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PHYSICS

NEET and JEE Main 2020 : 45 Days Crash Course

Problem Solving Class
(Current Electricity, Capacitance)

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PQ15Q6

Two resistance **R** and **2R** are connected in parallel in an electric circuit. The thermal energy developed in **R** and **2R** are in the ratio

(A) 1 : 2

(B) 2 : 1

(C) 1 : 4

(D) 4 : 1

$P = \frac{V^2}{R}$

$P \propto \frac{1}{R}$

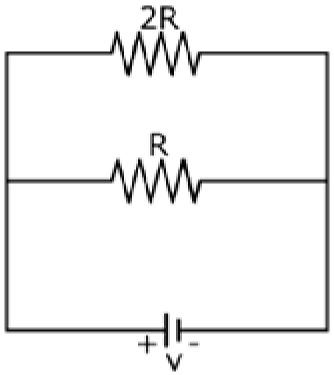
$\frac{P_1}{P_2} = \frac{2}{1}$

PQ15S6

Ans [B]

$$\text{Thermal energy developed} = \frac{V^2}{R}t$$

In parallel, voltage is same across the resistances.



$$\Rightarrow \frac{\text{Thermal energy developed in R}}{\text{Thermal energy developed in 2R}} = \frac{\left(\frac{V^2}{R}t\right)}{\left(\frac{V^2}{2R}t\right)} = \frac{2}{1}$$

PQ15Q7

The net resistance of a voltmeter should be large to ensure that

(A) it does not get overheated

(B) it does not draw excessive current

(C) it can measure large potential differences

(D) it does not appreciably change the potential difference to be measured

PQ15S7

Ans [D]

The net resistance of a voltmeter should be large to ensure that it does not appreciably change the potential difference to be measured.

$$\text{Measured potential difference, } V' = \left(\frac{V}{1+\frac{r}{R_v}}\right)$$

PQ15Q9

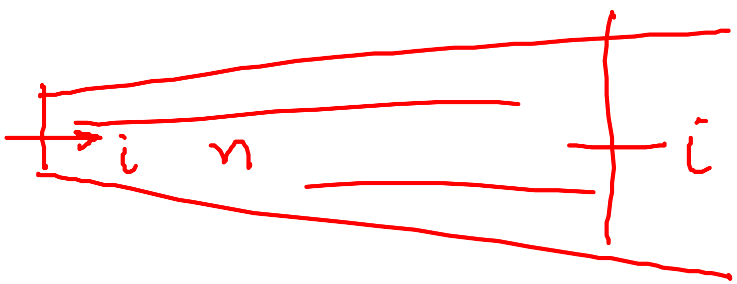
A current passes through a wire of non uniform cross-section. Which of the following quantities are independent of the cross-section?

(A) Free-electron density.

(B) The charge crossing in a given time interval

(C) Drift speed

(D) Both A and B



PQ15S9

Ans [D]

Free electron density is a property of the material.

Also the current does not depend on cross- section of the wire.

Drift speed will change as τ changes.

$$i = \frac{dQ}{dt}$$

$$\text{Drift speed } (v_d) = \frac{1}{2}\left(\frac{eE}{m}\right)\tau$$

PQ15Q13

Consider the following two statements:

(a) Kirchhoff's junction law follows from conservation of charge.

(b) Kirchhoff's loop law follows from conservative nature of electric field.

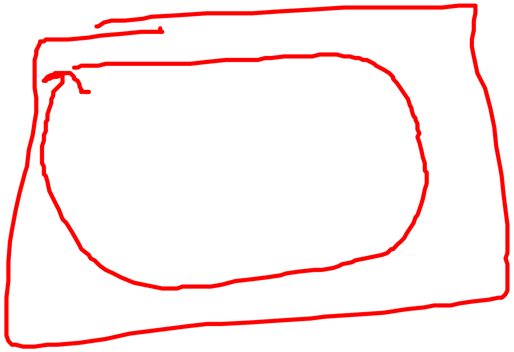
Energy cons.

(A) Both (a) and (b) are correct

(B) (a) is correct but (b) is wrong

(C) (b) is correct but (a) is wrong

(D) Both (a) and (b) are wrong



PQ15S13

Ans [A]

Kirchhoff's junction law ⇒ $$\sum_{\text{junction}} i = 0$$

Kirchhoff's loop law ⇒ $$\sum_{\text{closed loop}} \Delta V = 0$$

⇒ Kirchhoff's Junction Law follows from conservation of charge.

⇒ Kirchhoff's loop law follows from conservative nature of electric field.

PQ15Q14

A cylindrical wire is stretched to increase its length by 10%. The percentage increase in the resistance of the wire will be–

(A) 20% (B) 21%

(C) 22% (D) 24%

$l \rightarrow n$ times

$R \rightarrow n^2$ times

$R = \frac{\rho l}{A}$

$R' = \frac{\rho n l}{A/n}$

$= n^2 R$

$1.1\,l$

$(1.1)^2 R$

$1.21\,R$

$100 \rightarrow 21$

PQ15S14

Ans [B]

Let l_1 be the initial length of the wire. Then the new length will be

$$l_2 = \frac{110}{100} l_1 = \frac{11}{10} l_1$$

Since, the volume remains constant

Resistance(R) $= \frac{\rho l}{A}$

$$A_1 l_1 = A_2 l_2 \text{ or } A_1/A_2 = l_2/l_1 = \frac{11}{10}$$

(where A_1 and A_2 are initial and final area of cross– section of the wire).

If R_1 and R_2 are the initial and final resistances, then

$$\frac{R_1}{R_2} = \frac{l_1 A_2}{l_2 A_1} = \frac{10}{11} \times \frac{10}{11} = \left(\frac{10}{11}\right)^2 \text{ or } \frac{R_2}{R_1} = \left(\frac{11}{10}\right)^2$$

Now, percentage change in resistance is

$$\frac{\Delta R}{R_1} \times 100 = \left(\frac{R_2 - R_1}{R_1}\right) \times 100$$

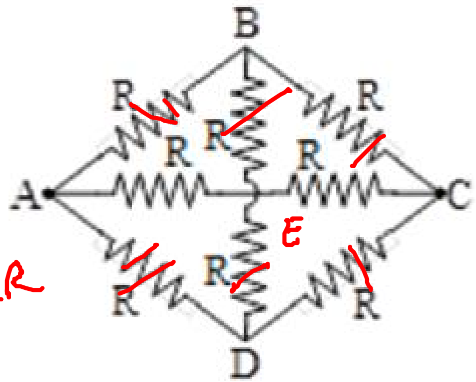
$$= \left[\left(\frac{11}{10}\right)^2 - 1\right] \times 100 = 21\%$$

PQ15Q15

The equivalent resistance between A and C is–

(A) 2R/3 (B) R/3

(C) R (D) 3R

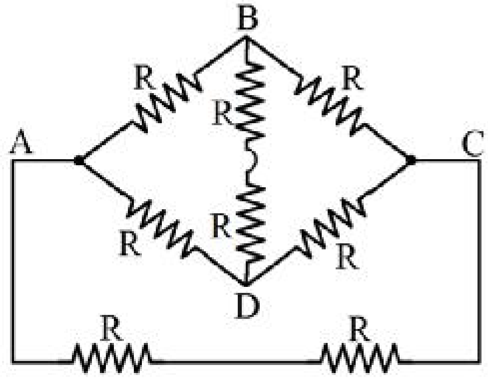


PQ15S15

Ans [A]

The circuit is equivalent to Fig. It is a balanced Wheatstone bridge between abcd, and then in parallel (2R) resistances. Thus ignoring resistance between bd arm.

