \frac{2{,}5 \cdot 4}{5} = 2\Omega$

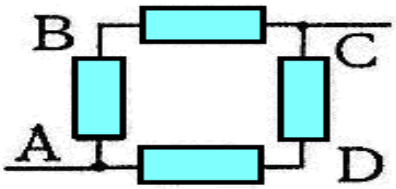
03/3-55. Elektr qarshiligi 1 Ω dan bo‘lgan 4 ta rezistor bir-biriga kvadrat shaklida ulangan (rasm). A va B nuqtalar orasidagi qarshilik (Ω) topilsin.

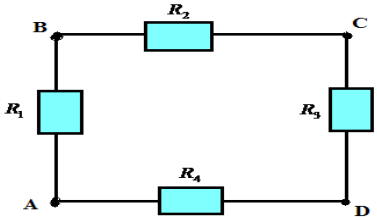


$$R_{123} = R_1 + R_2 + R_3 = 1 + 1 + 1 = 3\Omega; \frac{1}{R_{AB}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{1}{3} + \frac{1}{1} = \frac{4}{3} \rightarrow$$

$$R_{AB} = \frac{3}{4}\Omega$$

03/3-56. Elektr qarshiligi 1 Ω dan bo‘lgan 4 ta rezistor bir-biriga kvadrat shaklida ulangan (rasm). A va C nuqtalar orasidagi qarshilik (Ω) topilsin.



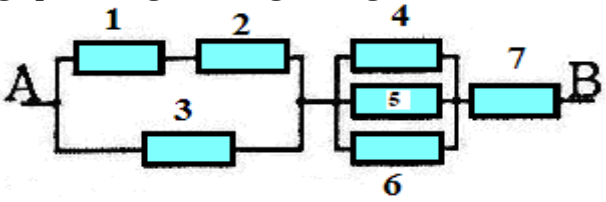


Masala tushunarli bo‘lishi uchun qarshiliklarga belgilash kiritamiz va qarshiliklarni ulash formulalaridan foydalanib hisoblaymiz.

$$R_{12} = R_1 + R_2 = 1 + 1 = 2\Omega; R_{34} = R_3 + R_4 = 1 + 1 = 2\Omega;$$

$$\frac{1}{R_{AC}} = \frac{1}{R_{12}} + \frac{1}{R_{34}} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} \rightarrow R_{AC} = 1\Omega$$

03/11-42. A va B nuqtalar orasidagi qarshilik qanday (Ω)?
Har bir rezistorning qarshiligi 1 Ω. ga teng.

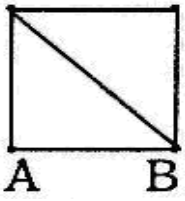


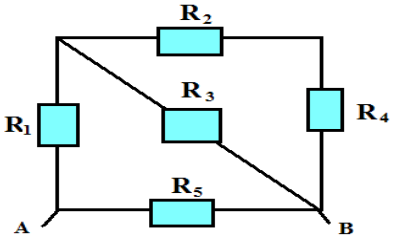
$$R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = R_7 = 1\Omega; R_{12} = R_1 + R_2 = 1 + 1 = 2\Omega;$$

$$\frac{1}{R_{123}} = \frac{1}{R_{12}} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{1} = \frac{3}{2}; R_{123} = \frac{2}{3}; \frac{1}{R_{456}} = \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6} = \frac{3}{1};$$

$$R_{456} = \frac{1}{3}\Omega; \; R_{AB} = R_{123} + R_{456} + R_7 = \frac{2}{3} + \frac{1}{3} + 1 = 2\Omega$$

02/8-45. Sxemada ko‘rsatilgan kvadratning har bir tomoni va diagonali 1 Ω qarshilikka ega. A va B nuqtalar orasidagi umumiy qarshilikni toping (Ω).





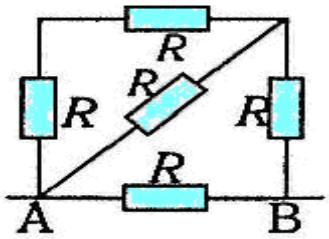
Bu sxema tushunarli bo‘lishi uchun uni quyidagi soda ko‘rinishga keltiramiz

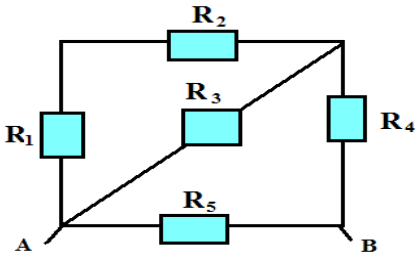
$R_1 = R_2 = R_3 = R_4 = R_5 = 1\Omega; R_{24} = R_2 + R_4 = 1 + 1 = 2\Omega;$

$\frac{1}{R_{243}} = \frac{1}{R_{24}} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{1} = \frac{3}{2} \rightarrow R_{243} = \frac{2}{3}\Omega; R_{1243} = R_1 + R_{243} = 1 + \frac{2}{3} = \frac{5}{3}\Omega;$

$\frac{1}{R_{AB}} = \frac{1}{R_5} + \frac{1}{R_{1243}} = \frac{1}{1} + \frac{3}{5} = \frac{8}{5} \rightarrow R_{AB} = \frac{5}{8}\Omega$

01/5-25. Rasmda tasvirlangan zanjirning A va B nuqtalari orasidagi qarshilikni toping (Ω). R=2 Ω.





Bu sxemani hisoblashga qulayroq va tushinarliroq bo‘lishi uchun qarshiliklarga nomer berib chiqamiz

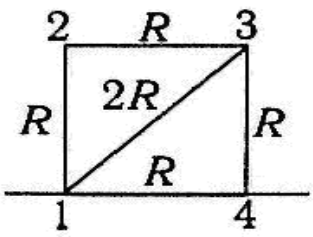
$R_1 = R_2 = R_3 = R_4 = R_5 = 2\Omega; R_{12} = R_1 + R_2 = 2 + 2 = 4\Omega;$

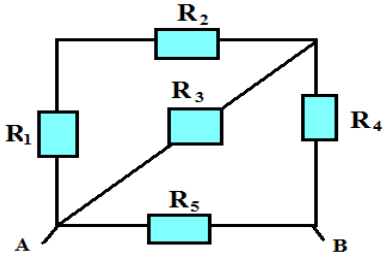
$\frac{1}{R_{123}} = \frac{1}{R_{12}} + \frac{1}{R_3} = \frac{1}{4} + \frac{1}{2} = \frac{3}{4} \rightarrow R_{123} = \frac{4}{3}\Omega$

$R_{1234} = R_4 + R_{123} = 2 + \frac{4}{3} = \frac{10}{3}\Omega;$

$\frac{1}{R_{AB}} = \frac{1}{R_5} + \frac{1}{R_{1234}} = \frac{1}{2} + \frac{3}{10} = \frac{8}{10} \rightarrow R_{AB} = \frac{10}{8} = 1{,}25\Omega$

02/3-49. Sxemasi rasmda berilgan zanjirning 1- va 4- nuqtalari orasidagi qarshiligini toping.

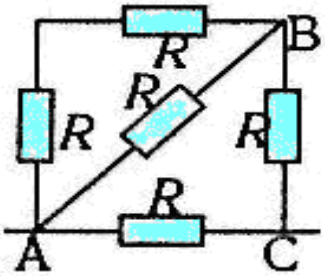


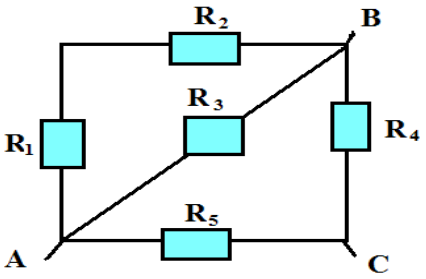


Bu sxemani hisoblashga qulayroq va tushinarliroq bo‘lishi uchun qarshiliklarni nomerlab chiqamiz

$$R_1 = R_2 = R_4 = R_5 = R \to R_3 = 2R;\ R_{12} = R_1 + R_2 = R + R = 2R;$$
$$\frac{1}{R_{123}} = \frac{1}{R_{12}} + \frac{1}{R_3} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \to R_{123} = R; R_{1234} = R_4 + R_{123} = R + R = 2R$$
$$\frac{1}{R_{AB}} = \frac{1}{R_5} + \frac{1}{R_{1234}} = \frac{1}{R} + \frac{1}{2R} = \frac{3}{2R} \to R_{AB} = \frac{2R}{3}$$

01/9-49. Zanjirning AC oraliqdagi qarshiligi AB oraliqdagi qarshiligidan necha marta katta?

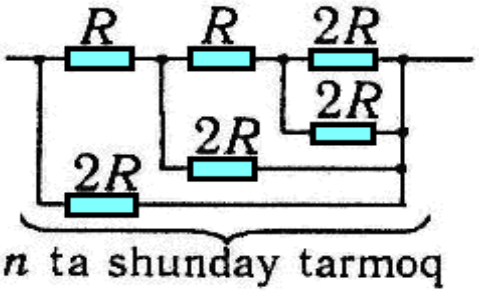




Bu sxemani hisoblash qulayroq va tushinarliroq bo‘lishi uchun qarshiliklarni nomerlab chiqamiz

$$R_1 = R_2 = R_3 = R_4 = R_5 = R; R_{12} = R_1 + R_2 = R + R = 2R;$$
$$\frac{1}{R_{123}} = \frac{1}{R_{12}} + \frac{1}{R_3} = \frac{1}{2R} + \frac{1}{R} = \frac{3}{2R} \to R_{123} = \frac{2R}{3};$$
$$R_{1234} = R_4 + R_{123} = R + \frac{2R}{3} = \frac{5}{3}R;$$
$$\frac{1}{R_{AC}} = \frac{1}{R_5} + \frac{1}{R_{1234}} = \frac{1}{R} + \frac{3}{5R} = \frac{8}{5R} \to R_{AC} = \frac{5R}{8}; R_{12} = R_1 + R_2 = R + R = 2R;$$
$$R_{45} = R_4 + R_5 = R + R = 2R; \frac{1}{R_{AB}} = \frac{1}{R_{12}} + \frac{1}{R_3} + \frac{1}{R_{45}} = \frac{1}{2R} + \frac{1}{R} + \frac{1}{2R} = \frac{4}{2R};$$
$$R_{AB} = \frac{R}{2}; \frac{R_{AC}}{R_{AB}} = \frac{\frac{5R}{8}}{\frac{R}{2}} = \frac{5R}{8} \cdot \frac{2}{R} = \frac{10}{8} = \frac{5}{4} = 1{,}25$$

98/8-63. Rasmda ko‘rsatilgan elektr zanjirning qarshiligini aniqlang.



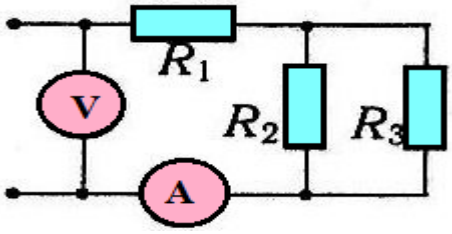
$$\frac{1}{R_{12}} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \to R_{12} = R; R_{123} = R_{12} + R_3 = R + R = 2R;$$

$$\frac{1}{R_{1234}} = \frac{1}{R_{123}} + \frac{1}{R_4} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \rightarrow R_{1234} = R$$

$$R_{12345} = R_{1234} + R = 2R; \frac{1}{R_{12346}} = \frac{1}{R_{12345}} + \frac{1}{R} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} \rightarrow R_{123456} = R$$

n ta shunday tarmoq uchun $R_{um} = nR$

02/4-25. Agar rasmda tasvirlangan sxemada R_1=2 Ω, R_2=20 Ω, R_3= 60 Ω va ampermetrning ko‘rsatishi 5 A bo‘lsa, voltmetrning ko‘rsatishi qanday (V)?



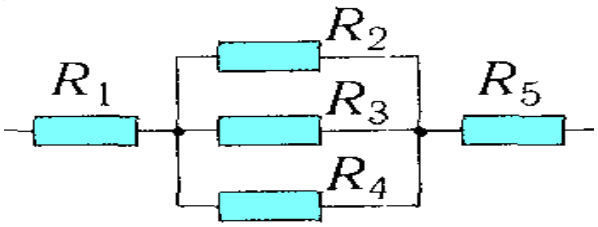
Voltimetr ko‘rsatgichini toppish uchun quyidagi formuladan foydalanamiz $I = \frac{U}{R_{um}}$ formuladan kuchlanishni topamiz $U = I \cdot R_{um}$.Kuchlanishni topish uchun bizga umumiy qarshilik kerak bo‘ladi va uni quyidagicha topamiz

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{20} + \frac{1}{60} = \frac{4}{60}; R_{23} = 15\Omega.$$

$$R_{um} = R_1 + R_{23} = 2 + 15 = 17\Omega;$$

$$U = 5 \cdot 17 = 85v$$

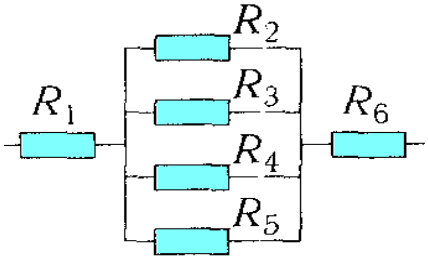
94. Rasmda tasvirlangan zanjirning umumiy qarshiligi necha Ω? R_1=3 Ω,R_2=R_3=R_4=12 Ω,R_5=5 Ω.



$$\frac{1}{R_{234}} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{3}{12} \rightarrow R_{234} = 4\Omega$$

$$R_{um} = R_1 + R_{234} + R_5 = 3 + 4 + 5 = 12\Omega$$

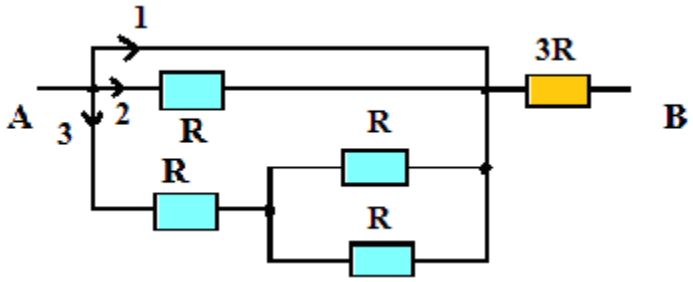
96/8-32. Rasmda tasvirlangan zanjirning umumiy qarshiligi necha Ω? R_1 = l Ω; R_2=R_3=2 Ω; R_4=R_5 =3 Ω; R_6=4 Ω.



$$\frac{1}{R_{2345}}=\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_5}=\frac{1}{2}+\frac{1}{2}+\frac{1}{3}+\frac{1}{3}=\frac{10}{6};R_{2345}=\frac{6}{10}\Omega$$

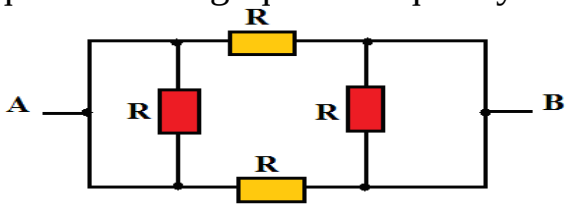
$$R_{um}=R_1+R_{2345}+R_6=1+\frac{6}{10}+4=\frac{56}{10}=5{,}6\Omega$$

99/7-42. Ushbu elektr sxemaning qarshiligi qanday?

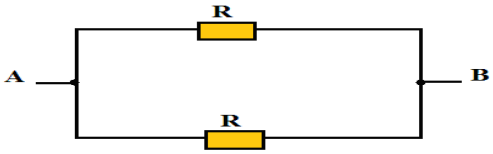


Elektr toki qarshiligi kamroq o‘tkazgikdan o‘tadi shuning uchun tok A nuqtadan B nuqtaga 2-va 3- yo‘nalishdan o‘tmaydi tok 1- yo‘nalishdan o‘tadi va shuning uchun umumiy qarshilik 3R

99/5-14. A va B nuqtalar orasidagi qarshilik qanday?

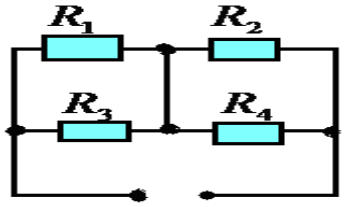


Tok zanjirning barcha qismlarida qarshilik bir xil bo‘lganligi uchun,A dan B ga qarab gorizontal yo‘nalishda harakatlanadi .Tokning yo‘nalishiga perpendikulyar joylashgan o‘tkazgichdan tok o‘tmaydi shuning uchun sxemani quyidagicha soddalashtiramiz.

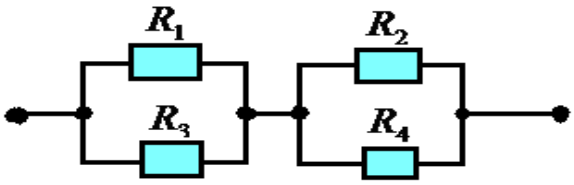


$$\frac{1}{R_{AB}}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R};R_{AB}=\frac{R}{2}$$

98/12-49. Rasmda ko‘rsatilgan zanjirning umumiy qarshiligi necha Ω? $R_1=R_2=R_3=R_4=2$.

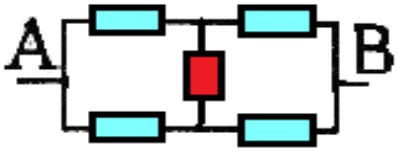


Janjirni quyidagicha soddaroq(tushinarliroq)holda tasvirlaymiz

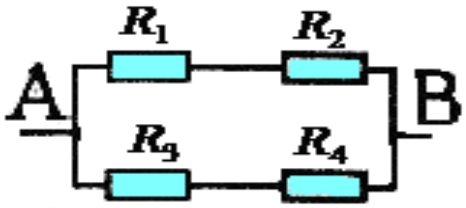


$$\frac{1}{R_{13}}=\frac{1}{R_1}+\frac{1}{R_3}=\frac{1}{2}+\frac{1}{2}=\frac{2}{2}=1\Omega;\frac{1}{R_{24}}=\frac{1}{R_2}+\frac{1}{R_4}=\frac{1}{2}+\frac{1}{2}=\frac{2}{2}=1\Omega;$$
$$R_{um}=R_{13}+R_{24}=1+1=2\Omega$$

99/5-47. Zanjirga ulangan rezistorlardan har birining qarshiligi 40 Ω. A va B nuqtalar orasidagi qarshilikni toping (Ω) (rasmga q.)



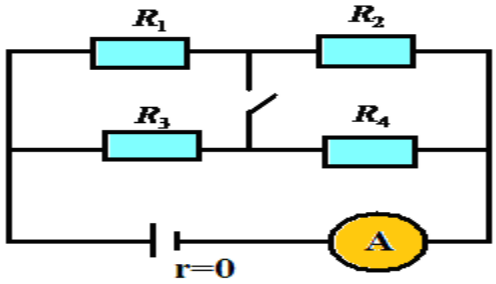
Zanjirning barcha qismlaridagi qarshiliklari bir-xil bo‘lganligi uchun o‘rtadagi qarshilik ning potensiallar farqi o ga teng shuning uchun u yerdan tok o‘tmaydi(48-masalada isb)
Masala tushunarli bo‘lishi uchun o‘rtadagi qarshilikni olib tashlaymiz.



$$R_{12}=R_1+R_2=40+40=80\Omega;R_{34}=R_3+R_4=40+40=80\Omega$$
$$\frac{1}{R_{AB}}=\frac{1}{R_{12}}+\frac{1}{R_{34}}=\frac{1}{80}+\frac{1}{80}=\frac{2}{80};R_{AB}=40\Omega$$

98/8-62. K kalit ulangandan so‘ng ampermetrning ko‘rsatishi qanday o‘zgaradi?

$R_1=R_2=R_3=R_4=R$



1) Kalit ulanmagan hol uchun tok kuchini topamiz, buning uchun bizga umumiy qarshilik kerak bo‘ladi.

$$R_{12}=R_1+R_2=R+R=2R; R_{34}=R_3+R_4=R+R=2R; \frac{1}{R_{um}}=\frac{1}{R_{12}}+\frac{1}{R_{34}}=\frac{1}{2R}+\frac{1}{2R}=\frac{2}{2R};$$

$$R_{um}=R; I=\frac{\varepsilon}{R_{um}+r}=\frac{\varepsilon}{R}$$

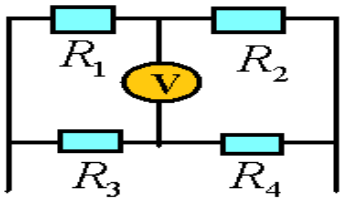
2) Kalit ulangan hol uchun umumiy qarshilikni topamiz

$\frac{1}{R_{13}}=\frac{1}{R_1}+\frac{1}{R_3}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{13}=\frac{R}{2}; \frac{1}{R_{24}}=\frac{1}{R_2}+\frac{1}{R_4}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow$
$R_{24}=\frac{R}{2};$

$$R_{um}=R_{13}+R_{24}=\frac{R}{2}+\frac{R}{2}=R; I=\frac{\varepsilon}{R_{um}+r}=\frac{\varepsilon}{R}$$

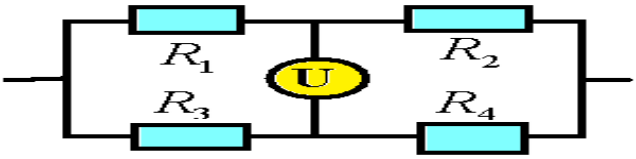
Ikkala holda ham tok kuchi bir xil chiqdi ya'ni ampermetr ko'rsatgichi o'zgarmas ekan.

98/11-48. Rasmda tasvirlangan elektr zanjir U=140 V bo'lgan o'zgarmas tok manbaiga ulangan. Agar qarshiliklar $R_1=R_3=40$ Ω, $R_1=R_4=30$ Ω bo'lsa, voltmetr necha volt kuchlanishni ko'rsatadi?



$\frac{R_1}{R_3}=\frac{R_2}{R_4}$ teng bo'lgani uchun voltimetr ulangan zanjirning qisqichlaridagi potensiallar farqi $\Delta\varphi=0$ bo'ladi shuning uchun voltimetrdan tok o'tmaydi yani voltimetr ko'satgichi 0 ga teng.

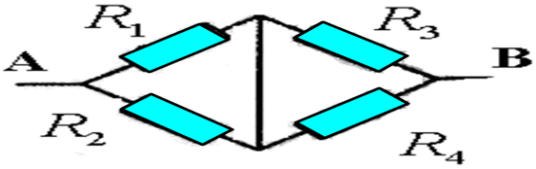
96/10-40. Rasmda ko'rsatilgan elektr zanjirda R_1 = 15 Ω, R_2=25 Ω, R_4=50 Ω ва voltmetrning ko'rsatishi nolga teng bo'lsa, R_3 necha Ω ga teng?



Agar $\frac{R_1}{R_3}=\frac{R_2}{R_4}$ teng bo'lgan hollarda $\Delta\varphi=0$ voltimetr ko'rsatgichi o bo'ladi.

$$\frac{R_1}{R_3}=\frac{R_2}{R_4}; formuladan R_3 nitopamiz R_3=\frac{R_1\cdot R_4}{R_2}=\frac{15\cdot 50}{25}=30\Omega$$

96/7-41. $R_1=R_2=R_3=R_4=12$ Ω. A va B nuqtalar orasidagi kuchlanish 120 V bo'lsa, R_1 qarshilikdan necha amper tok o'tadi?



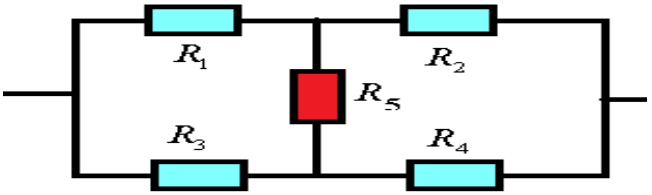
$$\frac{1}{R_{12}}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{12}+\frac{1}{12}=\frac{2}{12}\rightarrow R_{12}=6\Omega;\frac{1}{R_{34}}=\frac{1}{R_3}+\frac{1}{R_4}=\frac{1}{12}+\frac{1}{12}$$

$$\rightarrow$$

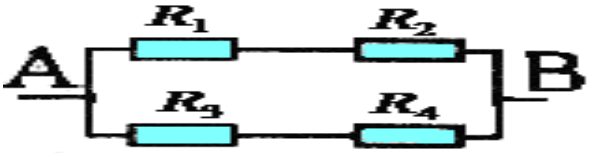
$$R_{34}=6\Omega;R_{um}=R_{12}+R_{34}=6+6=12\Omega$$

Endi zanjirning umumy tok kuchini topamiz $I=\frac{U}{R_{um}}=\frac{120}{12}=10A$ (R_1 +R_3) va (R_2+ R_4) qarshiliklar bir xil bo‘lgani uchun tok kuchi teng ikkiga bo‘linib harakatlanadi shuning uchun javob $I_1=\frac{I}{2}=\frac{10}{2}=5A$

96/3-93. Rasmda ko‘rsatilgan zanjirning umumiy qarshiligi necha? Ω?
R_1=R_3=10 Ω, R_2=R_4=20 Ω, R_5=105Ω.



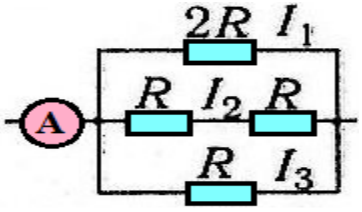
Agar $\frac{R_1}{R_3}=\frac{R_2}{R_4}$ teng bo‘lgan hollarda $\Delta\varphi=0$ o‘rtadagi qarshilikning potensiallar farqi o ga teng shuning uchun u yerdan tok o‘tmaydi.Masala tushunarli bo‘lishi uchun o‘rtadagi qarshilikni olib tashlaymiz.



$$R_{12}=R_1+R_2=10+20=30\Omega;R_{34}=R_3+R_4=10+20=30\Omega$$

$$\frac{1}{R_{AB}}=\frac{1}{R_{12}}+\frac{1}{R_{34}}=\frac{1}{30}+\frac{1}{30}=\frac{2}{30};R_{AB}=15\Omega$$

108. Ampermetr I tokni ko‘rsatib turibdi (rasmga q.). I_1, 1_2 va I_3 tok kuchlari qanday?



Paralel ulashda kuchlanishlar bir xil bo‘ladi shuning uchun kuchlanishlarni tenglashtiramiz. $U_1=U_2=U_3=U$

$$U=U_1;I\cdot\frac{R}{2}=I_1\cdot 2R;I_1=\frac{I}{4};U=U_2;I\cdot\frac{R}{2}=I_2\cdot 2R;I_2=\frac{I}{4};$$

$$U=U_3;I\cdot\frac{R}{2}=I_3\cdot R;I_3=\frac{I}{2};$$

$$R_1=2R;R_2=R+R=2R;R_3=R;$$

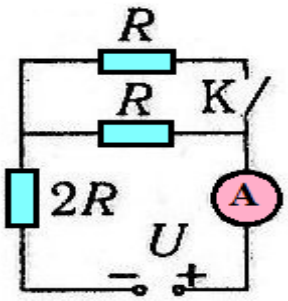
$$\frac{1}{R_{um}}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}=\frac{1}{2R}+\frac{1}{2R}+\frac{1}{R}=\frac{4}{2R};R_{um}=\frac{R}{2}$$

Zanjirning umumiy kuchlanishi: $U = I \cdot R_{um} = I \cdot \frac{R}{2}$ har bir qismdagi kuchlanishni topamiz $U_1 = I_1 \cdot R_1 = I_1 \cdot 2R;\ U_2 = I_2 \cdot R_2 = I_2 \cdot 2R;\ U_3 = I_3 \cdot R_3 = I_3 \cdot R$; ularni har birini umumiy kuchlanishga tenglashtiramiz

$$U = U_1; I \cdot \frac{R}{2} = I_1 \cdot 2R; I_1 = \frac{I}{4}; U = U_2; I \cdot \frac{R}{2} = I_2 \cdot 2R; I_2 = \frac{I}{4};$$

$$U = U_3; I \cdot \frac{R}{2} = I_3 \cdot R; I_3 = \frac{I}{2};$$

98/7-51. Sxemadagi ampermetr I tok kuchini ko‘rsatadi. Agar K kalit ulansa, I_2 tokni ko‘rsatadi. I_1 va I_2 toklar orasidagi munosabatni aniqlang.

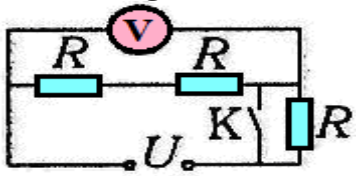


Tok kuchini 2 hol uchun $I = \frac{U}{R_{um}}$ formuladan foydalanib topamiz.

a-hol kalit ulanmagan hol uchun: avval umumiy qarshilikni topamiz:
Kalit ulanmasa yuqoridagi qarshilikdan tok o‘tmaydi shuning uchun uni hisobga olmaymiz.$R_{um} = 2R + R = 3R$ tok kuchi esa $I_1 = \frac{U}{3R}$.

b-hol kalit ulansa: avval umumiy qarshilikni topamiz:Kalit ulansa barcha qarshiliklarni inobatga olamiz: $\frac{1}{R_{12}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}; R_{12} = \frac{R}{2}; R_{um} = 2R + \frac{R}{2} = \frac{5R}{2}$ tok kuchi esa $I_2 = \frac{U}{\frac{5R}{2}} = \frac{2U}{5R}$ $\frac{I_2}{I_1} = \frac{\frac{2U}{5R}}{\frac{U}{3R}} = \frac{2U}{5R} \cdot \frac{3R}{U} = \frac{6}{5} = 1{,}2; I_2 = 1{,}2I_1$

98/9-40. K kalit ulansa, voltmetrning ko‘rsatishi qanday o‘zgaradi?



Kalit ulansa ham kalit ulanmasa ham o‘tkazgichning tok kuchi birxil bo‘ladi I.Ammo qarshilik ikki holda ikki xil bo‘ladi.

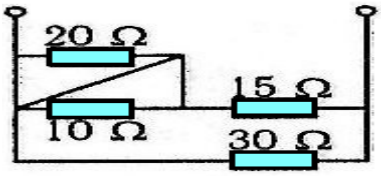
I-hol: Kalit ulanmasa: qarshiliklarning hammasidan tok o‘tadi va ularni hammasini inobatga olamiz.

$$R_{12} = R_1 + R_2 = R + R = 2R;\quad R_{um} = R_{12} + R_3 = 2R + R = 3R; U_1 = I \cdot R_{um} = I \cdot 3R = 3RI$$

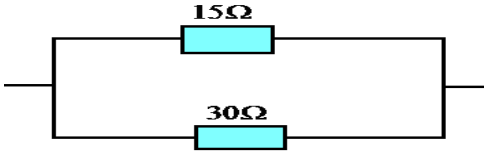
II-hol: Kalit ulansa: Kalit ulansa chetdagi uchinchi qarshilikni hisobga olmaymiz sababi undan tok o‘tmaydi. $R_{um} = R_1 + R_2 = R + R = 2R$

$U_2 = I \cdot R_{um} = I \cdot 2R = 2RI$ Endi kuchlanishlarni nisbatini olamiz: $\frac{U_2}{U_1} = \frac{2RI}{3RI} = \frac{1}{1{,}5}$

96/15-96. Sxemaning umumiy qarshiligi necha Ω?



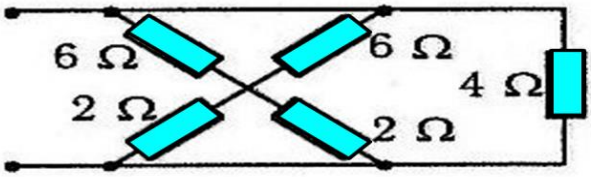
Bu sxemani soddaroq holga o‘tamiz sababi 20 va 10 qarshilikdan tok o‘tmaydi sababi tok qarshiligi yo‘q joydan harakatlanadi.o‘rtadagi qarshiligi yo‘q simdan o‘tadi



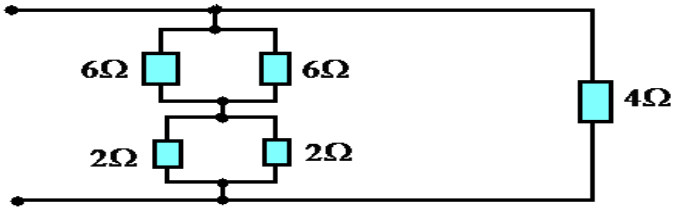
$$\frac{1}{R_{um}} = \frac{1}{15} + \frac{1}{30} = \frac{3}{30}; R_{um} = \frac{30}{3} = 10\Omega$$

96/3-27. Sxemaning umumiy qarshiligi necha Ω?

$$R_1 = R_2 = 6\Omega; R_3 = R_4 = 2\Omega; R_5 = 4\Omega$$



Bu sxemani quyidagicha soddalashtiramiz



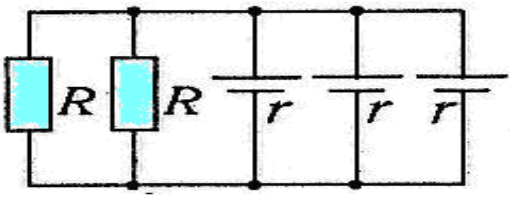
$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6} \rightarrow R_{12} = 3\Omega; \frac{1}{R_{34}} = \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} \rightarrow$$

$$R_{34} = 1\Omega$$

$$R_{1234} = R_{12} + R_{34} = 3 + 1 = 4\Omega; \frac{1}{R_{um}} = \frac{1}{R_{1234}} + \frac{1}{R_5} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4}$$

$$\rightarrow R_{um} = 2\Omega$$

00/1-29. Uchta galvanik element va ikkita rezistordan rasmda ko‘rsatilgandek zanjir tuzildi. Agar R=12 Ω, r=1,5 Ω bo‘lsa, zanjirning umumiy qarshiligi necha Ω?

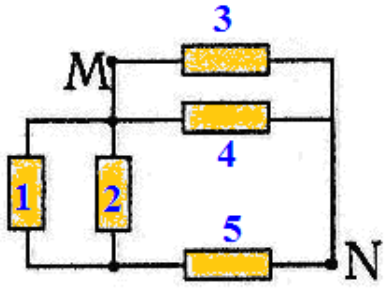


$$\frac{1}{R_{um}}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{um}=\frac{R}{2}=\frac{12}{2}=6\Omega;\frac{1}{r_{um}}=\frac{1}{r}+\frac{1}{r}+\frac{1}{r}=\frac{3}{r}\rightarrow$$

$$r_{um}=\frac{r}{3}=\frac{1{,}5}{3}=0{,}5\Omega$$

$$R_{um}+r_{um}=6+0{,}5=6{,}5\Omega$$

00/9-38. Chizmada tasvirlangan zanjirning M va N nuqtalari orasidagi umumiy qarshilik topilsin. Barcha qarshiliklar bir xil va R ga teng.



$$\frac{1}{R_{12}}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow R_{12}=\frac{R}{2};\frac{1}{R_{34}}=\frac{1}{R_3}+\frac{1}{R_4}=\frac{1}{R}+\frac{1}{R}=\frac{2}{R}\rightarrow$$

$$R_{34}=\frac{R}{2};R_{125}=R_{12}+R_5=\frac{R}{2}+R=\frac{3}{2}R;$$

$$\frac{1}{R_{um}}=\frac{1}{R_{34}}+\frac{1}{R_{125}}=\frac{1}{\frac{R}{2}}+\frac{1}{\frac{3R}{2}}=\frac{2}{R}+\frac{2}{3R}=\frac{8}{3R}\rightarrow R_{um}=\frac{3}{8}R$$

MURAKKAB SXEMALARNI SODDALASHTIRISHNING TO‘G‘RIDAN-TO‘G‘RI SODDA HOLGA O‘TISH VA BIRIN KETIN SODDALASHTIRISH USULLARIGA DOIR MASALALAR

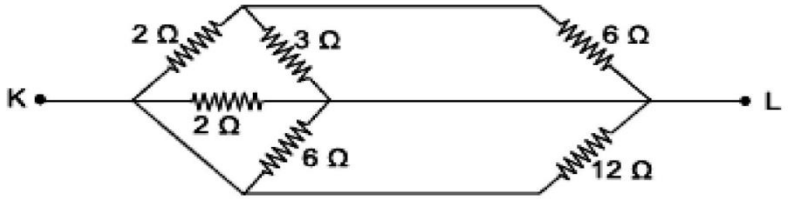
REZISTORLARNI KETMA-KET ULASH FORMULASI:

$$R_{Um} = R_1 + R_2 + R_3 + \dots R_n$$

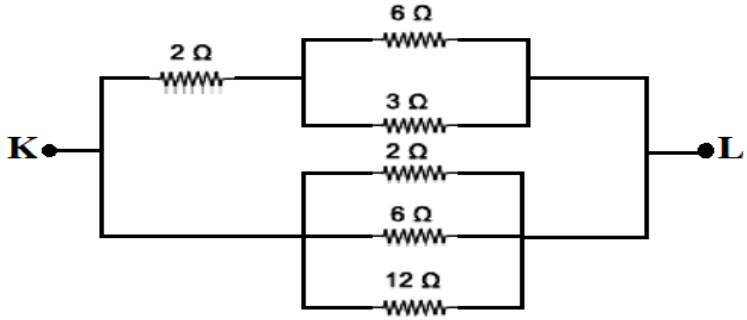
REZISTORLARNI PARALLEL ULASH FORMULASI:

$$\frac{1}{R_{Um}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \frac{1}{R_n}$$

1. Zanjirning K va L nuqtalar orasidagi umumiy qarshilikni toping(Ω)?

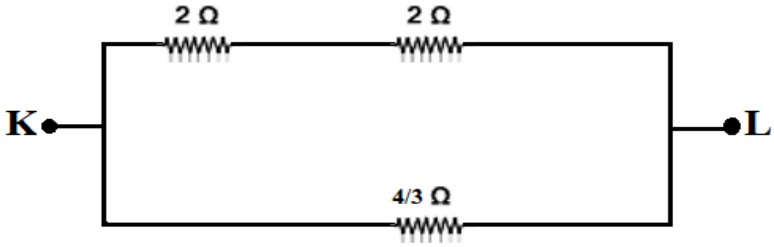


Yuqoridagi rasmni murakkab ko‘rinishdan dodda ko‘rinishga o‘tamiz.



Sxemadagi parallel ulangan qarshiliklarni parallel ulash formulasi yordamida hisoblaymiz

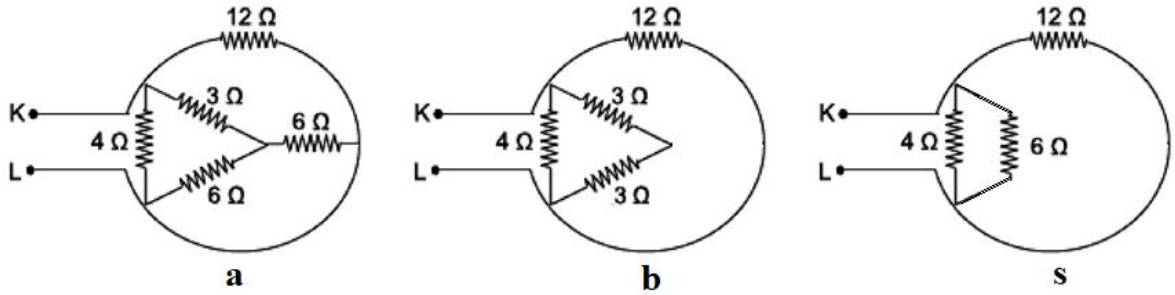
$$\frac{1}{R'} = \frac{1}{6} + \frac{1}{3} \rightarrow R' = 2\Omega; \frac{1}{R''} = \frac{1}{2} + \frac{1}{6} + \frac{1}{12} \rightarrow R'' = \frac{4}{3}\Omega;$$



Oxirgi soddalashgan sxemamizdan umumiy qarshilikni topamiz

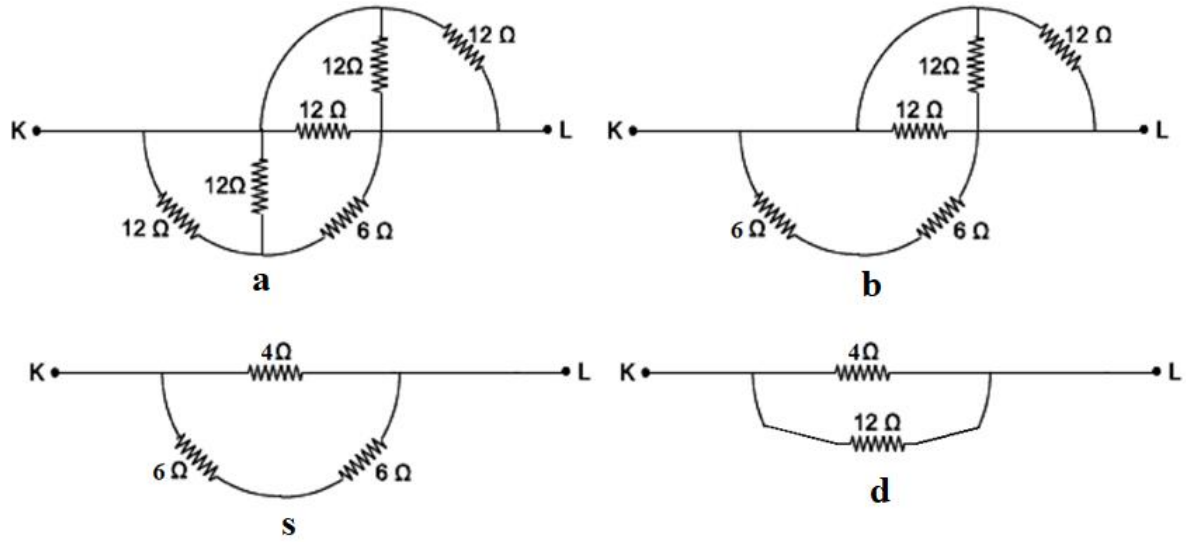
$$R_{12} = R_1 + R_2 = 2 + 2 = 4\Omega; \frac{1}{R_{Um}} = \frac{1}{R_{12}} + \frac{1}{R_3} = \frac{1}{4} + \frac{3}{4} = \frac{4}{4} \rightarrow R_{Um} = 1\Omega$$

2. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)(a-rasm)?



