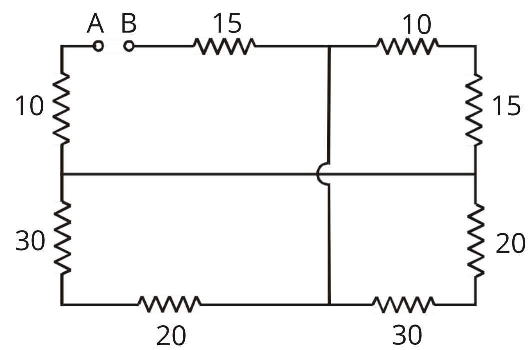
CURRENT ELECTRICITY

1. The equivalent resistance of the circuit across points A and B is equal to :



(A) 22.5 Ω

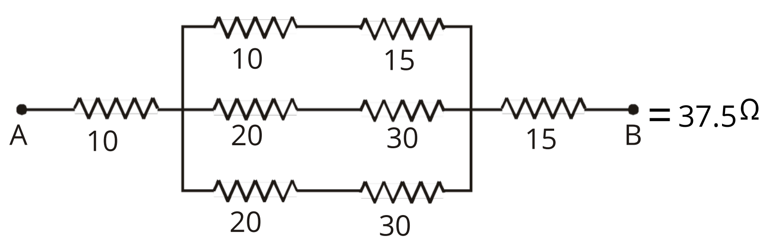
(B) 25 Ω

(C) 37.5 Ω

(D) 75 Ω

Answer: (C)

Equivalent circuit is



2. In the presence of an applied electric field □(E) in a metallic conductor.

(A) The electrons move in the direction of □E.

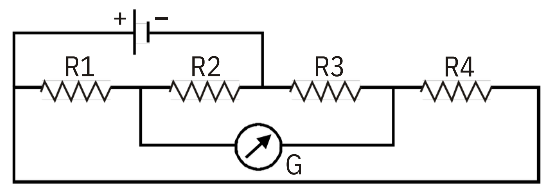
(B) The electrons move in a direction opposite to □E.

(C) The electrons may move in any direction randomly, but slowly drift in the direction of □E.

(D) The electrons move randomly but slowly drift in a direction opposite to $\vec{E}$.

Answer: (D)

Electrons move randomly and they slowly drift in a direction opposite to electric field.



3. In the given circuit, the galvanometer G will show zero deflection if

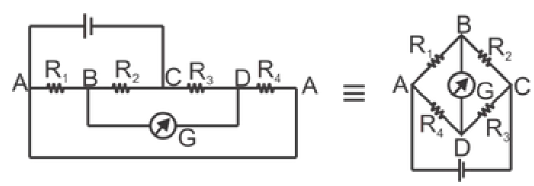
(A) R1R2 = R3R4

(B) R1R3 = R2R4

(C) R1R4 = R2R3

(D) none of the above

Answer: (B)



For balanced wheat stone bridge

$\frac{R_1}{R_4} = \frac{R_2}{R_3}$ or $R_1R_3 = R_2R_4$

4. Two heaters A and B are in parallel across the supply voltage. Heater A produces 500 kJ in 20 minutes and B produces 1000 kJ in 10 minutes. The resistance of A is 100

Ω. If the same heaters are connected in series across the same voltage, the heat produced in 5 minutes will be

(A) 200 kJ (B) 100 kJ

(C) 50 kJ (D) 10 kJ

Answer: (B)

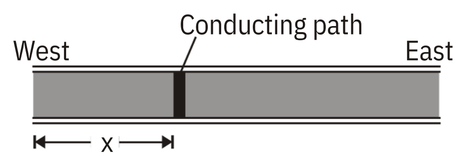
$\frac{V2\times20\times60=500\times103}{100}$ ⇒ $V2\ 5=\frac{}{12}\times105$

$V2\times10\times60=1000\times103$

RB

⇒ RB=25Ω (▯ Both were in parallel, same V)

∴ Heat in 5 min = ▯▯$\frac{V2}{▯RA+RB▯}$▯



5. A 10-km-long underground cable extends east to west and consists of two parallel wires, each of which has resistance 13Ω/km. A short develops at distance x from the west end when a conducting path of resistance R connects the wires (figure). The resistance of the wires and the short is then 100Ω when the measurement is made from the east end, 200Ω when it is made from the west end. What is value of R (in ohm).