The circuit is equivalent to three (2R) resistances in parallel



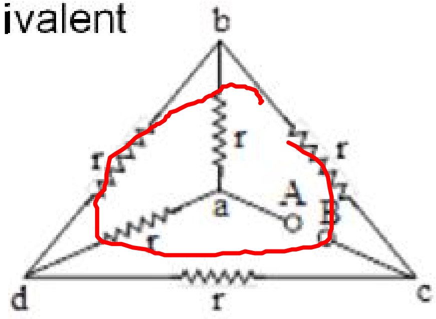
i.e. $\frac{1}{R_{eq}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{2R} = \frac{3}{2R}$

Þ $R_{eq} = \frac{2}{3}R$

Potential of B = Potential of D → No current through BD wire

PQ15Q16

In the adjoining network of resistors, each is of resistance r ohm, the equivalent resistance between points A and B is–

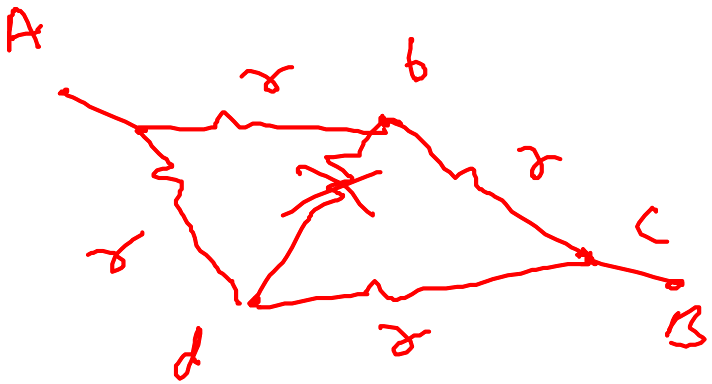


(A) 5r

(B) 2r/3

(C) r

(D) r/2



PQ15S16

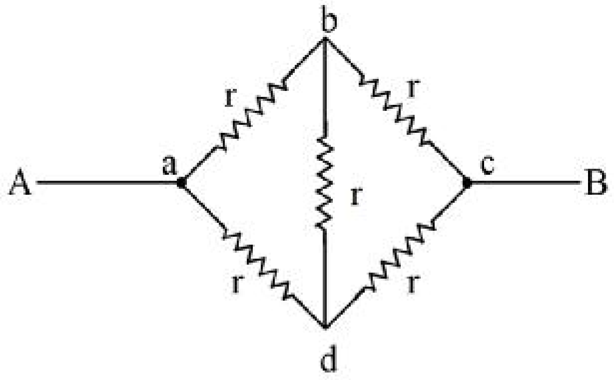
Ans [C]

Imagine, A being pulled on the left side, then abcd becomes a balanced Wheatstone bridge Fig. The arm bd can be ignored.

Then resistance between A, B becomes = r.

i.e. $\frac{1}{R_{eq}} = \frac{1}{2r} + \frac{1}{2r} = \frac{1}{r}$

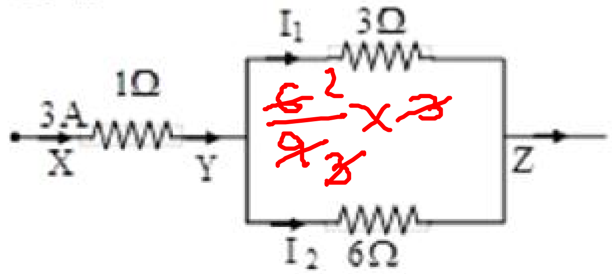
$\Rightarrow R_{eq} = r$



Potential of b = Potential of d → No current through bd wire

PQ15Q17

In the following fig. the ratio of current in 3Ω and 1Ω resistances is–



(A) $\frac{1}{3}$

(B) $\frac{2}{3}$

(C) 1

(D) 2

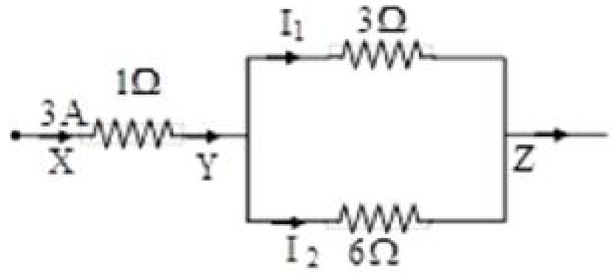
PQ15S17

Ans [B]

The current in 1Ω resistance is 3A. The current in 3Ω resistance is $I_1 = \frac{R_2}{R_1 + R_2} I$

$= \frac{6}{3+6} \times = 2A$

V = IR → $V_{YZ} = 3I_1 = 6I_2$



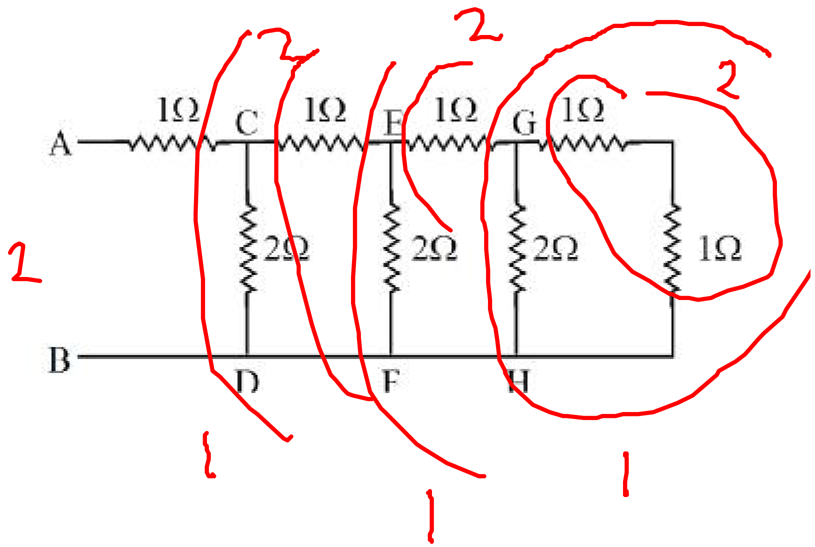
Therefore the ratio is $\frac{2}{3}$

PQ15Q18

The resultant resistance between the points A and B in the following diagram Fig. will be –

(A) 4Ω	(B) 8Ω

(C) 6Ω	(D) 2Ω



PQ15S18

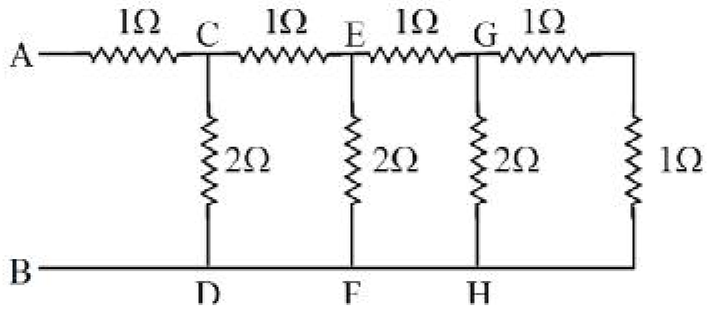
Ans [D]

R_{eq} about GH $\quad R_{GH} = \dfrac{2´\ 2}{2+4} = 1W$

R_{eq} about EF $\quad R_{EF} = \dfrac{2´\ 2}{2+2} = 1W$

R_{eq} about CD $\quad \dfrac{2´\ 2}{2+2} = 1W$

R_{eq} about AB $\quad 1 + 1 = 2W.$



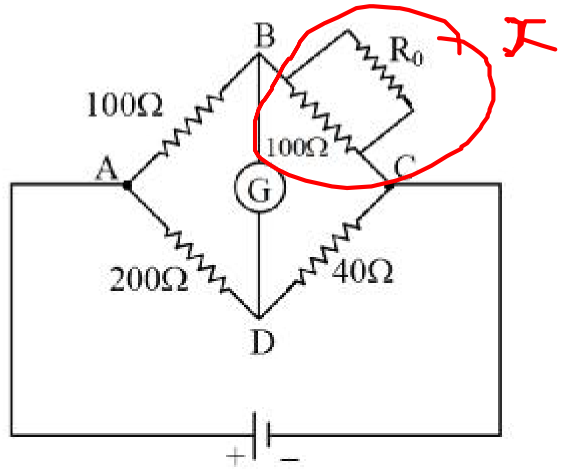
$R_{series} = R_1 + R_2$

$R_{parallel} = \dfrac{R_1 R_2}{R_1 + R_2}$

PQ15Q19

Fig. represents a balanced Wheatstone's Bridge.