Zanjirning umumiy qarshiligini topish uchun a rasmdagi 6Ω lik ikki qarshilikni parallel ulasak$\frac{1}{R'}=\frac{1}{6}+\frac{1}{6}=\frac{2}{6}\rightarrow R'=3\Omega$ sxemamiz b rasm ko‘rinishiga keladi,b rasmdagi 3Ω lik ikki qarshilikni esa ketma-ket ulaymiz $R''=3+3=6\Omega$ s rasm hosil bo‘ladi.Oxirgi s rasmdagi barcha qarshiliklarni parallel ulansa umumiy qarshilik kelib chiqadi $\frac{1}{R_{Um}}=\frac{1}{4}+\frac{1}{6}+\frac{1}{12}\rightarrow R_{Um}=2\Omega$

3. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?
(a-rasm)

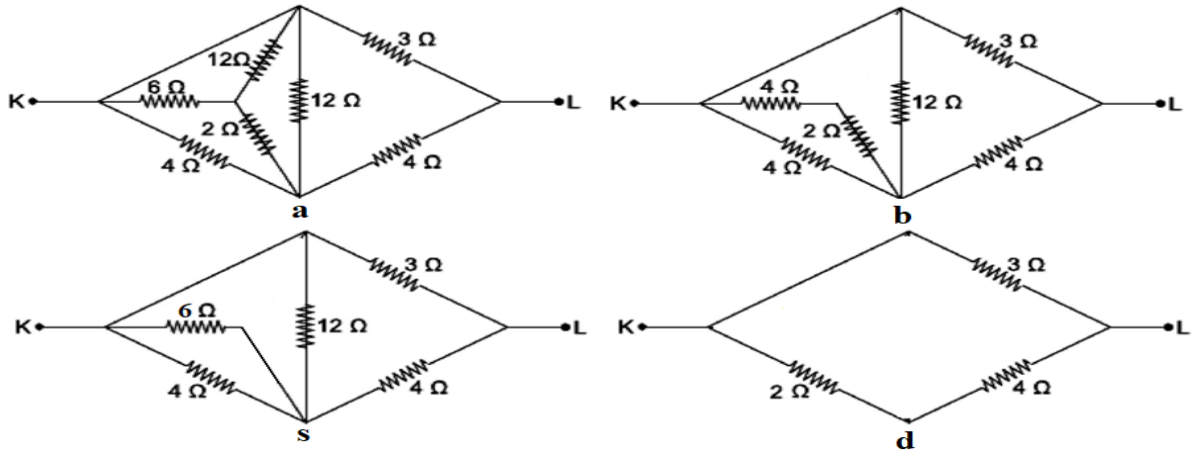


Zanjirning umumiy qarshiligini topish uchun a rasmdagi 12Ω lik ikki qarshilikni parallel ulasak $\frac{1}{R'}=\frac{1}{12}+\frac{1}{12}=\frac{2}{12}\rightarrow R'=6\Omega$ sxemamiz b rasm ko‘rinishiga keladi,b rasmdagi uchta 12Ω lik ikki qarshilikni parallel ulasak $\frac{1}{R''}=\frac{1}{12}+\frac{1}{12}+\frac{1}{12}=\frac{3}{12}\rightarrow R''=4\Omega$ s rasm hosil bo‘ladi.s rasmdagi 6Ω lik ikki qarshilikni esa ketma-ket ulasak $R'''=6+6=12\Omega$ d rasm hosil bo‘ladi

va d rasmdagi qarshiliklarni parallel ulansa umumiy qarshilik kelib chiqadi $\frac{1}{R_{Um}} = \frac{1}{4} + \frac{1}{12} = \frac{4}{12} \rightarrow R_{Um} = 3\Omega$

4. Zanjirning K va L nuqtalar orasidagi umumiy qarshilikni toping(Ω)?

(a-rasm)

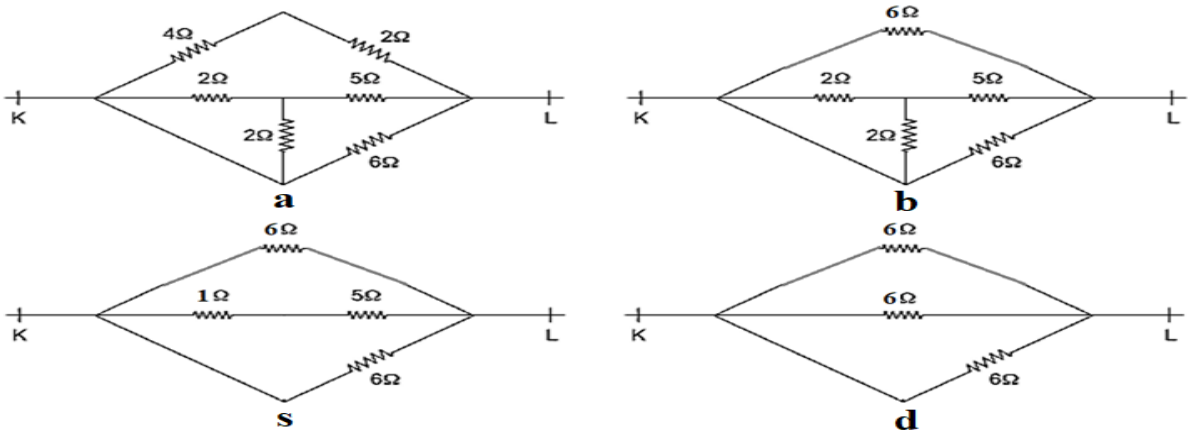


Zanjirning umumiy qarshiligini topish uchun a rasmdagi 12Ω va 6Ω lik ikki qarshilikni parallel ulasak $\frac{1}{R'} = \frac{1}{6} + \frac{1}{12} = \frac{3}{12} \rightarrow R' = 4\Omega$ sxemamiz b rasm ko‘rinishiga keladi,b rasmdagi 4Ω va 2Ω lik ikki qarshilikni ketma-ket ulasak

$R'' = 4 + 2 = 6\Omega$ s rasm hosil bo‘ladi.s rasmdagi 12Ω, 6Ω va 4Ω lik uchta qarshilikni esa parallel ulasak $\frac{1}{R'''} = \frac{1}{12} + \frac{1}{6} + \frac{1}{4} = \frac{6}{12} \rightarrow R''' = 2\Omega$ d rasm hosil bo‘ladi va d rasmdagi 2Ω va 4Ω qarshiliklar ketma-ket va chiqqan natija 3Ω qarshilikka parallel ulansa umumiy qarshilik kelib chiqadi $\frac{1}{R_{Um}} = \frac{1}{6} + \frac{1}{3} = \frac{3}{6} \rightarrow R_{Um} = 2\Omega$

5. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?

(a-rasm)



Zanjirning umumiy qarshiligini topish uchun a rasmdagi 4Ω va 2Ω ikki qarshilikni ketma-ket ulasak $R' = 4 + 2 = 6\Omega$ sxemamiz b rasm ko‘rinishiga keladi,b rasmdagi 2Ω lik ikkita qarshilikni parallel ulasak $\frac{1}{R''} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} \rightarrow R'' = 1\Omega$ s rasm hosil bo‘ladi.s rasmdagi 1Ω va 5Ω qarshilikni ketma-ket ulasak $R''' = 1 + 5 = 6\Omega$ d rasm hosil bo‘ladi va d rasmdagi barcha qarshiliklarni parallel ulab umumiy qarshilikni topamiz $\frac{1}{R_{Um}} = \frac{1}{6} + \frac{1}{6} + \frac{1}{6} = \frac{3}{6} \rightarrow R_{Um} = 2\Omega$

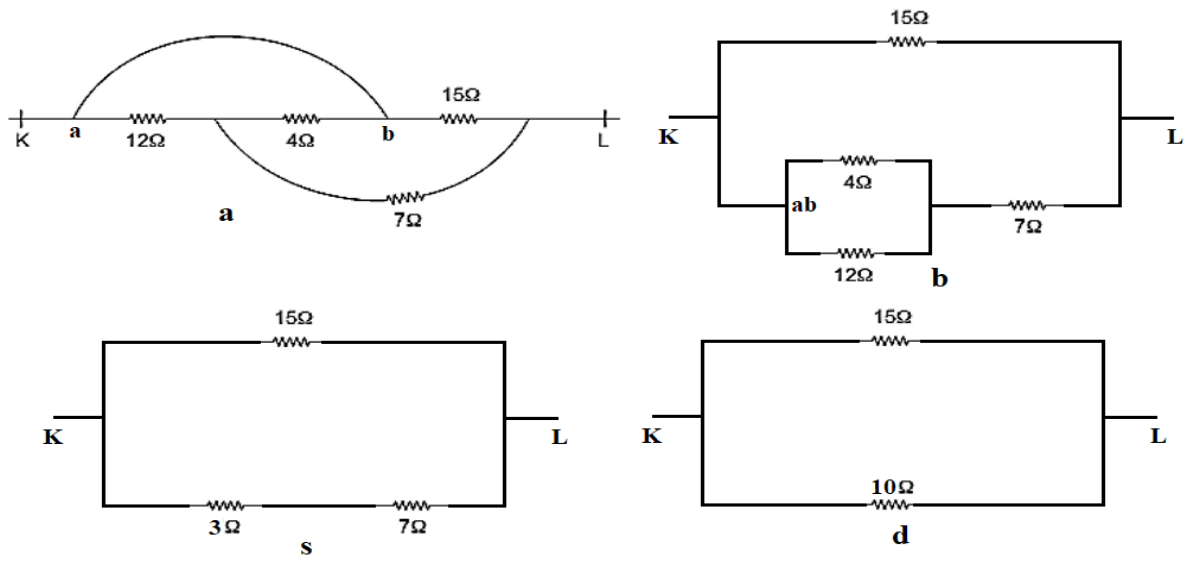
6. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?

(a-rasm)

Zanjirning umumiy qarshiligini topish uchun a rasmdagi murakkab sxemani b sodda ko‘rinishdagi sxemaga o‘tamiz, buning uchun a va b nuqtalarni tutashtiramiz va b sxemadagi 4Ω va 12Ω qarshilini parallel usalas

$\frac{1}{R'} = \frac{1}{4} + \frac{1}{12} = \frac{4}{12} \rightarrow R' = 3\Omega$ s rasmdagi sxema hosil bo‘ladi.s rasmdagi sxemadagi 3Ω va 7Ω qarshilikni ketmaket $R'' = 3 + 7 = 10\Omega$ ulasak d rasm ko‘rinishini egallaydi va d rasmdan umumiy qarshilikni topamiz.

$$\frac{1}{R_{Um}} = \frac{1}{15} + \frac{1}{10} = \frac{5}{30} \rightarrow R_{Um} = 6\Omega$$



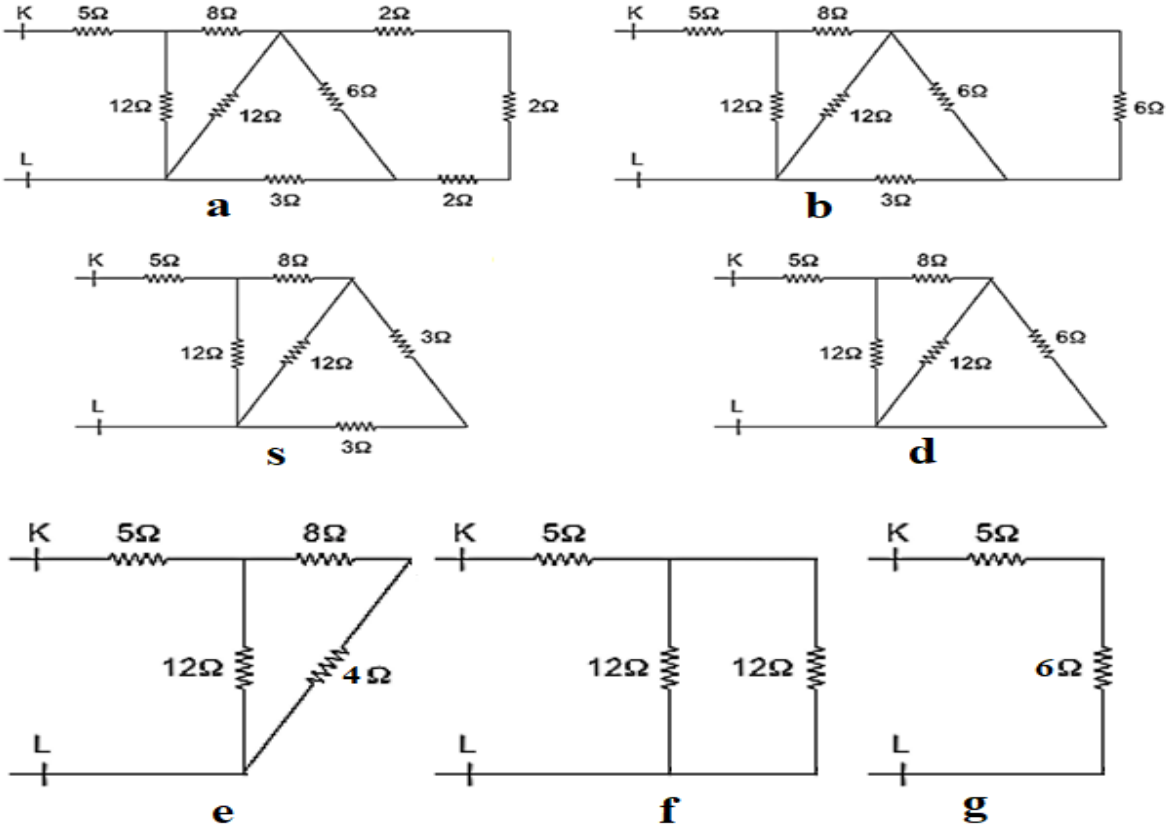
7. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?

Zanjirning umumiy qarshiligini topish uchun a rasmdagi 2Ω lik 3 ta qarshilikni ketma-ket ulab $R_1 = 2 + 2 + 2 = 6\Omega$ b rasmni hosil qilamiz, b rasmdagi 2 ta 6Ω lik qarshiliklarni esa parallel ulab $\frac{1}{R_2} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6} \rightarrow R_2 =$

3Ω s rasmni hosil qilamiz, s rasmdagi 2 ta 3Ω lik qarshiliklarni ketma-ket ulab $R_3 = 3 + 3 = 6\Omega$ d rasmni hosil qilamiz, d rasmdagi 6Ω va 12Ω qarshiliklarni parralel ulasak

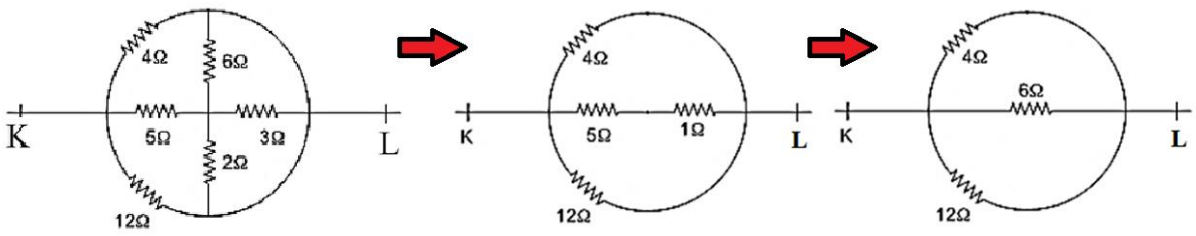
$\frac{1}{R_4} = \frac{1}{6} + \frac{1}{12} = \frac{3}{12} \rightarrow R_4 = 4\Omega$ e rasm hosil bo‘ladi.

e rasmdagi 4Ω va 8Ω lik qarshilikni ketma-ket ulab $R_5 = 4 + 8 = 12\Omega$ f rasmni hosil qilamiz, f rasmdagi 2 ta 12Ω lik qarshiliklarni esa parallel ulab $\frac{1}{R_6} = \frac{1}{12} + \frac{1}{12} = \frac{2}{12} \rightarrow R_6 = 6\Omega$ g rasmni hosil qilamiz, g rasmdagi 5Ω va 6Ω lik qarshiliklarni ketma-ket ulab $R_{Um} = 5 + 6 = 11\Omega$ umumiy qarshilikka ega bo‘lamiz.

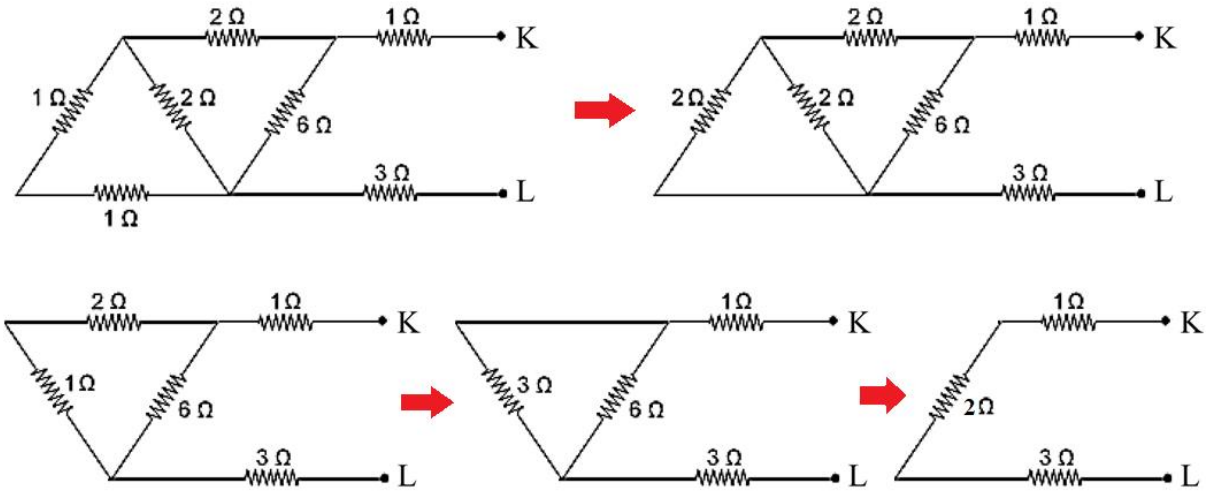


Keyingi masalalarda murakkab sxemalar birin-ketin soddalashtirish usuli bilan soddalashgan bo‘lib qanday soddalashtirish amallari bajarilganini o‘zingiz taxlil qilib umumiy qarshilikni toping

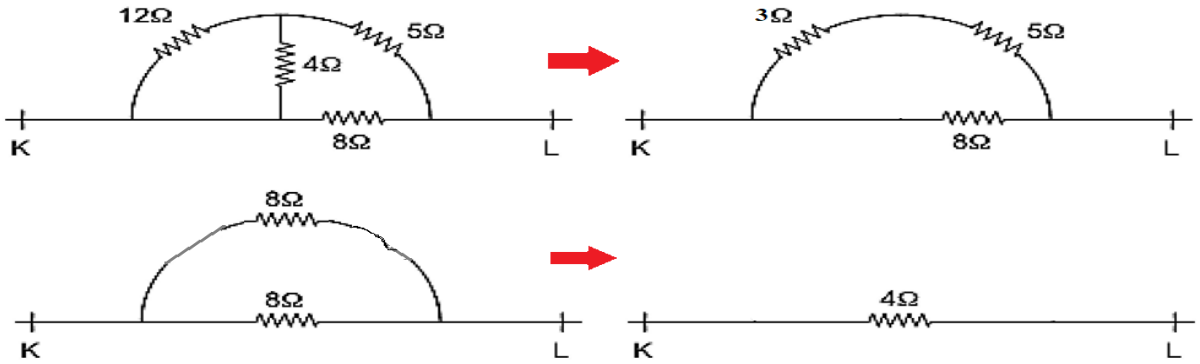
8. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



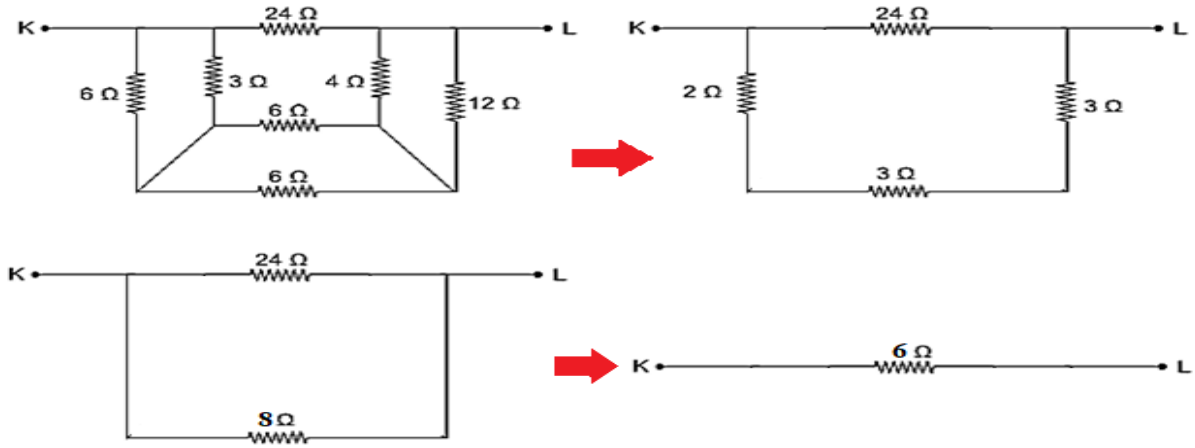
9. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



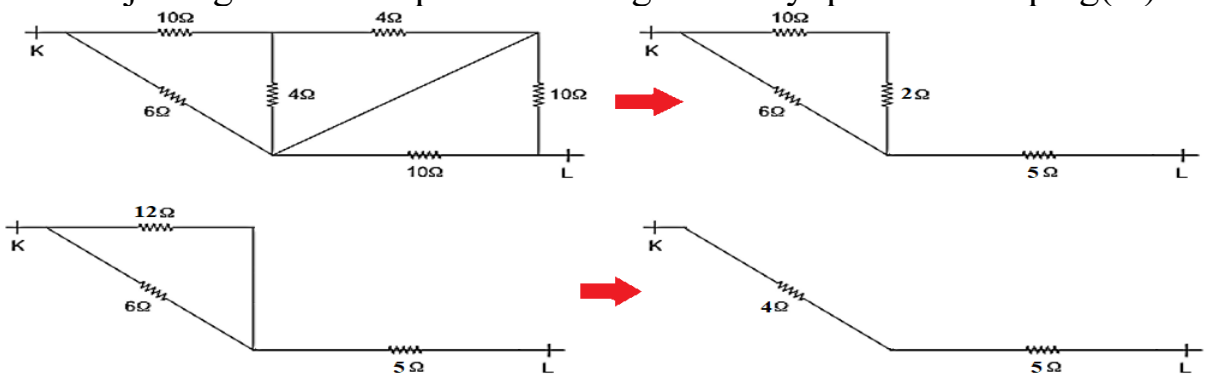
10. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



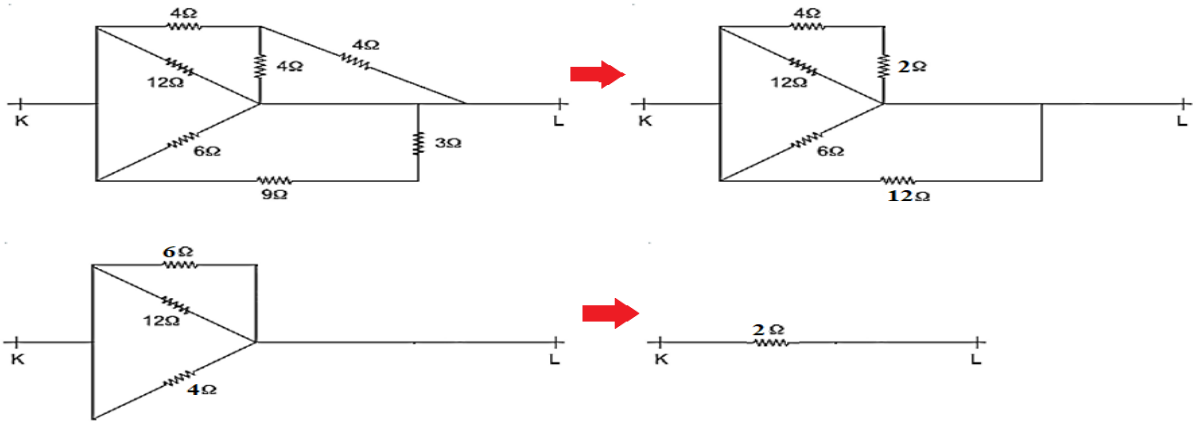
11. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



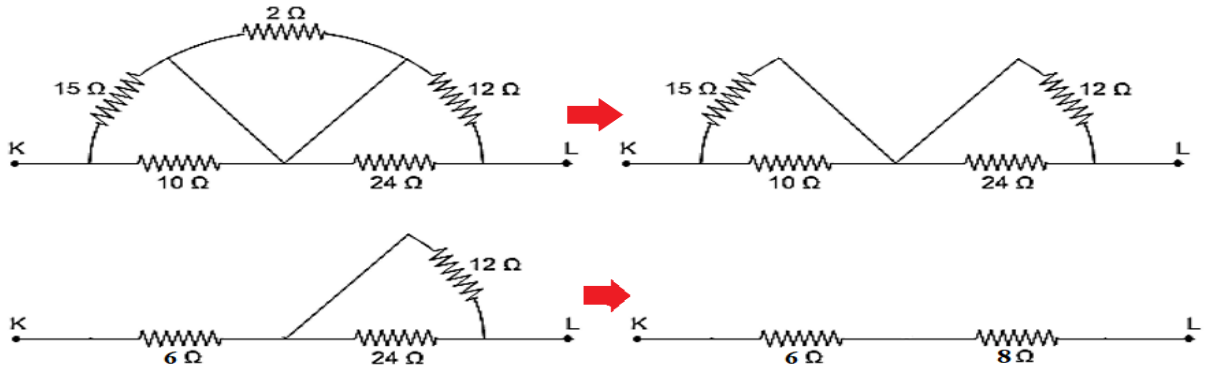
12. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



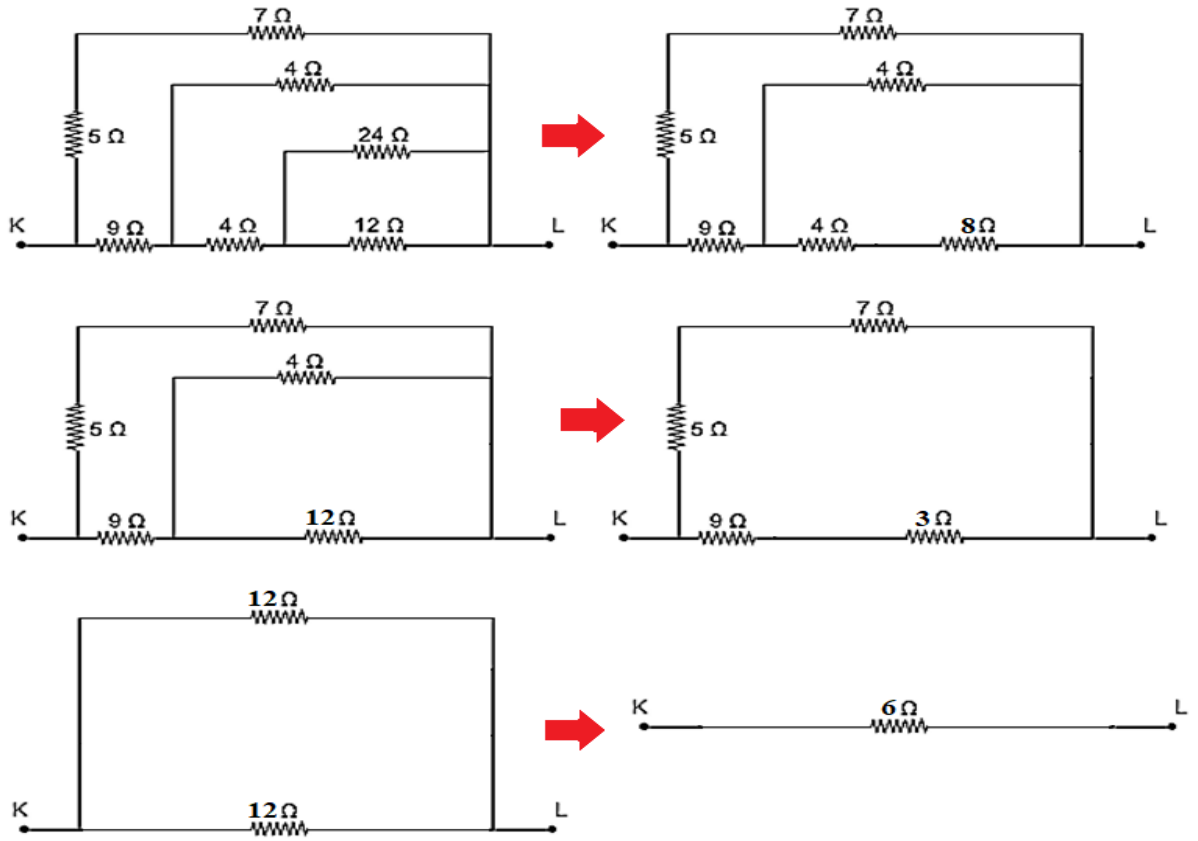
13. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



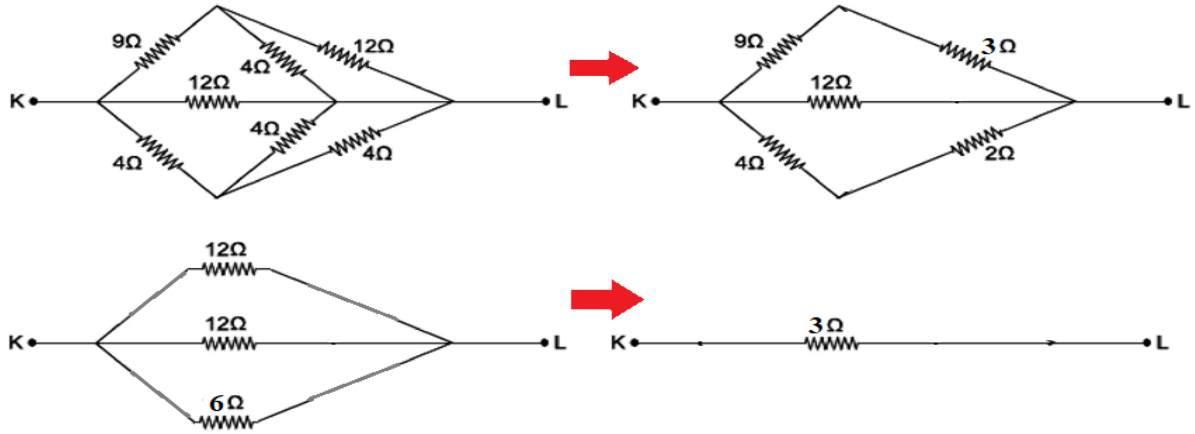
14. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



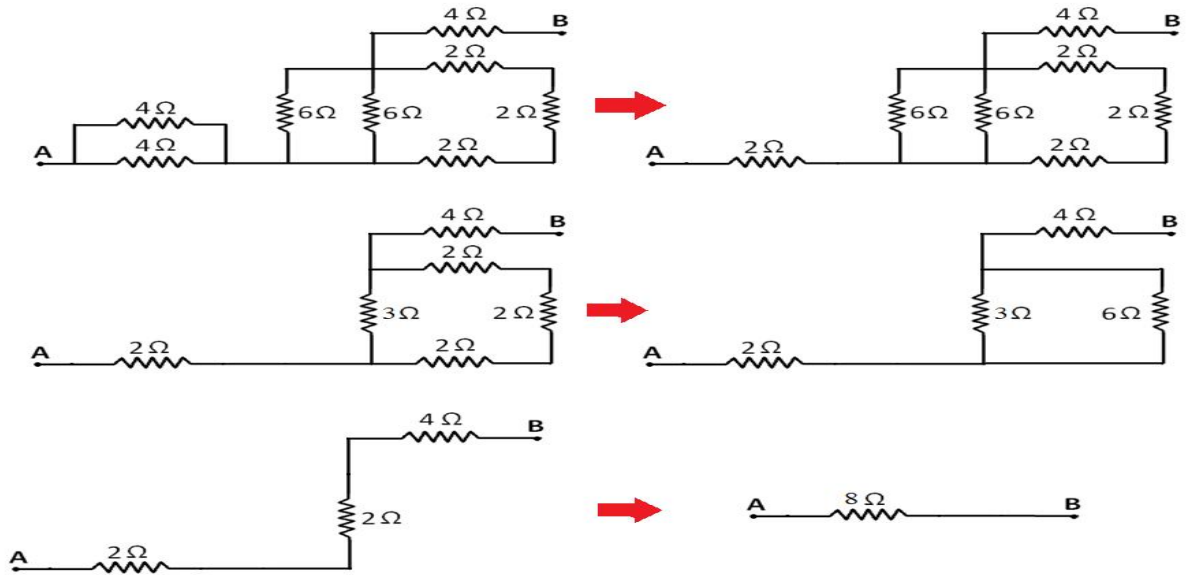
15. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



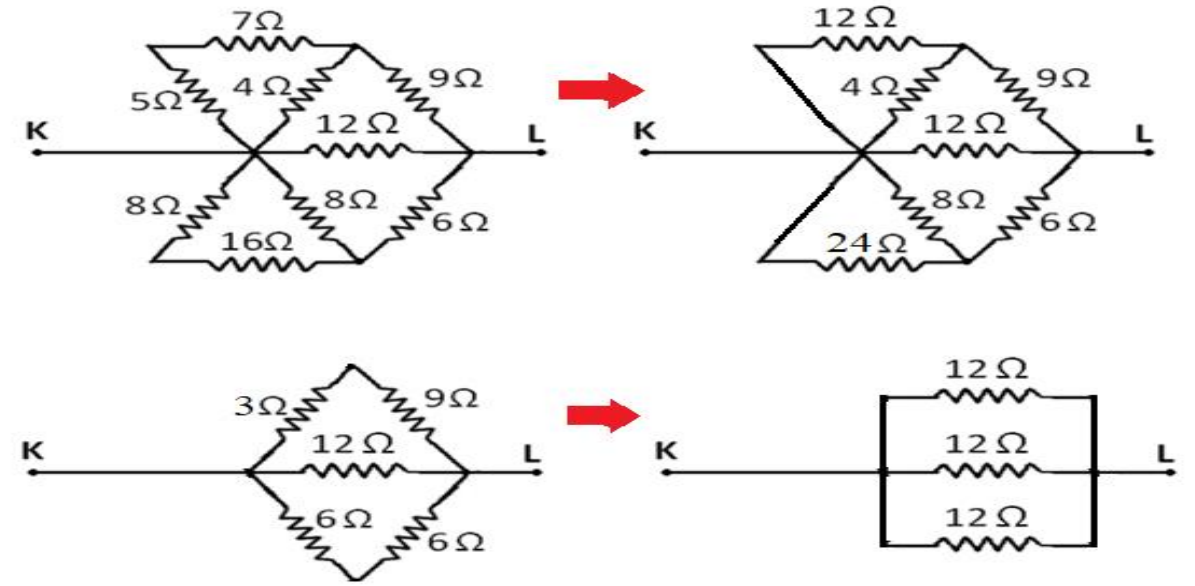
16. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



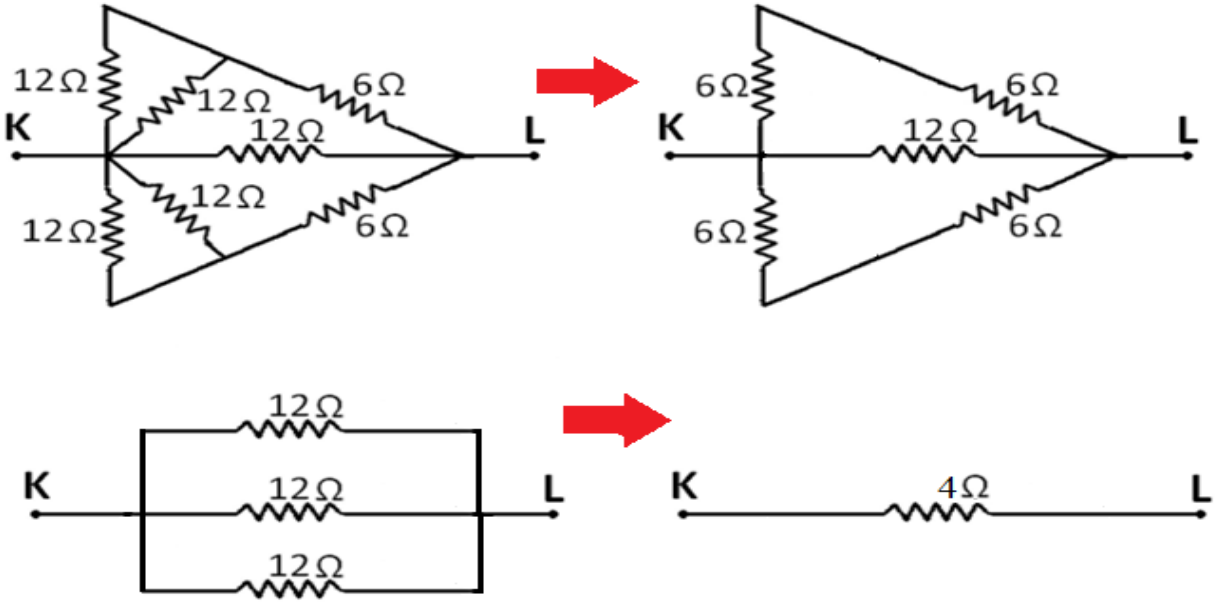
17. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



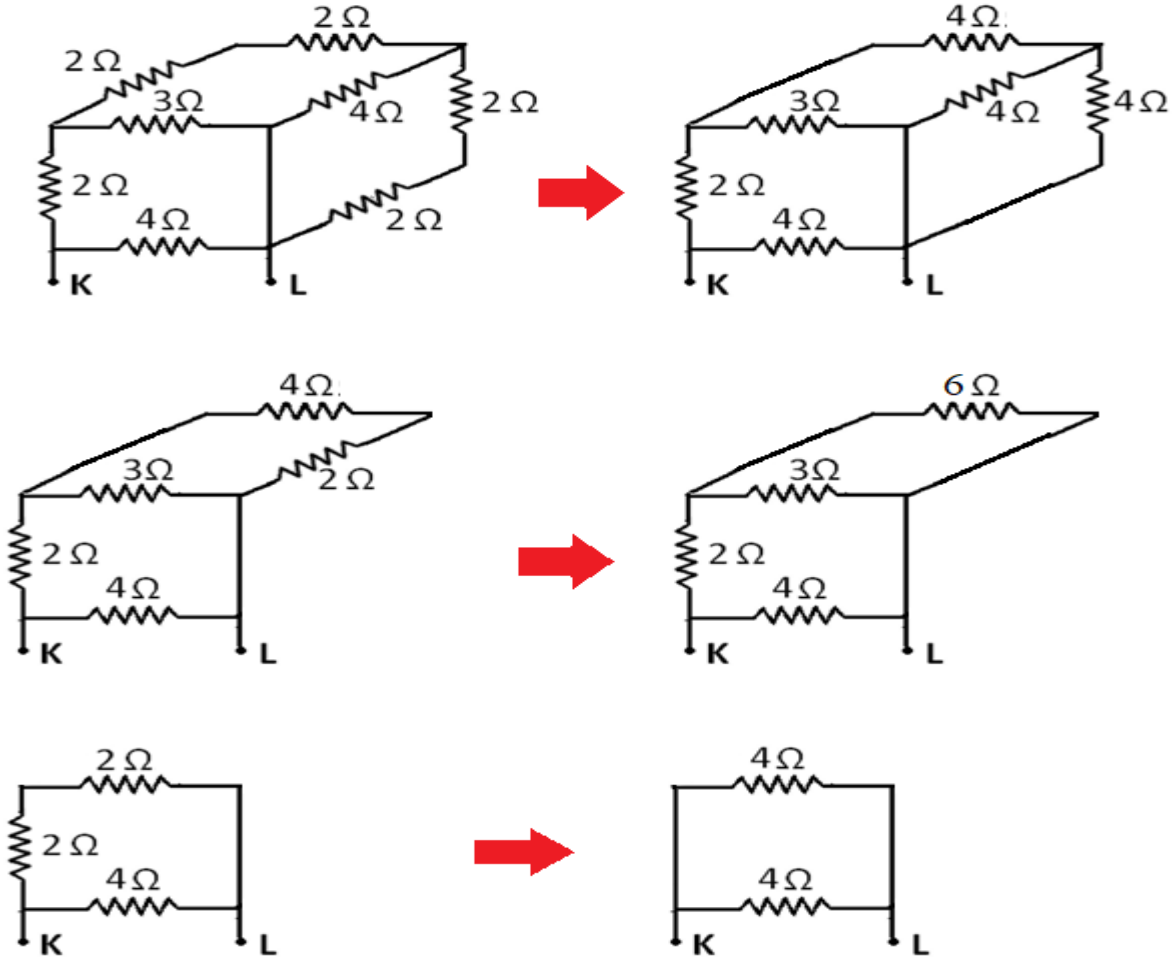
18. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