(A) 20 Ω (B) 25 Ω

(C) 30 Ω (D) 35 Ω

Answer: (A)

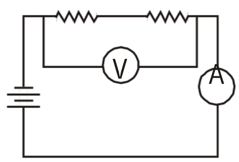
$13(2x) + R = 200$

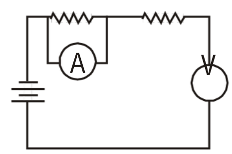
$13(2\,(10 - x)) + R = 100$

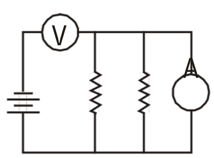
$260 + 2R = 300$

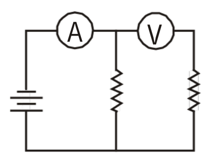
$R = 20\Omega$

6. It is required to measure equivalent resistance of circuit with ideal battery, ideal voltmeter & ideal ammeter. Which circuit diagram shows voltmeter V and ammeter A correctly positioned to measure the total resistance of circuit.

(A) 

(B) 

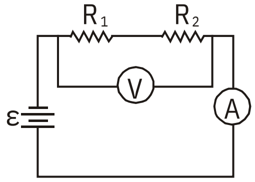
(C) 

(D) 

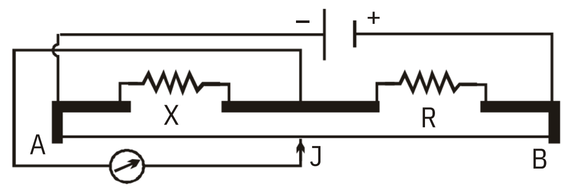
Answer: (A)

Voltmeter can't be in series & ammeter can't be in parallel.

Only (A) gives correct arrangement.



7. The figure shows a meter-bridge circuit, X = 12 Ω and R = 18 Ω. The jockey J is in the position of balance. If R is made 8Ω, through what distance will the jockey J have to be moved to obtain balance?



(A) 10 cm

(B) 20 cm

(C) 30 cm

(D) 40 cm

Answer: (B)

Let the distance AJ be y1 before shifting and y2 after shifting.

Before shifting: $\frac{12}{y_1} = \frac{18}{100-y_1}$ ⇒ $y_1 = 40cm$

After shifting: $\frac{12}{y_2} = \frac{8}{100-y_2}$ ⇒ $y_2 = 60$ cm

∴ Distance moved = 20 cm

8. The charge flown through a resistance R in time t varies with time according to Q = at – bt2. The total heat produced in R by the time current becomes zero is :

(A) $\frac{a^3R}{6b}$

(B) $\frac{a^3R}{2b}$

(C) $\frac{a^3R}{3b}$

(D) $\frac{a^3R}{b}$

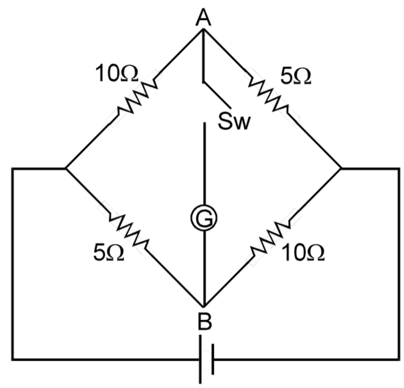
Answer: (A)

$Q = at - bt^2 \Rightarrow i = \frac{dQ}{dt} = a - 2bt$

Current becomes zero at time $t = \frac{a}{2b}$

Total heat produced = $\int_0^{t=\frac{a}{2b}} i^2 R\, dt = \int_0^{\frac{a}{2b}} (a - 2bt)^2 R\, dt = \frac{a^3 R}{6b}$

9. If the switch is closed then current will flow:



(A) from A to B

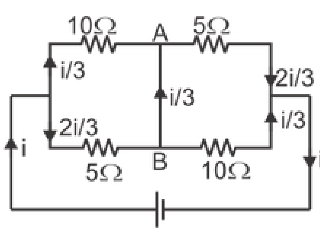
(B) from B to A

(C) 0

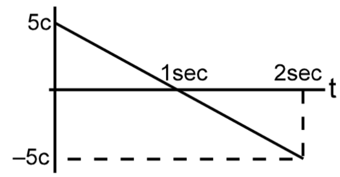
(D) cannot say unless resistance of galvanometer is given.