The value of resistance R_0 will be–



(A) 25Ω ✓ (B) 30Ω

(C) 100Ω (D) 200Ω

$$\frac{100}{200} = \frac{x}{40}$$

$$x = 20\,\Omega$$

$$\frac{R_0 \times 100}{R_0 + 100} = 20$$

$$5R_0 = R_0 + 100$$

$$4R_0 = 100$$

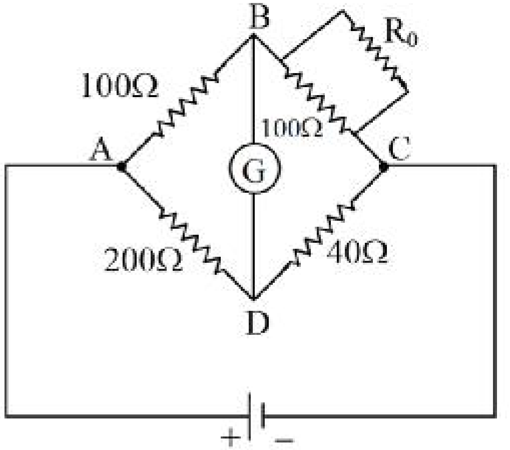
$$R_0 = 25\,\Omega$$

PQ15S19

Ans [A]

If P, Q, R, S are resistance of Wheatstone's Bridge, then in balanced position.

$\frac{P}{Q} = \frac{R}{S}$ Here P = 100Ω, R = 200Ω, S = 40Ω, Q = ?



$$\therefore Q = \frac{S}{R}, P = \frac{40}{200} \times 100 = 20\Omega$$

That is in arm BC, the net resistance should be 20Ω,

but the arm contains a combination of resistances 100Ω and RΩ

in parallel, therefore, we have

$$\frac{1}{20} = \frac{1}{100} + \frac{1}{R_0} \text{ or } \frac{1}{R_0} = \frac{1}{20} - \frac{1}{100}$$

$$= \frac{5-1}{20} = \frac{4}{100}$$

$$\therefore R_0 = \frac{100}{4} = 25\Omega$$

For Wheatstone's Bridge $\frac{R_{AB}}{R_{AD}} = \frac{R_{BC}}{R_{CD}}$

PQ15Q21

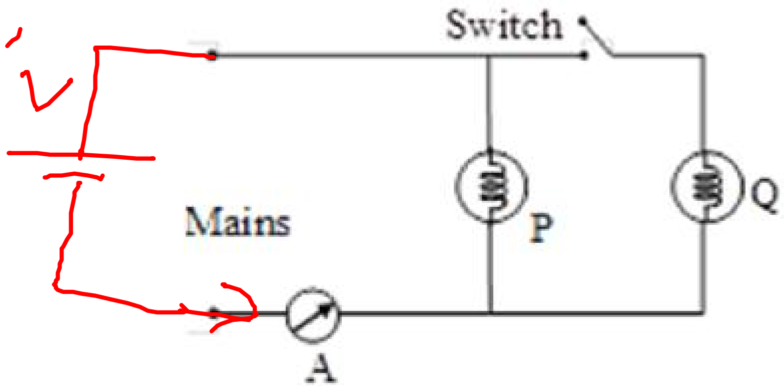
How will reading in the ammeter A of the fig. be affected if an other identical bulb Q is connected in parallel to P as shown. The voltage in the mains is maintained at constant value

(A) The reading will be reduced to one half.

(B) The reading will be double of previous one.

(C) The reading will not be affected.

(D) The reading will increase four fold.



$$I = \frac{V}{R_{eq}}$$

$$R_{eq-1} = R$$

$$R_{eq-2} = R/2$$

PQ15S21

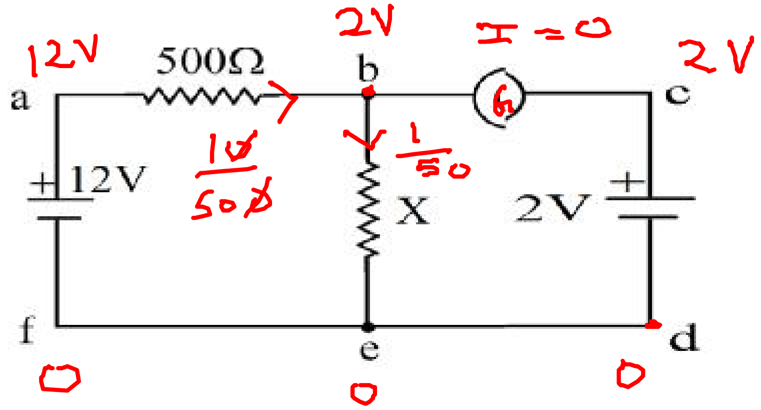
Ans [B]

Since Q is connected in parallel the net resistance becomes R/2, so the current I = 2V/R, double the value.

$$R_{parallel} = \frac{R_1 R_2}{R_1 + R_2}$$

PQ15Q22

In a circuit shown, the galvanometer G reads zero. If batteries have negligible internal resistances, the value of resistance X will be –



(A) 10Ω

(B) 100Ω

(C) 200Ω

(D) 500Ω

$V = IR$

$2 = \frac{1}{50} \times R_x$

$R_x = 100\Omega$

PQ15S22

Ans [B]

Since there is no current in edcb part, the p.d. across b, e should be 2V.

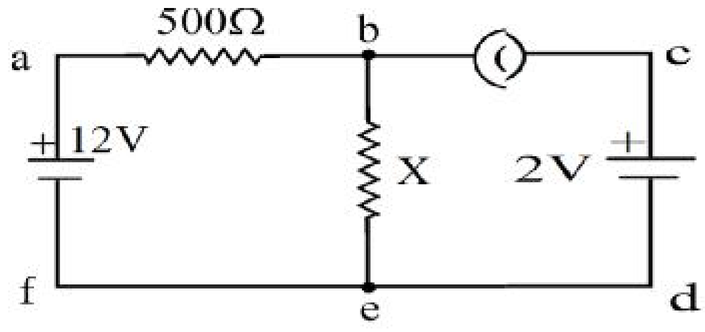
Let current in 500Ω is I, then same current flows through X (think).

$$\frac{12x}{500 + x} = 2$$

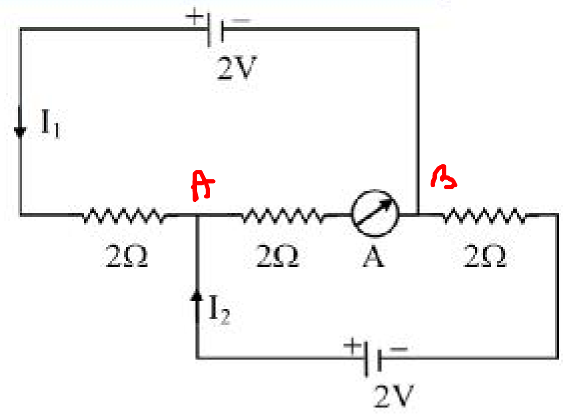
$$12x = 1000 + 2x$$

$$x = 100\Omega$$

V = IR → 12 = I(500 + x)