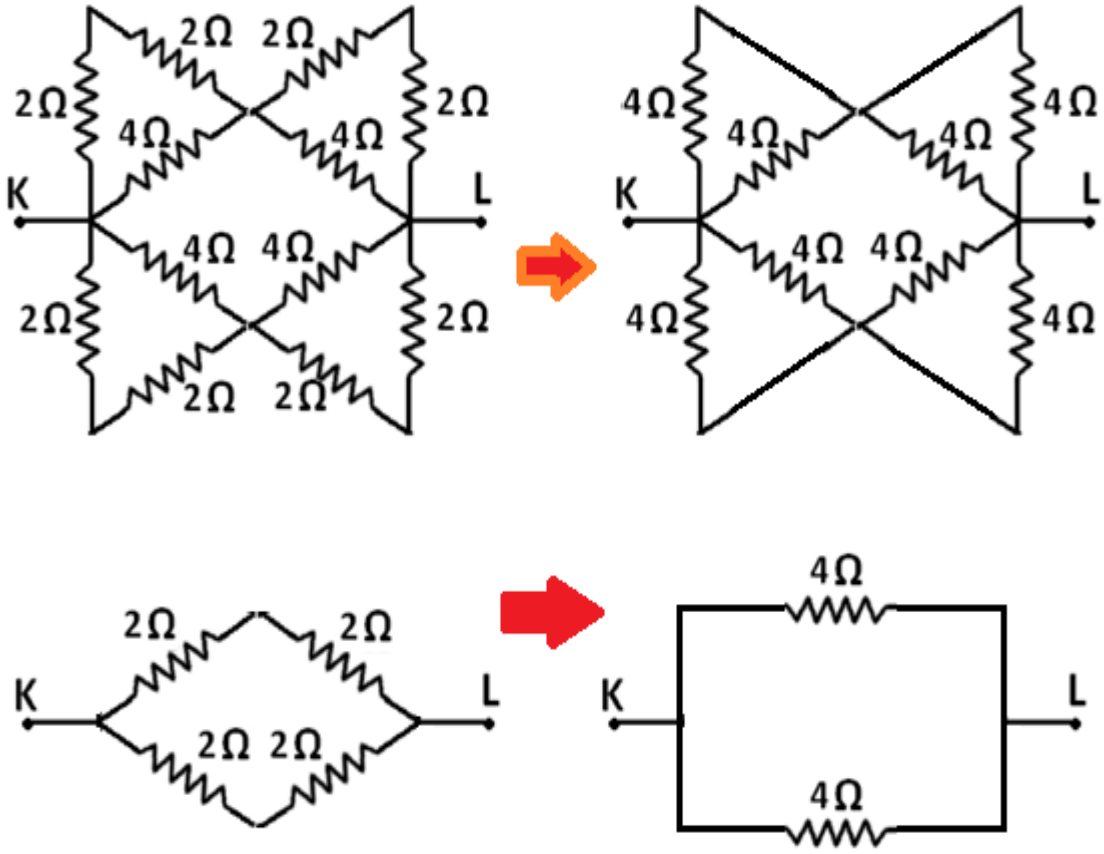
19. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



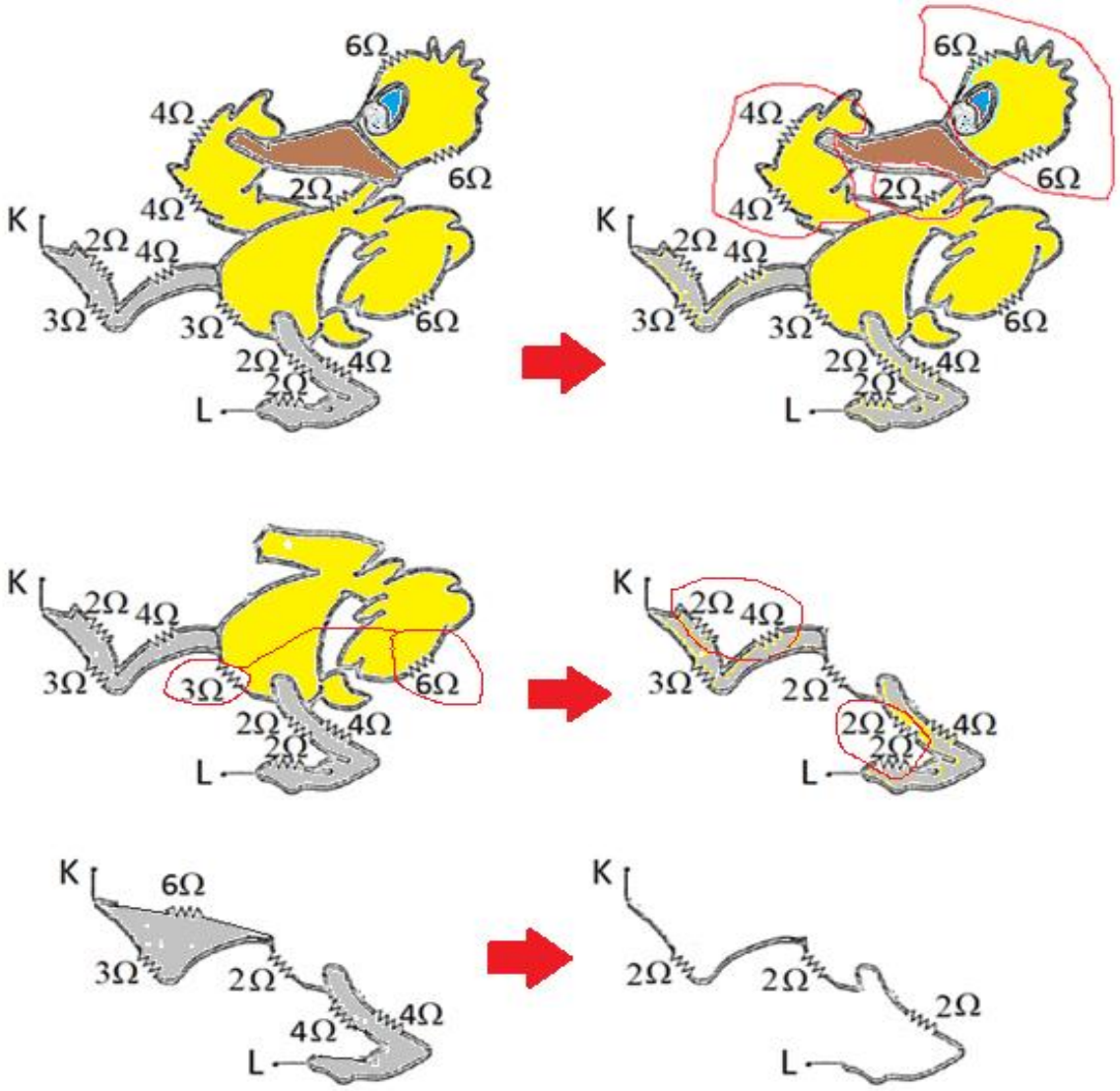
20. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



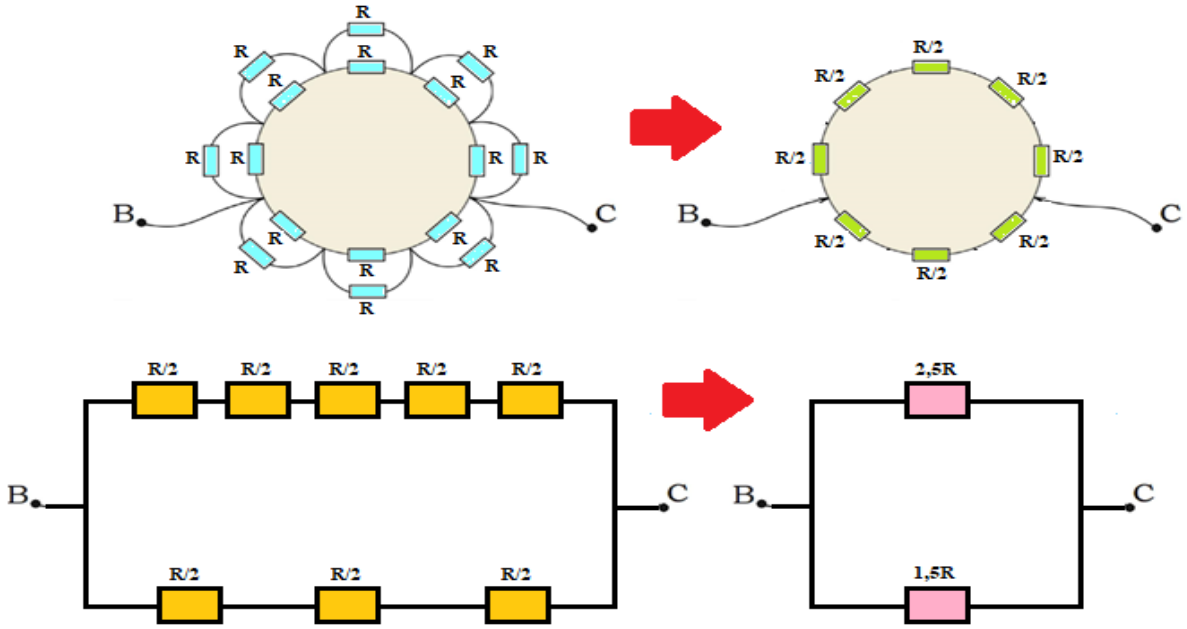
21. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



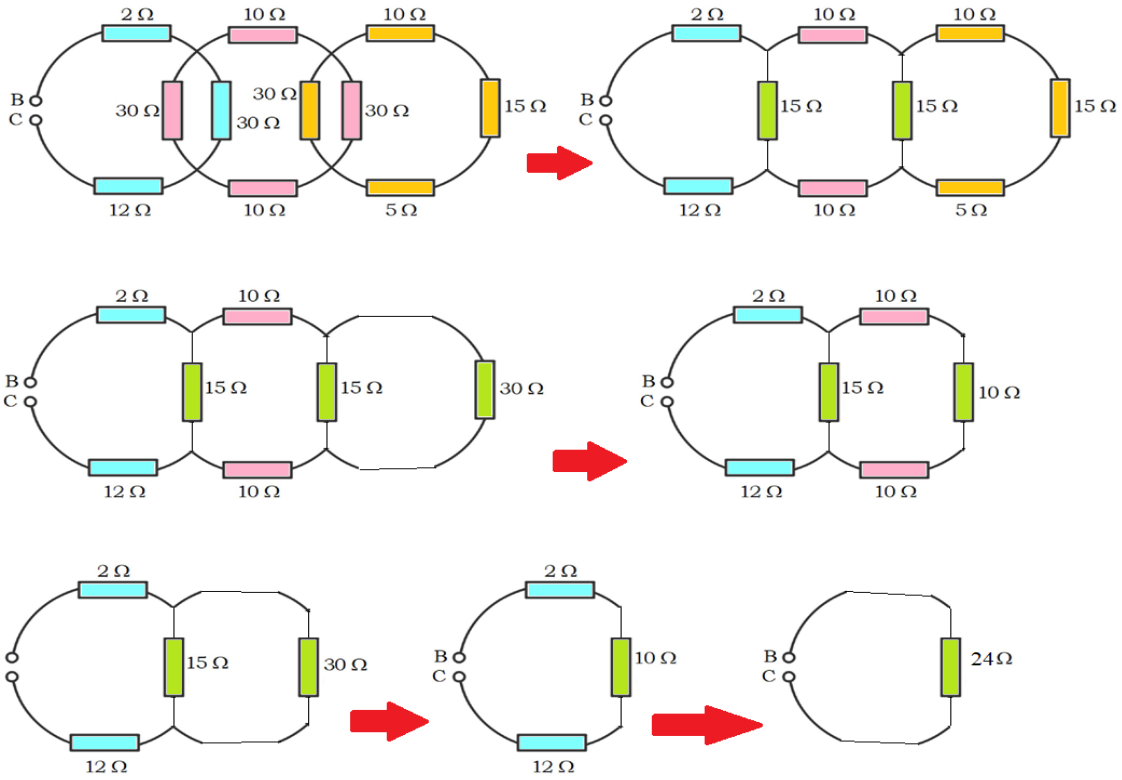
22. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



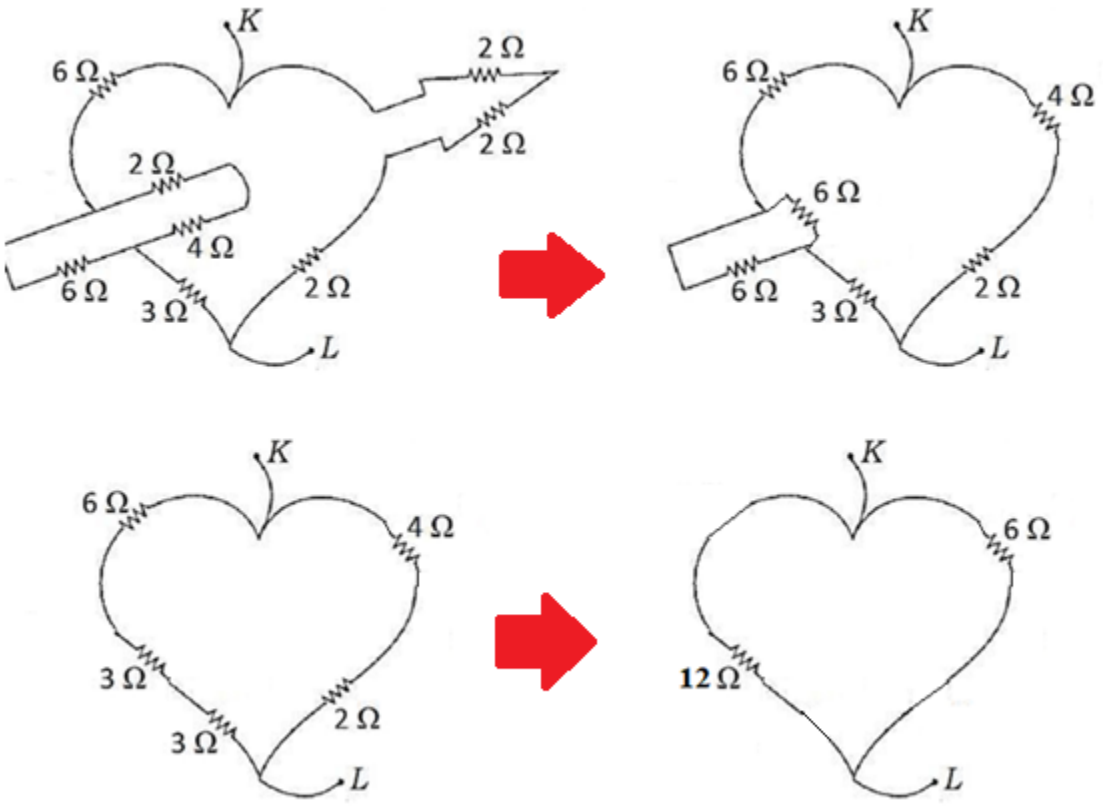
23. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



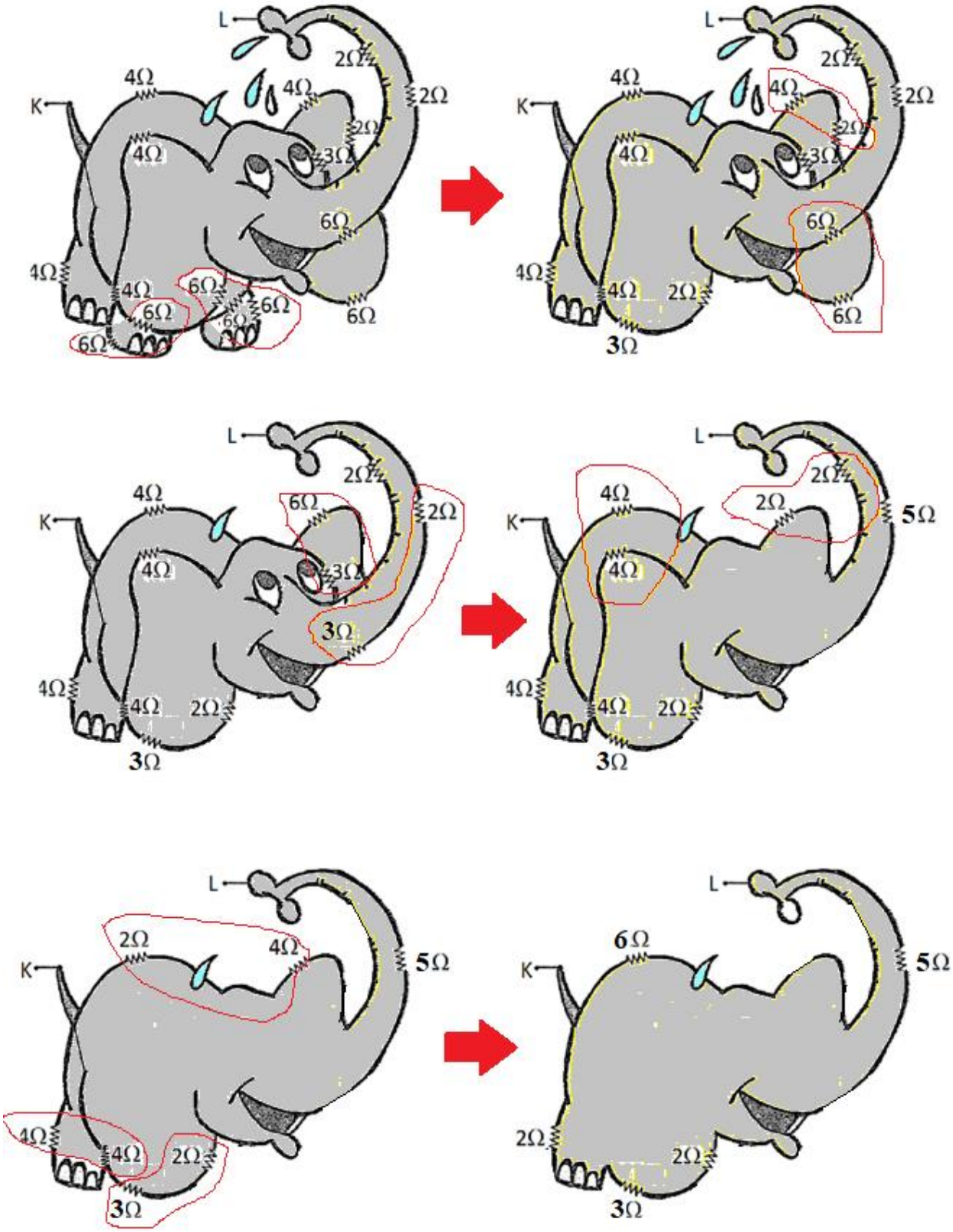
24. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



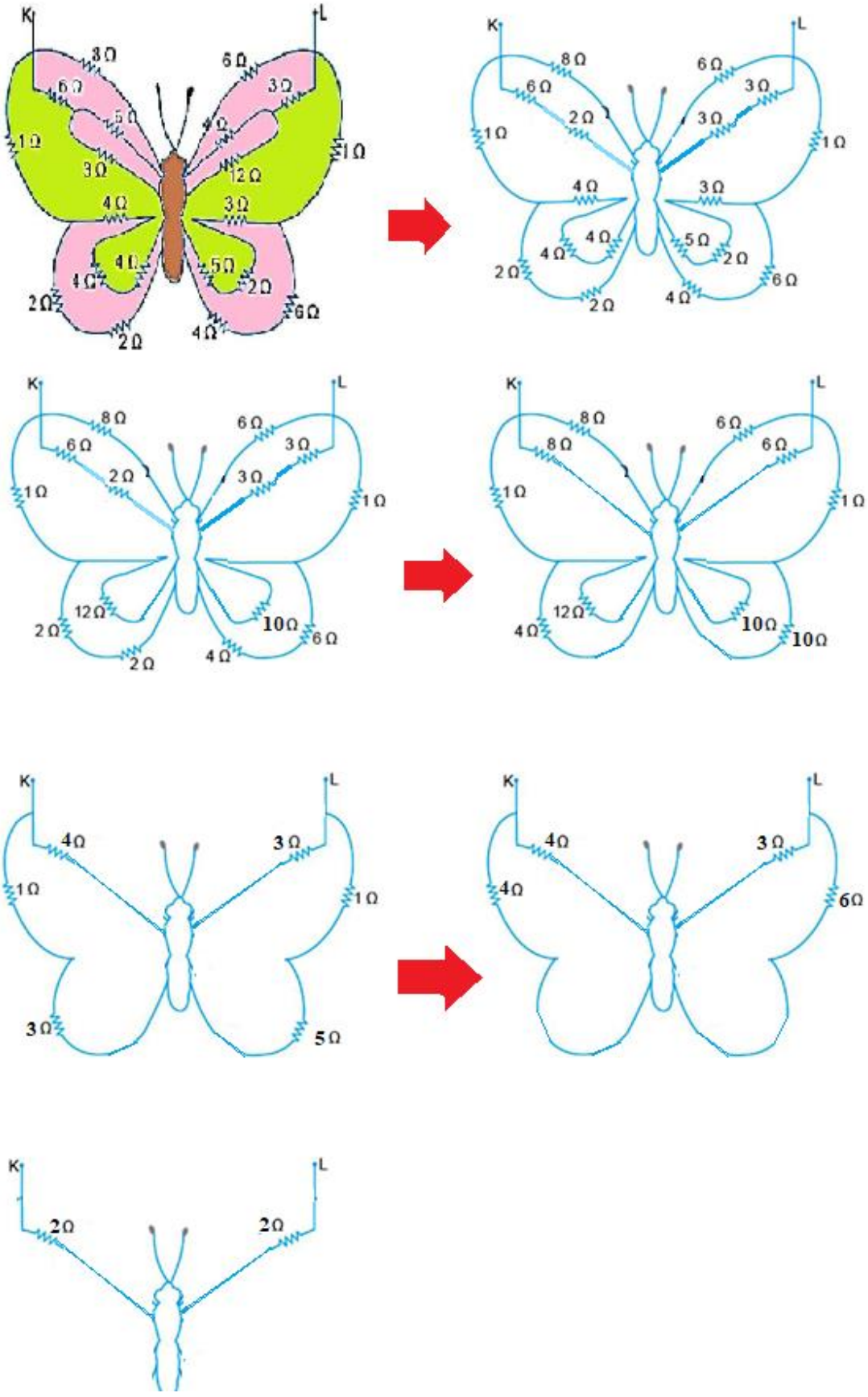
25. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



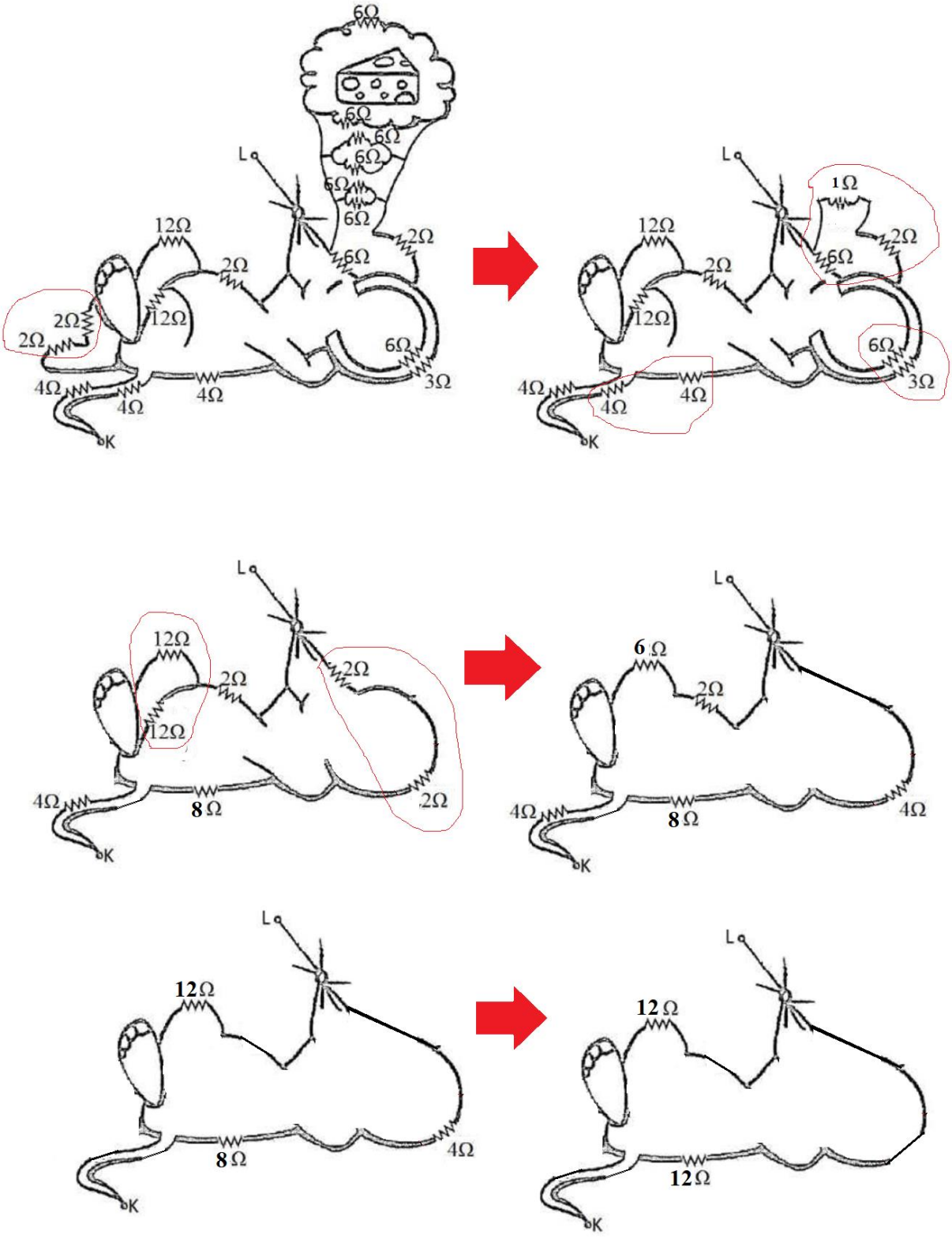
26. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



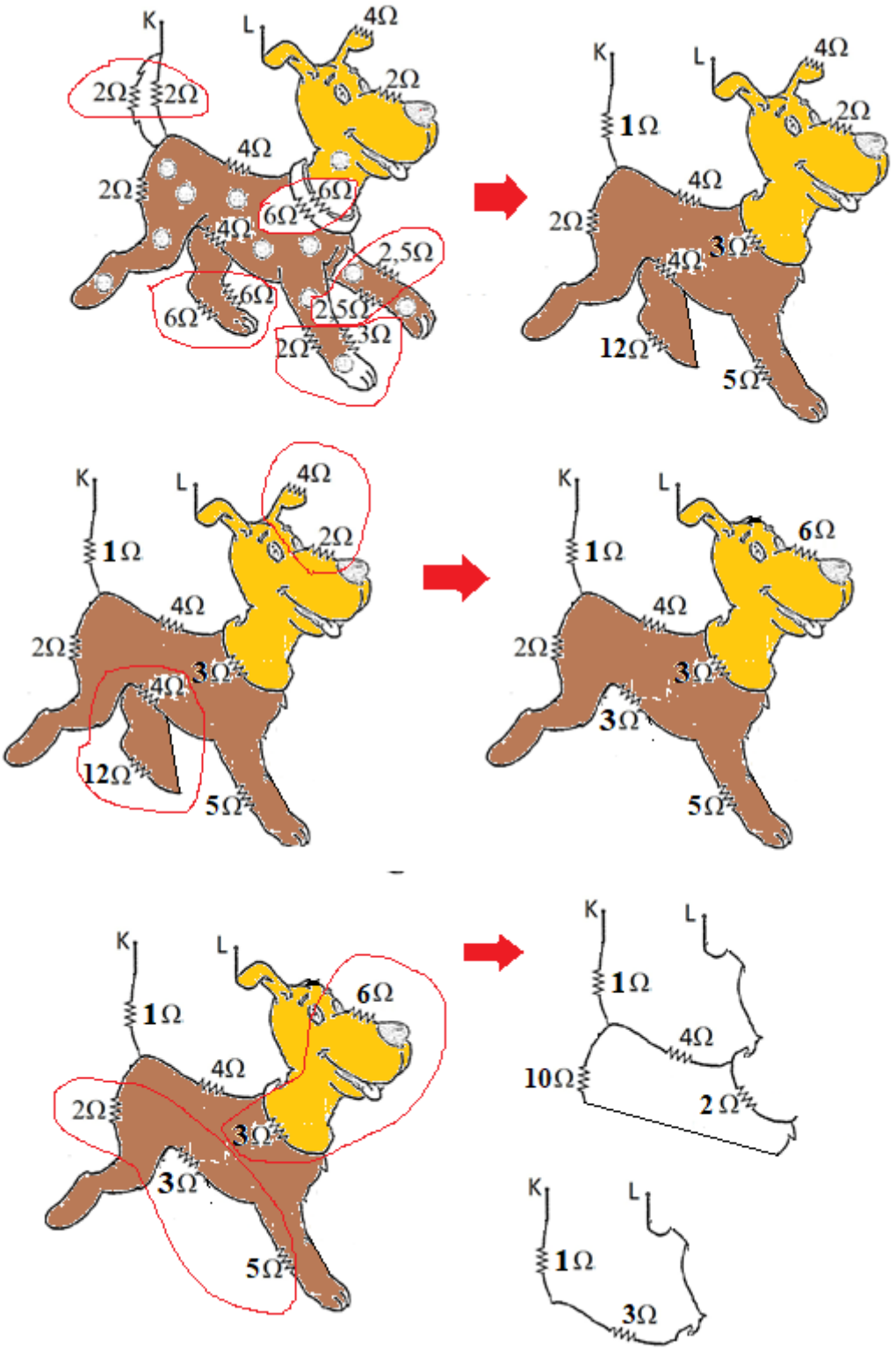
27. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



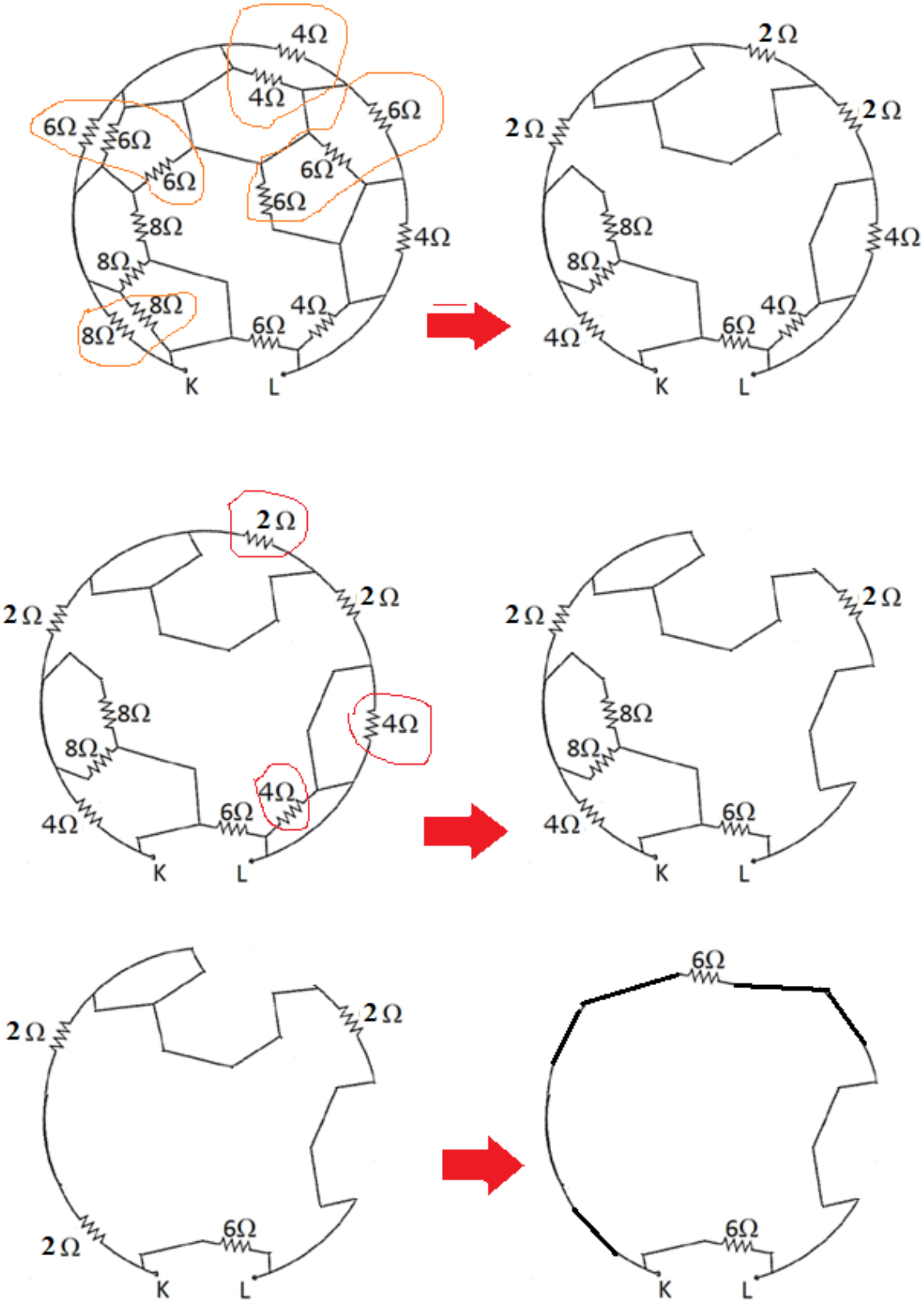
28. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



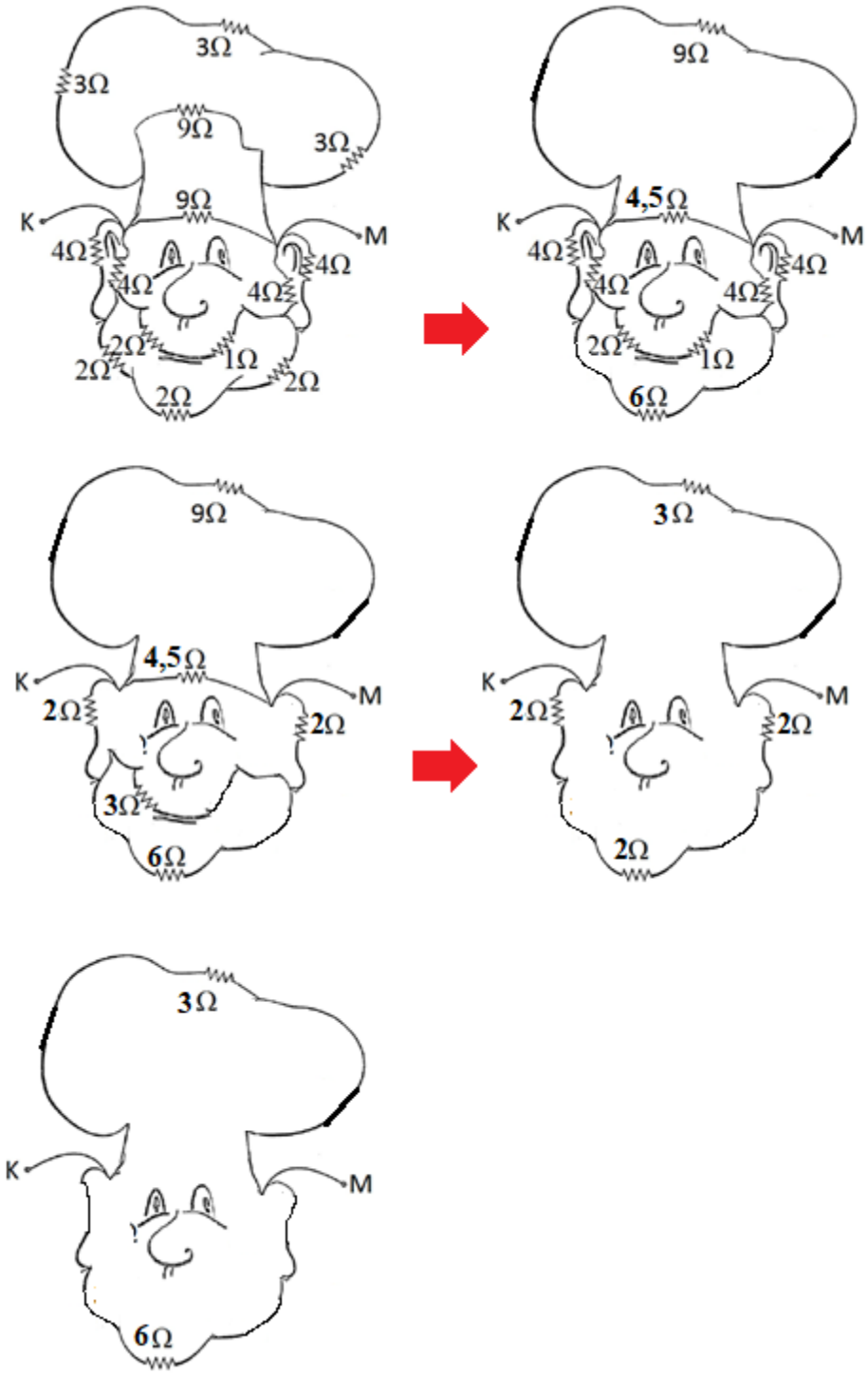
29. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?



30. Zanjirning K va L nuqtalari orasidagi umumiy qarshilikni toping(Ω)?

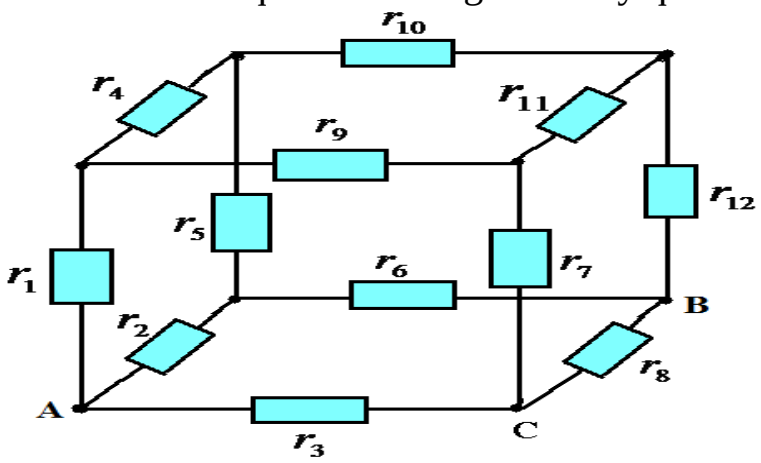


31. Zanjirning K va M nuqtalari orasidagi umumiy qarshilikni toping(**Ω**)?



REZISTORLARNI UMUMIY QARSHILIGINI TOPISHGA DOIR MUSTAQIL YECHISH UCHUN MASALALAR

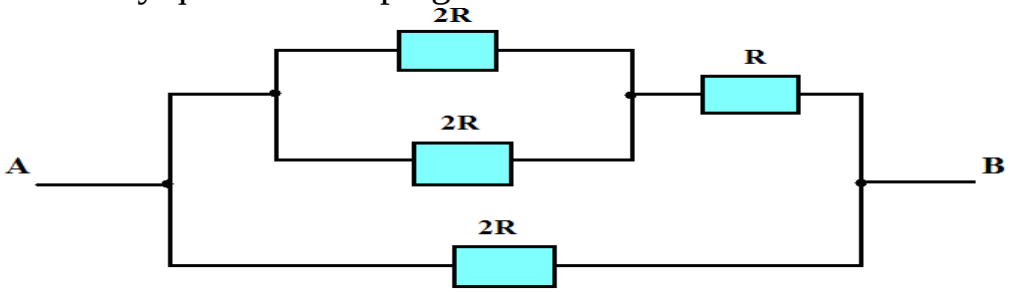
1. Zanjirning AB va AC nuqtalar orasidagi umumiy qarshilikni toping



(Bu sxemani umumiy qarshiligini topish uchun sig‘im mavzusiga qarang)

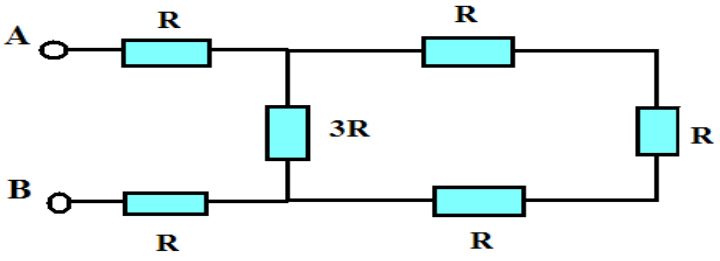
Javob: $R_{AC} = \frac{7}{12}R;$ $R_{AB} = 0{,}75R$

2. Umumiy qarshilikni toping



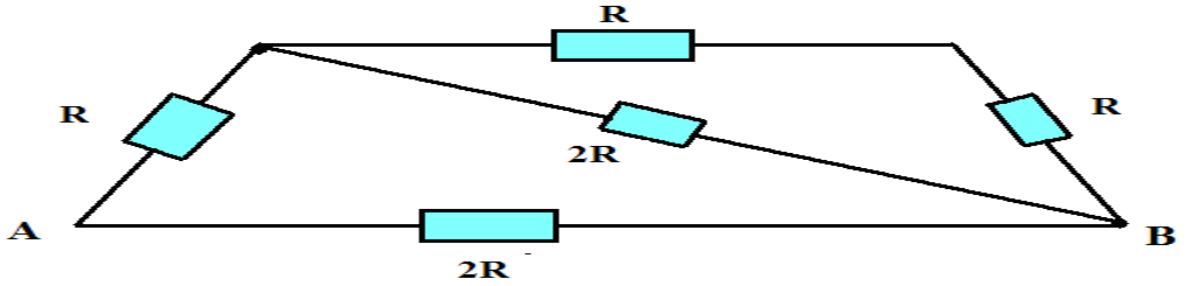
Javob: R

3. Umumiy qarshilikni toping



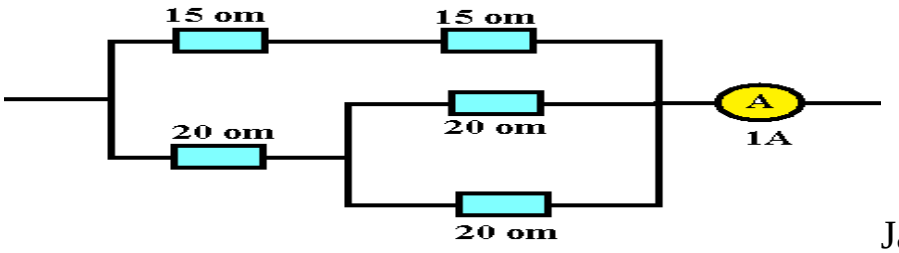
Javob: 3,5R

4. Umumiy qarshilikni toping



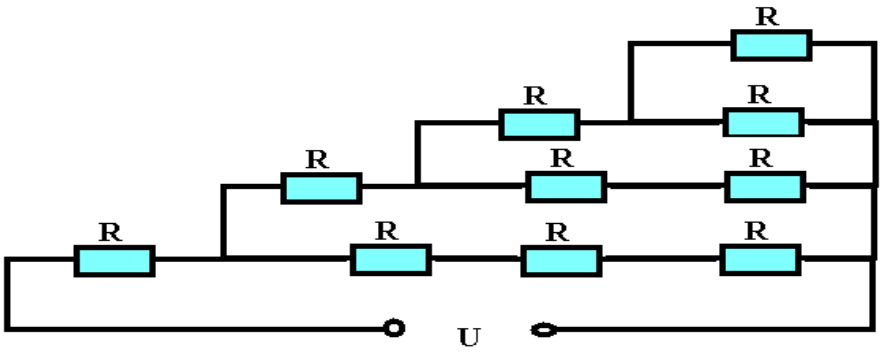
Javob:R

5. Manbadan 20 minutda qancha issiqlik ajraladi



Javob: 18kJ

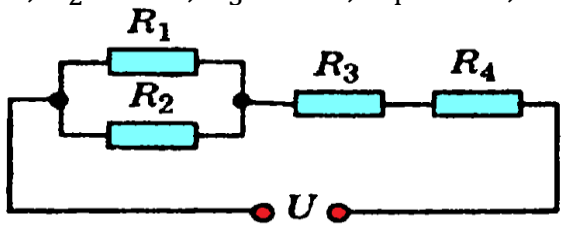
6. Manbadan berilgan umumiy tok kuchini aniqlang.?
(Manbaning kuchlanishi U)



Javob: $I = \frac{34U}{73R}$

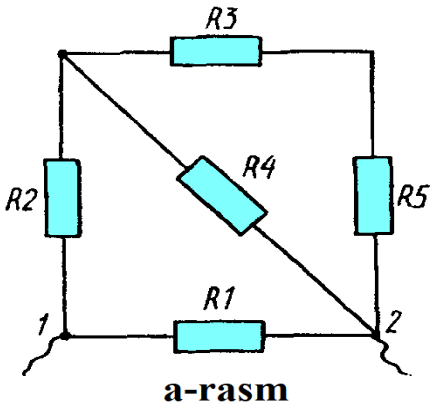
7. Har-bir resistor orqali o‘tadigan tok kuchini toping?

$$R_1 = 1\Omega, R_2 = 2\Omega, R_3 = 3\Omega, R_4 = 4\Omega, U = 100v$$

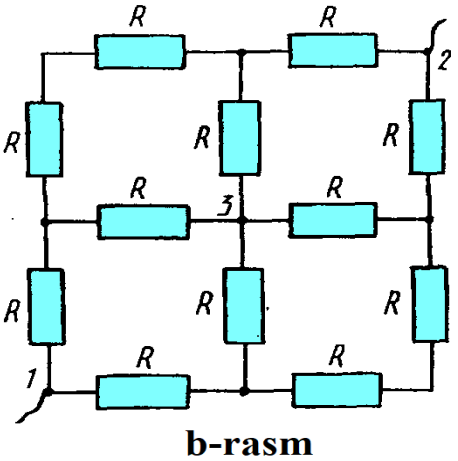


Javob: $I_1 = 8{,}7A, \quad I_2 = 4{,}3A, \quad I_3 = I_4 = 13A$

8. 1-va 2- nuqtalar orasidagi umumiy qarshilikni toping?
($R_1 = R_2 = R_3 = R_4 = R_5 = R$)



a-rasm



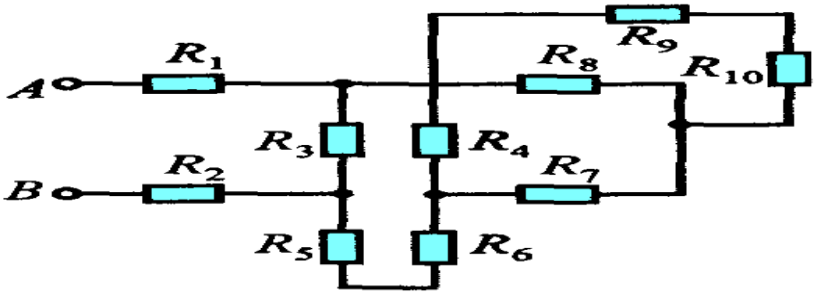
b-rasm

Javob: a rasm $R_{12} = \frac{5}{8}R$; b-rasm $R_{12} = \frac{3}{2}R$

9. Zanjirdagi umumiy tok kuchini toping?

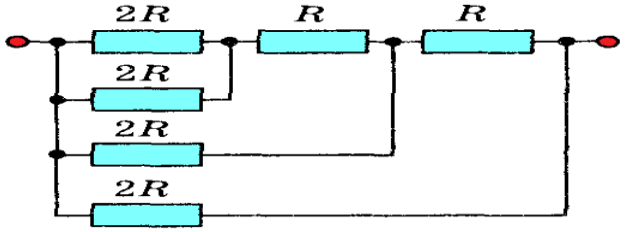
$$U = 10v, R_1 = R_2 = 0{,}5\Omega, R_3 = 8\Omega, R_4 = 12\Omega$$

$$R_5 = R_6 = 1\Omega, R_7 = 2\Omega, R_8 = 15\Omega, R_9 = 10\Omega, R_{10} = 20\Omega$$



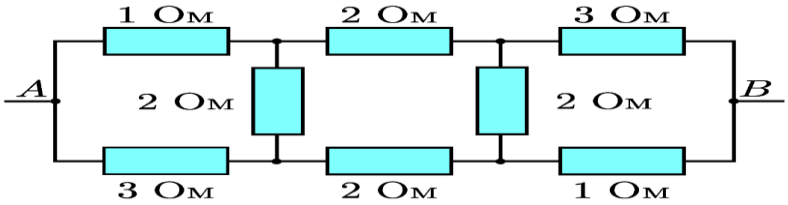
Javob: $I = 1{,}51A$

10. Zarjirning umumiy qarshiligini toping?



Javob: $R_{Um} = R$

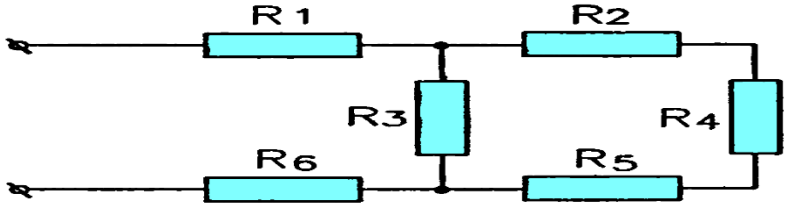
11. Zanjirdagi umumiy qarshilikni toping?