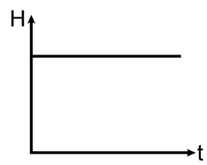
Answer: (B)

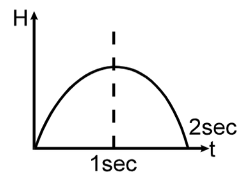
Therefore, current will flow from B to A

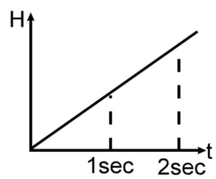


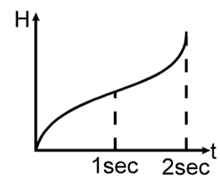
10. A charge passing through a resistor is varying with time as shown in the figure. The amount of heat generated in time ' t ' is best represented (as a function of time) by:



(A) 

(B) 

(C) 

(D) 

Answer: (C)

$Q=5-5t$ $\Rightarrow$ $i=-5A$

∴ Heat = $\int_0^t i2Rdt=25Rt$

∴ Linear graph

11. A 50 Ampere-hour battery can supply a current of 50 A for 1 hour, 25 A for 2 hour and so on. Then the total energy stored in the 12 V-50 Ampere-hour battery is

(A) 600 J

(B) 2.16 × 106 J

(C) Depends on for how much time it is used

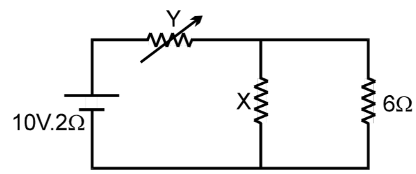
(D) 3.6× 104 J

Answer: (B)

E = VoIt = 12 × 50 × 3600 = 600 × 3600

$= 216 \times 104 = 2.16 \times 106$

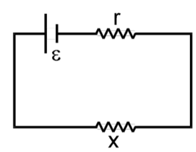
12. In the figure shown the thermal power generated in ' y ' is maximum when y = 4 Ω. Then X is:



(A) 2 Ω (B) 3Ω

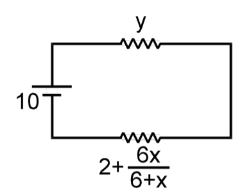
(C) 1 Ω (D) 6 Ω

Answer: (B)



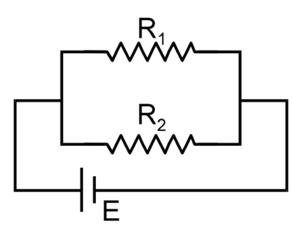
For this circuit → power generated in x is maximum when x = r.

In given circuit is



For power to be minimum in y, $y = 2 + \frac{6x}{6+x} = 4 \Rightarrow x = 3\Omega$

13. In the given circuit R1 > R2 . Find which of the following statement is correct.



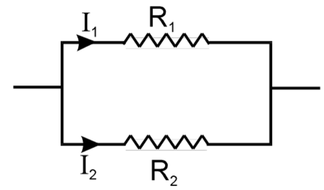
(A) Potential difference across R1 is high

(B) Current through R1 is greater than in R2

(C) Power consumed in R1 is greater than in R2

(D) None of these

Answer: (D)



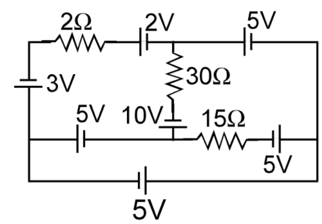
$I_1R_1 = I_2R_2$ as p. d. is same across the two resistances.

$R_1 > R_2 \Rightarrow I_1 < I_2$

$P_1 = \frac{V^2}{R_1}$ and $P_2 = \frac{V^2}{R_2}$

$P_1 < P_2$ (□ $R_1 > R_2$)

14. Find the current through the 30Ω resistance in the circuit shown.



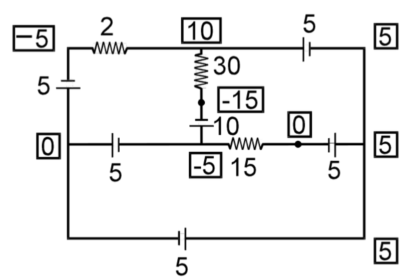
(A) 2/6 Ampere

(B) 3/6 Ampere

(C) 4/6 Ampere

(D) 5/6 Ampere

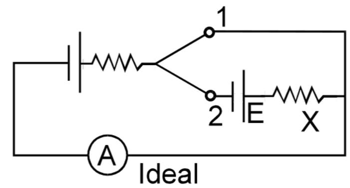
Answer: (D)



Potentials are indicated in figure

Current in 30Ω $= \frac{10-(-15)}{30} = \frac{25}{30} = \frac{5}{6}$ A, downwards