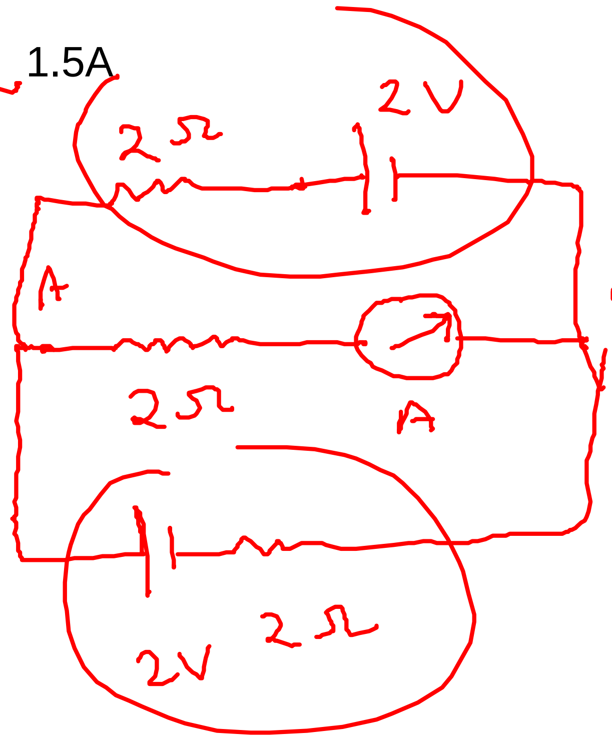
PQ15Q23

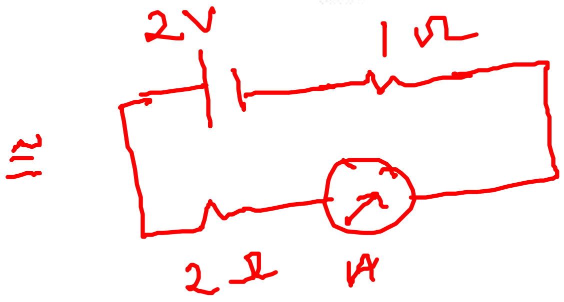


The reading in the ammeter is –

(A) 1A (B) 2A

(C) 0.67A (D) 1.5A





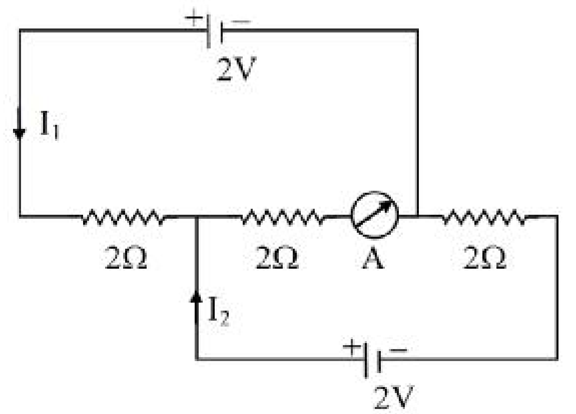
$\frac{2}{3}$

PQ15S23

Ans [C]

Let the current, in upper branch is I_1 and in lower branch I_2. The current in central resistance will be $I_1 + I_2$. Using Kirchhoff's laws. $2 = I_1 (2) + (I_1 + I_2) (2)$ upper branch $2 = I_2 (2) + (I_1 + I_2) (2)$ lower branch adding $4 = 2(I_1 + I_2) + 4(I1 + I_2)$ or $I_1 + I_2 = 4/6 = 2/3$ ampere. = 0.67 ampere

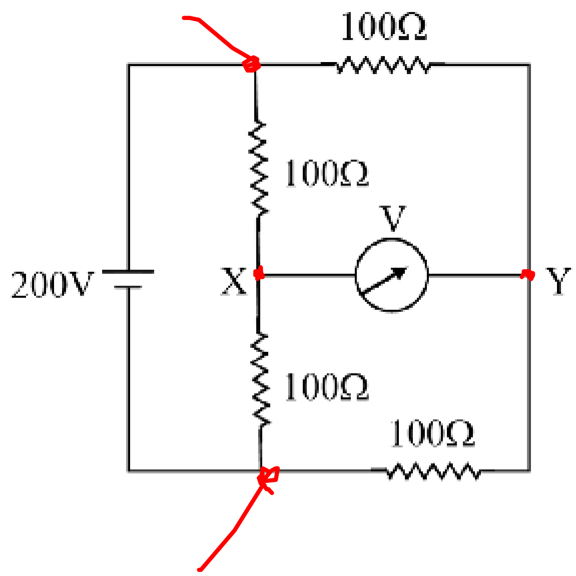
Kirchhoff's Law (junction rule) = Algebraic sum of the currents at a junction in a circuit is zero



PQ15Q25

The potential difference between the points X and Y in the adjoining diagram Fig. will be–

(A)	Zero	(B)	50V
(C)	10V	(D)	100V



$V_x = V_Y$

PQ15S25

Ans [A]

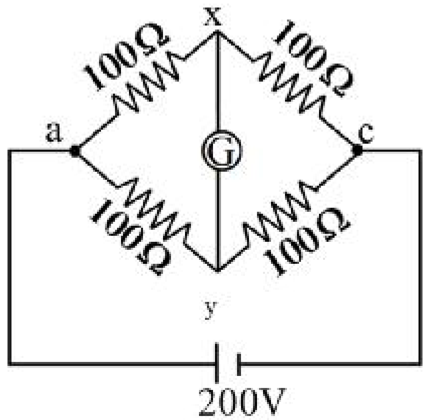
Equivalent circuit can be reduced as follows

Because $\frac{P}{Q} = \frac{R}{S}$

\ $V_X = V_Y$

\ $V_X - V_Y = 0$

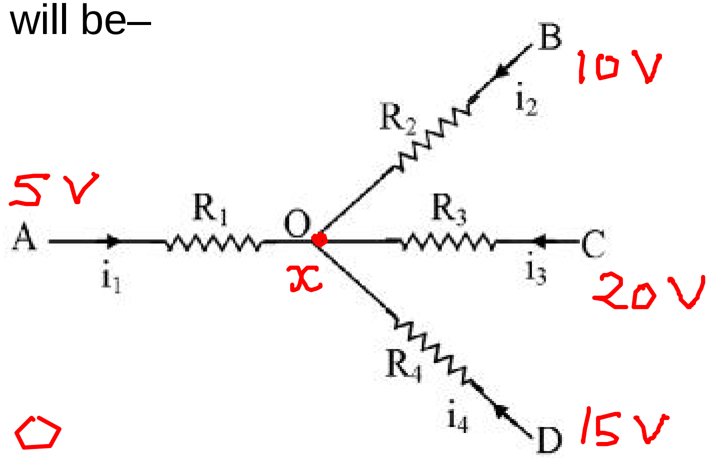
\ the reading of voltmeter will be zero.



For Wheatstone's Bridge $\frac{R_{ax}}{R_{ay}} = \frac{R_{xc}}{R_{cy}}$

PQ15Q26

In the adjoining diagram $R_1 = 10\Omega$, $R_2 = 20\Omega$, $R_3 = 40\Omega$, $R_4 = 80\Omega$ and $V_A = 5V$, $V_B = 10V$, $V_C = 20V$, $V_D = 15$ V. The current in the resistance R_1 will be–



(A) 0.4 A towards O

(B) 0.4 A away from O ✓

(C) 0.6 A towards O

(D) 0.6 A away from O

$$i_1 + i_2 + i_3 + i_4 = 0$$

$$\frac{5-x}{10} + \frac{10-x}{20} + \frac{20-x}{40} + \frac{15-x}{80} = 0$$

$$40 - 8x + 40 - 4x + 40 - 2x + 15 - x = 0$$

$$135 = 15x \Rightarrow \boxed{x = 9V}$$

$$i_1 = \frac{9-5}{10} = 0.4 \text{ away from O}$$

PQ15S26

Ans [B]

$i_1 + i_2 + i_3 + i_4 = 0$

Þ $\dfrac{V_O - V_A}{R_1} + \dfrac{V_O - V_B}{R_2} + \dfrac{V_O - V_C}{R_3} + \dfrac{V_O - V_D}{R_4} = 0$

Þ $\dfrac{V_O - 5}{10} + \dfrac{V_O - 10}{20} + \dfrac{V_O - 20}{40} + \dfrac{V_O - 15}{80} = 0$

or $V_O = 9$ volt

$i_1 = \dfrac{9 - 5}{10} = 0.4$ A away from O

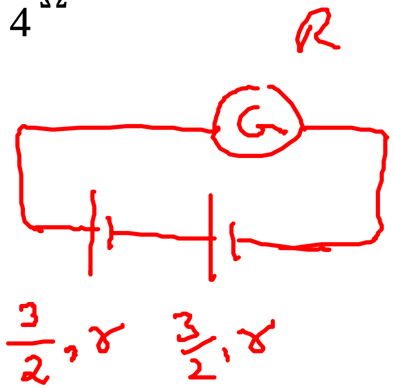
Kirchhoff’s Law (junction rule) = Algebraic sum of the currents at a junction in a circuit is zero

PQ15Q28

A galvanometer together with an unknown resistance in series is connected across two identical batteries of each 1.5 V. When the batteries are connected in series, the galvanometer records a current of 1 A and when the batteries are connected in parallel, the current is 0.6 A. The internal resistance of the battery will be–