Javob: $R_{Um} = \frac{8}{3}\Omega$

12. Sxemaning har-bir rezistordan o‘tadigan tok kuchini toping?

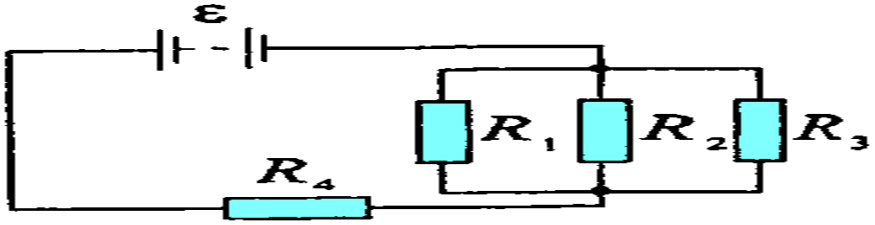
$$R_1 = R_2 = R_5 = R_6 = 3\Omega; R_4 = 24\Omega; U = 36V$$



Javob: $I_1 = 2A; I_2 = 0{,}8A; I_3 = 1{,}2A; I_4 = 0{,}8A; I_5 = 0{,}8A; I_6 = 2A$

13. Rasmda tasvirlangan sxemaning 2-rezistordagi kuchlanish va tok kuchini toping?

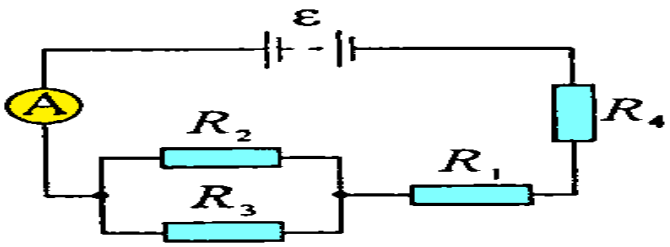
$(\varepsilon = 100v; R_1 = R_3 = 40\Omega; R_2 = 80\Omega; R_4 = 34\Omega;)$



Javob: $U_2 = 32v; \quad I_2 = 0{,}4A$

14. Rasmda tasvirlangan sxemaning 2-rezistorning qarshiligini toping?

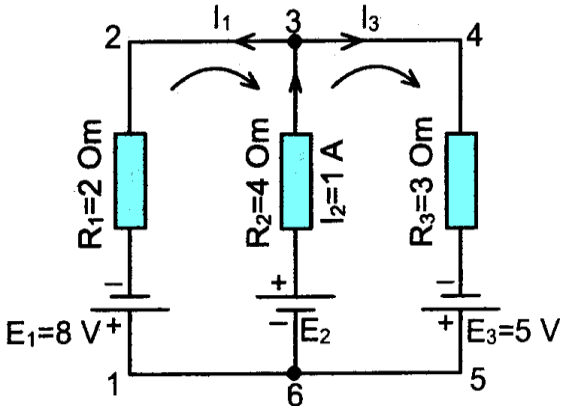
$(\varepsilon = 120v; R_3 = 20\Omega; R_4 = 25\Omega; I = 2A)$



Javob: $R_2 = 60\Omega$

KIRXGOF QOIDALARIGA DOIR MASALALAR

1. Quyidagi zanjirdagi noma'lum kattaliklarni aniqlang



Quyidagi zanjir uchun uchta tenglama tuzish mumkin:

1) 1-2-3-6-1 kontur uchun;
2) 3-4-5-6-3 kontur uchun;
3) 1-2-3-4-5-6-1 kontur uchun.

Oxirgi kontur birinchi ikkitasining qo‘shilishidan hosil bo‘ladi. Shuning uchun mustaqil tenglamalar sifatida uchala tenglamadan ixtiyoriy ikkitasini olish mumkin.

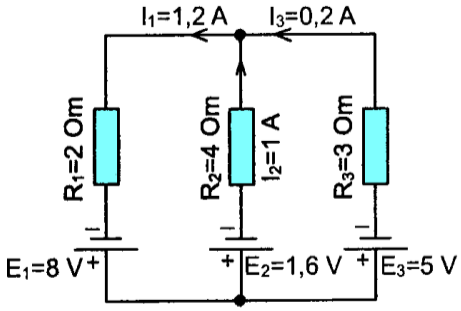
Tok va EYuK orqali Kirxgofning ikkinchi qoidasi tenglamalarini tuzishda tanlab olingan yo‘nalishning ishorasi ko‘rsatilishi kerak. I_1 tok tanlab olingan harakat yo‘nalishiga teskari tomonga oqqanligi uchun uni manfiy deb hisoblash lozim. E_1 uchun ham "-" ishorasi qo‘yilishi kerak, chunki u ham harakat yo‘nalishiga qarshi tomonga qarab ta'sir etadi.3-tugun uchun Kirxgofning birinchi qoidasi, 1-2-3-6-1 va 3-4-5-6-3 konturlar uchun Kirxgofning ikkinchi qonunlarini yozib olamiz.

$$\begin{cases} I_2 - I_1 - I_3 = 0 \\ -I_1R_1 - I_2R_2 = -\varepsilon_1 - \varepsilon_2 \\ I_2R_2 + I_3R_3 = \varepsilon_2 + \varepsilon_3 \end{cases}$$

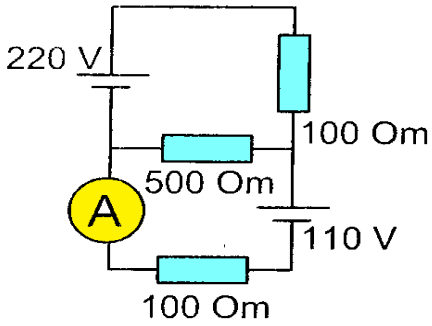
Berilganlarni o‘rniga qo‘ysak

$$\begin{cases} 1 = I_1 + I_3 \\ -2I_1 - 1\cdot 4 = -8 - \varepsilon_2 \\ 1\cdot 4 + 3I_3 = 5 + \varepsilon_2 \end{cases}$$

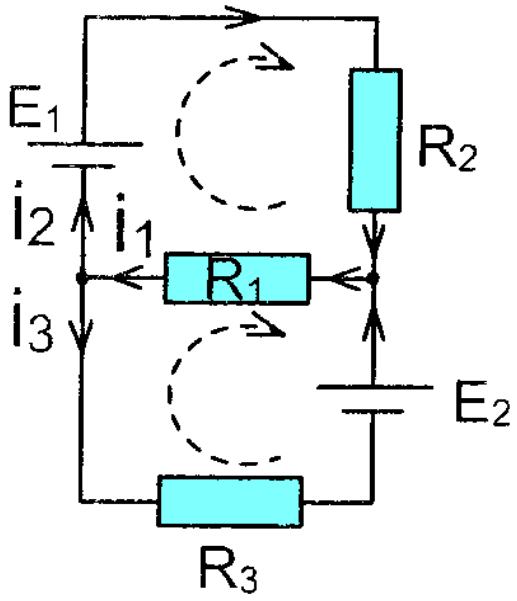
Tenglamalrsistemasini ishlaganimizdan keyin I_1=1,2 A, I_3=-0,2 A, E_2=-1,6 V kabi natijalarga ega bo‘lishimiz mumkin.Biz E_2 uchun manfiy qiymatga ega bo‘ldik. Bu esa E_2 ning yo‘nalishi hisob vaqtida qabul qilingan, ya'ni rasmda ko‘rsatilgan yo‘nalishga nisbatan qarama-qarshi bo‘lishi kerakligini ko‘rsatadi. Shuningdek, I_3 tok rasmda ko‘rsatilganidek, 3-4 yo‘nalish bo‘yicha emas, balki unga qarama-qarshi yo‘nalishda oqadi. I_1 tok musbat bo‘lgani uchun rasmda ko‘rsatilgan yo‘nalishda oqadi. Natijalardan kelib chiqib masala shartidagi rasmni quyidagi ko‘rinishda ifodalasak bo‘ladi:



2. Rasmda berilgan ma'lumotlardan foydalanib, ampermetrning ko‘rsatishini toping.



Bu misol Kirxgof qonunlariga asoslanib ishlanadi. Buning uchun zanjirda mavjud tugunlardagi toklarning yo‘nalishlarini o‘zimiz ixtiyoriy yo‘nalishda tanlab olamiz, muhimi, tugunga kirayotgan va tugundan chiqayotgan toklar bo‘lishi lozim. Aytmoqchi bo‘lganimiz, hamma tok tugunga yoki hamma tok tugundan tashqariga yo‘nalgan bo‘lmasligi kerak. Keyingi qilinadigan ish ikkita konturda toklarning umumiy aylanish yo‘nalishlarini tanlab olamiz.



Eslatma: tenglamalar sistemasi tuzib, uning yechimlari topilganidan keyin, agar biror tokning qiymati manfiy ishorali son chiqsa, demak, rasmda dastavval o‘zimiz ixtiyoriy ravishda tanlab olgan o‘sha tokning yo‘nalishi qarama-qarshisiga bo‘ladi.

Kirxgofning birinchi qonuniga ko‘ra, tugunga kirayotgan va undan chiqayotgan toklar uchun quyidagi tenglamani yozib olamiz:

$$I_1 = I_2 + I_3 (1)$$

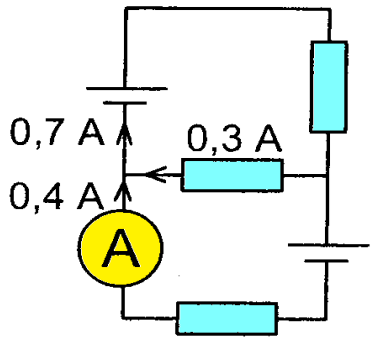
Kirxgofning ikkinchi qonuniga ko‘ra, ya'ni har bir konturdagi toklarning mos qarshiliklarga ko‘paytmalari algebraic yig‘indisi shu konturdagi EYuK larning algebraik yig‘indisiga tengligini bilgan holda, 2 ta kontur uchun tenglamalar sistemasi tuzib olamiz. Eslatma: agar konturdagi tokning va EYuKlarning yo‘nalishlari konturdagi biz tanlab olgan aylanish yo‘nalishimizga teskari bo‘lsa, yoniga minus ishorasini qo‘yib yozamiz.

$$\begin{cases} I_2R_2 + I_1R_1 = \varepsilon_1 \\ -I_1R_1 - I_3R_3 = -\varepsilon_2 \end{cases} \quad \begin{cases} I_2R_2 + I_1R_1 = \varepsilon_1 \\ I_1R_1 + I_3R_3 = \varepsilon_2 \end{cases}$$

Misolda ampermetrdan o‘tayotgan tok kuchini topish so‘ralgan. Bu I_3 tok kuchiga mos keladi. (1) formulaga asosan tenglamalar sistemasidagi barcha I_1 larning

o‘rniga I_2+I_3 ifodani qo‘yib chiqamiz. $\begin{cases} I_2R_2 + (I_2 + I_3)R_1 = \varepsilon_1 \\ (I_2 + I_3)R_1 + I_3R_3 = \varepsilon_2 \end{cases}$

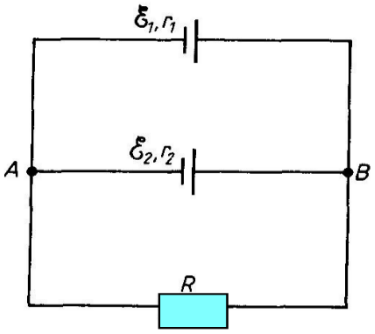
Tenglamalar sistemasini ishlab va (1) formuladan foydalanib quyidagi natijalarga ega bo‘lamiz: I_1=0,3A; I_2=0,7A; I_3=-0,4A zanjirda I_3 tokni pastga yo‘naltirgan edik. Natija manfiy son chiqdi. Demak I_3 tok kuchi yuqoriga yo‘nalgan ekan, ya'ni u tugunga kiradi.

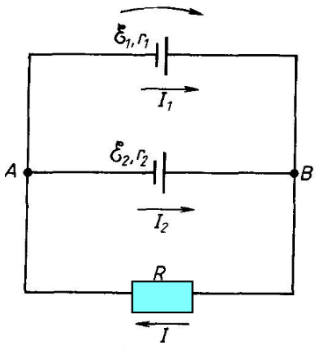


Ampermetrning ko‘rsatishi 0,4 A bo‘ladi.

3. EYuK lari 1,25 V va 1,5 V, ichki qarshiliklari 0,4Ω dan bo‘lgan 2 ta element rasmda ko‘rsatilgandek parallel ulangan bo‘lib ularga qarshiligi 10 Ω tashqi qarshilik ulangan.

Har bir elementdan o‘tadigan tok kuchini va tashqi qarshilikdan o‘tadigan tok kuchini aniqlang?





Manbalardan o‘tadigan tokning yo‘nalishini belgilab chiqamiz va tokning yo‘nalishini soat strelkasi bo‘yicha olamiz

A tugun uchun Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I - I_1 - I_2 = 0 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib Aε$_1$BRA va Aε$_1$B ε$_2$A konturlar uchun tegishli tenglama tuzamiz

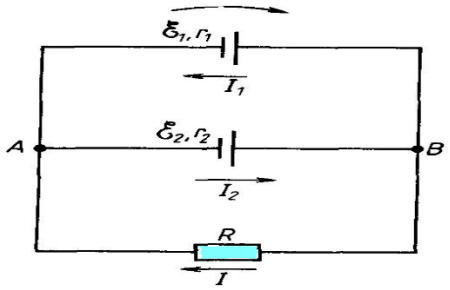
$$I_1 r_1 + IR = \varepsilon_1, I_1 r_1 - I_2 r_2 = \varepsilon_1 - \varepsilon_2 \quad (2)$$

Masala shartiga berilgan kattaliklarni 1-va2- tenglamalarga keltirib qo‘yib nomalum kattaliklarni tenglamalar sistemasi tuzib topamiz.

$$\begin{cases} I - I_1 - I_2 = 0 \\ 0{,}4I_1 + 10I = 1{,}25 \\ 0{,}4I_1 - 0{,}4I_2 = -0{,}25 \end{cases} \qquad (3)$$

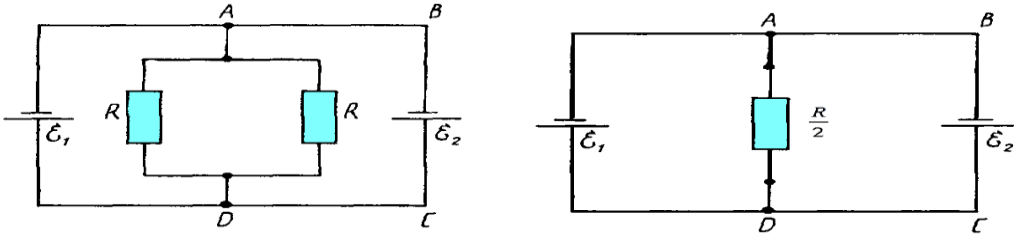
$$I \approx 0{,}135A, I_1 \approx -0{,}245A, I_2 \approx 0{,}38A$$

I$_1$ tok manfiy chiqdi demak u biz tanlagan yo‘nalishga teskari yo‘nalishda oqar ekan ya’ni quyidagicha(ε$_2$ >ε$_1$ 2-manba 1-manbani zaryadlaydi)



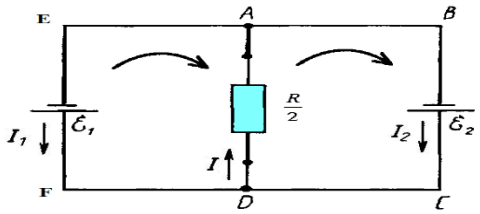
4. Tok manbalarining EYuK lari ε_1=12 V va ε_2=6 V, ichki qarshiliklari r_1=r_2=0,5 Ω dan bo‘lgan manbalarga 2 ta R qarshilik rasmda ko‘rsatilgandek ulandan.

R qarshilikning qanday qiymatida ABCD konturdan tok oqmaydi.



Tashqi qarshiliklar o‘zaro parallel ulangan bo‘lib ularning umumiysi R/2 ga tengligidan sxemani quyidagicha o‘zgartiramiz

Kirxgofning birinch va ikkinchi qoidasidan foydalanib tenglamalar tuzishimiz uchun manbadan chiqadigan toklarning yo‘nalishini va umumiy aylanish yo‘nalishini tanlab olishimiz kerak



D tugun uchun Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I - I_1 - I_2 = 0 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib EFDAE va BCDAB konturlar uchun tegishli tenglama tuzamiz

$$-I_1 r_1 - I\frac{R}{2} = -\varepsilon_1 \qquad (2)$$

$$I_2 r_2 + I\frac{R}{2} = \varepsilon_2 \qquad (3)$$

(2) tenglamalarning har birining oldiga minus qo‘yilishiga sabab tanlab olingan aylanish yo‘nalishiga teskari. 1- tenglamadan I ni topib 2 va 3-tenglamalarga keltirib qo‘yib quyidagicha soddalashtiramiz .

$$\begin{cases} I_1 r_1 + (I_1 + I_2)\frac{R}{2} = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2)\frac{R}{2} = \varepsilon_2 \end{cases} \qquad (4)$$

Masala shartida ABCD konturdan tok oqmasligi kerak edi bu degani $I_2=0$ bo‘ladi.

(4) tenglamaga $I_2=0$ ni etib qo‘yib R ni topamiz

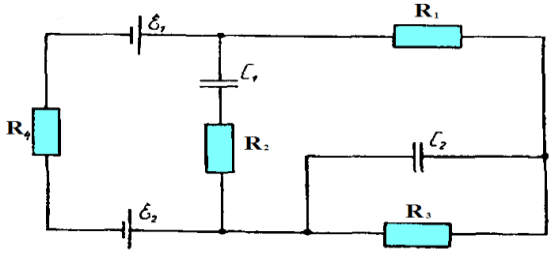
$$-\begin{cases} I_1 r_1 + I_1 \dfrac{R}{2} = \varepsilon_1 \\ I_1 \dfrac{R}{2} = \varepsilon_2 \end{cases} \quad I_1 r_1 = \varepsilon_1 - \varepsilon_2 \rightarrow I_1 = \frac{\varepsilon_1 - \varepsilon_2}{r_1}$$

$$+\begin{cases} I_1 r_1 + I_1 \dfrac{R}{2} = \varepsilon_1 \\ I_1 \dfrac{R}{2} = \varepsilon_2 \end{cases} \quad I_1 r_1 + I_1 R = \varepsilon_1 + \varepsilon_2 \rightarrow R = \frac{\varepsilon_1 + \varepsilon_2 - I_1 r_1}{I_1}$$

$$R = \frac{\varepsilon_1 + \varepsilon_2 - I_1 r_1}{I_1} = \frac{\varepsilon_1 + \varepsilon_2 - (\frac{\varepsilon_1 - \varepsilon_2}{r_1}) r_1}{\frac{\varepsilon_1 - \varepsilon_2}{r_1}} = \frac{2\varepsilon_2 r_1}{\varepsilon_1 - \varepsilon_2}$$

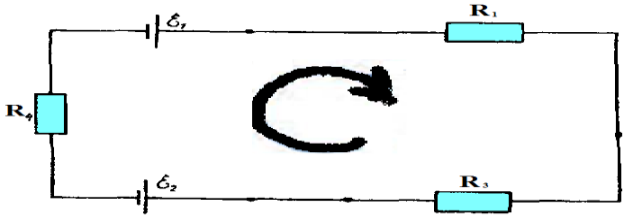
$$R = \frac{2\varepsilon_2 r_1}{\varepsilon_1 - \varepsilon_2} = \frac{2 \cdot 6 \cdot 0{,}5}{12 - 6} = \frac{6}{6} = 1\Omega$$

5. Sxemadaberilganlardan foydalanib kondensatorlarda to‘planadigan zaryadni aniqlang?



Sxemaga ulangan kondensatorlardan o‘zgarmas tok o‘tmaydi ular faqat o‘ziga parallel ulangan qarshilikning kuchlanishicha kuchlanish bilan zaryadlanadi.

Demak kondensatorlardan tok o‘tmagani uchun sxemadan ularni vaqtincha olib tashlaymiz, R_2 qarshilik kondensatorga ketma-ket ulangani uchun undan ham tok o‘tmaydi ya’ni uning qarshiligini kattaligi bizga aloqasi yo‘q.



Sxemani quyidagicha soddalashtirib aylanish yo‘nalishini soat strelkasining yo‘nalishi bilan bir-xil oldik. Bundan kelib chiqadiki aylanish

yo‘nalishidagi EYuK vat ok kuchilarni “+” unda qarama-qarshi yo‘nalganlarni “-” ishora bilan olamiz.

Endi Kirxgofning 2-qoidasidan foydalanib quyidagi tenglamani tuzamiz. (Sxemada ikkala manba va qarshiliklar ketma-ket ulanganligi uchun barcha joydan o‘tadigan tok kuchi bir-xil I ga teng)

$$\varepsilon_1 - \varepsilon_2 = IR_1 + IR_3 + IR_4 \rightarrow I = \frac{\varepsilon_1 - \varepsilon_2}{R_1 + R_3 + R_4}$$

1-rasmdan ko‘rinib turibdiki C_2 kondensator R_3 ga parallel ulangan R_3 dagi kuchlanish esa $U_3 = IR_3 = \frac{\varepsilon_1 - \varepsilon_2}{R_1 + R_3 + R_4} \cdot R_3$

Endi C_2 kondensatorning zaryadini topamiz $q_2 = C_2 \cdot U_3 = C_2 \cdot \frac{\varepsilon_1 - \varepsilon_2}{R_1 + R_3 + R_4} \cdot R_3$ 1-rasmdan ko‘rinib turibdiki C_1 kondensator R_1 va R_3 ga parallel ulangan R_1 va R_3 dagi kuchlanish esa

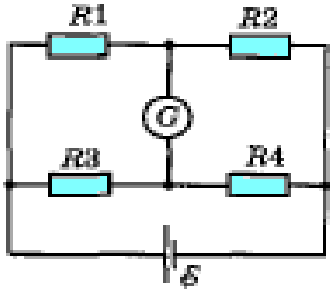
$$U_{1-3} = U_1 + U_3 = IR_1 + IR_3 = I(R_1 + R_3) = \frac{\varepsilon_1 - \varepsilon_2}{R_1 + R_3 + R_4} \cdot (R_1 + R_3)$$

Endi C_1 kondensatorning zaryadini topamiz

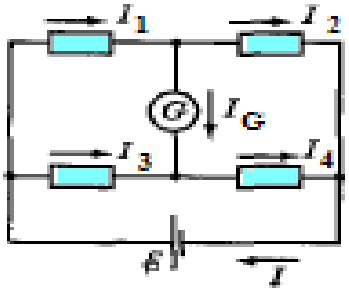
$$q_1 = C_1 \cdot U_{1-3} = C_1 \cdot \frac{\varepsilon_1 - \varepsilon_2}{R_1 + R_3 + R_4} \cdot (R_1 + R_3)$$

6. Rasmda tasvirlangan zanjirdagi galvanometer orqali qancha tok o‘tadi.

$$\varepsilon = 2V, R_1 = 60\Omega, R_2 = 40\Omega, R_3 = R_4 = 20\Omega, R_G = 100\Omega$$



1-rasm



1,1-rasm

1-rasmdagi zanjirda toklarni joylashtiramiz. (1,1-rasm)

Kirxgofning birinchi va ikkinchi qoidasini qo‘llab quyidagi tenglamalarni yozamiz

$$\begin{cases} I = I_1 + I_3 \\ I_1 = I_2 + I_G \\ I_2 + I_4 = I \\ I_3 + I_G = I_4 \end{cases}; \begin{cases} I_1R_1 + I_2R_2 = \varepsilon \\ I_3R_3 + I_4R_4 = \varepsilon \\ I_1R_1 + I_GR_G + I_4R_4 = \varepsilon \end{cases}$$

$$\begin{cases} 6I_1 + 4I_2 = 0{,}2 \\ 2I_3 + 2I_4 = 0{,}2 \\ 6I_1 + 10I_G + 2I_4 = 0{,}2 \end{cases} \Rightarrow \begin{cases} 6I_1 + 4(I_1 - I_G) = 0{,}2 \\ 2(I_4 - I_G) + 2I_4 = 0{,}2 \\ 6I_1 + 10I_G + 2I_4 = 0{,}2 \end{cases}$$

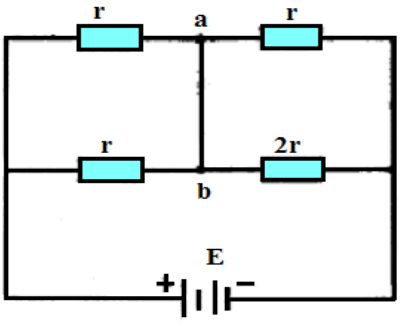
$$10I_1 - 4I_G = 0{,}2 \Rightarrow I_1 = \frac{0{,}2 + 4I_G}{10}, 4I_4 - 2I_G = 0{,}2 \Rightarrow I_4 = \frac{0{,}2 + 2I_G}{4}$$

$$6I_1 + 10I_G + 2I_4 = 0{,}2, 6\left(\frac{0{,}2 + 4I_G}{10}\right) + 10I_G + 2\left(\frac{0{,}2 + 2I_G}{4}\right) = 0{,}2$$

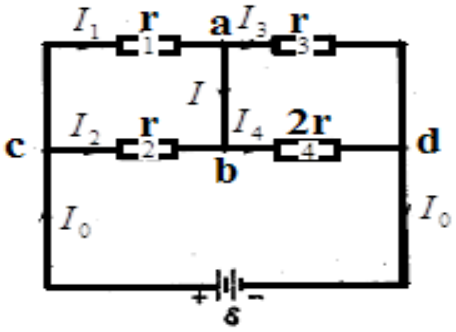
$$1{,}2 + 24I_G + 100I_G + 1 + 10I_G = 2{,}134I_G = -0{,}2, I_G = -1{,}49 \cdot 10^{-3}A$$

Demak galvonametr orqali 1,49 mA o‘tar ekan (yuqoridagi hisoblashga chiqarilgan natija manfiy chiqdi, demak biz tanlagan yo‘nalishga qarama-qarshi harakatlanar ekan)

7. Rasmda tasvirlangan sxemada ab ulagich (peremichka) orqali o‘tgan tokni toping. Ulagichning, ulovchi simlarning qarshiligi va batareyaning ichki qarshiligini juda kichik deb hisoblang.



1-rasm



1,1-rasm

1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm). 1,2,3,4 qarshiliklar orqali I_1, I_2, I_3, I_4, ulash simi (peremichka) orqali I , batareya orqali I_o tok harakatlanadi deb belgilaymiz. Batareyaning ichki qarshiligini hisobga olmay, manba zanjiridagi tokni aniqlaymiz:

$$I_0 = \frac{\varepsilon}{R} \qquad (1)$$

Bunda R, c va d nuqtalar orasidagi umumiy qarshilik.

$$R = \frac{r}{2} + \frac{2}{3}r = \frac{7}{6}r \qquad (2)$$

a tugunda (Kirxgofning 1-qoidasiga ko‘ra)

$$I_1 = I_3 + I \qquad (3)$$

1 va 2 qarshiliklarda kuchlanishlar teng (chunki ular parallel ulangan)

$$U_1 = U_2 \Rightarrow rI_1 = rI_2$$

c tugunda (Kirxgofning 1-qoidasiga ko‘ra) $I_0 = I_1 + I_2$bundan

$$I_1 = I_2 = \frac{I_0}{2} \qquad (4)$$

3 va 4 qarshiliklarda kuchlanishlar teng (chunki ular parallel ulangan)

$$U_3 = U_4 \Rightarrow rI_3 = 2rI_4$$

ni beradi, lekin d tugunda $I_0 = I_3 + I_4$ bundan

$$I_4 = \frac{I_0}{3}, I_3 = \frac{2I_0}{3} \qquad (5)$$

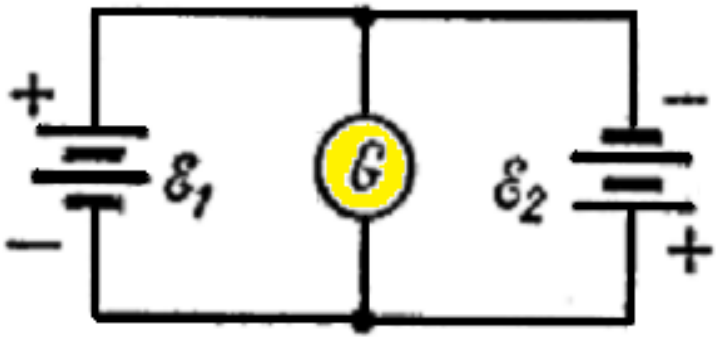
(4) va (5) dan foydalanib (3) tenglamadan

$$I = I_1 - I_3 = \frac{1}{6} I_0$$

Natijaga erishamiz. (1) va (2) tenglamalarni hisobga olib, quyidagi natijaga erishamiz. Demak ulagich orqali o‘tadigan tok quyidagiga teng

$$I = \frac{\varepsilon}{7r}$$

8. E.Yu.K lari ε_1 va ε_2 bo‘lgan ikkita batareya rasmdagidek ulangan. Batareyalarning ichki qarshiliklari nisbati qanday bo‘lganda gal’vanometr orqali tok o‘tmaydi? Ulovchi simlarning qarshiligini hisobga olmang.



Kirxgofning 2-qoidasidan foydalanib quyidagi tenglamalarni tuzamiz

$$\varepsilon_1 = U + Ir_1 \qquad (1)$$

$$\varepsilon_1 + \varepsilon_2 = I(r_1 + r_2) \qquad (2)$$

Masala shartiga ko‘ra gal’vonometr orqali tok o‘tmasa undagi kuchlanish tushuvi nol bo‘ladi va (1) tenglama quyidagi ko‘rinishga keladi

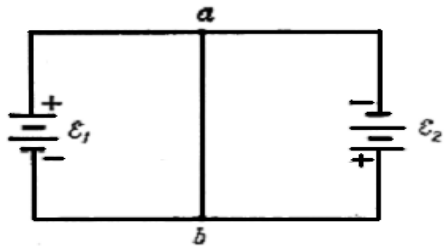
$$U = \varepsilon_1 - Ir_1 = 0 \qquad (3)$$

Bu yerda I batareyalar zanjiridagi tok (masala shartiga ko‘ra gal’vanometr orqali o‘tadigan tok 0 ga teng), U-gal’vanometrda kuchlanish tushuvi, r_1 va r_2 –mos ravishda ε_1 va ε_2 batareyalarning ichki qarshiliklari. Bu tenglamalardan I ni yo‘qotib, quyidagi natijani olamiz.

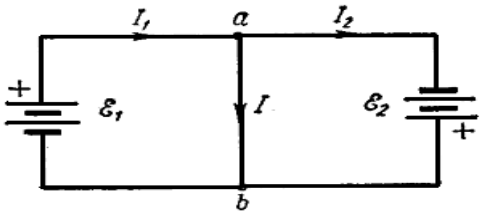
$$\frac{r_2}{r_1} = \frac{\varepsilon_2}{\varepsilon_1}$$

Yuqoridagi shatr bajarilsa gal’vanometr orqali tok o‘tmaydi

9. E.Yu.K lari ε_1 va ε_2 ichki qarshiliklari r_1 va r_2 bo‘lgan ikkita batareya rasmdagidek ulangan. Ulovchi simlarning qarshiligini hisobga olmay, ab ulagich orqali o‘tgan tokni toping. Ulagich qarshiligi nolga teng deb hisoblang.



1-rasm



1,1-rasm

1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm). Birinchi batareya zanjiridagi tok I_1, ikkinchi batareya zanjiridagi tok I_2 bo‘lsin. Ravshanki, perimechka orqali o‘tuvchi tok quyidagiga teng:

$$I = I_1 - I_2 \qquad (1)$$

Bundan I_1 - batareya $\mathcal{E}_1$ ning qisqa tutashuv toki

$$I_1 = \frac{\mathcal{E}_1}{r_1}$$

I_2 - batareya $\mathcal{E}_2$ ning qisqa tutashuv toki

$$I_2 = \frac{\mathcal{E}_2}{r_2}$$

Bu natijalarni (1)- formulaga etib qo‘ysak quyidagi natijaga erishamiz

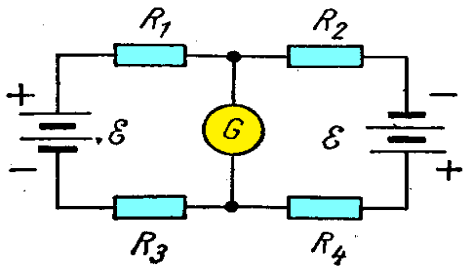
$$I = \frac{\mathcal{E}_1 \cdot r_2 - \mathcal{E}_2 \cdot r_1}{r_1 \cdot r_2}$$

Shuni eslatib o‘tamizki, bu echim perimechka qarshiligini hisobga olmasa bo‘ladi, deb taxmin qilinganda olingan. Agar bunday taxmin qilinmasa, unda I uchun yozilgan ifoda peremichkaning qarshiligiga bog‘liq bo‘ladi, biroq tok bo‘lmaslik sharti

$$\mathcal{E}_1 \cdot r_2 = \mathcal{E}_2 \cdot r$$

Ifodaga teng

10. Rasmda ko‘rsatilgan zanjirda $R_2 > R_1$. Gal’vanometr orqali o‘tuvchi tok nolga teng bo‘lishi uchun R_3 , R_4 ni qanday tanlash mumkin? Batareyalarning E.Yu.K birday. Batareyalarning ichki qarshiliklarini hisobga olmang.



Gal’vanometr orqali I_G tok nolga tengligini hisobga olib, batareyalar zanjiridagi tok uchun quyidagi ifodani yozamiz:

$$I = \frac{2\varepsilon}{R_1+R_2+R_3+R_4} \qquad (1)$$

Gal'vanometrdagi U kuchlanish ham nolga teng. Kirxgofning 2-qoidasiga ko'ra quyidagi tenglamani tuzamiz:

$$\varepsilon = U + IR_2 + IR_4 \Rightarrow U = \varepsilon - I(R_2 + R_4) = 0 \qquad (2)$$

(1) formulani (2) formulaga keltirib qo'yamiz va quyidagi natijaga erishamiz

$$\varepsilon - \frac{2\varepsilon(R_2+R_4)}{R_1+R_2+R_3+R_4} = 0 \qquad (3)$$

Bundan

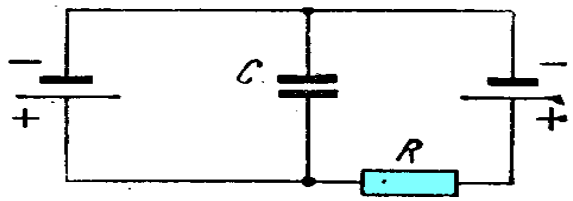
$$R_1 + R_2 + R_3 + R_4 = 2R_2 + 2R_4 \qquad (4)$$

Yoki

$$R_4 = R_3 - R_2 + R_1 \qquad (5)$$

R_2>R_1 bo'lgani tufayli quyidagi shart bajarilishi lozim (R_4>0) $R_3 \geq R_2 - R_1$

11. Rasmda tasvirlangan sxemada batareyalarning E.Yu.K kattaliklari ε_1 va ε_2, ularning ichki qarshiliklari r_1 va r_2, qarshilik R va sig'im C berilgan. Kondensator zaryadini aniqlang.



Kondensator U kuchlanish bilan zaryadlangandan keyin u orqali tok o'tishi to'xtaydi.