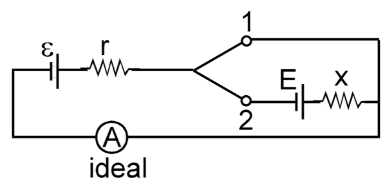
15. In the circuit shown the variable resistance X is to be adjusted such that the ideal ammeter reads the same in both the positions of the key, when connected independently to 1 and then to 2. The reading of the ammeter is 2A. If E = 10 V, then x is:



(A) 5 Ω (B) 20 Ω

(C) 50 Ω (D) cannot be determined

Answer: (A)



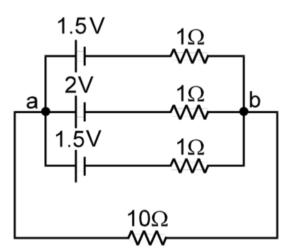
Hint: In position (1) $\varepsilon - ir = 0$ i = 2

$\Rightarrow$ $\varepsilon = 2r$.

now, In position (2) $\varepsilon - ir + E - ix = 0$

$\Rightarrow 2r - 2r + 10 - 2x = 0$ $\Rightarrow$ $x = 5\,\Omega$

16. Find the current passing through 10 Ω resistance in the figure below



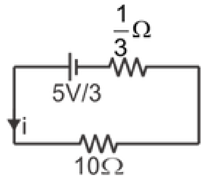
(A) 5/31 A

(B) 6/31 A

(C) 4/31 A

(D) none of these

Answer: (A)



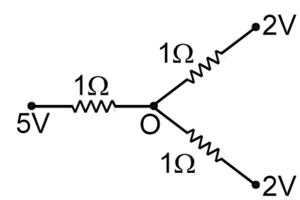
$$E_{eq} = \frac{\frac{\epsilon_1}{r1} + \frac{\epsilon_2}{r2} + \frac{\epsilon_3}{r3}}{\frac{1}{r1} + \frac{1}{r2} + \frac{1}{r3}} \qquad \frac{1}{req} = \frac{1}{r1} + \frac{1}{r2} + \frac{1}{r3}$$

$$E_{eq} = \frac{\frac{1.5}{1} + \frac{2}{1} + \frac{1.5}{1}}{\frac{1}{1} + \frac{1}{1} + \frac{1}{1}} = \frac{5}{3} \text{ Volts} \qquad \frac{1}{req} = \frac{1}{1} + \frac{1}{1} + \frac{1}{1} = 3$$

$$\therefore \; r_{eq} = \frac{1}{3}$$

$$i = \frac{5/3}{10 + \frac{1}{3}} = \frac{5}{31} \text{ A}$$

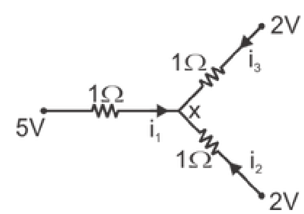
17. Three resistances are arranged as shown. The potential of the point O is:



(A) 3 V (B) 1 V

(C) 4 V (D) 5 V

Answer: (A)



$i1 = \frac{5 - x}{1}$ $\quad i2 = \frac{2 - x}{1}$ $\quad i_3 = \frac{2 - x}{1}$

Using KCL, $i1 + i_2 + i_3 = 0$

$$\Rightarrow \frac{5 - x}{1} + \frac{2 - x}{1} + \frac{2 - x}{1} = 0$$

$\Rightarrow$ x = 3 Volts

18. An electric heater is designed to operate in 100 V main with a power output of 1000 W. When it is connected to a 25 V source, power output is:

(A) 40 W (B) 100 W

(C) 62.5 W (D) 250 W

Answer: (C)

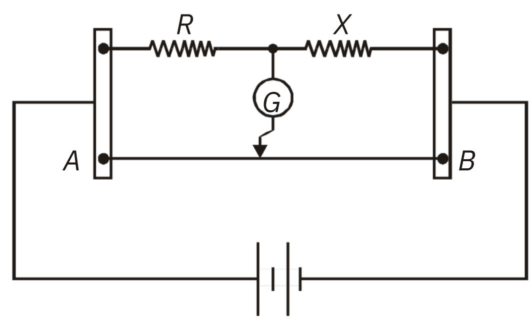
The resistance of the bulb rated 100V, 1000W is

$P = \frac{V2}{R}$ or $R = \frac{V2}{P} = \frac{100 \times 100}{1000} = 10\Omega$