(A) $\frac{1}{2}\Omega$ (B) $\frac{1}{3}\Omega$

(C) $\frac{1}{4}\Omega$ (D) $\frac{1}{5}\Omega$



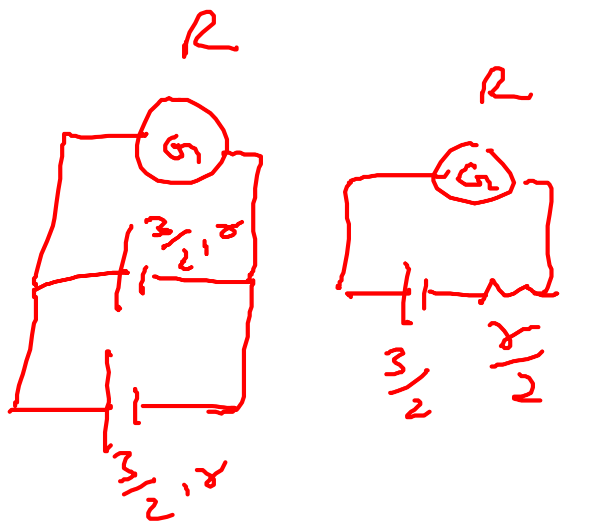
$\frac{3}{R+2r} = 1$

$R + 2r = 3$ — (1)

$2(3 - 2r) + r = 5$

$6 - 4r + r = 5$

$3r = 1$



$\frac{3/2}{R + \frac{r}{2}} = 0.6$

$\frac{5 \cdot 3}{2R + r} = ~~0.6~~ \Rightarrow 2R + r = 5$ — (2)

PQ15S28

Ans [B]

Let R be the combined resistance of galvanometer and an unknown resistance and r the internal resistance of each battery. When the batteries, each of e.m.f. E are connected in series, the net e.m.f. = 2E and net internal resistance = 2r

$\therefore$ Current $i_1 = \dfrac{2E}{R + 2r}$ or $1.0 = \dfrac{2 \times 15}{R + 2r}$

$\therefore R + 2r = 3.0$ ...(1)

When the batteries are connected in parallel, the e.m.f. remains E and net internal resistance becomes r/2.

therefore

Current $i_2 = \dfrac{E}{R + \frac{r}{2}} = \dfrac{2E}{2R + r}$

$\therefore 2R + R = \dfrac{2E}{i_2} = \dfrac{2 \times 1.5}{0.6} = 5.0$ ...(2)

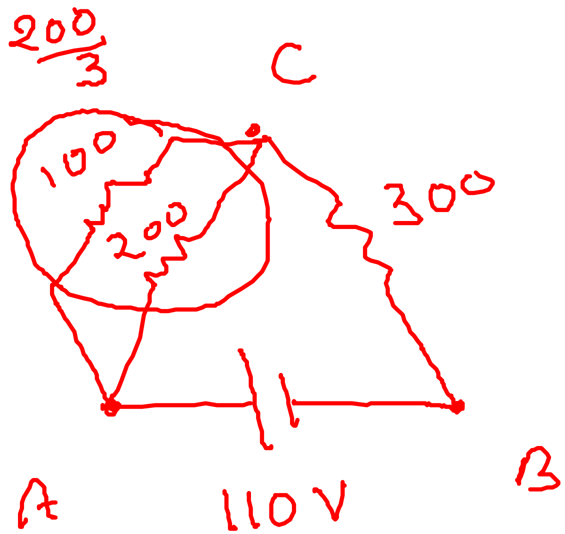
Solving (1) and (2), we get $r = \dfrac{1}{3}\Omega$

PQ15Q31

Two points A and B are maintained at a constant potential difference of 110 volt. A third point is connected to A by two resistances of 100 and 200 ohm in parallel, and to B by a single resistance of 300 ohm. Find the current in circuit.

(A) 0.1 A (B) 0.3 A

(C) 0.7 A (D) 0.5 A



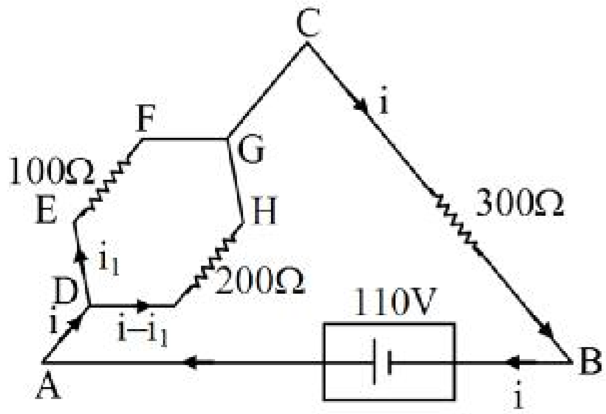
$$R_{eq.} = \frac{200}{3} + 300 = \frac{1100}{3}$$

$$I = \frac{V}{R_{eq}} = \frac{110}{1100/3} = \frac{3}{10} = 0.3\,A$$

PQ15S31

Ans [B]

The circuit with current distribution is shown in fig.



$$I = \frac{110}{300 + \frac{200 \times 100}{300}}$$

I = 0.3 A

$$R_{series} = R_1 + R_2$$

$$R_{parallel} = \frac{R_1 R_2}{R_1 + R_2}$$

PQ15Q46

An electric tea kettle has two heating coils. When one the coils is switched on, the kettle begins to boil in 6 minutes. When the other is switched on, the boiling begins in 8 minutes. In what time will the boiling begin if both coils are switched on simultaneously in series?

(A) 14 min (B) 12 min

(C) 16 min (D) 10 min

Heat req. = same

Pt = same

$$\frac{V^2}{R_1}\times 6 = \frac{V^2}{R_2}\times 8$$

$$3R_2 = 4R_1$$

$$\frac{V^2}{R_1+R_2}\cdot t = \frac{V^2}{R_1}\times 6$$

$$\frac{1}{R_1+\frac{4R_1}{3}}\cdot t = \frac{1}{R_1}\times 6$$

$$\frac{3}{7R_1}\,t = \frac{1}{R_1}\times 6$$

$x = 14$ min.

PQ15S46

Ans [A]

Let R_1 and R_2 be the resistances of the coils, V the supply voltage, Q the heat required to boil the water.

Heat produced by first coil of resistance R_1 in time t_1 (= 6 min)

$$Q = \frac{V^2 t_1}{JR_1} = \frac{V^2 \times 6 \times 60}{4.2R_1} \text{cal} \qquad \text{......(A)}$$

Heat produced in second coil of resistance R_2 in time t_2 (= 8 min)

$$= Q = \frac{V^2 t_1}{JR_2} = \frac{V^2 \times 6 \times 60}{4.2R_2} \qquad \text{.....(B)}$$

Equating (A) and (B), we get

$$\frac{6}{R_2} = \frac{8}{R_2} \text{ i.e. } \frac{R_2}{R_1} = \frac{8}{6} = \frac{4}{3}$$

or $R_2 = R_1$ .....(C)

When the two heating coils are in series, the effective resistance is

$$R' = R_1 + R_2 = R_1 + \frac{4}{3}. R_1 = \frac{7}{3} R_1$$

with two coils in series, let the kettle take t' time to boil. The.

$$Q = \frac{V^2 t'}{JR'} = \frac{V^2 t'}{4.2 \times \left(\frac{7}{3} R_1\right)} \qquad \text{.....(D)}$$

Comparing (A) and (D), we get $\frac{t'}{\left(\frac{7}{3}\right)} = 6 \times 60$ or

$$t' = \frac{7}{3} \times 6 \times 60 \text{ sec} = 14 \text{ min}$$

Heat produced coil of resistance R in time t is $Q = \frac{V^2 t}{JR}$

PQ15Q48

A 10 m long nichrome wire having 80 Ω resistance, has current carrying capacity of 5 A. What is the power which can be obtained as heat by the wire from a 200 V mains supply ? If the wires are cut in two equal parts and connected in such a way that it gives maximum power. What is the arrangement to obtain maximum power?