Kirxgofning 2-qoidasidan foydalanib chap tomondagi yopiq kontur uchun quyidagi tenglamalarni tuzamiz

$$\varepsilon_1 = I \cdot r_1 + U \qquad (1)$$

To'liq zanjir uchun Om qonunidan zanjirdan aylanadigan I tok kuchini topamiz

$$I = \frac{\varepsilon_1-\varepsilon_2}{R+r_1+r_2} \qquad (2)$$

(1) formuladagi I ning o'rniga (2) formulani etib qo'yib U ni topamiz

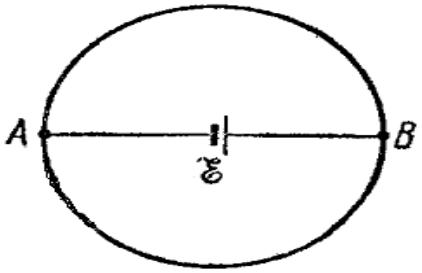
$$\varepsilon_1 = I \cdot r_1 + U \Rightarrow U = \varepsilon_1 - I \cdot r_1 = \varepsilon_1 - \frac{\varepsilon_1-\varepsilon_2}{R+r_1+r_2} \cdot r_1 = \frac{\varepsilon_1(r_2+R)+\varepsilon_2 r_1}{R+r_1+r_2} \qquad (3)$$

Endi kondensatordagi zaryadni topamiz

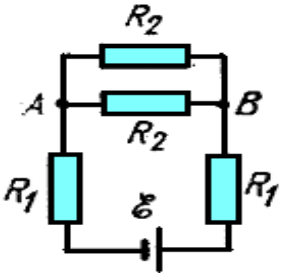
$$q = C \cdot U = C \cdot \frac{\varepsilon_1(r_2 + R) + \varepsilon_2 r_1}{R + r_1 + r_2}$$

12. Rasmda ko'rsatilgan nixrom sim $a = 1m$ radiusli halqa shaklida bukilgan. Halqa markaziga Grene gal'vanik elementi joylashtirilgan bo'lib, u xuddi shunday nixrom sim bilan halqaning diametri bo'yicha A va B nuqtalarga ulangan. Gal'vanik elementning E.Yu.K $\varepsilon = 2V$ va ichki

qarshiligi $r = 1{,}5\Omega$. A va B nuqtalar orasidagi kuchlanishni aniqlang. Nixromning solishtirma qarshiligi $\rho = 1{,}1 \cdot 10^{-6}\Omega \cdot m$, simning kesim yuzi $S = 1mm^2$. AB simning uzunligi halqaning diametriga teng deb hisoblang.



1-rasm

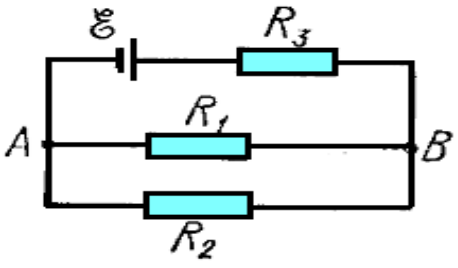


1,1-rasm

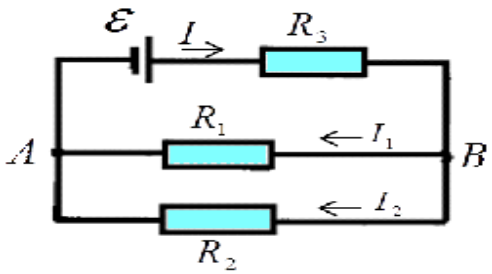
1-rasmdagi zanjirda sxemani quyidagicha o‘zgartiramiz(1,1-rasm). Sxemani yuqorida ko‘rsatilgan ekvivalent sxemasi ko‘rsatilgan, bunda R_1 qarshilik elementni halqa bilan tutashtiruvchi simlarning qarshiligiga mos keladi; R_2 qarshilik esa halqaning ikki yarmining qarshiligiga mos keladi. Tashqi zanjirning umumiy qarshiligi $R = 2R_1 + \frac{R_2}{2}$, bunda $R_1 = \rho\frac{a}{S}$, va $R_2 = \rho\frac{\pi \cdot a}{S}$. Umumiy zanjirdagi tok $I = \frac{\varepsilon}{R+r}$. A va B nuqtalar orasidagi kuchlanish.

$$U = I \cdot \frac{R_2}{2} = \frac{\varepsilon \cdot R_2}{4R_1 + R_2 + 2r} = \frac{\varepsilon \cdot \pi}{4 + \pi + \frac{2rS}{\rho a}} = 0{,}64V$$

13. Elektr zanjir rasmda tasvirlangan sxema bo‘yicha ulangan E.Yu.K manbai va $R_1 = 3\Omega$, $R_2 = 2\Omega$ va $R_3 = 18{,}8\Omega$ qarshiliklardan iborat. R_1 va R_2 qarshiliklar orqali o‘tuvchi toklarni aniqlang.Manbaning E.Yu.K $\varepsilon = 100V$va uning ichki qarshiligi $r = 0{,}2\Omega$



1-rasm



1,1-rasm

1-rasmdagi zanjirda toklarni joylashtiramiz(1,1-rasm) B tugun uchun Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Tashqi zanjirning umumiy qarshiligi $R_{Um} = R_3 + \frac{R_1 \cdot R_2}{R_1 + R_2} = 20\Omega$.

Umumiy zanjirdagi tokni

$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{\varepsilon}{R_3 + \frac{R_1 \cdot R_2}{R_1 + R_2} + r} = \frac{\varepsilon \cdot (R_1 + R_2)}{(R_3 + r)(R_1 + R_2) + R_1 \cdot R_2} = 4{,}95A$$

R_1 va R_2qarshiliklar paralelligidan tok kuchilarni munosabatini topamiz

$$U_1 = U_2 \to I_1 \cdot R_1 = I_2 R_2 \to I_2 = \frac{I_1 \cdot R_1}{R_2}$$

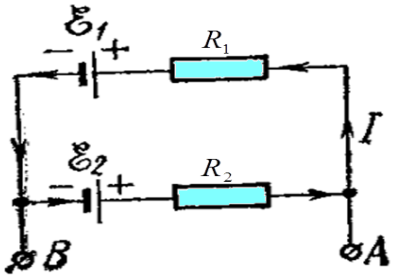
Hosil bo‘lgan bu munosabatni (1) formulaga etib qo‘ysak

$$I = I_1 + \frac{I_1 R_1}{R_2} I_1 = I \cdot \frac{R_2}{R_1 + R_2}; I_2 = I \cdot \frac{R_2}{R_1 + R_2} \cdot \frac{R_1}{R_2} = I \cdot \frac{R_1}{R_1 + R_2};$$

$$I_1 = \frac{\varepsilon \cdot (R_1 + R_2)}{(R_3 + r)(R_1 + R_2) + R_1 \cdot R_2} \cdot \frac{R_2}{R_1 + R_2} = \frac{\varepsilon \cdot R_2}{(R_3 + r)(R_1 + R_2) + R_1 \cdot R_2} = 1{,}98A$$

$$I_2 = \frac{\varepsilon \cdot (R_1 + R_2)}{(R_3 + r)(R_1 + R_2) + R_1 \cdot R_2} \cdot \frac{R_1}{R_1 + R_2} \cdot = \frac{\varepsilon \cdot R_1}{(R_3 + r)(R_1 + R_2) + R_1 \cdot R_2} == 2{,}97A$$

14. Rasmdagi A va B nuqtalar orasidagi potensiallar farqi qanday? Manbaning E.Yu.K $\varepsilon_1 = 1V$ va $\varepsilon_2 = 1{,}3V$, zanjirdagi qarshiliklar esa $R_1 = 10\Omega$ va $R_2 = 5\Omega$ ga teng. Manbalarning ichki qarshiligini hisobga olmang.



$\varepsilon_2 > \varepsilon_1$ shuning uchun I tok rasmda ko‘rsatilgan yo‘nalish bo‘ylab harakatlanadi, AB nuqtalar orasidagi potensiallar farqi har ikkala manba uchun tashqi kuchlanish hisoblanadi. Har ikkala manba uchun Kirxgofning 2-qoidasini yozamiz

Zanjirning ε_1 E.Yu.K va R_1 qarshilik ishtirok etgan qismdagi tashqi kuchlanish (Manba zaryadlanmoqda ya’ni tok olmoqda U kuchlanish ostida)

$$U = \varepsilon_1 + IR_1 \qquad (1)$$

Zanjirning ε_2 E.Yu.K va R_2 qarshilik ishtirok etgan qismdagi tashqi kuchlanish

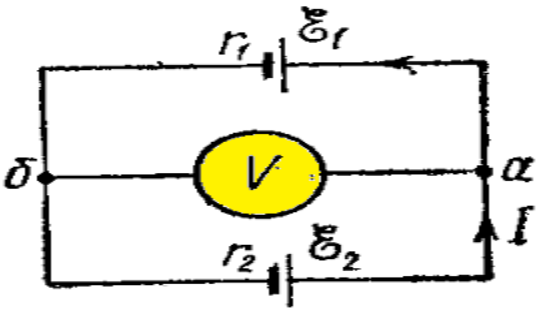
Bu holda (Manba razryadlanmoqda ya’ni tok bermoqda U kuchlanishli)

$$\varepsilon_2 = U + IR_2 \qquad (2)$$

(1) va (2) formulalarni soddalashtirsak quyidagi natijaga ega bo‘lamiz

$$U = \frac{\varepsilon_2 \cdot R_1 + \varepsilon_1 \cdot R_2}{R_1 + R_2} = 1{,}2V$$

15. Ikkita element rasmda ko‘rsatilgan sxema bo‘yicha ulangan. Birinchi elementning E.Yu.K $\varepsilon_1 = 1{,}5V$ va ichki qarshiligi $r_1 = 0{,}6\Omega$, ikkinchi elementning E.Yu.K $\varepsilon_2 = 2V$ va ichki qarshiligi $r_2 = 0{,}4\Omega$. Elementlarning klemmelariga (a va б nuqtalarga) ulangan vol’tmetr qanday U kuchlanishni ko‘rsatadi? Vol’tmetrning qarshiligi elementlarning ichki qarshiligidan ancha katta.



$\varepsilon_2 > \varepsilon_1$ bo‘lgani uchun I tok yo‘nalishini rasmda ko‘rsatilgandek tanlaymiz. Vol’tmetrning qarshiligi elementlarning ichki qarshiliklaridan ko‘p marta katta bo‘lgani sababli vol’tmetr orqali o‘tuvchi tokni hisobga olmaymiz. Elementlarning ichki qarshiliklaridagi kuchlanish tushishlari elementlar E.Yu.K larining ayirmasiga teng bo‘lishi kerak, chunki ular qarshi (bir xil qutblari bilan) ulangan:

$$Ir_1 + Ir_2 = \varepsilon_2 - \varepsilon_1 \rightarrow I = \frac{\varepsilon_2 - \varepsilon_1}{r_1 + r_2} \qquad (1)$$

a va b nuqtalar orasidagi potentsiallar farqi (vol’tmetrlarning ko‘rsatishi):

Zanjirning ε_1 E.Yu.K va r_1 qarshilik ishtirok etgan qismdagi tashqi kuchlanish

(Manba zaryadlanmoqda ya’ni tok olmoqda U kuchlanish ostida)

$$U = \varepsilon_1 + Ir_1 \qquad (2)$$

Zanjirning ε_2 E.Yu.K va r_2 qarshilik ishtirok etgan qismdagi tashqi kuchlanish

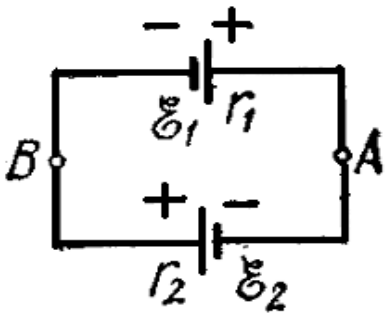
Bu holda (Manba razryadlanmoqda ya’ni tok bermoqda U kuchlanishli)

$$\varepsilon_2 = U + IR_2 \qquad (3)$$

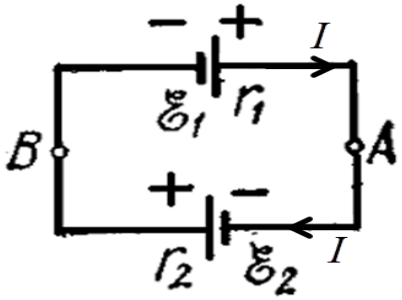
(2) yoki (3) formulaga (1) formulani keltirib qo‘ysak quyidagi natijaga ega bo‘lamiz

$$U = \frac{\varepsilon_2 \cdot R_1 + \varepsilon_1 \cdot R_2}{R_1 + R_2} = 1{,}8V$$

16. E.Yu.K. $\varepsilon_1 = 1{,}4V$ va $\varepsilon_2 = 1{,}1V$ va ichki qarshiliklari mos ravishda $r_1 = 0{,}3\Omega$ va $r_2 = 0{,}2\Omega$ bo‘lgan ikki element turli ismli qutblari bilan o‘zaro tutashtirilgan. Elementlarning klemmalaridagi kuchlanishni aniqlang. Qanday sharoitda B va A nuqtalar orasidagi potentsiallar farqi nolga teng bo‘lishini aniqlang.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda $\varepsilon_1 > \varepsilon_2$ bo‘lgani uchun toklarni joylashtiramiz. (1,1-rasm). $\varepsilon_1 > \varepsilon_2$ bo‘lgani uchun I tok yo‘nalishini rasmda ko‘rsatilgandek tanlaymiz. Elementlarning ichki qarshiliklaridagi kuchlanish tushishlari elementlar E.Yu.K larining yig‘indisiga teng bo‘lishi kerak, chunki ular bir tomonga yo‘nalgan (har xil qutblari bilan) ulangan:

$$Ir_1 + Ir_2 = \varepsilon_2 + \varepsilon_1 \rightarrow I = \frac{\varepsilon_2 + \varepsilon_1}{r_1 + r_2} \qquad (1)$$

B va A nuqtalar orasidagi potentsiallar farqi:

Zanjirning ε_1 E.Yu.K va r_1 qarshilik ishtirok etgan qismdagi tashqi kuchlanish

(Manba razryadlanmoqda ya’ni tok bermoqda U kuchlanishli)

$$\varepsilon_1 = U + Ir_1; U = \varepsilon_1 - Ir_1 = \varepsilon_1 - \frac{\varepsilon_2 + \varepsilon_1}{r_1 + r_2} \cdot r_1 = \frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2}$$

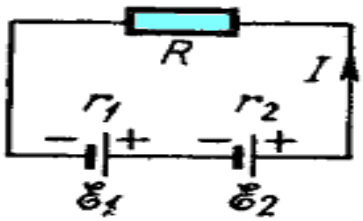
Natijalarni o‘rniga keltirib qo‘ysak

$$U = \frac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2} = -0{,}1V$$

Potensiallar farqi nolga teng bo‘lish sharti

$$U = 0 \rightarrow \varepsilon_1 r_2 = \varepsilon_2 r$$

17. E.Yu.K. lari $\varepsilon_1 = \varepsilon_2 = 2V$ dan va ichki karshiliklari $r_1 = 0{,}4\Omega$ va $r_2 = 0{,}2\Omega$ bo‘lgan ikkita tok manbai ketma-ket ulangan. Tashqi qarshilik qanday bo‘lganda manbalardan birining klemmalaridagi kuchlanish nolga teng bo‘ladi?



Zanjirdagi umumiy tok quyidagicha topiladi

$$I = \frac{\varepsilon_{Um}}{R_{Um}+r_{Um}} = \frac{\varepsilon_1+\varepsilon_2}{R+r_1+r_2} \qquad (1)$$

Har bir manba klemalaridagi kuchlanish quyidagiga teng

$$U_1 = \varepsilon_1 - Ir_1 \quad \text{va} \quad U_2 = \varepsilon_2 - Ir_2 \qquad (2)$$

(2) formuladan masala shartiga binoan U_1 ni nolga tenglashtiramiz (sababi manbalarning E.Yu.K teng birinchi manbaning ichki qarshiligi katta undan tok chiqmasligi mumkin ya'ni E.Yu.K chi uning ichki kuchlanishiga sarf bo'ladi).

I-yo'l Rasmdan ko'rinib turibdiki manbalar beradigan kuchlanishlar $U=I\cdot R$ tashqi kuchlanishga sarf bo'ladi.

$$U_1 = \varepsilon_1 - Ir_1 = 0 \rightarrow I = \frac{\varepsilon_1}{r_1} = 5A$$

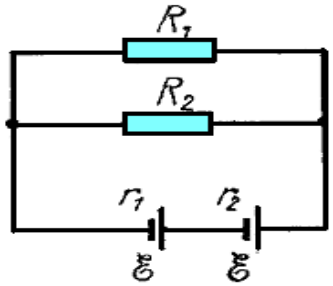
$$U_1 + U_2 = I \cdot R \rightarrow 0 + \varepsilon_2 - Ir_2 = IRR = \frac{\varepsilon_2 - Ir_2}{I} = 0{,}2\Omega$$

II-yo'l

$U_1 = \varepsilon_1 - Ir_1 = 0 \rightarrow I = \frac{\varepsilon_1}{r_1} = 5A$ chiqqan natijani (1) formulaga etib qo'yamiz

$$\frac{\varepsilon_1}{r_1} = \frac{\varepsilon_1 + \varepsilon_2}{R + r_1 + r_2} \rightarrow R = \frac{\varepsilon_2 r_1 - \varepsilon_1 r_2}{\varepsilon_1} = 0{,}2\Omega$$

18. Agar rasmda ko'rsatilga sxemada r_1 elementning klemmalaridagi potensiallar farqi nolga teng bo'lsa, uning ichki qarshiligi qanday. Sxemadagi $R_1 = 3\Omega$, $R_2 = 6\Omega$, $r_2 = 0{,}4\Omega$. Elementlarning E.Yu.K lari bir xil.



Umumiy zanjirdagi tok

$$I = \frac{2\varepsilon}{R+r_1+r_2} \qquad (1)$$

Tashqi zanjirdagi umumiy qarshiligi

$$R = \frac{R_1 R_2}{R_1 + R_2} \qquad (2)$$

(1) va (2) formulalarni umumlashtirsak

$$I = \frac{2\varepsilon}{\frac{R_1 R_2}{R_1 + R_2} + r_1 + r_2} = \frac{2\varepsilon(R_1 + R_2)}{R_1 R_2 + (R_1 + R_2)(r_1 + r_2)} \quad (3)$$

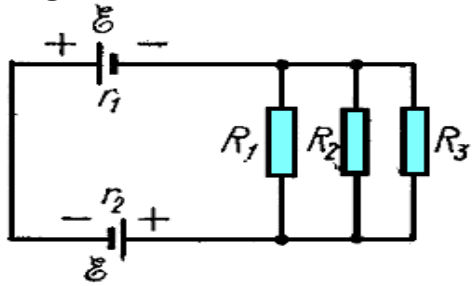
Masala shartiga ko‘ra birinchi element klemmalaridagi kuchlanish

$$U = \varepsilon - Ir_1 = 0 \to I = \frac{\varepsilon}{r_1}$$

chiqqan natijani (3) formulaga etib qo‘yamiz

$$\frac{\varepsilon}{r_1} = \frac{2\varepsilon(R_1 + R_2)}{R_1 R_2 + (R_1 + R_2)(r_1 + r_2)} \Rightarrow r_1 = \frac{R_1 R_2 + r_2(R_1 + R_2)}{R_1 + R_2} = 2{,}4\Omega$$

19. Rasmdagi sxemada R_1, R_2, R_3, r_1, r_2 qarshiliklar qanday munosabatda bo‘lganda, elementlardan birining klemmalaridagi potensiallar farqi nolga teng bo‘ladi. Manbalarbibg E.Yu.K. lari bir xil.



Umumiy zanjirdagi tok

$$I = \frac{2\varepsilon}{R + r_1 + r_2} \qquad (1)$$

R tashqi zanjirdagi umumiy qarshiligi

$$R = \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_3 + R_1 R_2} \qquad (2)$$

Masala shartiga ko‘ra elementlardan birining klemmalaridagi kuchlanish nolga teng bo‘lishi kerak

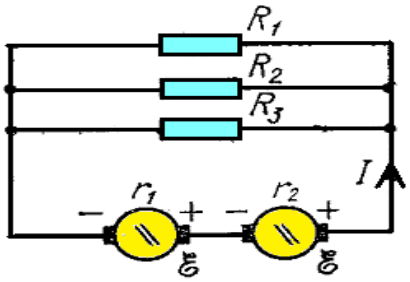
$$U_1 = \varepsilon - Ir_1 = 0 \to I = \frac{\varepsilon}{r_1}; U_2 = \varepsilon - Ir_2 = 0 \to I = \frac{\varepsilon}{r_2}$$

chiqqan natijani (1) formulaga etib qo‘yamiz

$$\frac{\varepsilon}{r_1} = \frac{2\varepsilon}{R + r_1 + r_2} \Rightarrow R = r_1 - r_2; \frac{\varepsilon}{r_2} = \frac{2\varepsilon}{R + r_1 + r_2} \Rightarrow R = r_2 - r_1$$

Qaysi birining ichki qarshiligi katta bo‘lsa o‘sha manbaning klemmalaridagi potensiallar farqi nolga teng bo‘ladi.

20. Rasmda tasvirlangan sxema bo‘yicha generatorlarning klemmalaridagi U_1 va U_2 potensiallar farqini aniqlang. Generatorlarning E.Yu.K lari birday va $\varepsilon = 6V$ga teng, ularning ichki qarshiliklari $r_1 = 0{,}5\Omega$ va $r_2 = 0{,}38\Omega$. Tashqi zanjir qarshiliklari $R_1 = 2\Omega, R_2 = 4\Omega$ va $R_3 = 7\Omega$.



Umumiy zanjirdagi tok

$$I = \frac{2\varepsilon}{R+r_1+r_2} \qquad (1)$$

R tashqi zanjirdagi umumiy qarshiligi

$$R = \frac{R_1R_2R_3}{R_2R_3+R_1R_3+R_1R_2} \qquad (2)$$

(2) formuladan chiqqan natijani (1) formulaga eltib qo‘yamiz

$$I = \frac{2\varepsilon}{\frac{R_1R_2R_3}{R_2R_3+R_1R_3+R_1R_2}+r_1+r_2} = \frac{2\varepsilon(R_2R_3+R_1R_3+R_1R_2)}{R_1R_2R_3+(r_1+r_2)(R_2R_3+R_1R_3+R_1R_2)} \qquad (3)$$

Birinchi va ikkinchi generatorlardagi kuchlanish tushishlari:

$$U_1 = \varepsilon - Ir_1 = \frac{\varepsilon[R_1R_2R_3 + (r_2 - r_1)(R_2R_3 + R_1R_3 + R_1R_2)]}{R_1R_2R_3 + (r_1 + r_2)(R_2R_3 + R_1R_3 + R_1R_2)} = 3V$$

$$U_2 = \varepsilon - Ir_2 = \frac{\varepsilon[R_1R_2R_3 + (r_1 - r_2)(R_2R_3 + R_1R_3 + R_1R_2)]}{R_1R_2R_3 + (r_1 + r_2)(R_2R_3 + R_1R_3 + R_1R_2)} = 3{,}72V$$

21. E.Yu.K lari $\varepsilon_1 = 2{,}2V, \varepsilon_2 = 1{,}1V, \varepsilon_3 = 0{,}9V$ ichki qarshiliklari mos ravishda $r_1 = 0{,}2\Omega, r_2 = 0{,}4\Omega, r_3 = 0{,}5\Omega$ bo‘lgan uchta gal’vanik element zanjirga ketma-ket ulangan. Tashqi zanjir qarshiligi $R = 1\Omega$. Har bir element klemmalaridagi kuchlanishni aniqlang.

Butun zanjir uchun Om qonuniga ko‘ra undagi tok

$$I = \frac{\varepsilon}{R+r} \qquad (1)$$

Bu yerda ε va r quyidagiga teng

$$\varepsilon = \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \text{ va } r = r_1 + r_2 + r_3 \qquad (2)$$

(2) formuladan chiqqan natijalarni (1) formulaga etib qo‘yamiz

$$I = \frac{\varepsilon_1+\varepsilon_2+\varepsilon_3}{R+r_1+r_2+r_3} \qquad (3)$$

Har bir elementdagi kuchlanish E.Yu.K va elementning ichki qarshiligidagi kuchlanish tushishi orasidagi farqqa teng:

$$U_1 = \varepsilon_1 - Ir_1 = \frac{\varepsilon_1(R + r_2 + r_3) - (\varepsilon_2 + \varepsilon_3)r_1}{R + r_1 + r_2 + r_3} = 1{,}8V$$

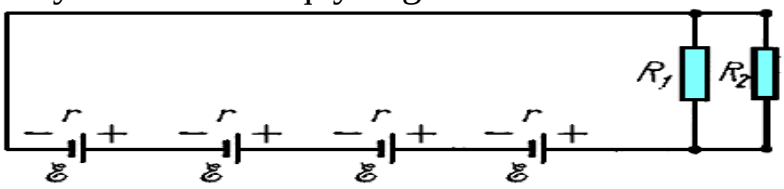
$$U_2 = \varepsilon_2 - Ir_2 = \frac{\varepsilon_2(R + r_1 + r_3) - (\varepsilon_1 + \varepsilon_3)r_2}{R + r_1 + r_2 + r_3} = 0{,}3V$$

$$U_3 = \varepsilon_3 - Ir_3 = \frac{\varepsilon_3(R + r_1 + r_2) - (\varepsilon_1 + \varepsilon_2)r_3}{R + r_1 + r_2 + r_3} = -0{,}1V$$

Batareya klemmalaridagi kuchlanish tashqi zanjirdagi kuchlanish tushishiga teng: $U = U_1 + U_2 + U_3 = 2V$ uchinchi element klemmalaridagi kuchlanish manfiy bo‘lib chiqdi, chunki tok zanjirdagi hamma qarshilik va yig‘indi E.Yu.K ga bog‘liq, r_3 qarshilikdagi kuchlanish tushishi esa ε_3 ga qaraganda katta.

22. E.Yu.K. lari $\varepsilon = 1{,}25V$dan, ichki karshiliklari $r = 0{,}1\Omega$ dan bo‘lgan ketma-ket ulangan to‘rtta elementdan iborat batareya parallel ulangan $R_1 = 50\Omega, R_2 = 200\Omega$ qarshilikli ikki o‘tkazgichni tok bilan ta'minlaydi. Batareya klemmalaridagi kuchlanishni aniqlang.

Ushbu masalani yechish uchun quyidagi sxemani chizamiz



Butun zanjir uchun Om qonuniga ko‘ra undagi tok

$$I = \frac{\varepsilon_{Um}}{R_{Um} + r_{Um}} \qquad (1)$$

Bu yerda ε_{Um}, R_{Um} va r_{Um} quyidagiga teng $\varepsilon_{Um} = \varepsilon + \varepsilon + \varepsilon + \varepsilon = 4\varepsilon$, $r_{Um} = r + r + r + r = 4r$, $R_{Um} = \frac{R_1 R_2}{R_1 + R_2}$ (2)

(2) formuladan chiqqan natijalarni (1) formulaga etib qo‘yamiz

$$I = \frac{4\varepsilon}{\frac{R_1 R_2}{R_1 + R_2} + 4r} = \frac{4\varepsilon(R_1 + R_2)}{R_1 R_2 + 4r(R_1 + R_2)} \qquad (3)$$

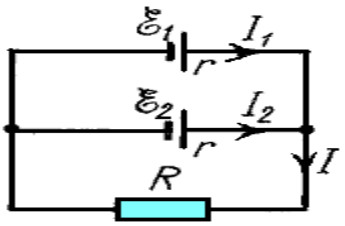
Har bir elementdagi kuchlanish E.Yu.K va elementning ichki qarshiligidagi kuchlanish tushishi orasidagi farqqa teng:

$$U_1 = U_2 = U_3 = U_4 = \varepsilon - Ir = \varepsilon - \frac{4\varepsilon(R_1 + R_2)}{R_1 R_2 + 4r(R_1 + R_2)} \cdot r =$$

$$= \frac{\varepsilon R_1 R_2}{R_1 R_2 + 4r(R_1 + R_2)}$$

$$U = U_1 + U_2 + U_3 + U_4 = \frac{4\varepsilon R_1 R_2}{R_1 R_2 + 4r(R_1 + R_2)} = 4{,}95V$$

23. Rasmda tasvirlangan sxemaning E.Yu.K lari $\varepsilon_1 = 1{,}25V$, $\varepsilon_2 = 1{,}5V$, ichki qarshiliklari birday va $r = 0{,}4\Omega$ga teng bo‘lgan ikki element parallel ulangan. Tashqi zanjirning qarshiligi $R = 10\Omega$ga teng. Tashqi zanjirdan va har bir elementdan o‘tuvchi toklarni aniqlang.



Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r + IR = \varepsilon_1, I_2 r + IR = \varepsilon_2 \qquad (2)$$

1-tenglamadan I ni 2-tenglamaga keltirib qo‘ysak

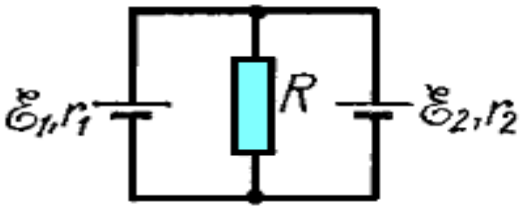
$$\begin{cases} I_1 r + (I_1 + I_2)R = \varepsilon_1 \\ I_2 r + (I_1 + I_2)R = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 r + I_1 R + I_2 R = \varepsilon_1 \\ I_2 r + I_1 R + I_2 R = \varepsilon_2 \end{cases}$$

$$\begin{cases} 0{,}4I_1 + 10I_1 + 10I_2 = 1{,}25 \\ 0{,}4I_2 + 10I_1 + 10I_2 = 1{,}5 \end{cases} \rightarrow \begin{cases} 10{,}4I_1 + 10I_2 = 1{,}25 \\ 10{,}4I_2 + 10I_1 = 1{,}5 \end{cases}$$

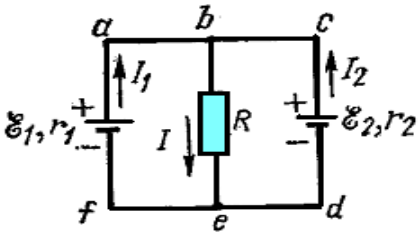
$$I_1 = -0{,}25A I_2 = 0{,}35A I = I_1 + I_2 = 0{,}1A$$

I_1 tok manfiy chiqdi demak I_1 tok yo‘nalishi biz tanlagan yo‘nalishga qarama-qarshi harakatlanar ekan.

24. Rasmda tasvirlangan $R = 10\Omega$ qarshilikdan o‘tuvchi tokni aniqlang. Tok manbalarining E.Yu.K lari $\varepsilon_1 = 6V, \varepsilon_2 = 5V$, ichki qarshiliklari $r_1 = 1\Omega, r_2 = 2\Omega$.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz(1,1-rasm). Tok va uning yo‘nalishlarini yuqoridagi rasmda ko‘rsatilgandek belgilab, Kirxgof tenglamasini tuzamiz, *b* tugun uchun

$$I = I_1 + I_2$$

abef kontur uchun(soat strelkasi yo‘nalishi bo‘yicha aylaniladi)

$$I_1 r_1 + IR = \varepsilon_1$$

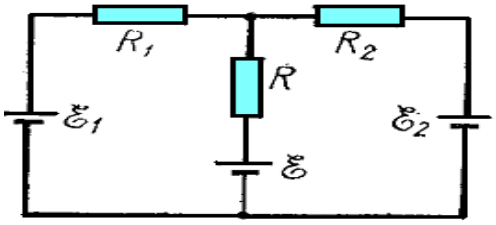
Bcde kontur uchun (soat strelkasiga teskari yo‘nalishda aylanadi)

$$I_2 r_2 + IR = \varepsilon_2$$

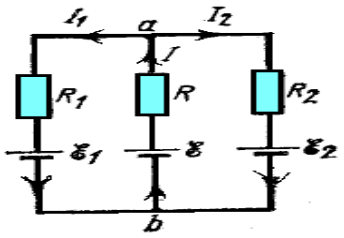
Yuqoridagi tenglamalarda quyidagi natija kelib chiqadi

$$I = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{R(r_1 + r_2) + r_1 r_2} = 0{,}53A$$

25. Rasmda tasvirlangan sxemada R_1, R_2 qarshiliklar hamda manbalarning E.Yu.K lari $\varepsilon_1, \varepsilon_2$ ma'lum . Uchichi elementning E.Yu.K qanday bo'lganda R qarshilikdan tok o'tmaydi?



1-rasm.

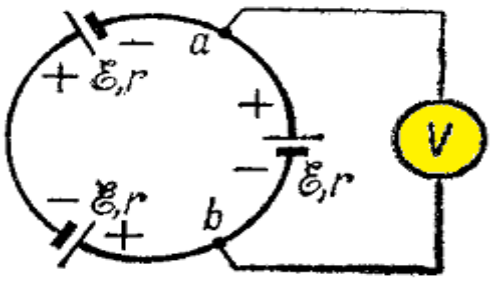


1,1-rasm.

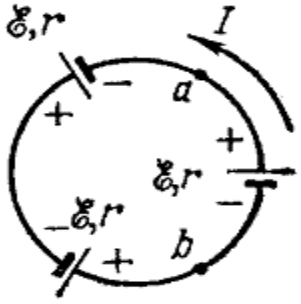
1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm).R_1, R_2va R qarshiliklar orqali o'tuvchi I_1, I_2, I toklar yuqoridagi rasmda ko'rsatilgan. U holda $I_1 + I_2 = I$ a va b nuqtalar orasidagi kuchlanish tushishi $\varepsilon_1 + I_1 R_1 = \varepsilon - IR = \varepsilon_2 + I_2 R_2$ bo'ladi. Agar masala shartiga ko'ra *I=0* bo'lsa, u holda $I_1 = -I_2$,
$\varepsilon_1 + I_1 R_1 = \varepsilon = \varepsilon_2 - I_1 R_2$. Bundan I_1ni yo'qotsak, quyidagini olamiz:

$$\varepsilon = \frac{\varepsilon_1 R_2 + \varepsilon_2 R_1}{R_1 + R_2}$$

26. Ketma-ket ulangan uchta bir xil elementdan tuzilgan zanjir qisqa tutashtirilgan. Har bir elementning E.Yu.K $\mathcal{E}$ ga va ichki qarshiligi r ga teng. Elementlardan birining qutblariga ulangan vol'tmetr qanday kuchlanishni ko'rsatadi? Ulovchi similar qarshiligini xisobga olmang.



1-rasm.

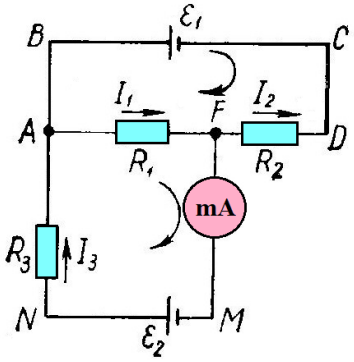


1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz(1,1-rasm). Xuddi o'sha sxemani vol'tmetrsiz qaraymiz. Butun zanjir uchun Om qonunidan undagi tokni topamiz: $I = \frac{3\varepsilon}{3r} = \frac{\varepsilon}{r}$. Zanjirning bir qismi uchun Om qonunidan zanjirning *a* va *b* nuqtalar orasidagi qismi uchun $U_{ab} = \varepsilon - Ir$ tok kuchining o'rniga yuqoridagi natijani keltirib qo'ysak $U_{ab} = \varepsilon - Ir = \varepsilon - \frac{\varepsilon}{r} \cdot r = 0$. Potensiallar farqi nolga teng bo'lgan ikki nuqtaga har qanday vol'tmetrning

ulanishi zanjirda hech nimani o‘zgartira olmaydi. Shuning uchun vol’tmetr nol kuchlanishni ko‘rsatadi.

27. Rasmda sxemasi berilgan elektr zanjirga uchta rezistor: $R_1 = 100\Omega, R_2 = 50\Omega,$ $R_3 = 20\Omega$; E.Yu.K $\varepsilon_1 = 2V$ va ε_2 bo‘lgan gal’vanik elementlar ulangan. Ampermetr 50 mA tok kuchini ko‘rsatadi. Rezistorlardagi tok kuchini va ikkinchi elementning E.Yu.K ni aniqlang. Ampermetr va elementning ichki qarshiligini hisobga olmang.



Tokning yo‘nalishini ixtiyoriy tanlaymiz va uni zanjir sxemasida ko‘rsatamiz.Tugunga keluvchi va undan ketuvchi tok kuchlarining algebraik yig‘indisi nolga tengligini hisobga olib (Kirxgofning birinchi qoidasidan)

$$I_1 - I_2 - I_3 = 0 \Rightarrow I_3 = I_1 - I_2 \qquad (1)$$

Ampermetr ko‘rsatayotgan tok kuchi: $I_A = I_3$.Konturni soat strelkasi bo‘yicha aylanib o‘tishini kelishib olamiz va buni sxemada ko‘rsatamiz. Berk konturda kuchlanish tushishining algebraic yig‘indisi E.Yu.K ning algebraic yig‘indisiga tengligidan (Kirxgofning ikkinchi qoidasi) quyidagilarni yozamiz:

ABCDFA kontur uchun:

$$-I_1R_1 - I_2R_2 = -\varepsilon_1 \Rightarrow I_1R_1 + I_2R_2 = \varepsilon_1 \qquad (2)$$

AFMNA kontur uchun:

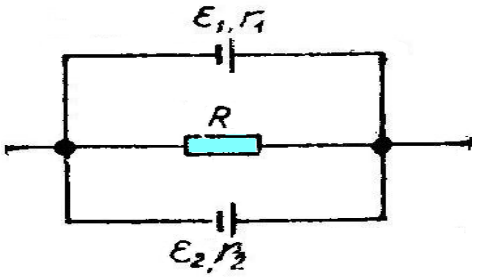
$$I_1R_1 + I_3R_3 = \varepsilon_2 \qquad (3)$$

(1) tenglamadan I_1ni aniqlab, (2) tenglamaga qo‘yamiz:

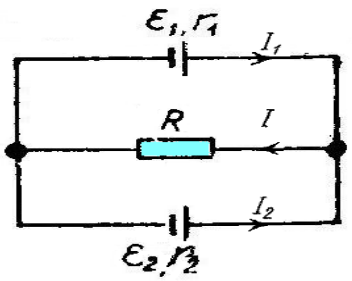
$I_1 = I_2 + I_3; (I_3 + I_2)R_1 + I_2R_2 = \varepsilon_2$ bundan $I_2 = \frac{\varepsilon_1 - I_3R_1}{R_1 + R_2} = -0{,}02A$

Minus ishora tok kuchi I_2 sxemada shartli ko‘rsatilgan yo‘nalishga qarama-qarshi ekanini bildiradi. Tok kuchi $I_1 = I_2 + I_3 = -0{,}02 + 0{,}05 = 0{,}03A$$I_1$ ni (3) tenglamaga qo‘yib, $\varepsilon_2$ni topamiz: $\varepsilon_2 = 4V$

28. Zanjirga rasmdagidek ulangan $R = 2\Omega$qarshilikdan o‘tuvchi tok kuchini aniqlang. Berilganlar $\varepsilon_1 = 2V, r_1 = 0{,}5\Omega, \varepsilon_2 = 4V, r_2 = 0{,}7\Omega.$



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm).
Tok va uning yo‘nalishlarini yuqoridagi rasmda ko‘rsatilgandek belgilab.
Kirxgof 1-qoidasidan quyidagi tenglamani tuzamiz

$$I = I_1 + I_2$$

yuqoridagi kontur uchun Kirxgofning 2-qoidasini qo‘llaymiz

$$I_1 r_1 + IR = \varepsilon_1$$

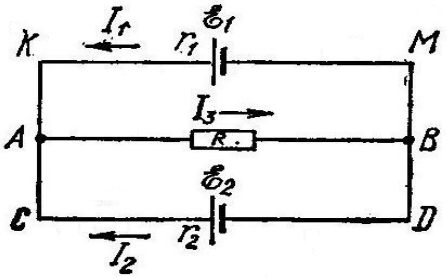
Pastki kontur uchun Kirxgofning 2-qoidasini qo‘llaymiz

$$I_2 r_2 + IR = \varepsilon_2$$

Yuqoridagi tenglamalarda quyidagi natija kelib chiqadi

$$I = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{R(r_1 + r_2) + r_1 r_2} = 1{,}24A$$

29. Rasmda tasvirlangan elektr zanjiri E.Yu.K lari $\varepsilon_1 = 1{,}6V$ va $\varepsilon_2 = 1{,}3V$ ichki qarshiligi mos ravishda $r_1 = 1\Omega$ va $r_2 = 0{,}5\Omega$ bo‘lgan ikki element rasmdagidek ulangan. Hamma tarmoqlardagi toklarni hisoblang. Ulovchi simlarning qarshiligini hisobga olmang.



I-Usul
Kirxgof qonunidan foydalanib va toklarning shartli tanlangan yo‘nalishini hisobga olgan holda zanjirning turli qismlari uchun tenglamalar tuzamiz.
A tugun uchun:

$$I_1 + I_2 = I_3$$

KCDM yopiq kontur uchun:

$$\varepsilon_1 - \varepsilon_2 = I_1 r_1 - I_2 r_2$$

KABM yopiq kontur uchun:

$$\varepsilon_1 = I_1 r_1 + I_3 R$$

Oxirgi tenglamadan I_3ni yo‘qotib va tenglamalar sistemasini I_1va I_2ga nisbatan echib, quyidagini olamiz:

$$I_1 = \frac{\varepsilon_1 r_2 + (\varepsilon_1 - \varepsilon_2)R}{r_1 R + r_1 r_2 + R r_2} = 0{,}7A, I_2 = \frac{I_1 r_1 + \varepsilon_2 - \varepsilon_1}{r_2} = 0{,}8A$$

$$I_3 = 1{,}5A$$

II-Usul

Masalani tugunlar potensiali usulidan foydalanib echamiz. A tugun potensialini $\varphi_A$deb belgilab, Btugun potensialini nolga teng deb qabul qilamiz. U holda $\varphi_A - \varphi_B = U_{AB}$bo‘ladi.E.Yu.K bo‘lgan va E.Yu.K bo‘lmagan zanjirning bir qismi uchun Om qonuni bo‘yicha toklar ifodasini yozamiz.

$$I_1 = \frac{\varepsilon_1 - U_{AB}}{r_1}, I_2 = \frac{\varepsilon_2 - U_{AB}}{r_2}, I_3 = \frac{U_{AB}}{R}$$

Bundan $I_1 + I_2 = I_3$ bo‘lgani uchun

$$\frac{\varepsilon_1 - U_{AB}}{r_1} + \frac{\varepsilon_2 - U_{AB}}{r_2} = \frac{U_{AB}}{R}$$

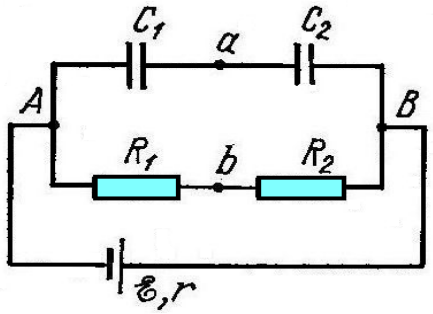
ni olamiz

Kattaliklarni son qiymatini qo‘yib, U_{AB}ni topamiz $U_{AB} = 0{,}9V$

Endi toklarni hisoblaymiz:

$$I_1 = 0{,}7A I_2 = 0{,}8A I_3 = 1{,}5A$$

30. Rasmda tasvirlangan elektr zanjiri E.Yu.K $\varepsilon = 12V$ va ichki qarshiligi $r = 1Om$li elektr energiya manbaidan $R_1 = 3Om$ va $R_2 = 6Om$ li ikki qarshilik hamda $C_1 = 1\mu F$ va $C_2 = 2\mu F$ sig‘imli ikki kondensatordan tuzilgan. Zanjirning a va b nuqtalari orasidagi potentsiallar farqini va har bir kondensatorda to‘plangan zaryad miqdorini aniqlang.