Hence, when the bulb is connected to 25 volt source the output power is

$P = \frac{V^2}{R} = \frac{25 \times 25}{10} = 62.5 \text{Watts}$

19. In the meter bridge shown, the resistance *R* has a negative temperature coefficient of resistance. Neglecting the variation in other resistors, when current is passed for some time, in the circuit, balance point should shift towards



(A) A

(B) B

(C) First A then B

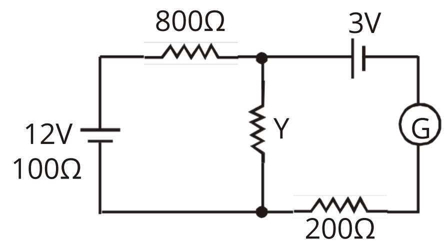
(D) It will remain at C

Answer: (A)

As current will flow, heat will produce in the circuit. So, R will decrease.

So, balance point will shift towards left.

20. If galvanometer shows null deflection in the given figure then the value of Y is



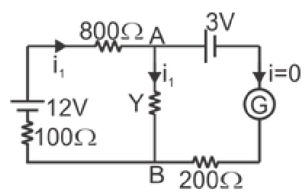
(A) 100 Ω

(B) 200 Ω

(C) 300 Ω

(D) 400 Ω

Answer: (C)



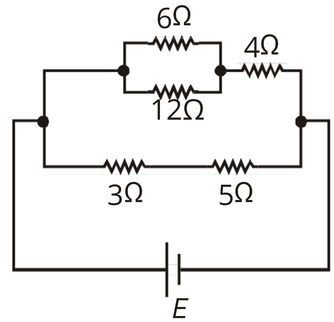
$V_A - V_B = 3V = i_1 Y$

$i_1 = \frac{12}{100+800+Y} = \frac{12}{900+Y}$

$i_1 Y = 3 \Rightarrow \frac{12Y}{900+Y} = 3$

$\Rightarrow Y = 300\Omega$

21. In the circuit shown, the potential drop across 6 Ω resistor is 12 V. The emf of the ideal battery is



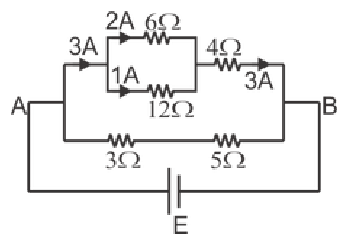
(A) 8 V

(B) 16 V

(C) 24 V

(D) 32 V

Answer: (C)



$i(6\Omega) = \frac{12}{6} = 2A$ $\quad i(12\Omega) = \frac{12}{12} = 1A$

$\therefore E = V_A - V_B = \left[3 + 4 + \frac{6\times 12}{6+12}\right] \times 3 = 24V$

22. A plausible reason for the increase in resistivity of most of the conductors with temperature is

(A) The mass of the electron changes with temperature.

(B) The charge on each electron changes with temperature.

(C) The electron density changes with temperature.

(D) The time between collisions changes with temperature.

Answer: (D)

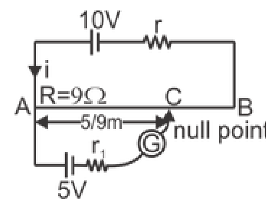
$\rho \propto \frac{1}{\tau}$ $\quad$ (τ = Relaxation Time)

23. The emf of driver cell in a potentiometer circuit is 10 V. The length of potentiometer wire is 1 m and its resistance is 9 Ω. A cell of emf 5 V is balanced on 5/9 m length of the wire. The internal resistance of the driver cell is

(A) 1 Ω (B) 0.1 Ω

(C) 2 Ω (D) 0.5 Ω

Answer: (A)

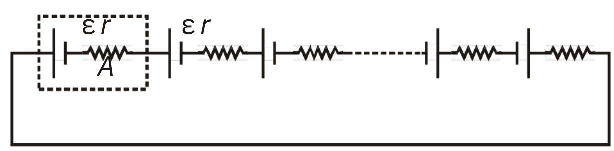


$i = \frac{10}{9 + r}$

C is the balance point, So p.d. across AC = 5V

$\Rightarrow \frac{10}{9+r} \times 5\,\Omega \quad \Rightarrow \quad r = 1\,\Omega$

24. In a arrangement, 3*n* cells of emf ε and internal resistance *r* are connected in series. Out of 3*n* cells, polarity of *n* cells is reversed. Current in the circuit is