(A) 50 W, 200 W ✗

(B) 500 W, 2000 W ✓

(C) 50 W, 100 W ✗

(D) 500 W, 1000 W

$P = \frac{V^2}{R} = \frac{200 \times 200}{80} = 500\,W$

$R' = 40\,\Omega$

$R' = 40\,\Omega$

$R_{eq.} = 20\,\Omega = \frac{R}{4}$

$P' = 4P = 2000\,W$

PQ15S48

Ans [B]

If the wire is connected as such across the battery, then current in wire,

$I = \frac{V}{R} = \frac{200}{80}$ = 2.5 A and power obtained,P = $\frac{V^2}{R} = \frac{200 \times 200}{80}$ = 500 watts.

The wire can carry maximum current of 5 A, therefore to double the current, the resistance should be halved. Thus if we divide the wire in two parts and the two parts are connected in parallel across 200 V mains supply, the resistance of each part = 40Ω, therefore current in each wire = $\frac{200}{40}$ = 5A.

Power obtained $= \frac{V^2}{R}$

Net resistance, R' = $\frac{R_1R_2}{R_1+R_2} = \frac{40\times40}{40+40}$ =20Ω

and new power obtained, Pmax $= \frac{V^2}{R'}$

$= \frac{200 \times 200}{20}$ = 2000 Watts.

Thus maximum power is 2000 watts and this is obtained when wire is cut in two halves and they are connected in parallel across the given supply.

PQ15Q49

A heating–coil of 2000 watt is immersed in an electric kettle. The time taken in raising the temperature of 1 litre of water from 4°C to 100°C will be– (Only 80% part of the thermal energy produced is used in raising the temperature of water.) [Use, 1 calorie = 4.2 J]

(A) 252 s

(B) 250 s

(C) 245 s

(D) 247 s

Heat = $ms\Delta T$

$\frac{80}{100} \times 2000 \times t = 1000 \times 1 \times \frac{4.2}{8} \times 96$

$t = \frac{4.2 \times 96 \times 100}{80 \times 2} = 42 \times 6$

PQ15S49

Ans [A]

We know that the relation between work and heat produced is

W = JH

$\Rightarrow$ P.t = J. $ms\Delta\theta$

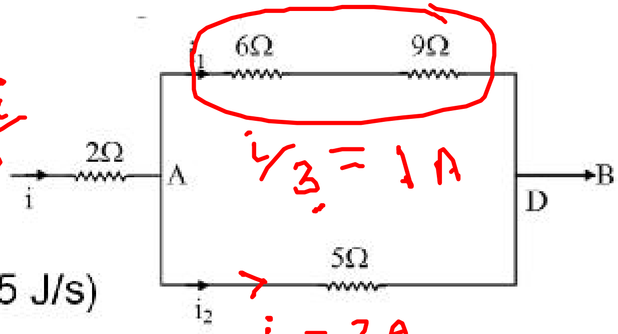
$$\Rightarrow \frac{80}{100} \times 2000.\, t = 4.2 \times 1000 \times 1\ x \times (100-4)$$

$$t = \frac{42 \times 1000 \times 96 \times 1000}{2000 \times 80} = 252 \text{ sec.}$$

Heat produced coil of resistance R in time t is $Q = \frac{V^2 t}{JR}$

PQ15Q50

In the following figure the rate of heat generated in 2 ohm resistor and potential differents across 6 ohm resister will be respectively–



(Heat generated in 5 ohm resistor due to current flowing in it is 45 J/s)

(A) 32 J/s, 6V

(B) 16 J/s, 3V

(C) 8 J/s, 1V

(D) 64 J/s, 12V

PQ15S50

Ans [A]

Rate of Heat generated $= i^2R$

Let current in 5 Wis i_2 then $P = i_2^2 R_2$

Þ $45 = i_2^2 \times 5$ or $i_2 = 3$ amp

Since $\dfrac{i_1}{i_2} = \dfrac{R_2}{R_1} = \dfrac{5}{15} = \dfrac{1}{3}$

\ $i_1 = 1$ amp

The total current through 2Wresistor is

$i = i_1 + i_2 = 3 + 1 = 4$ amp.

The rate of heat generation in 2Wresistor is $= i^2R$

$= 4^2 \times 2 = 32$ joule/sec.

Potential difference across 6Wresistor is

$V = i_1 \times 6$

$= 1 \times 6$

$= 6$ volt.

PQ15Q51

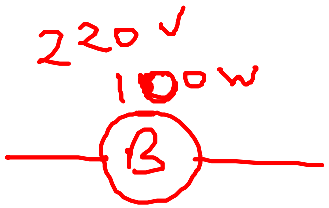
A 220 volt 100 watt bulb is connected to a 110 volt source. The power consume by the bulb will be –

(A) 25 W

(B) 20 W

(C) 484 W

(D) 120 W



$R_{bulb} = \frac{V^2}{P}$ (V: Rated voltage; P: Rated Power)

$P = \frac{V^2}{R}$

$V' = V/2$

$P' = \frac{P}{4} = 25\text{ W}$

PQ15S51

Ans [A]

Resistance of the bulb $R = \frac{V^2}{P} = \frac{220 \times 220}{100}$

Rate of Heat generated (P) = i^2R

The new power for the voltage of 110 volt is

$P' = \frac{V'^2}{R}$

$= \frac{110 \times 110}{484}$

= 25 watt.

PQ15Q52

An electric motor whose resistance is 2 ohm is started with a supply of 110 volt. It takes 10 ampere current at its full speed. The electric power consumed and part of the power used in mechanical work will be respectively–

(A) 900 W, 82%

(B) 800 W, 80%

(C) 200 W, 62%

(D) None of the above.

PQ15S52

Ans [A]

Power of the motor = VI = 110 × 10 = 1100 watt

Heat loss in the motor = $i^2R = (10)^2 \times 2 = 200$ watt

∴ Power converted to mechanical work = (1100 – 200) watt = 900 watt

∴ Percentage of total power consumed in mechanical

work = (900/1100) × 100 = 82% (approx.).

Power of the motor = VI

Rate of Heat loss in the motor = i^2R

PQ15Q54

A wire of resistance 0.1 ohm cm^{-1} bent to form a square ABCD of side 10 cm. A similar wire is connected between the corners B and D to form the diagonal BD. Find the effective resistance of this combination between corners A and C. If a 2 V battery of negligible internal resistance is connected across A and C calculate the total power dissipated.

(A) 2 watt

(B) 4 watt

(C) 8 watt

(D) 6 watt

PQ15S54

Ans [B]

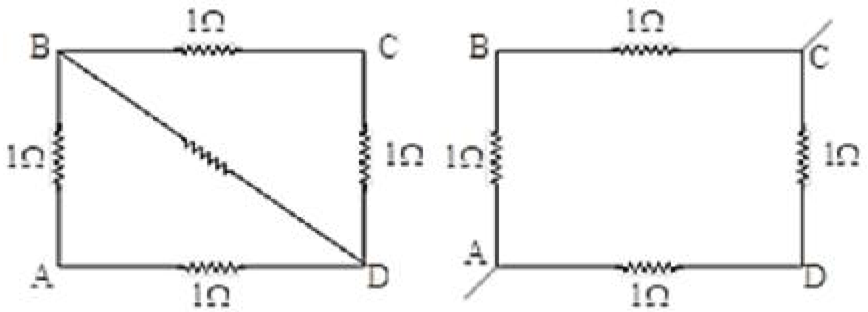
In fig (a). A square of 10 cm side is shown. The resistance of each side is 10 $\times$ 0.1 = 1 ohm. The corners B and D also connected by the same wire. The square forms a Wheatstone's bridge because the condition P/Q = R/S is satisfied. Now no current will flow through BD. The fig has the form as shown in fig (b).

Resistance of ABC part = 1 + 1 = 2 ohm (They are in series

For Wheatstone's Bridge $\frac{R_{AB}}{R_{AD}} = \frac{R_{BC}}{R_{CD}}$

Resistance of ADC part = 1 + 1 = 2 ohm.