A nuqtaning potensiali nolga teng, *a* va *b* nuqtalarning potensiallarini $\varphi_a$va $\varphi_b$ga teng deb olishni shartlashib olamiz; u holda $\Delta\varphi = \varphi_a - \varphi_b$. Masala $\varphi_a$va $\varphi_b$ni topishga keltiriladi.

Zanjirdagi tokni topamiz:

$$I = \frac{\varepsilon}{R_1 + R_2 + r}$$

b nuqtaning potensiali noldan R_1 qarshilikdagi kuchlanish tushuvi qadar yuqori bo‘ladi

$$\varphi_b = IR_1 = \frac{\varepsilon R_1}{R_1 + R_2 + r}$$

AB qismdagi kuchlanish tushuvi:

$$U_{AB} = \varepsilon - Ir = \frac{\varepsilon(R_1 + R_2)}{R_1 + R_2 + r}$$

Ketma-ket ulangan ikki kondensatordagi potensiallar farqi ham U_{AB} ga teng. Kondensatorlarning ulanish usulini hisobga olib, ulardagi zaryad birday va

$$q = C_{Um} \cdot U_{AB} = \frac{C_1 \cdot C_2}{C_1 + C_2} \cdot U_{AB} = \frac{\varepsilon(R_1 + R_2)}{R_1 + R_2 + r} \cdot \frac{C_1 \cdot C_2}{C_1 + C_2} = 7{,}2 \cdot 10^{-6} Kl$$

ga tengligini ko‘ramiz.

Birinchi kondensator zaryadi va sig‘imini bilgan holda uning qoplamalaridagi potensiallar farqini aniqlash mumkin, demak, φ_a ni ham aniqlash mumkin

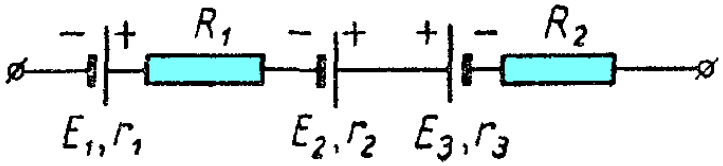
$\Delta\varphi$ ning ifodasini yozamiz va uning son qiymatlarini topamiz:

$$\Delta\varphi = \frac{\varepsilon(R_1 + R_2)C_2}{(R_1 + R_2 + r)(C_1 + C_2)} - \frac{\varepsilon R_1}{R_1 + R_2 + r}$$
$$= \varepsilon \frac{R_2 C_2 - R_1 C_1}{(R_1 + R_2 + r)(C_1 + C_2)} = 3{,}6V$$

Kondensatordagi elektr zaryadni topamiz:

31. Rasmda tasvirlangan batareyaning umumiy E.Yu.K ni va umumiy qarshiligini toping. $\varepsilon_1 = 10V, r_1 = 1\Omega, \varepsilon_2 = 8V, r_2 = 2\Omega, \varepsilon_3 = 15V, r_3 = 3\Omega, R_1 = 5\Omega,$

$$R_2 = 10\Omega.$$



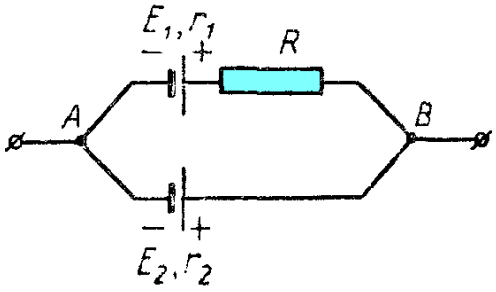
Batareyalar ketme-ket ulanganligi uchun umumiy E.Yu.K va umumiy qarshiligi quyidagiga teng.

$$\varepsilon = \varepsilon_1 + \varepsilon_2 - \varepsilon_3 = 3V, R = r_1 + r_2 + r_3 + R_1 + R_2 = 21\Omega$$

Uchinchi manba birinchi va ikkinchi manbalarga teskari ulanganligi uchun manfiy ishora bilan olindi.

32. Rasmda tasvirlangan sxemaning umumiy E.Yu.K va Qarshiligini hisoblang.

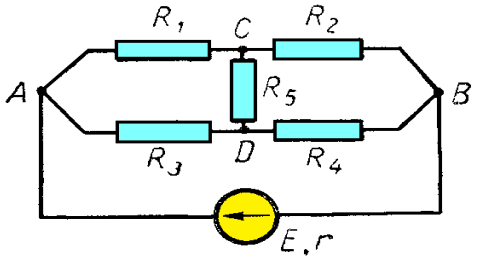
$$\varepsilon_1 = 12V, r_1 = 1\Omega, \varepsilon_2 = 30V, r_2 = 3\Omega, R = 5\Omega.$$



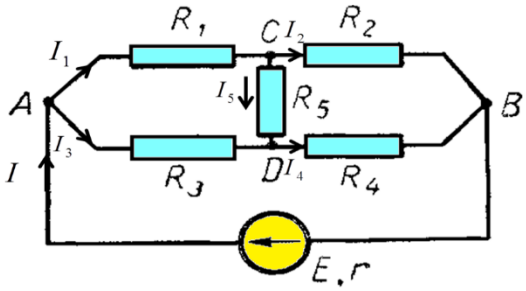
$$R_1 = r_1 + R = 6\Omega, R_2 = r_2 = 3\Omega, R_{Um} = \frac{R_1 \cdot R_2}{R_1 + R_2} = 2\Omega.$$

$$\frac{\varepsilon_{Um}}{R_{Um}} = \frac{\varepsilon_1}{R_1} + \frac{\varepsilon_2}{R_2}, \frac{\varepsilon_{Um}}{2} = \frac{12}{6} + \frac{30}{3}, \varepsilon_{Um} = 24V$$

32. Rasmdagi sxemada $\varepsilon = 22V, r = 0, R_1 = 1\Omega,$ qolgan qarshiliklarning har biri
2 Ω dan. Zanjirdagi toklarni toping.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm). Yuqoridagi rasmdagidek toklarni joylashtirib chiqamiz. B nuqtadagi potensialni nolga ($\varphi_B = 0$) teng desak A nuqtadagi potensial ($r=0$) $\varphi_A = \varepsilon = 22V$ga teng bo‘ladi. Endi toklarni quyidagicha topib chiqamiz.

$$I_1 = \frac{\varphi_A - \varphi_C}{R_1}, I_2 = \frac{\varphi_C - \varphi_B}{R_2} = \frac{\varphi_C}{R_2}, I_3 = \frac{\varphi_A - \varphi_D}{R_3},$$

$$I_4 = \frac{\phi_D - \phi_B}{R_4} = \frac{\phi_D}{R_4}, I_5 = \frac{\phi_C - \phi_D}{R_5} \qquad (1)$$

Kirxgofning birinchi qoidasiga ko‘ra quyidagi tenglamani tuzamiz

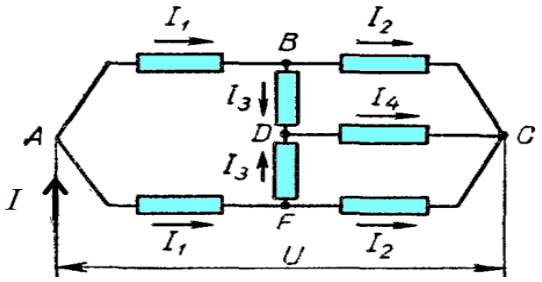
$$I = I_1 + I_3 I_1 = I_2 + I_5 I_4 = I_3 + I_5 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirsak

$$\begin{cases} \frac{22 - \varphi_C}{1} = \frac{\varphi_C}{2} + \frac{\varphi_C - \varphi_D}{2} \\ \frac{22 - \varphi_D}{2} + \frac{\varphi_C - \varphi_D}{2} = \frac{\varphi_D}{2} \end{cases} \qquad (3)$$

(3) tenglamani yechsak $\varphi_C = 14V$, $\varphi_D = 12V$ natijaga erishamiz ularni yuqoridagi (1) formulaga etib qo‘ysak $I = 13A,\ I_1 = 8A,\ I_2 = 7A,\ I_3 = 5A,\ I_4 = 6A,\ I_5 = 1A.$

33. Rasmda tasvirlangan sxemada $U = 14V$, barcha qarshilik 1Ω dan. Zanjirdagi toklarni toping.



Yuqoridagi rasmdagidek toklarni joylashtirib chiqamiz. C nuqtadagi potensialni nolga ($\varphi_C = 0$)teng desak A nuqtadagi potensial $\varphi_A = U = 14V$ ga teng bo‘ladi.

Endi toklarni quyidagicha topib chiqamiz.

$$I_1 = \frac{14-\varphi_B}{1},\ I_2 = \frac{\varphi_B-\varphi_C}{1} = \frac{\varphi_B}{1},\ I_3 = \frac{\varphi_B-\varphi_D}{1},\ I_4 = \frac{\varphi_D-\varphi_C}{1} = \frac{\varphi_D}{1} \qquad (1)$$

Kirxgofning birinchi qoidasiga ko‘ra quyidagi tenglamani tuzamiz

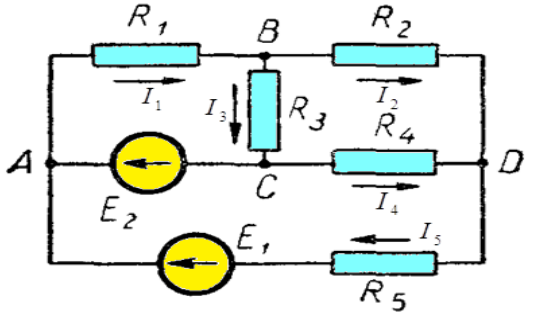
$$I = I_1 + I_1; I_1 = I_2 + I_3 I_4 = I_3 + I_3 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirsak

$$14-\varphi_B = \varphi_B + (\varphi_B - \varphi_D); \qquad 2(\varphi_B - \varphi_D) = \varphi_D \qquad (3)$$

(3) tenglamani yechsak $\varphi_B = 6V$, $\varphi_D = 4V$ natijaga erishamiz ularni yuqoridagi (1) formulaga etib qo‘ysak $I = 16A, I_1 = 8A, I_2 = 6A, I_3 = 2A, I_4 = 4A,$

34. Rasmda ko‘rsatilga sxemada berilganlaridan foydalanib barcha toklarni toping.Ichki qarshilikni hisobga olmang. $\varepsilon_1 = 65V, \varepsilon_2 = 39V, R_1 = 20\Omega,$ $R_2 = R_3 = R_4 = R_5 = 10\Omega.$



Yuqoridagi rasmdagidek toklarni joylashtirib chiqamiz. C nuqtadagi potensialni nolga ($\varphi_C = 0$)teng desak A nuqtadagi potensial $\varphi_A = \varepsilon_2 = 39V$ ga teng bo‘ladi.

Endi toklarni quyidagicha topib chiqamiz.

$$I_1 = \frac{39-\varphi_B}{20},\ I_2 = \frac{\varphi_B-\varphi_D}{10},\ I_3 = \frac{\varphi_B-\varphi_C}{10} = \frac{\varphi_B}{10},$$
$$I_4 = \frac{\varphi_C-\varphi_D}{10} = -\frac{\varphi_D}{10}.\quad I_5 = \frac{65+\varphi_D-39}{10} \qquad (1)$$

Kirxgofning birinchi qoidasiga ko‘ra quyidagi tenglamani tuzamiz

$$I_1 = I_2 + I_3 \qquad I_2 + I_4 = I_5 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirsak

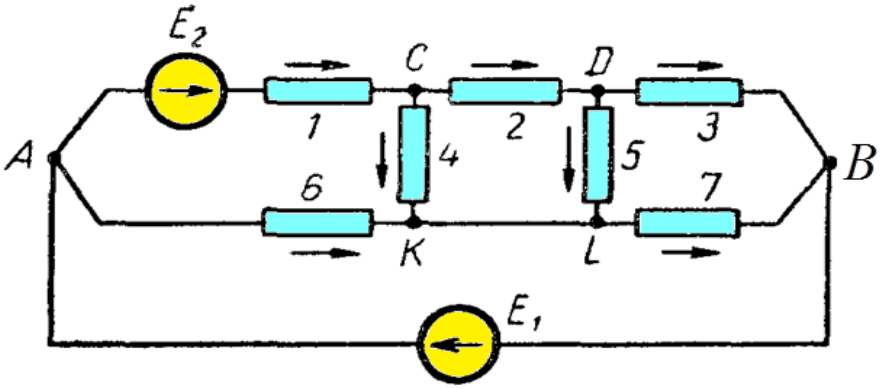
$$\begin{cases} \frac{39-\varphi_B}{20} = \frac{\varphi_B-\varphi_D}{10} + \frac{\varphi_B}{10} \\ \frac{\varphi_B-\varphi_D}{10} - \frac{\varphi_D}{10} = \frac{26+\varphi_D}{10} \end{cases} \qquad (3)$$

(3) tenglamani yechsak $\varphi_B = 5V$, $\varphi_D = -7V$ natijaga erishamiz ularni yuqoridagi (1) formulaga etib qo‘ysak $I_1 = 1{,}7A, I_2 = 1{,}2A, I_3 = 0{,}5A, I_4 = 0{,}7A, I_5 = 1{,}9A$

E_2 manba orqali o‘tadigan tok kuchi $I_{E_2} = I_4 - I_3 = 0{,}2A$ (A dan C ga yo‘nalgan).

E_1 manba orqali o‘tadigan tok kuchi $I_{E_1} = I_5 = I_{E_2} + I_1 = 1{,}9A$ (I_5 yo‘nalishida).

35. Rasmda tasvirlangan sxemada E.Yu.K lari $\varepsilon_1 = 10V, \varepsilon_2 = 30V$, barcha qarshiliklar $R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = R_7 = 1\Omega$ dan bo‘lsa barcha toklarni toping. Manbaning ichki qarshiligini hisobga olmang



Yuqoridagi rasmdagidek toklarni joylashtirib chiqamiz. B nuqtadagi potensialni nolga ($\varphi_B = 0$) teng desak A nuqtadagi potensial $\varphi_A = \varepsilon_1 = 10V$ ga teng bo‘ladi. Qolgan potensiallarni quyidagicha belgilaymiz. $\varphi_C = x,\ \varphi_D = y,\ \varphi_K = \varphi_L = z.$

Endi toklarni quyidagicha topib chiqamiz.

$$I_1 = \frac{\varepsilon_1 + \varepsilon_2 - \varphi_C}{R_1} = \frac{30+10-x}{1} = 30+10-x, \quad I_2 = \frac{\varphi_C - \varphi_D}{R_2} = \frac{x-y}{1} = x-y,$$

$$I_3 = \frac{\varphi_D - \varphi_B}{R_3} = \frac{y}{1} = y, \quad I_4 = \frac{\varphi_C - \varphi_K}{R_4} = \frac{x-z}{1} = x-z. \quad I_5 = \frac{\varphi_D - \varphi_L}{R_5} = \frac{y-z}{1} = y-z$$

$$I_6 = \frac{\varphi_A - \varphi_K}{R_6} = \frac{10-z}{1} = 10-z, \quad I_7 = \frac{\varphi_L - \varphi_B}{R_7} = \frac{z-0}{1} = z$$

Kirxgofning birinchi qoidasiga ko‘ra quyidagi tenglamalarni tuzamiz

$$I_1 = I_2 + I_4 \qquad I_3 + I_5 = I_2 \qquad I_4 + I_6 = I_5 + I_7$$

Yuqoridagi tenglamalarni soddalashtirsak.

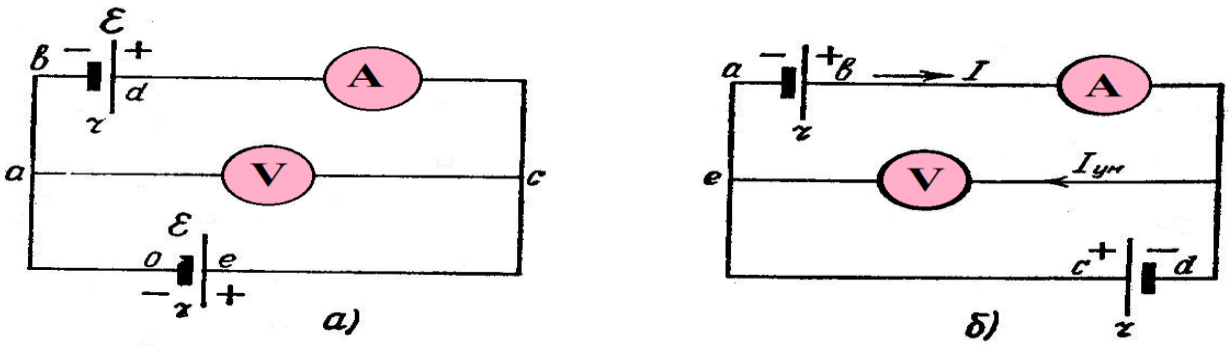
$$\begin{cases} 40 - x = x - y + x - z \\ x - y = y + y - z \\ x - z + 10 - z = y - z + z \end{cases}$$

Tenglamani yechsak $x = 20V,\ y = 10V,\ z = 10V$ natijaga erishamiz ularni yuqoridagi (1) formulaga etib qo‘ysak $I_1 = 20A,\ I_2 = I_3 = I_4 = I_7 = 10A,\ I_5 = I_6 = 0$ natijalarga ega bo‘lamiz.

E_2 manba orqali o‘tadigan tok kuchi $I_{E_2} = I_1 = 20A$ (A dan C ga yo‘nalgan)

E_1 manba orqali o‘tadigan tok kuchi $I_{E_1} = I_3 + I_7 = 20A$ (B dan A ga yo‘nalgan)

36. a va b rasmlardagi vol’tmetr va ampermetrlar nimani ko‘rsatadi? ε va r berilgan deb faraz qiling. Ulovchi simlarning qarshiligini hisobga olmang.



(a-rasm uchun). Elektr energiya manbalarini parallel ulash deb, manbalarning musbat qutblari bir o‘tkazgichga, manfiy qutblari boshqa o‘tkazgichga ulanishiga aytiladi.

Bunday ulashda bir manbaning toki boshqasi orqali o‘tmaydi. Shuning uchun har bir zaryad bitta manbadan energiya oladi. Bundan parallel ulanganda batareyaning E.Yu.K bitta manbaning E.Yu.K ga teng bo‘lishi kelib chiqadi.

Har bir manba orqali zaryadlarning bir qismi o‘tadi, shuning uchun batareyaning qarshiligi bitta manbaning qarshiligidan ikki marta kichik bo‘ladi, u holda Om qonuni quyidagicha yoziladi:

$$I = \frac{\varepsilon}{R + \frac{r}{2}} \qquad (1)$$

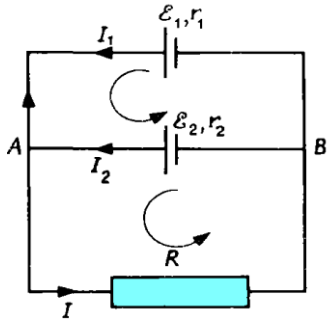
Masalaning shartiga ko‘ra (a rasm) $R = \infty$ bo‘lgani uchun $I = 0$.
Sxemaga ulangan vol’tmetr bitta elementning kuchlanishiga teng kuchlanishni ko‘rsatadi,ya’ni $U = \varepsilon$ (b-rasm uchun) Batareya zanjiridagi tok I ga teng bo‘lsin. Vol’tmetr orqali o‘tuvchi tok

$$I_{Um} = I - I = 0$$

Bo‘ladi. Tok $I = \frac{\varepsilon}{r}$, zanjirning ichki qismdagi kuchlanish tushuvi $U = Ir$, chunki tashqi qism qarshiligi nolga teng, ya’ni vol’tmetr nolni ko‘rsatadi. (a rasmdagi) shartga ko‘ra $U = \varepsilon$, bundan batareya klemmalaridan uzoqlashgan sari potensial ortadi (b-rasm uchun) holda batareya klemmalaridan uzoqlashilgan sari potensial kamayadi, bundan batareya klemmasidan eng katta uzoqlashishi.

37. Rasmda tasvirlangan sxemadagi barcha toklarni toping.

$$\varepsilon_1 = 2V, \varepsilon_2 = 4V, r_1 = r_2 = 2\Omega, R = 9\Omega.$$



Kirxgofning birinchi qoidasini qo‘llab A tugun uchun quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + IR = \varepsilon_1, \quad I_2 r_2 + IR = \varepsilon_2 \qquad (2)$$

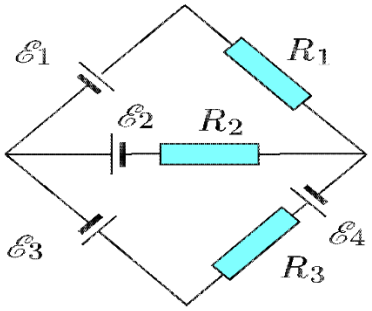
(1)va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$I_1 = \frac{\varepsilon_1 - IR}{r_1}; \quad I_2 = \frac{\varepsilon_2 - IR}{r_2}; \quad I = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 \cdot r_2 + R(r_1 + r_2)},$$

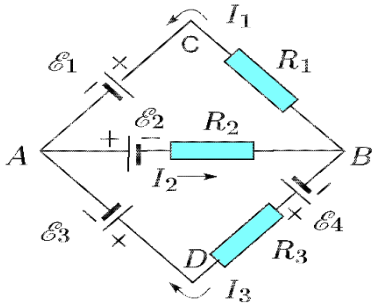
$$I = 0{,}3A, \quad I_1 = -0{,}35A, \quad I_2 = 0{,}65A.$$

38. Rasmda ko‘rsatildan sxemadan foydalanib har bir qarshilikdan o‘tuvchi tok kuchini toping.

$\varepsilon_1 = 15V, \varepsilon_2 = 5V,\ \varepsilon_3 = 10V, \varepsilon_4 = 35V,\ R_1 = 2\Omega, R_2 = 5\Omega, R_3 = 10\Omega.$



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz (1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab A tugun uchun quyidagi tenglamani yozamiz

$$I_2 = I_1 + I_3 \qquad \text{(a)}$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

ACB kontur uchun $\varepsilon_1 + \varepsilon_2 = -I_1R_1 - I_2R_2$ (b)

ABD kontur uchun $-\varepsilon_2 + \varepsilon_4 - \varepsilon_3 = I_2R_2 + I_3R_3$ (v)

ACBD kontur uchun $\varepsilon_1 + \varepsilon_4 - \varepsilon_3 = -I_1R_1 + I_3R_3$ (g)

Yuqoridagi formulalardagi minus ishoralar biz tanlab olgan yo‘nalishga teskari ekanligini bildiradi. Endi yuqoridagi formulalardan I_1 va I_3 ni topamiz (*b* va *v* dan):

$$I_1 = \frac{-\varepsilon_1 - \varepsilon_2 - I_2R_2}{R_1};\ I_3 = \frac{-\varepsilon_2 + \varepsilon_4 - \varepsilon_3 - I_2R_2}{R_3};$$

Bu formulalarni (a) formulaga eltib qo‘ysak

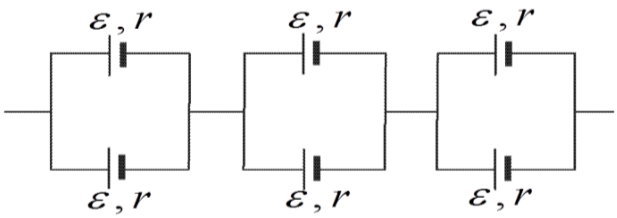
$$I_2 = \frac{-(\varepsilon_1 + \varepsilon_2)R_3 + (-\varepsilon_2 + \varepsilon_4 - \varepsilon_3)R_1}{R_1R_2 + R_1R_3 + R_2R_3}$$

Yuqorida topilgan formulalarga masala shartida berilgan kattaliklarni son qiymatini keltirib qo‘ysak quyidagi javoblar kelib chiqadi.

$$I_2 = -2\,A,\quad I_1 = -5\,A,\quad I_3 = 3\,A,$$

Toklarning oldidagi minus ishora biz tanlagan yo‘nalishdan teskari yo‘nalishda oqishidan dalolat beradi.

39. Rasmda tasvirlangan sxemining umumiy E.Yu.K ni va umumiy qarshiligini aniqlang. Har bir manbaning E.Yu.K $\varepsilon = 1{,}8V$, ichki qarshiliklari $r = 0{,}6\Omega$ dan.



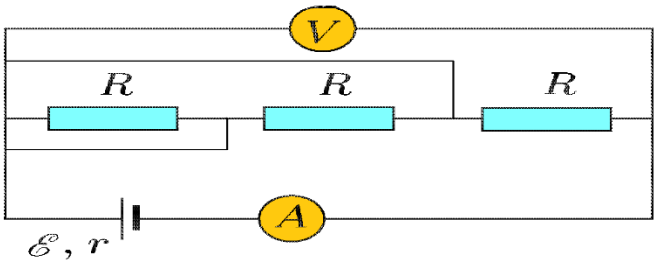
Har ikkita manba o‘zaro parallae ulangan bo‘lib uch juft manba ketma-ket ulangan parallel ulashda E.Yu.K umumiysi har birining o‘ziga teng, ketme-ket ulashda esa umumiy E.Yu.K har bir juftning yig‘indisiga teng

$$\varepsilon_{Um} = \varepsilon_{12} + \varepsilon_{34} + \varepsilon_{56} = \varepsilon + \varepsilon + \varepsilon = 3\varepsilon = 5{,}4V$$

Har ikkita manba o‘zaro parallae ulangan bo‘lib uch juft manba ketma-ket ulangan parallel ulashda ichki qarshilik $r_{12} = \dfrac{r_1 \cdot r_2}{r_1 + r_2} = \dfrac{r}{2}$. ketme-ket ulashda esa umumiy ichki qarshilik har bir juftning yig‘indisiga teng

$$r_{Um} = r_{12} + r_{34} + r_{56} = \frac{r}{2} + \frac{r}{2} + \frac{r}{2} = \frac{3r}{2} = 0{,}9\,\Omega$$

40. Rasmda tasvirlangan sxemaning E.Yu.K $\varepsilon = 4V$, har bir qarshiliklari $R = 45\Omega$ dan, manbaning ichki qarshiligi $r = 1\Omega$ bo‘lsa. Vol’tmetr va Ampermetrning ko‘rsatgichini aniqlang. Voltimetrning qarshiligi juda katta, Ampermetrning qarshiligi juda kichik. Ulovchi simlarning qarshiligini hisobga olmang.



Rasmda ko‘rinib turibdiki barcha tashqi qarshiliklar parallel ulangan

$$\frac{1}{R_{Um}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow R_{Um} = 15\Omega$$

To‘liq zanjir uchun Om qonunidan umumiy tokni ya’ni ampermetrdan o‘tadigan tokni topamiz

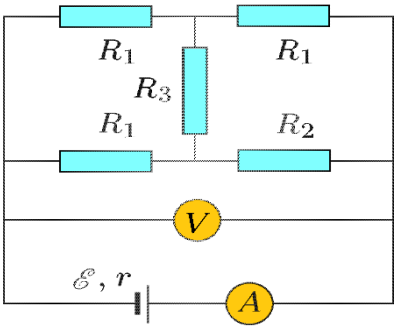
$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{4}{15+1} = 0{,}25\,A$$

Vol’tmetr uchta qarshilikdagi kuchlanish tushuvini ko‘rsatadi

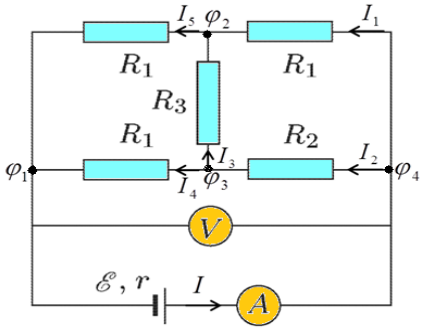
$$U = IR_{Um} = 0{,}25 \cdot 15 = 3{,}75V$$

41. Rasmda tasvirlangan sxemadan ampermetr va vol’tmetr ko‘rsatishini va har bir qarshilikdan o‘tadigan toklarni aniqlang. Tashqi zanjirdagi qarshiliklar $R_1 = 1\Omega, R_2 = 3\Omega, R_3 = 4\Omega$, manbaning E.Yu.K $\varepsilon = 3{,}3V$ va

ichki qarshiligi $r=0{,}2\Omega$. Vol'metrning qarshiligi juda katta, ampermetrning qarshiligi juda kichik. Ulovchi simlarning qarshiligini hisobga olmang.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirda toklarni joylashtiramiz(1,1-rasm). Yuqoridagi rasmdagidek toklarni joylashtirib chiqamiz. $\varphi_1=0$ teng desak $\varphi_4-\varphi_1=\varphi_4=U=\varepsilon-Ir=3{,}3-0{,}2I$ ga teng bo'ladi.

Endi toklarni quyidagicha topib chiqamiz.

$$I_1=\frac{\varphi_4-\varphi_2}{R_1},\ I_2=\frac{\varphi_4-\varphi_3}{R_2},I_3=\frac{\varphi_3-\varphi_2}{R_3},\ I_4=\frac{\varphi_3-\varphi_1}{R_1},I_5=\frac{\varphi_2-\varphi_1}{R_1} \qquad (1)$$

Endi Kirxgofning birinchi qoidasiga ko'ra quyidagi tenglamani tuzamiz

$$I=I_1+I_2;\ I_2=I_3+I_4;I_1+I_3=I_5 \qquad (2)$$

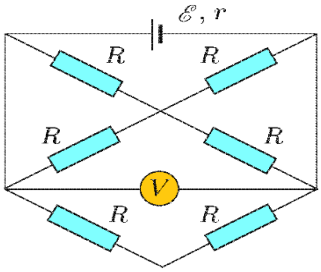
(1) va (2) tenglamalarni soddalashtirsak quyidagi natijaga erishamiz

$I_1=1{,}5\,A,\ \ I_2=0{,}7\,A,\ \ I_3=-0{,}14\,A,\ I_4=0{,}8\,A,\ \ I_5=1{,}36\,A$

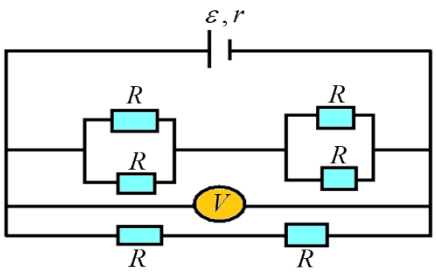
Vol'tmetr ko'rsatgichi $U=\varepsilon-Ir=3{,}3-0{,}2I=2{,}86V$

Ampermetr ko'rsatgichi $I=I_1+I_2=2{,}2\,A$

42. Rasmda tasvirlangan sxemadan Vol'tmetrning ko'rsatgichini aniqlang. $\varepsilon=6V,\ r=2/3\Omega,\ R=2\Omega$.

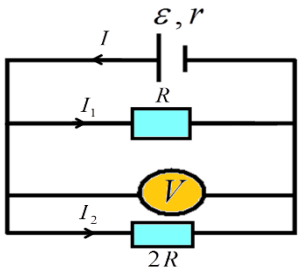


1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha soddalashtiramiz(1,1-rasm). Sxemani yanaham soddalashtiramiz ya'ni qarshiliklarni ketma-ket va paralel ulab toklarni joylashtirib chiqamiz



To‘liq zanjir uchun Om qonunidan umumiy tok kuchini topamiz

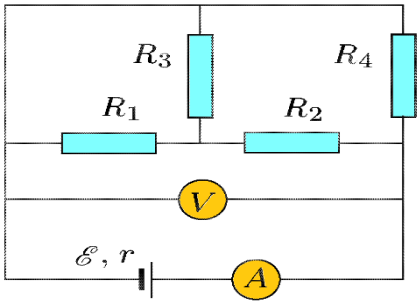
$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{6}{\frac{4}{3} + \frac{2}{3}} = 3A$$

Kixgofning birinchi qonuni va qarshiliklarni paralelligidan quyidagi tenglamalarni tuzamiz

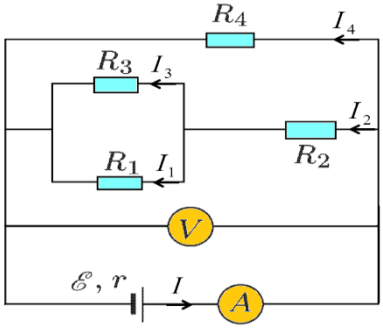
$$I = I_1 + I_2$$
$$U_{Vol} = U_1 = U_2 \rightarrow I_1 R = I_2 2R \rightarrow I_1 = 2I_2$$

Ushbu tenglamalardan $I_1 = 2\,A,\ I_2 = 1A,\ U_{Vol} = 4V$ natijalarga erishamiz.

43. Rasmda tasvirlangan sxemadan ampermetr va vol’tmetr ko‘rsatishini va har bir qarshilikdan o‘tadigan toklarni aniqlang. Tashqi zanjirdagi qarshiliklar $R_1 = 4\Omega, R_2 = 3\Omega, R_3 = 12\Omega,\ R_4 = 6\Omega$, manbaning E.Yu.K $\varepsilon = 21V$ va ichki qarshiligi $r = 1\Omega$. Vol’metrning qarshiligi juda katta, ampermetrning qarshiligi juda kichik. Ulovchi simlarning qarshiligini hisobga olmang.



1-rasm.



1,1-rasm.

1-rasmdagi Sxemaga quyidagicha o‘zgartiramiz (1,1-rasm). Zanjirning umumiy tashqi qarshiligini topamiz

$$R_{13} = \frac{R_1 \cdot R_3}{R_1 + R_3} = 3\Omega, R_{123} = R_{13} + R_2 = 6\Omega, R_{Um} = \frac{R_{123} \cdot R_4}{R_{123} + R_4} = 3\Omega$$

To‘liq zanjir uchun Om qonunidan umumiy tok kuchini topamiz

$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{21}{3 + 1} = \frac{21}{4} A$$

Kixgofning birinchi qonuni va qarshiliklarni paralelligidan quyidagi tenglamalarni tuzamiz

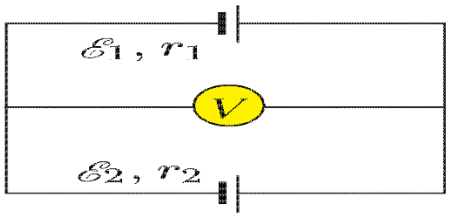
$$I = I_2 + I_4, I_2 = I_1 + I_3, U_{Vol} = U_4,$$
$$U_1 = U_3 \Rightarrow I_1R_1 = I_3R_3 \Rightarrow I_1 \cdot 4 = I_3 \cdot 12 I_1 = 3I_3$$
$$U_{123} = U_4 \rightarrow I_2R_{123} = I_4R_4 \rightarrow I_2 \cdot 6 = I_4 \cdot 6 I_2 = I_4$$

Yuqoridagi tenglamalarni soddalashtirsak quyidagi natijaga ega bo‘lamiz

$$I_2 = I_4 = \frac{I}{2} = \frac{21}{8}A, I_1 = \frac{3I}{8} = \frac{63}{32}, I_3 = \frac{I}{8} = \frac{21}{32}A$$
$$U_{Vol} = U_4 = I_4R_4 = 15{,}75V, U_{Vol} = \varepsilon - Ir = 15{,}75$$

44. Rasmda tasvirlangan sxemadagi voltmetrning ko‘rsatgichini aniqlang.

$$\varepsilon_1 = 1{,}8V, \varepsilon_2 = 2V, r_1 = 0{,}6\Omega, r_2 = 0{,}4\Omega,$$



$\varepsilon_2 > \varepsilon_1$ bo‘lganligi uchun birinchi manba zaryadlanadi, ikkinchi manba razryadlanadi (zaryadsizlanadi). Zanjirda tarmoqlanish yo‘qligi uchun toklar bir xil bo‘ladi. To‘liq zanjir uchun Om qonunini ikkita hol uchun quyidagicha yozamiz

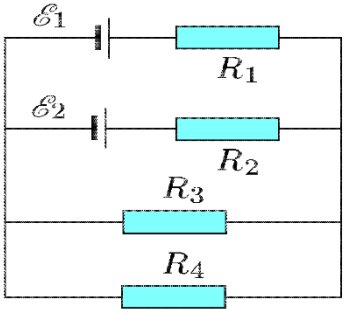
I-hol razryadlanish uchun $\varepsilon_2 = U + I \cdot r_2$ (1)

II-hol zaryadlanish uchun $U = \varepsilon_1 + I \cdot r_1$ (2)

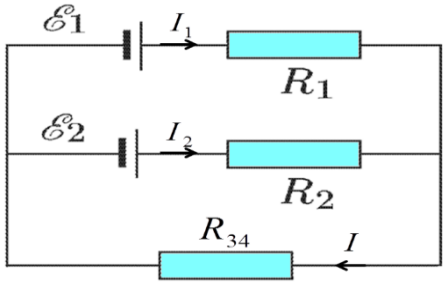
Bu ikkita formulani soddalashtiramiz

$$\begin{cases} \varepsilon_2 = U + I \cdot r_2 \\ U = \varepsilon_1 + I \cdot r_1 \end{cases} \rightarrow \begin{cases} I \cdot r_2 = \varepsilon_2 - U \\ I \cdot r_1 = U - \varepsilon_1 \end{cases}$$
$$\frac{I \cdot r_2}{I \cdot r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \rightarrow \frac{r_2}{r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \rightarrow U = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 1{,}92V$$

45. Rasmda tasvirlangan sxemadagi har-bir qarshilikdan o‘tadigan tok kuchini toping. $\varepsilon_1 = 10V, \varepsilon_2 = 4V, R_1 = R_4 = 2\Omega, R_2 = R_3 = 4\Omega, r_1 = r_2 = 0$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz (1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab A tugun uchun quyidagi tenglamani yozamiz

$$I = I_1 + I_2 = I_3 + I_4 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1R_1 + IR_{34} = \varepsilon_1, I_2R_2 + IR_{34} = \varepsilon_2 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$I_1 = 3A; I_2 = 0; I = 3A,$$

Uchinchi va to‘rtinchi qarshiliklar paralelligidan quyidagi tenglamalarni tuzamiz

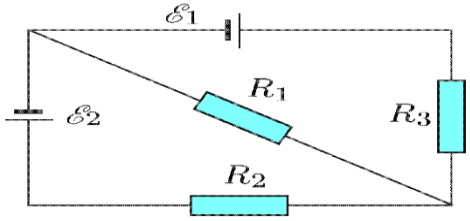
$$U_3 = U_4 \rightarrow I_3R_3 = I_4R_4 \rightarrow I_4 = 2I_3$$

Ushbu natijani (1) tenglamaga eltib qo‘ysak tok kuchilarning son qiymati kelib chiqadi

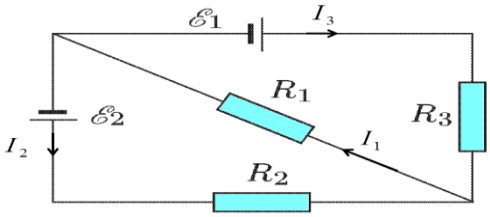
$$I_4 = 2AI_3 = 1A$$

46. Rasmda tasvirlangan sxemaning har bir qarshilikdan o‘tadigan toklarni toping

$$\varepsilon_1 = 2{,}1V, \varepsilon_2 = 1{,}9V, R_1 = 45\Omega, R_2 = R_3 = 10\Omega, r_1 = r_2 = r_3 = 0$$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz (1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I_1 = I_2 + I_3 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_3R_3 + I_1R_1 = \varepsilon_1, I_2R_2 + I_1R_1 = \varepsilon_2 \qquad (2)$$

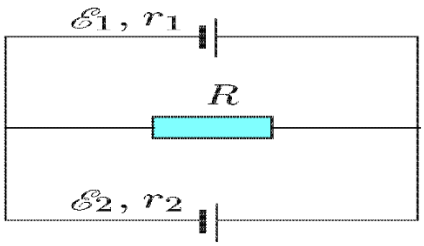
(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$\begin{cases} I_3R_3 + (I_2 + I_3)R_1 = \varepsilon_1 \\ I_2R_2 + (I_2 + I_3)R_1 = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_3 \cdot 10 + (I_2 + I_3) \cdot 45 = 2{,}1 \\ I_2 \cdot 10 + (I_2 + I_3) \cdot 45 = 1{,}9 \end{cases}$$

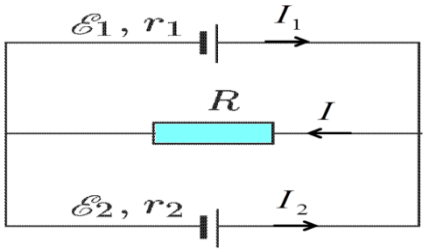
$$\begin{cases} 55I_3 + 45I_2 = 2{,}1 \\ 55I_2 + 45I_3 = 1{,}9 \end{cases} \rightarrow I_3 = 0{,}03A, I_2 = 0{,}01A, I_1 = I_2 + I_3 = 0{,}04A$$

46. Rasmda tasvirlangan sxemadagi toklarni toping

$$\varepsilon_1 = 1{,}6V, \varepsilon_2 = 1{,}3V, r_1 = 1\Omega, r_2 = 0{,}5\Omega R = 0{,}6\Omega$$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + IR = \varepsilon_1, I_2 r_2 + IR = \varepsilon_2 \qquad (2)$$

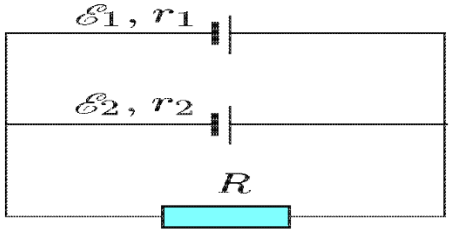
(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$\begin{cases} I_1 r_1 + (I_1 + I_2)R = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2)R = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 1 + (I_1 + I_2) \cdot 0{,}6 = 1{,}6 \\ I_2 \cdot 0{,}5 + (I_1 + I_2) \cdot 0{,}6 = 1{,}3 \end{cases}$$

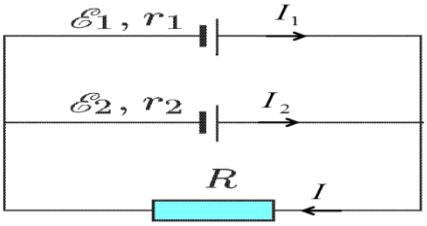
$$\begin{cases} 1{,}6I_1 + 0{,}6I_2 = 1{,}6 \\ 0{,}6I_1 + 1{,}1I_2 = 1{,}3 \end{cases} \rightarrow I_1 = 0{,}7A, I_2 = 0{,}8A, I = I_1 + I_2 = 1{,}5A$$

47. Rasmda tasvirlangan sxemada rezistor orqali o‘tadigan tokni toping

$$\varepsilon_1 = 1{,}9V, \varepsilon_2 = 1{,}1V, r_1 = 0{,}8\Omega, r_2 = 0{,}1\Omega R = 10\Omega$$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

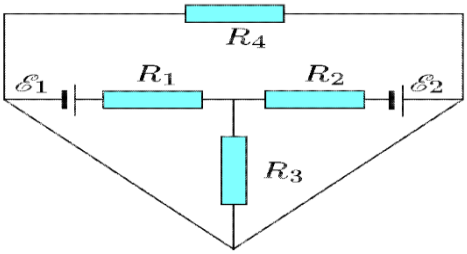
$$I_1 r_1 + IR = \varepsilon_1, I_2 r_2 + IR = \varepsilon_2 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

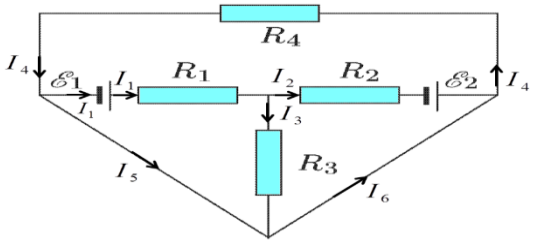
$$\begin{cases} I_1 r_1 + (I_1 + I_2)R = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2)R = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 0{,}8 + (I_1 + I_2) \cdot 10 = 1{,}9 \\ I_2 \cdot 0{,}1 + (I_1 + I_2) \cdot 10 = 1{,}1 \end{cases}$$

$$\begin{cases} 10{,}8I_1 + 10I_2 = 1{,}9 \\ 10{,}1I_2 + 10I_1 = 1{,}1 \end{cases} \rightarrow I_1 = 0{,}92A, I_2 = -0{,}8A, I = I_1 + I_2 = 1{,}2A$$

48. Rasmda tasvirlangan sxemadagi barcha qarshiliklardan o‘tuvchi toklarni toping. $\varepsilon_1 = 1{,}5V, \varepsilon_2 = 1{,}8V, R_1 = R_2 = R_3 = R_4 = 1k\Omega, r_1 = 0, r_2 = 0$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

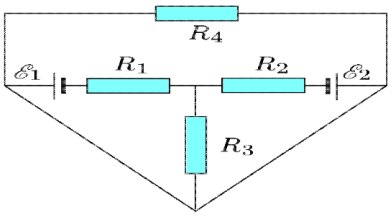
$$I_1 = I_2 + I_3$$
$$I_6 = I_3 + I_5$$
$$I_4 = I_1 + I_5$$
$$I_4 = I_2 + I_6 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

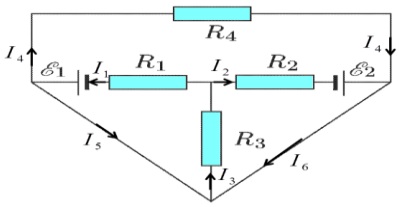
$$I_1R_1 + I_3R_3 = \varepsilon_1$$
$$I_2R_2 - I_3R_3 = \varepsilon_2$$
$$I_1R_1 + I_2R_2 + I_4R_4 = \varepsilon_1 + \varepsilon_2 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

49. Rasmda tasvirlangan sxemadagi barcha qarshiliklardan o‘tuvchi toklarni toping. $\varepsilon_1 = 4V,\ \varepsilon_2 = 8\ V, R_1 = R_2 = 2k\Omega, R_3 = 1k\Omega,\ R_4 = 5k\Omega,\ r_1 = 0, r_2 = 0$



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I_1 = I_4 + I_5$$
$$I_3 = I_1 + I_2$$
$$I_6 = I_2 + I_4$$
$$I_3 = I_5 + I_6 \qquad (1)$$

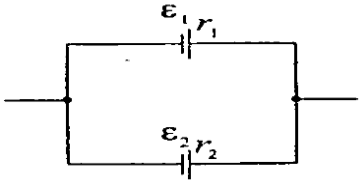
Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1R_1 + I_3R_3 = \varepsilon_1$$
$$I_2R_2 + I_3R_3 = \varepsilon_2$$
$$I_1R_1 - I_2R_2 + I_4R_4 = \varepsilon_1 - \varepsilon_2 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$I_1 = 0{,}5mA, I_2 = 2{,}5mA, I_3 = 3mA, I_4 = 0$$

50. E.Yu.K. lari ε_1=1,4 *V* va ε_2=1,2 *V* hamda ichki qarshiliklari r_1=0,6 Ω va r_2=0,4 Ω bo‘lgan ikkita element o‘zaro parallel ulangan. Elementlarning qisqichlaridagi potensiallar ayirmasi topilsin.