Now the two parts are in parallel corresponding to points A and C, hence effective resistance R is given by –



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

$\therefore$ R = 1 ohm

When 2V battery is connected between A and C, the current.

$$i = \frac{E}{R} = \frac{2}{1} = 2 \text{ amp}$$

Power dissipated P = E_i = 2 $\times$ 2 = 4 watt

PQ15Q55

Three equal resistors connected in series across a source of e.m.f together dissipate 10 watt of power. What would be the power dissipated if the same resistors are connected in parallel across the same source of e.m.f?

(A) 30 watt

(B) 50 watt

(C) 90 watt

(D) 70 watt

PQ15S55

Ans [C]

Let R be the resistance of each resistor.

When they are connected in series, the total resistance = R + R + R = 3R ohm.

∴ Power dissipated $W_1 = E^2/3R$, where E = e.m.f of the source.

When the resistors are connected in parallel, their effective resistance is given by

$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} \text{ or } R' = \frac{R}{3}$$

Rate of Heat generated (P) $= \frac{V^2}{R}$

∴ Power dissipated $W_2 = \frac{E^2}{\frac{R}{3}} = \frac{3E^2}{R}$

Now, $\frac{W_1}{W_2} = \frac{3E^2}{R} \times \frac{3R}{E^2} = 9$

or W2 = 9W1 = 9 × 10 = 90 watt (∵ W_1 = 10 watt)

P-Q1653

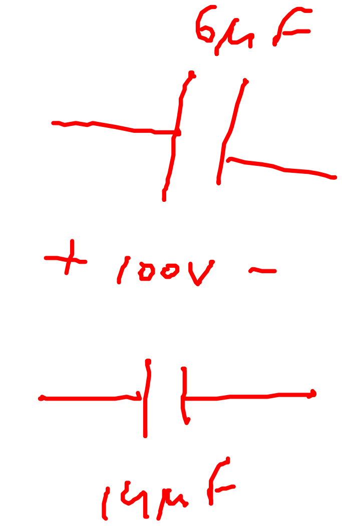
A condenser having a capacity of $6\mu F$ is charged to 100 V and is then joined to an uncharged condenser of $14\,\mu F$ and then removed. The ratio of the charges on $6\mu F$ and $14\mu F$ and the potential of $6\mu F$ will be

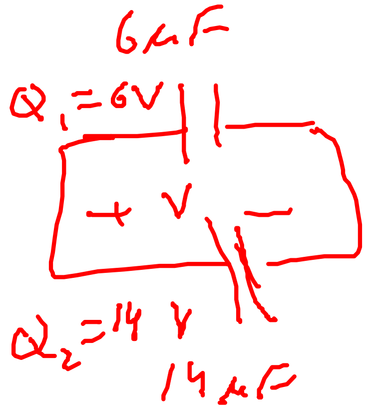
(a) $\frac{6}{14}$ and 50 *volt*

(b) $\frac{14}{6}$ and 30 *volt*

(c) $\frac{6}{14}$ and 30 *volt* ✓

(d) $\frac{14}{6}$ and 0 *volt*





$$V' = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

$$= \frac{6 \times 100 + 0}{20} = 30V$$

$$\frac{Q_1}{Q_2} = \frac{6}{14}$$

P-Q1653-Solution

Ans [C]

Let q_1, q_2 be the charges on two condensers

$$\therefore \; V = \frac{q_1}{6} = \frac{q_2}{14} \Rightarrow \frac{q_1}{q_2} = \frac{6}{14} = \frac{3}{7}$$

Both are joined in parallel so potential is same

$$\text{Also } q_1 + q_2 = 600 \Rightarrow q_1 + \frac{14}{6} q_1 = 600 \Rightarrow q_1 = \frac{600}{20} \times 6$$

Total charge form initial conditions is same

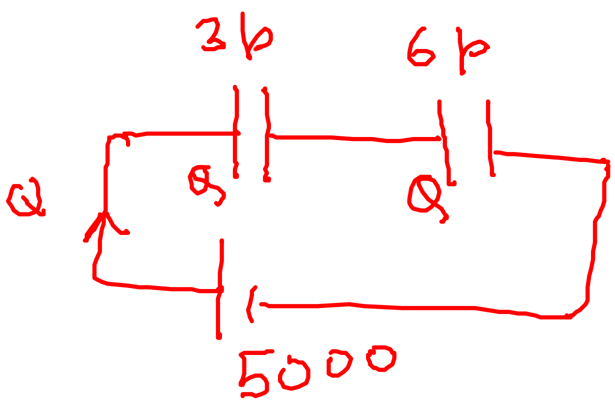
$$\therefore \; V = \frac{q_1}{6} = \frac{600}{20} = 30 \text{ volt}$$

P-Q1654

Two capacitors of $3pF$ and $6pF$ are connected in series and a potential difference of 5000 V is applied across the combination. They are then disconnected and reconnected in parallel. The potential between the plates is

(a) 2250 V (b) 2222 V

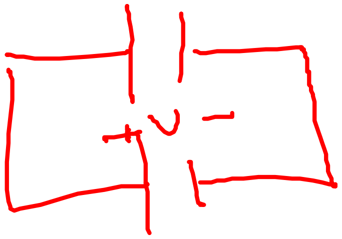
(c) $2.25 \times 10^6\ V$ (d) $1.1 \times 10^6\ V$



$C_{eq.} = \frac{3 \times 6}{3+6} = 2pF$

$Q = C_{eq.} V = 2 \times 10^{-12} \times 5000$

$= 10 \times 10^{-9}\ C$



$V = \frac{Q_1 + Q_2}{C_1 + C_2}$

$= \frac{2 \times 10 \times 10^{-9}}{9 \times 10^{-12}} = \frac{20 \times 10^3}{9}$

$= 2.222 \times 10^3$

P-Q1654-Solution

Ans [B]

$$\frac{1}{C}=\frac{1}{3}+\frac{1}{6} \Rightarrow C=2\ pF$$

Equivalent capacitor in series

$$\text{Total charge} = 2\times10^{-12}\times5000 = 10^{-8}\ C$$

Total charge in series

The new potential when the capacitors are connected in parallel is

$$V=\frac{2\times10^{-8}}{(3+6)\times10^{-12}}=2222\ V$$

P-Q1655

A capacitor $4\,\mu F$ charged to 50 V is connected to another capacitor of $2\,\mu F$ charged to 100 V with plates of like charges connected together. The total energy before and after connection in multiples of $(10^{-2}\,J)$ is

(a) 1.5 and 1.33

(b) 1.33 and 1.5

(c) 3.0 and 2.67

(d) 2.67 and 3.0

P-Q1655-Solution

Ans [B]

The total energy before connection

By individual potential

$$= \frac{1}{2} \times 4 \times 10^{-6} \times (50)^2 + \frac{1}{2} \times 2 \times 10^{-6} \times (100)^2$$

$$= 1.5 \times 10^{-2} J$$

When connected in parallel

$$4 \times 50 + 2 \times 100 = 6 \times V \Rightarrow V = \frac{200}{3}$$

Total charge is balance
à New potential

Total energy after connection

$$= \frac{1}{2} \times 6 \times 10^{-6} \times \left(\frac{200}{3}\right)^2 = 1.33 \times 10^{-2} J$$

P-Q1662

The energy stored in a condenser of capacity C which has been raised to a potential V is given by

(A) $\frac{1}{2}CV$

(B) $\frac{1}{2}CV^2$

(C) CV

(D) $\frac{1}{2VC}$

P-Q1662-Solution

Ans [B]

$$U = \int_0^V CV\, dV = \frac{1}{2} CV^2$$

Energy stored in a capacitor

P-Q1664

A condenser of capacity $50\ \mu F$ is charged to $10\ volts$.

Its energy is equal to

(A) $2.5 \times 10^{-3}\ joule$ (B) $2.5 \times 10^{-4}\ joule$

(C) $5 \times 10^{-2}\ joule$ (D) $1.2 \times 10^{-8}\ joule$

$\frac{1}{2} \times 50 \times 10^{-6} \times 100$

$= 25 \times 10^{-4}$

P-Q1664-Solution

Ans [A]

Energy stored in a capacitor

$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 50 \times 10^{-6} \times (10)^2 = 2.5 \times 10^{-3}\,J$$

P-Q1665

A parallel plate condenser has a capacitance **50** μF in air and **110** μF when immersed in an oil. The dielectric constant 'k' of the oil is

(A) 0.45 (B) 0.55

(C) 1.10 (D) 2.20

$$C = \frac{\varepsilon_0 A}{d}$$

$$C' = \frac{K \varepsilon_0 A}{d}$$

$$K = \frac{C_{medium}}{C_{air}} = \frac{110}{50} = 2.2$$

P-Q1665-Solution

Ans [D]

$C_{medium} = K C_{air}$ $Capacitance\ in\ medium = Capacitance\ in\ air \times Dielectric\ constant$

$$\Rightarrow K = \frac{C_{medium}}{C_{air}} = \frac{110}{50} = 2.20$$

P-Q1666

The capacity of a parallel plate condenser is C .

Its capacity when the separation between the plates is halved will be

(A) $4C$

(B) $2C$

(C) $\frac{C}{2}$

(D) $\frac{C}{4}$

$C = \frac{\varepsilon_0 A}{d}$

$d' = d/2$

$C' = 2C$

P-Q1666-Solution

Ans [B]

$$C = \frac{\varepsilon_0 A}{d} . C' = \frac{\varepsilon_0 A}{d/2} \Rightarrow C' = 2C$$

$$C \propto \frac{1}{d}$$

P-Q1667

The respective radii of the two spheres of a spherical condenser are **12 cm** and **9 cm** . The dielectric constant of the medium between them is **6**. The capacity of the condenser will be

(A) 240 pF (B) 240 μF

(C) 240 F (D) None of the above

$$C = \frac{4\pi K \varepsilon_0 r_1 r_2}{r_2 - r_1} = \frac{1}{9\times10^9} \times \frac{6 \times 12 \times 9 \times 10^{-4}}{3 \times 10^{-2}}$$

$$= 24 \times 10^{-11}\ F$$

$$= 240 \times 10^{-12}\ F$$

P-Q1667-Solution

Ans [A]

Capacitance of a spherical capacitor

$$C = 4\pi\varepsilon_0 K\left[\frac{ab}{b-a}\right] = \frac{1}{9\times 10^{9}}.6\left[\frac{12\times 9\times 10^{-4}}{3\times 10^{-2}}\right]$$

$$= 24\times 10^{-11} = 240\ pF$$

P-Q1668

A capacitor of capacity C has charge Q and stored energy is W. If the charge is increased to $2Q$, the stored energy will be

(A) $2W$

(B) $W/2$

(C) $4W$

(D) $W/4$

$U = \frac{Q^2}{2C}$

P-Q1668-Solution

Ans [C]

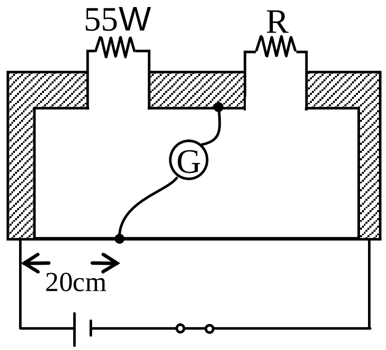
Relation between W, Q and C

$$W = \frac{Q^2}{2C} \Rightarrow W' = 4W$$

$W \propto Q^2$

P-Question

Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer.



The value of the unknown resistor R is -

(A) 13.75 W (B) 220 W

(C) 110 W (D) 55 W

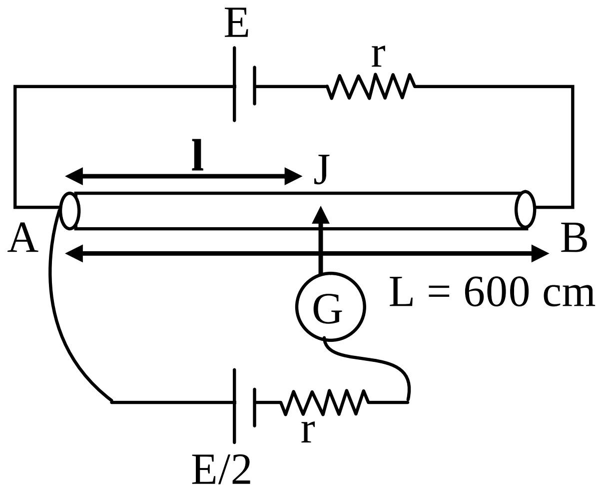
P-Solution

Ans [B]

$$\frac{P}{Q} = \frac{R}{S} \text{ Þ } \frac{20}{80} = \frac{55}{R} \text{ Þ } R = 220 \text{ W}$$

P-Question

If resistance of potentiometer wire = 15 r then calculate the balance length **l** :



(A) 320 cm (B) 200 cm
(C) 400 cm (D) 100 cm

P-Solution

Ans [A]

P.D of ext. ckt = ϕ × balance length

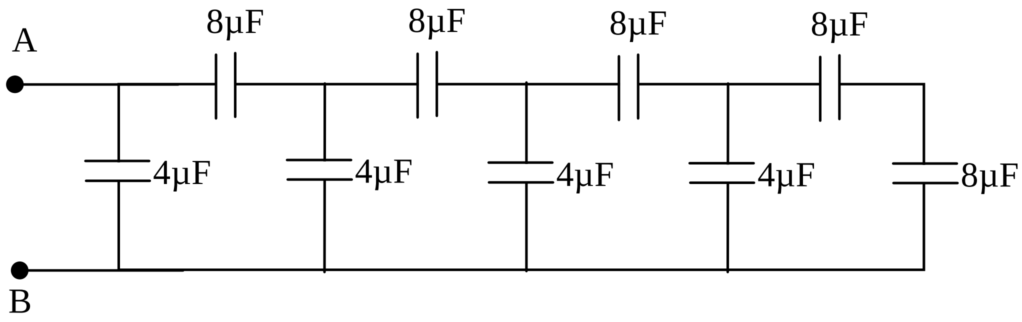
$$E/2 = \left(\frac{E}{L} \times \frac{R_w}{R_w + r}\right) \times l$$

$$\text{or} \quad E/2 = \frac{E}{600} \times \frac{15r}{16r} \times l$$

$$\therefore \quad l = \frac{600 \times 16}{30} = 320 \text{ cm}$$

P-Question

Find the equivalent capacitance between A and B.



(A) 2 μF (B) 6 μF

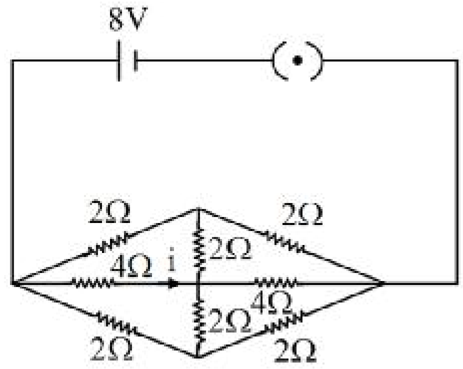
(C) 8 μF (D) 12 μF

P-Solution

Ans [C]

PQ15Q27

The value of i in the following circuit diagram will be –



(A) $\frac{3}{2}$A

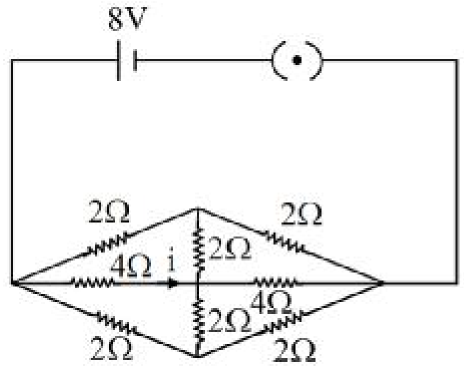
(B) $\frac{3}{4}$A

(C) $\frac{1}{2}$A

(D) 1A

PQ15S27

Ans [D]



Resultant resistance

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{4} = \frac{5}{8} \therefore R = \frac{8}{5}$$

net current $I_{net} = \frac{E}{R} = \frac{8 \times 5}{8} = 5$ amp.

$$I = \frac{I_{net} \times 2}{2+8} \Rightarrow I = \frac{5 \times 2}{10} = 1A$$

Alternative solution:

$$i = \frac{V}{R} = \frac{8}{8} = 1A$$

There is no current in the both vertical 2Ω because of same potential at the end due to the symmetry