$\varepsilon_1 > \varepsilon_2$ bo‘lganligi uchun birinchi manba razryadlanadi, ikkinchi manba zaryadlanadi. Zanjirda tarmoqlanish yo‘qligi uchun toklar bir xil bo‘ladi

To‘liq zanjir uchun Om qonunini ikkita hol uchun quyidagicha yozamiz

I-hol razryadlanish uchun

$$\varepsilon_1 = U + I \cdot r_1 \qquad (1)$$

II-hol zaryadlanish uchun

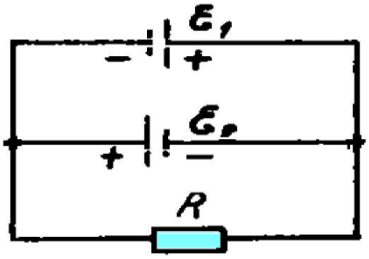
$$U = \varepsilon_2 + I \cdot r_2 \qquad (2)$$

Bu ikkita formulani soddalashtiramiz

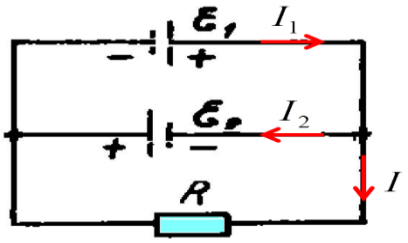
$$\begin{cases} \varepsilon_1 = U + I \cdot r_1 \\ U = \varepsilon_2 + I \cdot r_2 \end{cases} \rightarrow \begin{cases} I \cdot r_1 = \varepsilon_1 - U \\ I \cdot r_2 = U - \varepsilon_2 \end{cases}$$

$$\frac{I \cdot r_1}{I \cdot r_2} = \frac{\varepsilon_1 - U}{U - \varepsilon_2} \rightarrow \frac{r_1}{r_2} = \frac{\varepsilon_1 - U}{U - \varepsilon_2} \rightarrow U = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 1{,}28V$$

51. Ikkita akkumulyatorlar batareyasi $\varepsilon_1 = 10V, r_1 = 1\Omega, \varepsilon_2 = 8V, r_2 = 2\Omega$ va reostat R=6Ω. Rasmda ko‘rsatilgandek qilib ulangan. Batareyalardagi va reostatdagi tok kuchi topilsin.



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I_1 = I_2 + I \qquad (1)$$

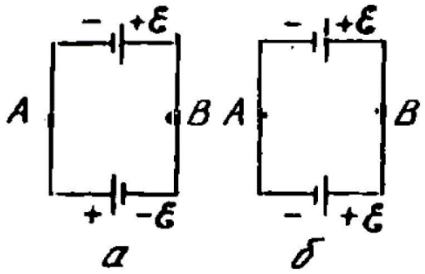
Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + IR = \varepsilon_1, I_2 r_2 - IR = \varepsilon_2 \qquad (2)$$

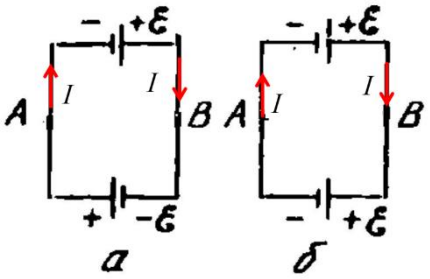
(1) va (2) tenglamalarni soddalashtirib berilganlarni keltirib qo‘ysak quyidagi natijalarga erishamiz

$$\begin{cases} I_1 r_1 + (I_1 - I_2)R = \varepsilon_1 \\ I_2 r_2 - (I_1 - I_2)R = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 1 + (I_1 - I_2)6 = 10 \\ I_2 \cdot 2 - (I_1 - I_2)6 = 8 \end{cases}$$
$$I_1 = 6{,}4A; I_2 = 5{,}8A; I = 0{,}6A$$

52. EYuK $\varepsilon_1 = 1{,}2V$ va ichki qarshiligi $r = 0{,}4\Omega$ bo‘lgan ikkita bir xil tok manbai a,b-rasmlarda ko‘rsatilgandek qilib ulangan. Birinchi va ikkinchi holler uchun zanjirdagi tok kuchi I hamda A va B nuqtalar orasidagi potensiallar farqi U topilsin.



1-rasm.



1,1-rasm.

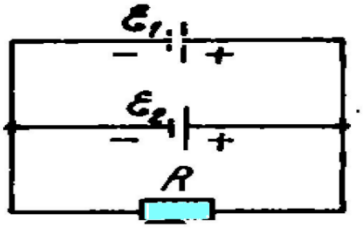
1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). a rasm Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzib tok kuchini va AB nuqta orasidagi potensiallar farqini tpamiz.

$$Ir + Ir = \varepsilon + \varepsilon \rightarrow I = \frac{2\varepsilon}{2r} = \frac{\varepsilon}{r} = 3A; U_{AB} = \varepsilon - Ir = 1{,}2 - 0{,}4 \cdot 3 = 0V$$

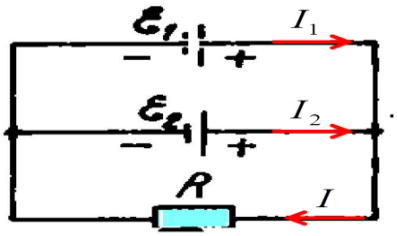
б rasm Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzib tok kuchini va AB nuqta orasidagi potensiallar farqini tpamiz.

$$Ir + Ir = \varepsilon - \varepsilon \rightarrow I = \frac{\varepsilon - \varepsilon}{2r} = 0; U_{AB} = \varepsilon = 1{,}2V$$

53. Ikkita tok manbai $\varepsilon_1 = 8V, r_1 = 2\Omega; \varepsilon_2 = 6V, r_2 = 1{,}5\Omega; R = 10\Omega$rasmda ko‘rsatilgandek qilib ulangan. Reostat orqali oquvchi tok kuchi I hisoblansin.



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

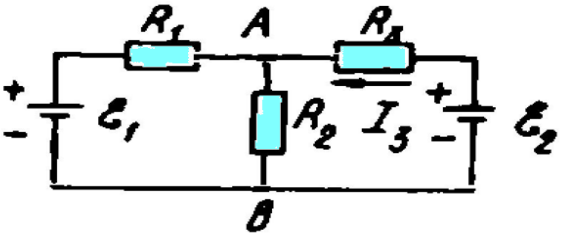
$$I_1 r_1 + IR = \varepsilon_1, I_2 r_2 + IR = \varepsilon_2 \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

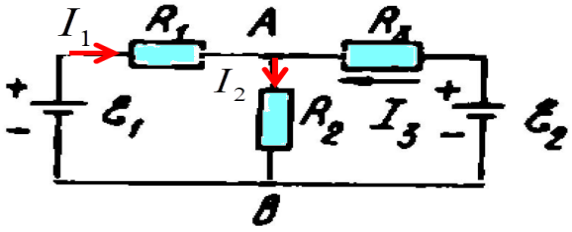
$$\begin{cases} I_1 r_1 + (I_1 + I_2)R = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2)R = \varepsilon_2 \end{cases}; \begin{cases} I_1 \cdot 2 + (I_1 + I_2) \cdot 10 = 8 \\ I_2 \cdot 1{,}5 + (I_1 + I_2) \cdot 10 = 6 \end{cases}; \begin{cases} 12I_1 + 10I_2 = 8 \\ 11{,}5I_2 + 10I_1 = 6 \end{cases}$$

$$I_1 = 0{,}84A, I_2 = -0{,}21A, I = I_1 + I_2 = 0{,}63A$$

54. Agar $\varepsilon_1 = 4V, \varepsilon_2 = 3V, R_1 = 2\Omega; R_2 = 6\Omega, R_3 = 1\Omega$ bo‘lsa, R_3 qarshilikli rezistordagi I_3 tok kuchi va resistor uchlaridagi kuchlanish U_3 aniqlansin. Tok manbalarining ichki qarshiliklari hisobga olinmasin.



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I_2 = I_1 + I_3 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

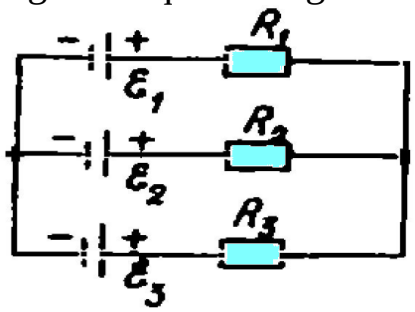
$$\begin{cases} I_1 R_1 + I_2 R_2 = \varepsilon_1 \\ I_3 R_3 + I_2 R_2 = \varepsilon_2 \end{cases} \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

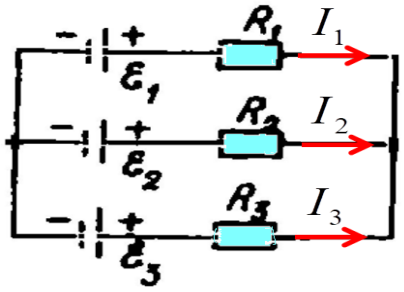
$$\begin{cases} I_1 R_1 + (I_1 + I_3)R_2 = \varepsilon_1 \\ I_3 R_3 + (I_1 + I_3)R_2 = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 2 + (I_1 + I_3) \cdot 6 = 4 \\ I_3 \cdot 1 + (I_1 + I_3)6 = 3 \end{cases}$$

$$I_1 = 0{,}5A; I_2 = 0{,}5A; I_3 = 0; U_3 = I_3 R_3 = 0$$

55. EYuK lari $\varepsilon_1 = 11V, \varepsilon_2 = 4V, \varepsilon_3 = 6V$ bo‘lgan uchta tok manbai va $R_1 = 5\Omega, R_2 = 10\Omega$ va $R_3 = 2\Omega$ qarshilikli uchta reostat rasmda ko‘rsatilgandek qilib ulangan. Reostatlardagi tok kuchi aniqlansin.



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I_1 + I_2 + I_3 = 0 \rightarrow I_1 = -I_2 - I_3 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

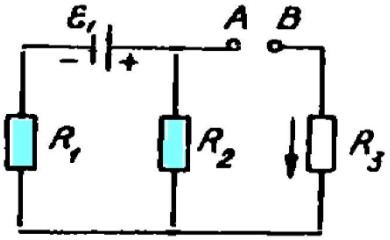
$$\begin{cases} I_1R_1 - I_2R_2 = \varepsilon_1 - \varepsilon_2 \\ I_2R_2 - I_3R_3 = \varepsilon_2 - \varepsilon_3 \end{cases} \qquad (2)$$

(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

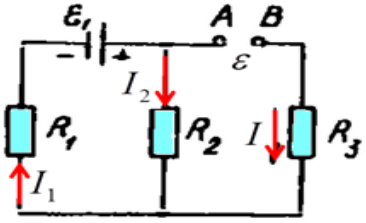
$$\begin{cases} (-I_2 - I_3)R_1 - I_2R_2 = \varepsilon_1 - \varepsilon_2 \\ I_2R_2 - I_3R_3 = \varepsilon_2 - \varepsilon_3 \end{cases} \rightarrow \begin{cases} (-I_2 - I_3)5 - I_2 \cdot 10 = 11 - 4 \\ I_2 \cdot 10 - I_3 \cdot 2 = 4 - 6 \end{cases}$$

$$I_1 = 0{,}8A; I_2 = -0{,}3A; I_3 = -0{,}5A$$

56. $R_1 = 5\Omega, R_2 = 1\Omega, R_3 = 3\Omega$, li uchta qarshilik hamda $\varepsilon_1 = 1{,}4V$ EYuK li tok manbai rasmda ko‘rsatilgandek qilib ulangan. R_3 qarshilikdan ko‘rsatilgan yo‘nalishda I=1 A tok oqishi uchun zanjirning A va B nuqtalari orasiga ulanishi kerak bo‘lgan tok manbaining EYuK aniqlansin.



1-rasm.



1,1-rasm.

1-rasmdagi sxemani quyidagicha o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I + I_2 = I_1 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$\begin{cases} IR_3 - I_2R_2 = \varepsilon \\ I_2R_2 + I_1R_1 = \varepsilon_1 \end{cases} \qquad (2)$$

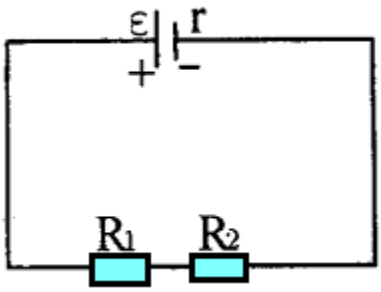
(1) va (2) tenglamalarni soddalashtirib quyidagi natijalarga erishamiz

$$\begin{cases} IR_3 - I_2R_2 = \varepsilon \\ I_2R_2 + (I + I_2)R_1 = \varepsilon_1 \end{cases} \rightarrow \begin{cases} 1 \cdot 3 - I_2 \cdot 1 = \varepsilon \\ I_2 \cdot 1 + (1 + I_2)5 = 1{,}4 \end{cases}$$

$$\varepsilon = 3{,}6V$$

ABUTURIYENT GAZETASIDAN OLINGAN MASALALAR

1. Zanjirning ichki qarshiligi 1 Ω, EYuKi 18 V bo‘lgan tok manbaidan va qarshiliklari R_1=3 Ω; R_2=5 Ω o‘tkazgichlardan tashkil topgan. R_2 o‘tkazkichdagi kuchlanish nimaga teng.

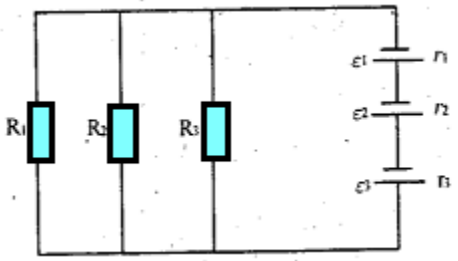


To‘liq zanjir uchun Om qonuni formulasidan foydalanamiz

$$I = \frac{\varepsilon}{R_{12} + r} = \frac{\varepsilon}{R_1 + R_2 + r} = \frac{18}{8 + 1} = 2A$$

$$U_2 = I \cdot R_2 = 2 \cdot 5 = 10V$$

2. Agar EYuKlari mos ravishda 3 V, 4 V, 8 V . Ichki qarshiliklari 1Ω dan, tashqi qarshiliklari mos ravishda 4 Ω, 2 Ω, 4 Ω bo‘lsa, tok kuchini toping.



To‘liq zanjir uchun Om qonuni formulasidan foydalanamiz

$$I = \frac{\varepsilon}{R + r}$$

Ushbu formulani masala shartiga moslaymiz

$$I = \frac{\varepsilon_{Um}}{R_{Um} + r_{Um}} \qquad (1)$$

$$\varepsilon_{Um} = \varepsilon_1 + \varepsilon_2 + \varepsilon_3 = 15V$$

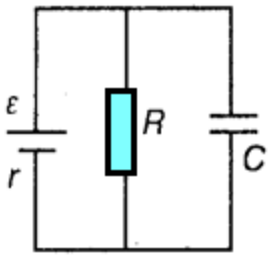
$$\frac{1}{R_{Um}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}; R_{Um} = 1\Omega$$

$$r_{Um} = r_1 + r_2 + r_3 = 3\Omega$$

Natijalarni 1-formulaga etib qo‘ysak zang‘irdagi umumiy tok kuchi kelib chiqadi

$$I = \frac{15}{1 + 3} = 3{,}75A$$

3. Rasmda keltirilgan zanjirdagi kondensatorning zaryadi nimaga teng?



Kondensator zaryadini quyidagi formula bilan topamiz

$$q = C \cdot U \qquad (1)$$

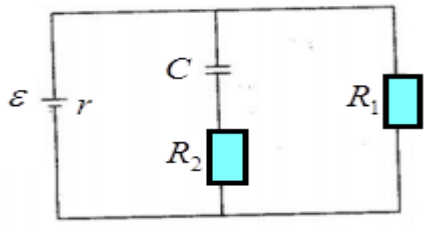
Kondensator tashqi qarshilikka parallel ulanganligi uchun tashqi qarshilikdagi kuchlanish bilan kondensator kuchlanishi bir-xil bo‘ladi.

$$U = I \cdot R = \frac{\varepsilon}{R+r} \cdot R \qquad (2)$$

Ikkinchi formulani birinchi formulaga etib qo‘ysak quyidagi natijaga ega bo‘lamiz.

$$q = \frac{C \cdot \varepsilon \cdot R}{R+r} \qquad (3)$$

4. Rasmda ko‘rsatilgan manbaning EYuKi va ichki qarshiligi mos ravishda ε=12 V va r=2 Ω ga teng. R_1=10 Ω va R_2=15 Ω ga teng. Kondensatorning sig‘imi 1μF ga teng. Kondensatorda to‘plangan zaryadni toping.



Kondensator zaryadini quyidagi formula bilan topamiz

$$q = C \cdot U \qquad (1)$$

Kondensator R_1 qarshilikka parallel ulanganligi uchun R_1 qarshilikdagi kuchlanish bilan kondensator kuchlanishi bir-xil bo‘ladi.

$$U = I \cdot R_1 = \frac{\varepsilon}{R_1 + r} \cdot R_1 \qquad (2)$$

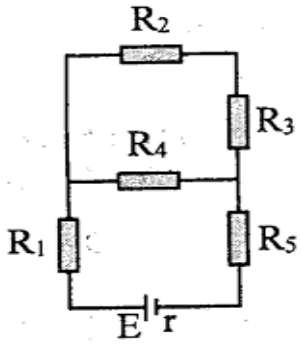
2-formuladan ko‘rinadiki R_2 qarshilikni inobatga olmadik chunki R_2 qarshilik kondensatorga ketma-ket ulangan, zanjirning shu qismidan tok o‘tmaydi ya’ni kondensator o‘zgarmas tokka ulanganda juda qisqa vaqtda zaryadlanadi va zanjirning shu qismini uzib qo‘yadi.

Ikkinchi formulani birinchi formulaga etib qo‘ysak quyidagi natijaga ega bo‘lamiz.

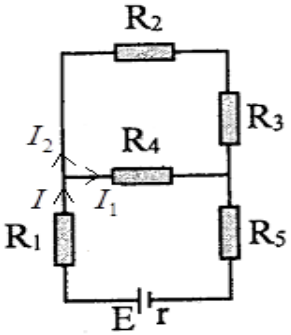
$$q = \frac{C \cdot \varepsilon \cdot R_1}{R_1 + r} = \frac{10^{-6} \cdot 12 \cdot 10}{10+2} = 10^{-5} C = 10 \mu C$$

5. R_4 qarshilikdagi kuchlanishni toping.

$$E = 26V, R_1 = 4\Omega, R_2 = 2\Omega, R_3 = 4\Omega, R_4 = 6\Omega, R_5 = r = 3\Omega,$$



1-rasm.



1,1-rasm.

1-rasmdagi sxemaga toklarning yo‘nalishini chizib chiqamiz(1,1-rasm)

R_4 qarshilikdagi kuchlanish quyidagi formula bilan topiladi

$$U_4 = I_1 \cdot R_4 \qquad (1)$$

Bu yerdagi I_1 tarmoqlangan qismdagi tok kuchi I_1 ni topish uchun umumiy tok kuchi I ni to‘liq zanjir uchun Om qonunidan foydalanib topamiz

$$I = \frac{E}{R_{Um} + r} \qquad (2)$$

R_{Um} Zanjirning umumiy qarshiligi bo‘lib uni quyidagicha hisoblaymiz

$$R_{23} = R_2 + R_3 = 6\Omega; R_{234} = \frac{R_{23} \cdot R_4}{R_{23} + R_4} = \frac{6 \cdot 6}{6 + 6} = 3\Omega$$

$$R_{Um} = R_1 + R_{234} + R_5 = 4 + 3 + 3 = 10\Omega$$

Umumiy qarshilikni 2-formulaga eltib qo‘ysak I=2 A tok kuchi kelib chiqadi

Endi Krixgofning 1-qoidasidan va R_{23} bilan R_4 paralellik shartidan foydalanib I_1 tok kuchini topamiz

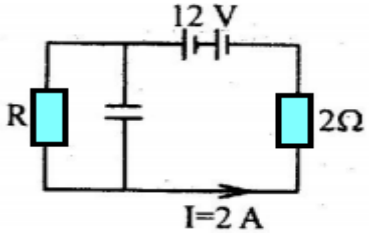
$$I = I_1 + I_2 = 2A$$

$$U_{23} = U_4 \rightarrow I_2(R_2 + R_3) = I_1 R_4 \rightarrow I_2 \cdot 6 = I_1 \cdot 6 \rightarrow I_1 = I_2 = 1A$$

Chiqqan natijani 1-formulaga eltib qo‘yamiz $U_4 = I_1 \cdot R_4 = 1 \cdot 6 = 6V$

6. Rasmda berilganlarga ko‘ra, kondensatorning quyi qoplamasida 10^{14} ta electron

to‘plangan bo‘lsa, kondensatorning sig‘imini toping.



Kondensator sig‘imini quyidagi formula bilan topamiz

$$C = \frac{q}{U} \qquad (1)$$

Masala shartida kondensator zaryadi berilgan ya’ni elektronlar sonini bilsak $q=Ne=10^{14} \cdot 1{,}6 \cdot 10^{-19} = 16 \cdot 10^{-6}$ C zaryadni topa olamiz.

Kondensator R qarshilikka parallel ulanganligi uchun R qarshilikdagi kuchlanish bilan kondensator kuchlanishi bir-xil bo‘ladi.

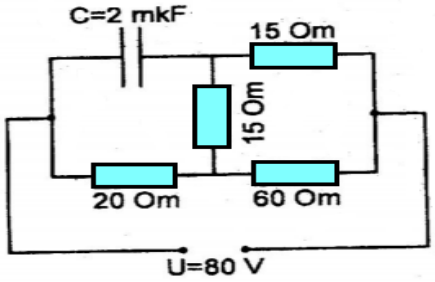
$$U = I \cdot R \qquad (2)$$

Bizga tok kuchi berilga lekin R qarshilik berilmaga, uni to‘liq zanjir uchun Om qonuni formulasidan topib olamiz, ichqi qarshilik berilmaganligi uchun r=o deb hisoblaymiz

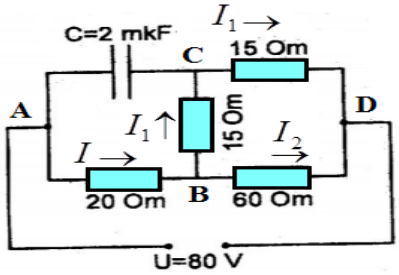
$$I = \frac{E}{R_{Um}} = \frac{E}{R+2} \rightarrow R = 4\Omega \qquad (3)$$

3- va 2- formulalardan U=8 V kelib chiqadi. Chiqqan natijalarni 1-formulaga eltib qo‘ysak quyidagi natijaga ega bo‘lamiz $C = \frac{q}{U} = \frac{16 \cdot 10^{-6}}{8} = 2 \cdot 10^{-6} = 2\mu F$

7. Rasmda ko‘rsatilgan sxemadagi kondensator zaryadini toping.



1-rasm.

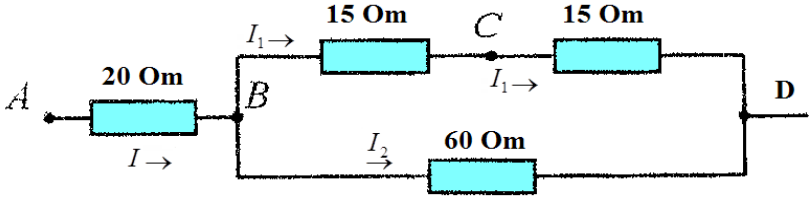


1,1-rasm.

1-rasmdagi sxemaga toklarning yo‘nalishini chizib chiqamiz. (1,1-rasm). Kondensator zaryadini toppish uchun uning qoplamalari orasidagi potensiallar farqini aniqlash kerak. Sxemaga binoan bir tomondan bu potensiallar farqi A va C nuqtalar orasidagi U_{AC} potensiallar farqiga teng. Ikkinchi tomondan u 20 Ω va 15 Ω qarshiliklardagi U_1 va U_2 kuchlanishlar yig‘indisiga teng. Shunday qilib, kondensatorning zaryadi.

$$q = C \cdot U_{AC}; U_{AC} = U_1 + U_2; U_1 = I \cdot 20, U_2 = I_1 \cdot 15$$

Qarshiliklarni ketma-ket va parallel ulanishidan foydalanish uchun sxemani quyidagi ekvivalent sxema bilan almashtirish mumkin



Bunday zanjirning to‘la qarshiligi $R_{Um} = 20 + \frac{(15+15)\cdot 60}{(15+15)+60} = 40\Omega$ ga teng bo‘ladi.

Berk zanjir uchun Om qonunidan foydalanib umumiy tokni topamiz.

$$I = \frac{U}{R_{Um}} = \frac{80}{40} = 2A$$

Endi Krixgofning 1-qoidasidan va qarshiliklarning paralellik shartidan foydalanib I_1 tok kuchini topamiz

$$I = I_1 + I_2 = 2A; U_{23} = U_4 \rightarrow I_1(15+15) = I_2 \cdot 60 \rightarrow I_1 \cdot 30 = I_2 \cdot 60$$

$$\rightarrow$$

$$I_1 = 2I_2; I_1 + \frac{I_1}{2} = 2A \rightarrow I_1 = \frac{4}{3}A$$

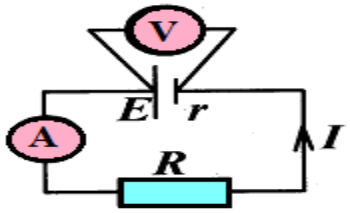
Natijalarni 2- formulaga etib qo‘ysak

$$U_1 = I \cdot 20 = 2 \cdot 20 = 40V, U_2 = I_1 \cdot 15 = \frac{4}{3} \cdot 15 = 20V$$

$$U_{AC} = U_1 + U_2 = 40 + 20 = 60V$$

$$q = C \cdot U_{AC} = 2 \cdot 10^{-6} \cdot 60 = 120 \cdot 10^{-6}C = 120\mu C$$

8. E=40 V, I=4 A va voltimetrning ko‘rsatishi 30 V bo‘lsa, manbaning ichki qarshiligini toping.



Manbaga ulangan voltimetr tashqi qarshilikdagi kuchlanish tushuvini o‘lchaydi

Zanjirning bir qismi uchun va to‘liq zanjir uchun Om qonunidan foydalanib quyidagi formulalarni yozamiz.

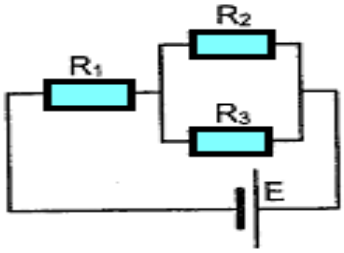
$$I = \frac{U}{R} \qquad (1)$$

$$I = \frac{E}{R+r} \qquad (2)$$

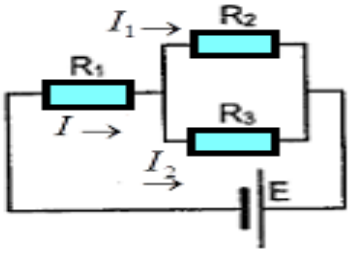
1-formuladan R ni topib 2-tenglamaga keltirib qo‘yamiz

$$I = \frac{U}{R} \rightarrow R = \frac{U}{I} = \frac{30}{4} = 7{,}5\Omega; I = \frac{E}{R+r} \rightarrow 4 = \frac{40}{7{,}5+r} \rightarrow r = 2{,}5\Omega$$

9. Zanjirda $R_1 = 18\Omega, R_2 = 18\Omega, R_3 = 6\Omega, E = 7{,}5V$, manbaning ichki qarshiligi nolga teng. R_3 qarshilikdan o‘tayotgan tok kuchini toping.



1-rasm.



1,1-rasm.

1-rasmga toklarni yo‘nalishini chizib chiqamiz (1,1-rasm)

To‘liq zanjir uchun Om qonuni formulasidan umumiy tok kuchini topamiz.

$$I = \frac{E}{R_{Um}+r} \qquad (1)$$

$$R_{Um} = \frac{R_2 \cdot R_3}{R_2 + R_3} + R_1 = 22{,}5\Omega; I = \frac{E}{R_{Um}+r} = \frac{7{,}5}{22{,}5} = \frac{1}{3}A$$

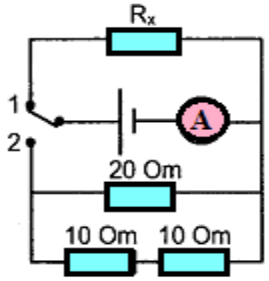
Endi Krixgofning 1-qoidasidan va R_2,R_3 qarshiliklarning paralellik shartidan foydalanib I_2 tok kuchini topamiz

$$I = I_1 + I_2 = \frac{1}{3}A$$

$$U_2 = U_3 \rightarrow I_1 \cdot R_2 = I_2 \cdot R_3 \rightarrow I_1 \cdot 18 = I_2 \cdot 6 \rightarrow 3I_1 = I_2$$

$$I_1 + 3I_1 = \frac{1}{3}A \rightarrow I_1 = \frac{1}{12}A; I_2 = 3 \cdot \frac{1}{12} = \frac{1}{4}A$$

10. Zanjirdagi kalit 2-holatga o‘tkazilganida ideal ampermetrning ko‘rsatishi 2 marta kamaydi. R_x ning qiymatini toping.



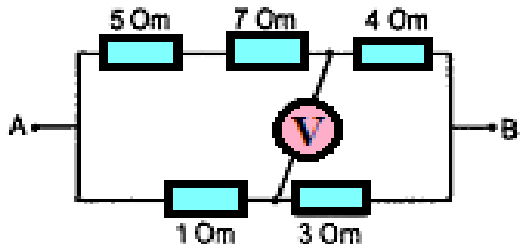
Ampermetr zanjirning tarmoqlanmagan qismiga ulanganligi uchun u umumiy tok kuchini ko‘rsatadi. Har bir hol uchun tenglama tuzamiz

$$1-hol; I_1 = \frac{E}{R_x}; 2-hol; I_2 = \frac{E}{R_{Um}}; R_{Um} = \frac{20 \cdot 20}{20+20} = 10Om$$

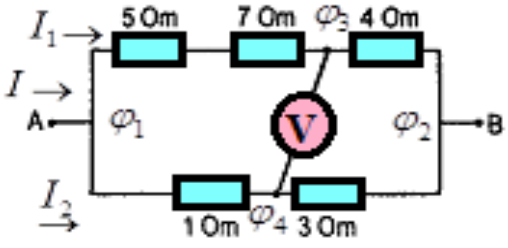
Masala shartiga ko‘ra $I_1/I_2=2$ tok kuchilarni keltirib o‘rniga qo‘ysak

$$\frac{I_1}{I_2} = \frac{R_{Um}}{R_x} = 2, \rightarrow R_x = \frac{R_{Um}}{2} = 5Om$$

11. A va B nuqtalar orasidagi kuchlanish U=32 V. Voltimetrning ko‘rsatishini toping.



1-rasm.



1,1-ram.

1-rasmdagi sxemaga quyidagicha o‘zgartirish kiritamiz(1,1-rasm).

Zanjirning umumiy tok kuchini va har ikkala tarmoqdagi tok kuchini topamiz.

$$I = \frac{U}{R_{Um}} = \frac{32}{3{,}2} = 10A; I = I_1 + I_2 = 10A$$

$U_1 = U_2 \to I_1(5+7+4) = I_2 \cdot (1+3) \to I_1 \cdot 16 = I_2 \cdot 4 \to 4I_1 = I_2$

$I_1 + 4I_1 = 10A \to I_1 = 2A; I_2 = 8A$

Kuchlanish tushuvlarini potensiallar ayirmasi bilan ifodalaymiz

$$\varphi_1 - \varphi_2 = U = 32V$$

$$\varphi_1 - \varphi_3 = I_1 \cdot (5+7) = 24V$$

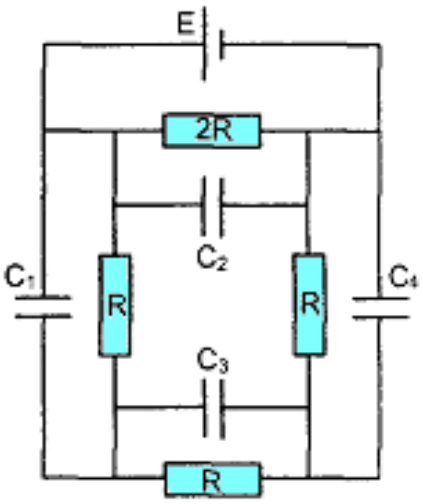
$$\varphi_1 - \varphi_4 = I_2 \cdot 1 = 8V$$

$$\varphi_3 - \varphi_2 = I_1 \cdot 4 = 8V$$

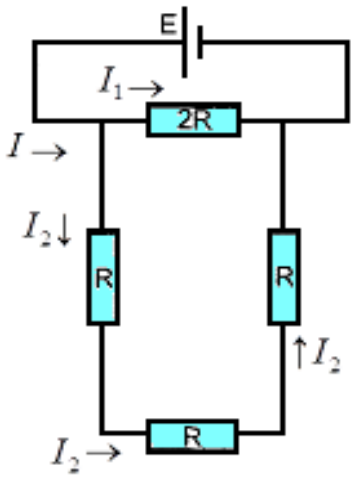
$$\varphi_4 - \varphi_2 = I_2 \cdot 3 = 24V$$

Voltimetrning ko‘rsatishi $U_V = \varphi_4 - \varphi_3$ yuqoridagi 4-5-formulalarni soddalashtirsak $U_V = \varphi_4 - \varphi_3 = 16V$ natija kelib chiqadi.

12. Rasmda ko‘rsatilgan sxemada C_1=12mkF va barcha kondensatorlar zaryadi bir xil. C_2, C_3 va C_4 larning qiymati mkF larda topib, $C_2(C_3 \cdot C_4)^{0,5}$ ifodaning son qiymatini toping.



1-rasm.



1,1-rasm.

O‘zgarmas tok manbayiga kondensatorlar ulansa ular jada tez zaryadlanadilar va manbadan uziladilar, kondensator ulangan tarmoqdan tok o‘tmaydi faqatgina kondensator o‘ziga parallel ulangan qarshilik kuchlanishicha kuchlanish bilan zaryadlanadi.Shuning uchun umumiy tok kuchini va har-bir qarshilikka to‘g‘ri keladigan kuchlanishni topish uchun sxemadan kondensatorlarni vaqtincha olib tashlaymiz va toklarning yo‘nalishini qo‘yib chiqamiz(1,1-rasm).

$$I = \frac{E}{R_{Um}+r} \qquad (1)$$

$$r = 0; R_{Um} = \frac{2R \cdot 3R}{2R+3R} = \frac{6R}{5}; \to I = \frac{E}{\frac{6}{5}R +} = \frac{5E}{6R}$$

Endi Krixgofning 1-qoidasidan va qarshiliklarning paralellik shartidan foydalanib tok kuchlarini topamiz

$$I = I_1 + I_2$$
$$U_2 = U_3 \to I_1 \cdot 2R = I_2 \cdot 3R \to 2I_1 = 3I_2 \to I_1 = 1{,}5I_2$$
$$1{,}5I_2 + I_2 = I \to I_2 = \frac{I}{2{,}5}; I_1 = 1{,}5 \cdot \frac{I}{2{,}5} = \frac{3I}{5}$$

1-rasmdan ko‘rinib turibdiki C_1 kondensator R qarshilikka parallel ulangan shuning uchun

$$q_1 = C_1 \cdot U_1 = C_1 \cdot (I_2 \cdot R) = C_1 \cdot \frac{I}{2{,}5} \cdot R$$

C_2 kondensator 2R qarshilikka parallel ulangan shuning uchun

$$q_2 = C_2 \cdot U_2 = C_2 \cdot (I_1 \cdot 2R) = C_2 \cdot \frac{3I}{5} \cdot 2R = C_2 \cdot \frac{6I}{5} \cdot R$$

C_3 va C_4 kondensator R qarshilikka parallel ulangan shuning uchun

$$q_3 = C_3 \cdot U_3 = C_3 \cdot (I_2 \cdot R) = C_3 \cdot \frac{I}{2{,}5} \cdot R; q_4 = C_4 \cdot U_4 = C_4 \cdot (I_2 \cdot R) = C_4 \cdot \frac{I}{2{,}5} \cdot R$$

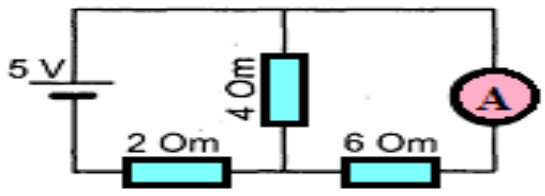
Masala shartiga binoan barcha kondensatorlardagi zaryad tengligidan quyidagi natijalar kelib chiqadi.

$$q_1 = q_2$$
$$C_1 \cdot \frac{I}{2{,}5} \cdot R = C_2 \cdot \frac{6I}{5} \cdot R \to C_2 = \frac{C_1}{3} = \frac{12}{3} = 4mkF$$
$$q_1 = q_3$$
$$C_1 \cdot \frac{I}{2{,}5} \cdot R = C_3 \cdot \frac{I}{2{,}5} \cdot R \to C_2 = C_3 = 12mkF$$
$$q_1 = q_4$$
$$C_1 \cdot \frac{I}{2{,}5} \cdot R = C_4 \cdot \frac{I}{2{,}5} \cdot R \to C_2 = C_4 = 12mkF$$

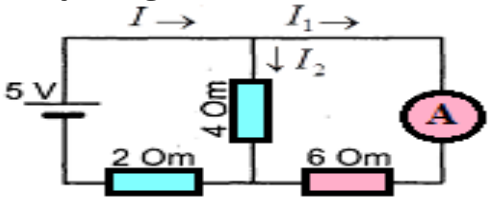
Barcha kondensatorlar sig‘imi aniqlandi endi masala shartida aytilgan ifodani son qiymatini topamiz.

$$C_2(C_3 \cdot C_4)^{0,5} = 4 \cdot (12 \cdot 12)^{0,5} = 4 \cdot 12 = 48$$

13. Rasmda ko‘rsatilgan zanjirda ampermtr bilan manbaning o‘rni almashtirilsa, ampermetrning ko‘rsatishi qanday o‘zgaradi.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz (1,1-rasm).

Rasmdan ko‘rinib turibdiki ampermetr tarmoqlangan tok kuchini I_1 ni o‘lchaydi. Zanjirning umumiy tok kuchini va har ikkala tarmoqdagi tok kuchini topamiz.

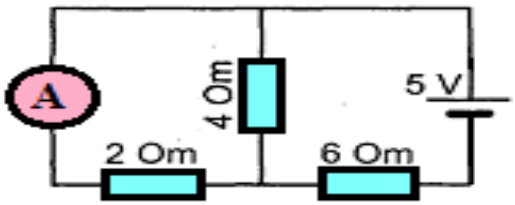
$$R_{12} = \frac{4 \cdot 6}{4+6} = 2{,}4\Omega; R_{Um} = R_{12} + R_3 = 4{,}4\Omega; r = 0 I = \frac{\varepsilon}{R_{Um} + r} = \frac{5}{4{,}4} A$$

$$I = I_1 + I_2 = \frac{5}{4{,}4} A; U_1 = U_2 \rightarrow I_1 \cdot 6 = I_2 \cdot 4 \rightarrow 1{,}5 I_1 = I_2$$

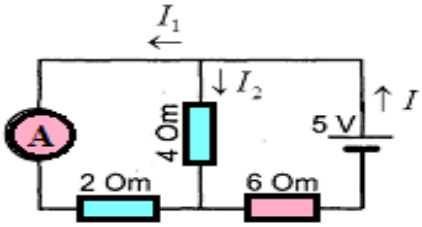
$$I_1 + 1{,}5 I_1 = \frac{5}{4{,}4} A \rightarrow I_1 = \frac{2}{4{,}4} A;$$

I-holda zanjirdagi ampermetr I_1 tokni ko‘rsatadi.

Endi ampermetr va manbaning joyini almashtiramiz



1-rasm.



1,2-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,2-rasm).

Rasmdan ko‘rinib turibdiki ampermetr I_1 tok kuchini o‘lchaydi.

Zanjirning umumiy tok kuchini va har ikkala tarmoqdagi tok kuchini topamiz.

$$R_{12} = \frac{4 \cdot 2}{4+2} = \frac{8}{6}\Omega; R_{Um} = R_{12} + R_3 = \frac{8}{6} + 6 = \frac{44}{6}\Omega; r = 0$$

$$I = \frac{\varepsilon}{R_{Um} + r} = \frac{5}{\frac{44}{6}} = \frac{30}{44} = \frac{3}{4{,}4} A; I = I_1 + I_2 = \frac{3}{4{,}4} A;$$

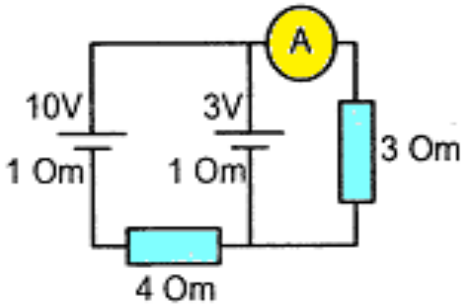
$$U_1 = U_2 \rightarrow I_1 \cdot 2 = I_2 \cdot 4 \rightarrow I_1 = 2 I_2$$

$$I_1 + 0{,}5 I_1 = \frac{3}{4{,}4} A \rightarrow I_1 = \frac{2}{4{,}4} A;$$

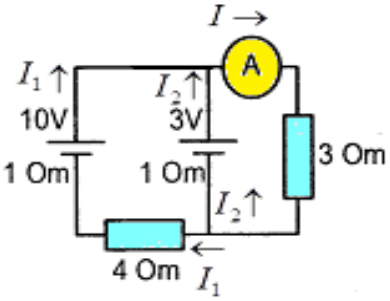
II-holda ham zanjirdagi ampermetr ko‘rsatgichi o‘zgarmadi.

14. Ampermetr qanday tok kuchini ko‘rsatadi?

$$\varepsilon_1 = 10V; r_1 = 1\Omega; \varepsilon_2 = 3V; r_2 = 1\Omega; R_1 = 3\Omega; R_2 = 4\Omega;$$



1-rasm.



1,1-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,1-rasm).
Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + IR_1 + I_1 R_2 = \varepsilon_1, I_2 r_2 + IR_1 = \varepsilon_2 \qquad (2)$$

1-tenglamadan I ni 2-tenglamaga keltirib qo‘ysak

$$\begin{cases} I_1 r_1 + (I_1 + I_2)R_1 + I_1 R_2 = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2)R_1 = \varepsilon_2 \end{cases}$$

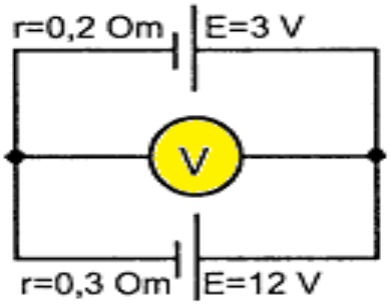
$$\begin{cases} I_1 \cdot 1 + (I_1 + I_2) \cdot 3 + I_1 \cdot 4 = 10 \\ I_2 \cdot 1 + (I_1 + I_2) \cdot 3 = 3 \end{cases}$$

$$\begin{cases} 8I_1 + 3I_2 = 10 \\ 4I_2 + 3I_1 = 3 \end{cases} \quad I_1 = \frac{31}{23}; I_2 = -\frac{6}{23}; I = I_1 + I_2 = 1{,}086A$$

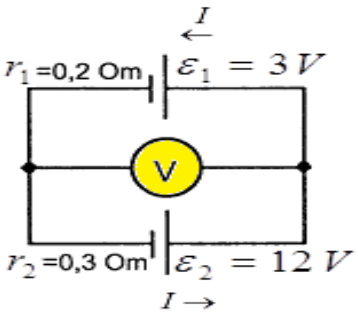
Zanjirdagi ampermetr I tok kuchini ko‘rsatadi. I_2 tok kuchi manfiy chiqishiga sabab biz tanlagan yo‘nalish (Soat sitrelkasining yo‘nalishi)ga qarama-qarshi yo‘nalishda harakatlanar ekan.

15. Zanjirda berilgan ma’lumotlardan foydalanib, voltimetrning ko‘rsatishini toping.

I-yo‘l



1-rasm



1,1-rasm

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,1-rasm).

$\varepsilon_2 > \varepsilon_1$ bo‘lganligi uchun birinchi manba zaryadlanadi, ikkinchi manba razryadlanadi(zaryadsizlanadi). Zanjirda tarmoqlanish yo‘qligi uchun toklar birxil bo‘ladi

To‘liq zanjir uchun Om qonunini ikkita hol uchun quyidagicha yozamiz

I-hol razryadlanish uchun

$$\varepsilon_2 = U + I \cdot r_2 \qquad (1)$$

II-hol zaryadlanish uchun

$$U = \varepsilon_1 + I \cdot r_1 \qquad (2)$$

Bu ikkita formulani soddalashtiramiz

$$\begin{cases} \varepsilon_2 = U + I \cdot r_2 \\ U = \varepsilon_1 + I \cdot r_1 \end{cases} \rightarrow \begin{cases} I \cdot r_2 = \varepsilon_2 - U \\ I \cdot r_1 = U - \varepsilon_1 \end{cases}$$

$$\frac{I \cdot r_2}{I \cdot r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \to \frac{r_2}{r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \to U = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 6{,}6V$$

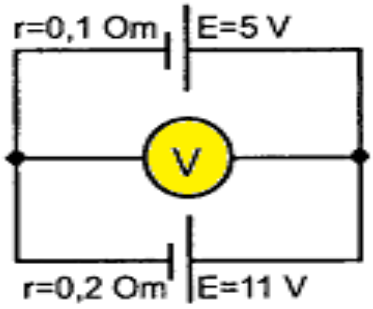
II-yo‘l.

Manbalarning mos qutblari ulanganligidan ularni parallel desak umumiy tok kuchi(qisqa tutashuv toklari) quyidagicha bo‘ladi

$$I_{Um} = I_1 + I_2$$

$$\frac{\varepsilon_{Um}}{r_{Um}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}; r_{Um} = \frac{r_1 \cdot r_2}{r_1 + r_2} \varepsilon_{Um} = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 6{,}6V$$

16. Zanjirda berilgan ma’lumotlardan foydalanib, voltimetrning ko‘rsatishini toping. $r_1 = 0{,}1\Omega, \varepsilon_1 = 5V, r_2 = 0{,}2\Omega, \varepsilon_2 = 11V,$



I-yo‘l

$\varepsilon_2 > \varepsilon_1$ bo‘lganligi uchun birinchi manba zaryadlanadi, ikkinchi manba razryadlanadi (zaryadsizlanadi).Zanjirda tarmoqlanish yo‘qligi uchun toklar bir xil bo‘ladi.

To‘liq zanjir uchun Om qonunini ikkita hol uchun quyidagicha yozamiz

I-hol razryadlanish uchun.

$$\varepsilon_2 = U + I \cdot r_2 \qquad (1)$$

II-hol zaryadlanish uchun

$$U = \varepsilon_1 + I \cdot r_1 \qquad (2)$$

Bu ikkita formulani soddalashtiramiz

$$\begin{cases} \varepsilon_2 = U + I \cdot r_2 \\ U = \varepsilon_1 + I \cdot r_1 \end{cases} \to \begin{cases} I \cdot r_2 = \varepsilon_2 - U \\ I \cdot r_1 = U - \varepsilon_1 \end{cases}$$

$$\frac{I \cdot r_2}{I \cdot r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \to \frac{r_2}{r_1} = \frac{\varepsilon_2 - U}{U - \varepsilon_1} \to U = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 7V$$

II-yo‘l

Manbalarning mos qutblari ulanganligidan ularni parallel desak umumiy tok kuchi(qisqa tutashuv toklari) quyidagicha bo‘ladi.

$$I_{Um} = I_1 + I_2$$

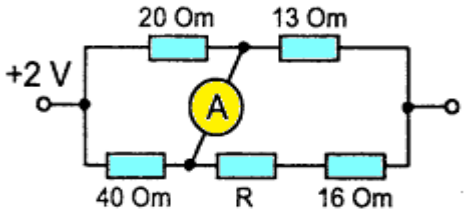
$$\frac{\varepsilon_{Um}}{r_{Um}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}; r_{Um} = \frac{r_1 \cdot r_2}{r_1 + r_2} \varepsilon_{Um} = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 7V$$

17. Zanjirning AB qismidagi kuchlanish 24 V, R_1=4 Ω va R_2=46 Ω . Ularning orasiga qarshiligi 110 Ω bo‘lgan voltimetr ulangan. Uning ko‘rsatishini toping.

Sxemada 3 ta qarshilik ketma-ket ulanganda umumiy kuchlanish,qarshilik vat ok kuchilar quyidagiga tengligidan voltimetr ko‘rsatgichini aniqlaymiz.

$$U_{AB} = U_1 + U_{Vol} + U_3 = 24V$$
$$R_{Um} = R_1 + R_{Vol} + R_3 = 160\Omega$$
$$I_{Um} = I_1 = I_{Vol} = I_3 = \frac{U_{AB}}{R_{Um}} = \frac{24}{160} = 0{,}15A$$
$$U_{Vol} = I_{Vol} \cdot R_{Vol} = 0{,}15 \cdot 110 = 16{,}5V$$

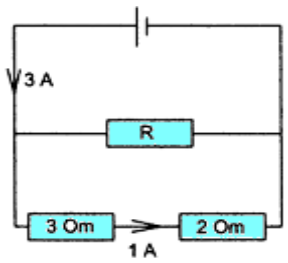
18. Rasmda ko‘rsatilgan sxemada ampermetrning ko‘rsatishi nol bo‘lishi uchun R qarshilik qanday bo‘lishi kerak.



Ampermetr ulangan nuqtalardagi potensiallar farqi nolga teng bo‘lsa ampermetr ulangan simdan tok o‘tmaydi buning uchun quyidagi tenglik o‘rtinli bo‘lishi kerak.

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \rightarrow \frac{20}{40} = \frac{13}{R+16} \rightarrow R = 10om$$

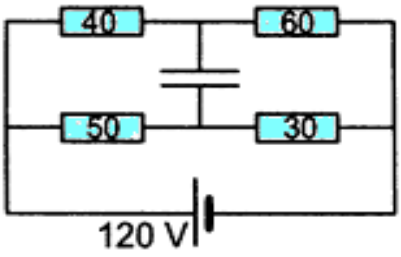
19. Rasmda berilgan ma’lumotlardan foydalanib, R rezistorning qarshiligini toping.



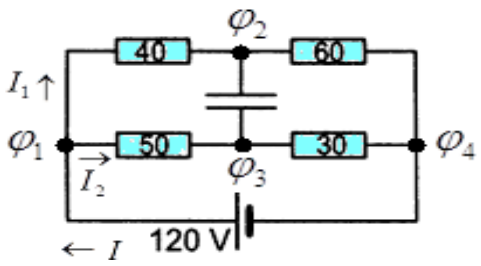
Krixgofning I-qoidasi va qarshiliklar paralelligidan quyidagi formulalarni yozamiz.

$$3 = I + 1 \rightarrow I = 2A$$
$$U_1 = U_2 \rightarrow I \cdot R = 1 \cdot (3+2) \rightarrow 2 \cdot R = 1 \cdot 5 \rightarrow R = 2{,}5om$$

20. Agar rasmda tasvirlangan elektr zanjirdagi kondensatorning qoplamalar orasidagi masofa 3 mm bo‘lsa, qoplamalar orasidagi elektr maydon kuchlanganligini toping.



1-rasm.



1,1-rasm.

Elektr maydon kuchlanganligini topish uchun bizga kondensator qoplamalar orasidagi potensiallar farqini bilishimiz kerak (φ_2- φ_3), buning uchun 1-rasmdagi sxemani quyidagi ko‘rinishda ifodalaymiz (1,1-rasm).
Endi Krixgofning 1-qoidasidan va qarshiliklarning paralellik shartidan (R_{12}//R_{34}) foydalanib tok kuchlarini topamiz

$$I = I_1 + I_2 R_{Um} = \frac{R_{12} \cdot R_{34}}{R_{12} + R_{34}} = \frac{100 \cdot 80}{100 + 80} = \frac{8000}{180} = \frac{400}{9}\Omega$$

$$I = \frac{U}{R_{Um}} = \frac{120}{\frac{400}{9}} = \frac{120 \cdot 9}{400} = \frac{1080}{400} = 2{,}7A$$

$$U_{12} = U_{34} \rightarrow U_1 + U_2 = U_3 + U_4$$

$$I_1 \cdot 40 + I_1 \cdot 60 = I_2 \cdot 50 + I_2 \cdot 30 \rightarrow 100I_1 = 80I_2 \rightarrow I_1 = 0{,}8I_2$$

$$0{,}8I_2 + I_2 = 2{,}7A \rightarrow I_2 = 1{,}5A; I_1 = 1{,}2A$$

Yuqoridagi natijalardan foydalanib har-bir qarshilikdagi kuchlanish tushuvlarini topamiz.

$$U_1 = I_1 \cdot 40 = 48V \qquad U_2 = I_1 \cdot 60 = 72V$$
$$U_3 = I_2 \cdot 50 = 75V \qquad U_4 = I_4 \cdot 30 = 45V$$

Kuchlanish tushuvlarini potensiallar farqi bilan ifodalaymiz

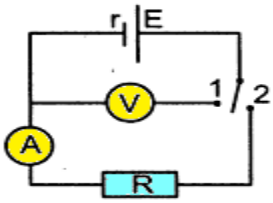
$$\begin{cases} \varphi_1 - \varphi_2 = U_1 = 48V \\ \varphi_2 - \varphi_4 = U_2 = 72V \\ \varphi_1 - \varphi_3 = U_3 = 75V \\ \varphi_3 - \varphi_4 = U_4 = 45V \end{cases}$$

Sistemani soddalashtirib $\varphi_2 - \varphi_3 = 27\ V$ kelib chiqadi

Kondensatorning elektr maydon kuchlanganligini quyidagicha topamiz

$$E = \frac{U}{d} = \frac{\varphi_2 - \varphi_3}{d} = \frac{27}{3 \cdot 10^{-3}} = 9 \cdot 10^3 V/m = 9kV/m$$

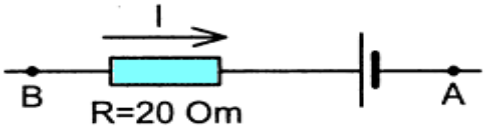
21. Ulagichlar birinchi holatida voltimetr 2 V ni ko‘rsatadi, ikkinchi holatida esa ampermetr 0,8 A ni ko‘rsatadi. Agar R=2 Om bo‘lsa, manbaning ichki qarshiligini toping.



Birinchi holatda manbaga tashqi qarshilik ulanmagani uchun voltimetr manbaning EYuK ni ko‘rsatadi. Ikkinchi holatda ampermetr umumiy tok kuchini ko‘rsatadi

$$I = \frac{\varepsilon}{R+r}; 0{,}8 = \frac{2}{2+r} \rightarrow r = 0{,}5\Omega$$

22. Rasmda ko‘rsatilgan zanjirning bir qismadagi EYuK i 8 V ga teng (r=0) va $\Delta\varphi_{AB} = 18V$ bo‘lsa , 5 minut ichida rezistordan qancha issiqlik ajrab chiqadi?



Rasmdan ko‘rinib turibdiki manba AB potensiallar farqi bilan zaryadlanmoqda. To‘liq zanjir uchun Om qonunini zaryadlanish uchun quyidagicha yoziladi

$$\Delta\varphi_{AB} = \varepsilon + I \cdot (R+r)$$

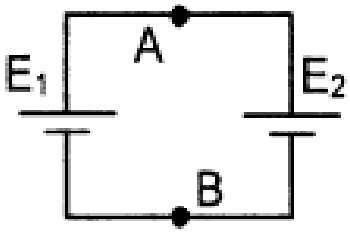
Bu tenglamadan I ni topamiz

$$18 = 8 + I \cdot (20+0) \rightarrow I = 0{,}5A$$

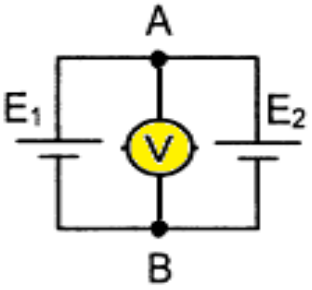
Topilgan natijalarni Jou-Lens qonuniga etib qo‘yamiz

$$Q = I^2 \cdot R \cdot t = (0{,}5)^2 \cdot 20 \cdot 300 = 1500J$$

23. Rasmda ko‘rsatilgan elektr zanjirda E_1=57 V va E_2=32 V. Agar r_1/r_2=1,5 bo‘lsa, A va B nuqtalar orasidagi potensiallar farqini toping.



1-rasm.



1,1-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,1-rasm).

I-yo‘l

$\varepsilon_2 < \varepsilon_1$ bo‘lganligi uchun ikkinchi manba zaryadlanadi, birinchi manba razryadlanadi(zaryadsizlanadi). Zanjirda tarmoqlanish yo‘qligi uchun toklar bir-xil bo‘ladi

To‘liq zanjir uchun Om qonunini ikkita hol uchun quyidagicha yozamiz
I-hol razryadlanish uchun

$$\varepsilon_1 = U + I \cdot r_1 \qquad (1)$$

II-hol zaryadlanish uchun

$$U = \varepsilon_2 + I \cdot r_2 \qquad (2)$$

Bu ikkita formulani soddalashtiramiz

$$\begin{cases} \varepsilon_1 = U + I \cdot r_1 \\ U = \varepsilon_2 + I \cdot r_2 \end{cases} \rightarrow \begin{cases} I \cdot r_1 = \varepsilon_1 - U \\ I \cdot r_2 = U - \varepsilon_2 \end{cases}$$

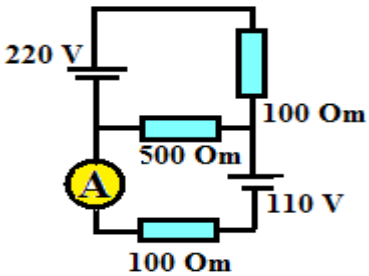
$$\frac{I \cdot r_1}{I \cdot r_2} = \frac{\varepsilon_1 - U}{U - \varepsilon_2} \rightarrow \frac{r_1}{r_2} = \frac{\varepsilon_1 - U}{U - \varepsilon_2} \rightarrow U = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 42V$$

II-yo‘l
Manbalarning mos qutblari ulanganligidan ularni parallel desak umumiy tok kuchi(qisqa tutashuv toklari) quyidagicha bo‘ladi

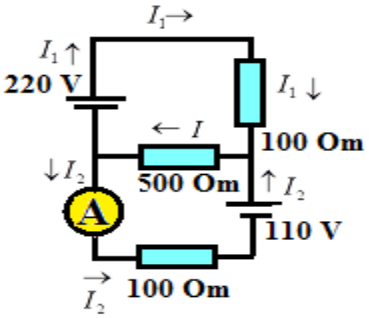
$$I_{Um} = I_1 + I_2$$

$$\frac{\varepsilon_{Um}}{r_{Um}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}; r_{Um} = \frac{r_1 \cdot r_2}{r_1 + r_2} \varepsilon_{Um} = \frac{r_1 \cdot \varepsilon_2 + r_2 \cdot \varepsilon_1}{r_1 + r_2} = 42V$$

24. Rasmda berilgan ma’lumotlardan foydalanib, ampermetrning ko‘rsatishini toping.
$\varepsilon_1 = 220V, \varepsilon_2 = 110V, R_1 = 100Om, R_2 = 100Om, R_3 = 500Om, r_1 = r_2 = 0$



1-rasm.



1,1-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 + I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + I_1 R_1 + I R_3 = \varepsilon_1, I_2 r_2 + I R_3 + I_2 R_2 = \varepsilon_2 \qquad (2)$$

1-tenglamadan I ni 2-tenglamaga keltirib qo‘ysak

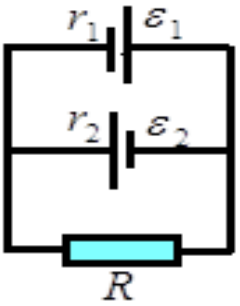
$$\begin{cases} I_1 r_1 + I_1 R_1 + (I_1 + I_2) R_3 = \varepsilon_1 \\ I_2 r_2 + (I_1 + I_2) R_3 + I_2 R_2 = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 100 + (I_1 + I_2) \cdot 500 = 220 \\ (I_1 + I_2) \cdot 500 + I_2 \cdot 100 = 110 \end{cases}$$

$$\begin{cases} 600 I_1 + 500 I_2 = 220 \\ 500 I_1 + 600 I_2 = 110 \end{cases} \rightarrow I_1 = 0{,}7A, I_2 = -0{,}4A$$

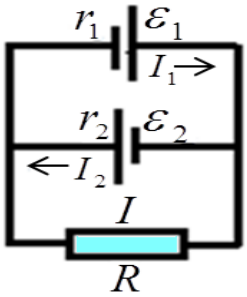
I_2 tok manfiy chiqishiga sabab I_2 tok yo‘nalishi biz tanlagan yo‘nalishga teskari harakatlanar ekan, lekin baribir Ampermter I_2 tokni o‘lchaydi.

25. Rasmda berilgan ma’lumotlardan foydalanib, 1 minut ichida rezistordan ajraladigan issiqlik energiyasini hisoblang.

$$\varepsilon_1 = 10V, \varepsilon_2 = 6V, R = 10Om, r_1 = 5Om, r_2 = 2Om, t = 60s$$



1-rasm.



1,1-rasm.

1-rasmdagi zanjirga o‘zgartirish kiritamiz(1,1-rasm). Kirxgofning birinchi qoidasini qo‘llab quyidagi tenglamani yozamiz

$$I = I_1 - I_2 \qquad (1)$$

Kirxgofning ikkinchi qoidasidan foydalanib berk konturlar uchun tegishli tenglama tuzamiz

$$I_1 r_1 + IR = \varepsilon_1, I_2 r_2 + IR = \varepsilon_2 \qquad (2)$$

1-tenglamadan I ni 2-tenglamaga keltirib qo‘ysak

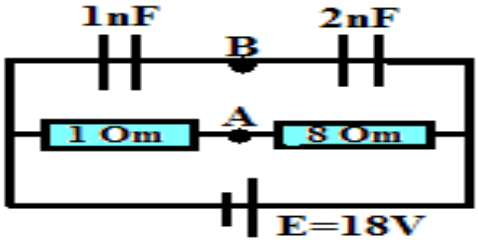
$$\begin{cases} I_1 r_1 + (I_1 - I_2)R = \varepsilon_1 \\ I_2 r_2 + (I_1 - I_2)R = \varepsilon_2 \end{cases} \rightarrow \begin{cases} I_1 \cdot 5 + (I_1 - I_2) \cdot 10 = 10 \\ I_2 \cdot 2 + (I_1 - I_2) \cdot 10 = 6 \end{cases}$$

$$\begin{cases} 15I_1 - 10I_2 = 10 \\ 10I_1 - 8I_2 = 6 \end{cases} \rightarrow I_1 = 1A, I_2 = 0{,}5A, I = I_1 - I_2 = 0{,}5A$$

Rezistordan ajralib chiqadigan issiqlik miqdorini Jou-Lens qonunidan topamiz

$$Q = I^2 \cdot R \cdot t = 0{,}5^2 \cdot 10 \cdot 60 = 150J$$

26. Rasmda ko‘rsatilgan zanjirdagi A va B nuqtalar orasidagi potensiallar farqini toping.



Rasmda ko‘rsatilgani kabi zanjir 2 ta o‘zaro parallel tarmoqdan iborat: pastki tarmoq o‘zaro ketma-ket ulangan 1 Om va 8 Om qarshilikka ega bo‘lgan rezistorlardan, yuqoridagi tarmoq o‘zaro ketma-ket ulangan 1 nF va 2 nF sig‘imli kondensatorlardan iborat. Har ikkala tarmoqdagi kuchlanishlar bir xil va 18 V ga teng.

Om qonuniga ko‘ra, har ikkala rezistordan o‘tayotgan tok kuchi teng, shuning uchun ulardagi kuchlanish tushuvlari ularning qarshiliklariga to‘g‘ri proporsional ravishda bo‘ladi:

x+8x=18 V 9x=18 V x=2 V

Shunda. 1 Om lik rezistordagi kuchlanish tushuvi x=2 V ga, 8 Om lik rezistordagi kuchlanish tushuvi 8x=16 V ga teng bo‘ladi. Kondensatorlar ketma-ket ulangani uchun ulardagi zaryadlar teng bo‘ladi. q=CU formulaga ko‘ra, ketma-ket ulangan kondensatorlardagi kuchlanish tushuvlari ularning sig‘imlariga teskari proporsional bo‘ladi:

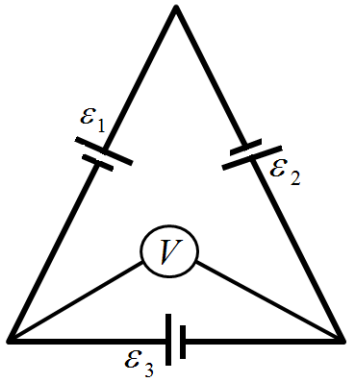
2y+y=18 V 3y=18 V y=6 V

Shunda, 1 nF sig‘imli kondensatordagi kuchlanish 2y=12 V ga, 2 nF sig‘imli kondensatordagi kuchlanish y=6 Vga teng bo‘ladi. Har bir elementdagi kuchlanish tushuvlarini bilgan hoida, A va B nuqtalardagi potensiallarni aniqlaymiz:

A nuqtaning potensiali 2 V, B nuqtaning potensiali 12 V. Demak bu ikki nuqta orasidagi potensiallar farqi (kuchlanish) 10 V ekan. Agar A va B nuqtalarga voltmetr ulaganimizda u 10 V ni ko‘rsatgan bo‘lar edi.

27. Rasmda keltirilgan ma’lumotlardan foydalanib, voltmetrning ko‘rsatishini toping.

$$\varepsilon_1 = 1V, \varepsilon_2 = 2V, \varepsilon_3 = 3V, r_1 = 3\Omega, r_2 = 2\Omega, r_3 = 1\Omega,$$



Uchta manba ketma-ket ulangan ulardan o‘tadigan umumiy tok kuchi

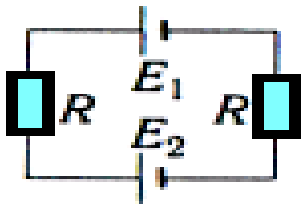
$$I = \frac{\varepsilon_1 + \varepsilon_2 + \varepsilon_1}{r_1 + r_2 + r_3} = \frac{1 + 2 + 3}{3 + 2 + 1} = 1A$$

Kirxgofning 2-qoidasini qo‘llab quyidagi tenglamani tuzamiz

$$I \cdot r_3 + U = \varepsilon_3 \rightarrow U = \varepsilon_3 - I \cdot r_3 = 3 - 1 \cdot 1 = 2V$$

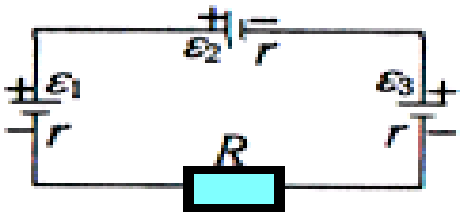
KIRXGOF QOIDALARIGA DOIR MUSTAQIL YECHISH UCHUN MASALALAR

1. Rasmda ko‘rsatilgan elektr zan-iirda E_1=6 V, E_2=18 V, R=3Ω. Manbalar ichki qarshilikka ega emas. Zanjirdagi tok kuchi necha amper?



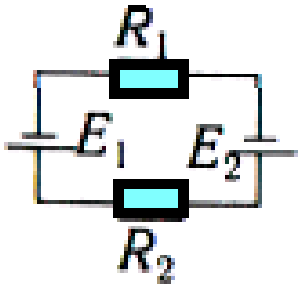
Javob: 2

2. E_1=5 V,E_2=3V,E_3=4 V, r=1Ω va R=7 Ω bo‘lsa, R qarshilikdagi kuch-lanishning tushishi necha volt bo‘iadi (rasmga q.)?



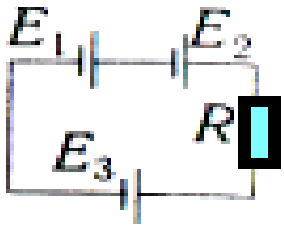
Javob: 1,4

3. Sxemada E_1=9 V, E_2=6 V va R_1/R_2=2 bo‘lsa, R_2 qarshilikdagi kuchlanish tushishi necha volt bo‘ladi? Manbalarning ichki qarshiliklari $r_1=r_2=0$



Javob:1

4. Rasmda ko‘rsatilgan zanjirdagi tok kuchi necha amperga Teng? E_1=E2=E3=6 V, $r_1=r_2=r_3$=0,5 Ω,R=1,5Ω.



Javob:2

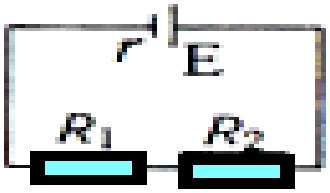
5. Uchta tok manbai va bitta qarshilikdan rasmda ko‘rsatilgandek zanjir tuzilgan. Agar E_1=3,5 V, E_2=1,5 V, E_3=2 V, $r_i=r_2=r_3$=0,2 Ω, va R=4,4 Ω bo‘lsa, R qarsnilikdan o‘tayotgan tok kuchi necha amper?

Javob: 0,8.

6. Sxemada ε_1=2V, ε_2=1 V, r_1=r_2=1 Ω,R=2 Ω. Tashqi qarshilikdagi kuchlanishning tushishmi toping (V).

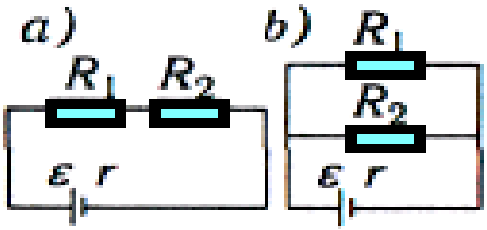
Javob:1,5

7. Keltirilgan sxemada EYK ε=9 V, ichki qarshilik r=1 Ω, R_1=3 Ω va R_2=5 Ω bo‘lsa, R_2qarshilikda 10 minut davomida tok qanday (kJ) ish bajaradi?



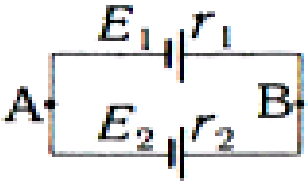
Javob:12

8. R_1=R_2=r bo‘lsa, a-sxemadan b-sxemaga o‘tganda, zanjirning tashqi qismidagi quvvat qanday o‘zgaradi?



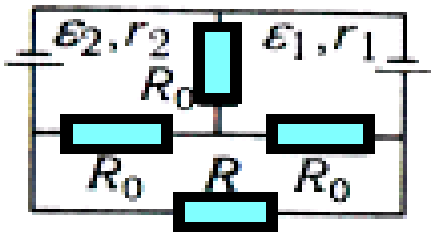
Javob: O‘zgarmaydi

9. Ichki qarshiligi r_2=3 Ω, EYKi E_2=4 V bo‘lgan batareya orqali o‘tadigan tok nolga teng bo‘lishi uchun A va B nuqtalar orasiga necha omli qarshilik ulash kerak? Bunda E_1= 6V, r_1=r_2.



Javob: 6

10. Qanday shartlar bajarilgan-da sxemadagi R qarshilikdan o‘tayotgan tok nolga teng bo‘ladi?



Javob: ε1=ε2, r_1=r_2

Ilovalar

1. Xalqaro sistema(SI)ning asosiy va qo‘shimcha birliklari

Kattalik	Birlik	
	nomi	belgisi
Asosiy birliklar		
Uzunlik	metr	m
Massa	kilogramm	kg
Vaqt	sekund	s
Elektr tokening kuchi	amper	A
Termodinamik harorat (temperatura)	kel`vin	K
Modda miqdori	mol`	mol`
Yorug`lik kuchi	kandela	kd
Qo‘shimcha birliklar		
Yassi burchak	radian	rad
Fazoviy burchak	steradian	sr

2. Asosiy fizik kattaliklar

Fizik kattaliklar	**Son qiymati**
Tortishish kuchi doimiysi γ	$6{,}67\cdot10^{-11}$ $m^3/kg\cdot sek^2$
1kmol dagi molekulalsr soni (Avogadro soni) N_0	$6{,}025\cdot10^{26}$ $kmol^{-1}$
Normal sharoitlarda *1 kmol'* ideal gazning hajmi V_0	22,4 m^3
Universal gaz doimiysi R	$8{,}31\cdot10^3$ j/kmol·grad
Bol‘sman doimiysi *k*	$1{,}38\cdot10^{-23}$ j/grad
Faradey soni F	$9{,}65\cdot10^7$ k/kg·ekv
Stefan –bolsman doimiysi ζ	$5{,}67\cdot10^{-8}$ bt/m^2grad^4
Plank doimiysi h	$6{,}625\cdot10^{-19}$k
Elektron zaryad *e*	$1{,}602\cdot10^{-19}$ k
Elektronning tich holatidagi massasi m_e	$9{,}11\cdot10^{-31}$kg=$5{,}49\cdot10^{-4}$m.a.b. (massa atom birligi)
Protonning tinch holatdagi massasi m_n	$1{,}672\cdot10^{-27}$kg=1,00759 m.a.b
Neytronning tinch holatdagi massasi m_n	$1{,}675\cdot10^{-27}$kg=1,00899 m.a.b
Yorug‘likning vakuumda tarqalish tezligi	$3{,}00\cdot10^8$m/sek

3. Ba’zi moddlarning dielektrik singdiruvchanligi

Anilin……..	84	Benzin……..	2,3
Bakuum……..	1	Suv……...	81
Marmar……...	8-9	Parafin……..	6
Rezina…….	2-3	Vodorod……...	1,0003
Mum……	5,8	Glitserin……	39
Kerosin……	2	Transformator moyi…….	2,2-2,5
Slyuda…….	6-9	Shisha……...	5-10
Chinni……..	4-7	Ebonit……...	2,7
Mo‘m.....	7,8	Kerosin.....	2
Moy.....	5	Slyuda.....	6
Parafinlangan qog‘oz…	2	Yoqut……...	2,8

4. Ba’zi moddalarning solishtirma qarshiligi (Om·m, $\cdot 10^{-8}$)

Alyuminiy……..	2,7	Volfram……	5,3
Temir…….	8,7	Oltin…….	2,2
Konstantan…….	47	Jez…….	6,3
Mis……..	1,7	Nikel…….	7,3
Nixrom…….	105	Qalay……...	11,3
Platina……..	10,5	Simob……	95,4
Qo‘rg‘oshin……..	20,2	Kumush……	1,58
Rux……	5,95	Po‘lat……	10,0
Grafit.....	39	Po‘lat.....	10

5. Ba’zi moddalarning temperaturaviy qarshilik koeffisienti (K^{-1})

Volfram……..	0,005	Konstantan……	0,000005
Nikilin……..	0,0001	Nixrom……	0,0002
Po‘lat……	0,006	Cho‘yan……	0,002
Alyuminiy……	0,004	Jez……...	0,002
Mis……	0,004	Qo‘rg‘oshin…….	0,004
Kumush…….	0,004	Pux……	0,004

6. Karrali ulushli birliklarnig old qo‘shimchalari

T	tera	10^{12}	d	detsi	10^{-1}	n	nano	10^{-9}
G	giga	10^{9}	s	santi	10^{-2}	p	piko	10^{-12}
M	mega	10^{6}	m	mili	10^{-3}	f	femto	10^{-15}
k	kilo	10^{3}	mk	mikro	10^{-6}	a	atto	10^{-18}

FOYDALANILGAN ADABIYOTLAR RO‘YXATI

1. O‘lmasova M.H. Fizika. Elektrodinamika asoslari. Tebranishlar va to‘lqinlar. 2- kitob. Akademik litseylar uchun o‘quv qo‘llanma. O‘qituvchi“ NMIU. 2004. – 360 b.

2. G‘aniyev A.G.Fizika (I-qism) Akademik litsey va kasb-hunar kollejlari uchun darslik. «o‘qituvchi» nashriyoti-matbaa ijodiy uyi. Toshkent-2021.-385 b.

3. Ismoilov M,Yunusov M Elementar fizika kursi: Oliy o‘quv yurtlariga kiruvchilar va mustaqil shug‘ullanuvchilar uchun spravochnik-qo‘llanma-T.: O‘qituvchi, 1990-488 b

4. Chertov A.G.,Vorobev A.A. Fizikadan masalalar to‘plami: Texnika oliygohlarining talabalari uchun o‘quv qo‘llanmasi,-ruscha qayta ishlangan va to‘ldirilgan 5-nashr, tark.-T,: O‘zbekiston. 1997.-604 b.

5. Abituriyent gazetasi 2001-2019 yilgi sonlari

6. Uzoqov A.A. Fizikadan testlar to‘plami (1996-2003)

7. Черноуцан А.И. Физика. Задачи с ответами и решениями: Учебное пособие. М:Книжный дом «Университет», 2001. -336 с.

8. Бессонов, Л . А . Б53 Теоретические основы электротехники. Электрические цепи: учебник для бакалавров / Л. А. Бессонов. -11-е изд., перераб. и доп.- М .: Издательство Юрайт, 2012. — 701 с.

9. Турчина Н. В.Физика в задачах для поступающих в вузы / Н. В. Турчина. — М.: ООО «Издательство Оникс»: ООО «Издательство «Мир и Образование», 2008. — 768 с.: ил.

10. М.С.Цедрик Пособие по физике для поступающих ва вузы.Изд. 2-е,стереоинное Под общ ред М.С.Цедрика. Минск,”Высшая школа”,1966.279 стр.

11. А.П.Рымкевича “Сборник задач по физике.”5-е изд.,стереотип.-М.: Дрофа,2004.-384с

12. Бендриков Г.А., Бухосвцев Б.Б., Керженцев В.В., Мякишев Г.Я. Задачи по физике для поступающих в вузы: Уче. Пособие для подгот. Отделений вузов.-10-е изд.-М.:Физматлит,2005.-344 с

13. Волькенштейн В.С. Сборник задач по общему курсу физики: Учебное пособие.-11-е изд.,перераб.-М.: Наука.Главная редакция физико-математической литературы, 1985.-384 с.

14. Sardor Berdiyev. “Innova Fizikadan testlar to‘plami” Toshkent-2022.-385 b.

Qaydlar uchun

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ELEKTR ZANJIR ELEMENTLARIGA DOIR MASALALAR YECHISH

O‘quv qo‘llanma

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