(A) $\frac{2\varepsilon}{r}$ (B) $\frac{2\varepsilon}{3r}$

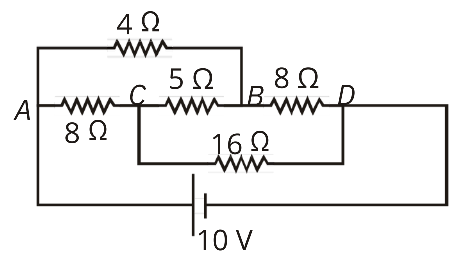
(C) $\frac{\varepsilon}{3r}$ (D) $\frac{\varepsilon}{r}$

Answer: (C)

$E_{effective} = \varepsilon$ $r_{effective} = 3r$

$\therefore \quad i = \frac{\varepsilon}{3r}$

25. In the circuit shown in the figure, current through 5 Ω is



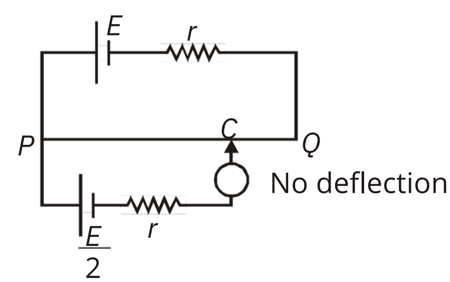
(A) 1 A (B) 2 A

(C) Zero (D) 0.5 A

Answer: (C)

The given circuit is a balanced wheat stone bridge. So, current through 5Ω resistor is zero.

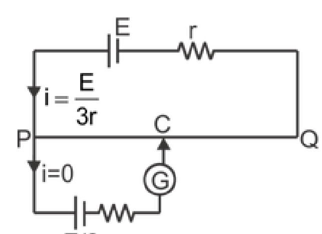
26. The potentiometer wire *PQ* is 100 cm long and its resistance is 2*r*. Where *r* is internal resistance of the battery. *PC* is equal to



(A) 25 cm (B)75 cm

(C) 50 cm (D) 40 cm

Answer: (B)

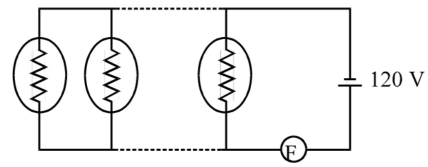


For galvanometer to show zero deflection, $V_{PC} = \frac{E}{2}$

$\Rightarrow iR_{PC} = \frac{E}{2} \quad \Rightarrow \frac{E}{3r} \times R_{PC} = \frac{E}{2} \quad \Rightarrow R_{PC} = \frac{3r}{2}$

$\therefore \; PC = \frac{3r}{2r} \times 100cm = 75cm$

27. Some light bulbs are connected in parallel to a 120 V source as shown in the figure. Each bulb dissipates an average power of 60 W. The circuit has a fuse F that burns out when the current in the circuit exceeds or equals 9 A. Determine the largest number of bulbs of the following that can be used in the circuit without burning out the fuse.



(A) 9 (B) 17

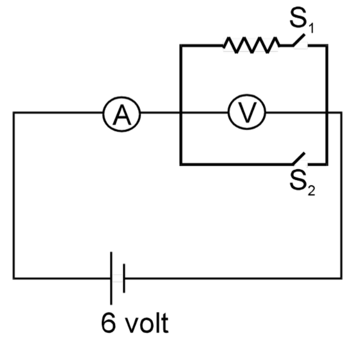
(C) 36 (D) 34

Answer: (B)

Current through each bulb = $\frac{60}{120} = 0.5A$ ($\because P=VI$)

$\therefore$ For current not exceed or equal to 9A, maximum number of bulb = 17

28. An ammeter and a voltmeter are initially connected in series to a battery of zero internal resistance. When switch S1 is closed the reading of the voltmeter becomes half of the initial, whereas the reading of the ammeter becomes double. If now switch S2 is also closed, then reading of ammeter becomes:



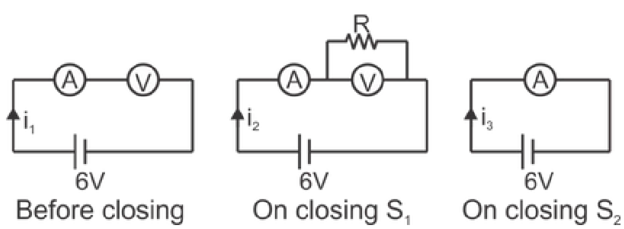
(A) 3/2 times the initial value

(B) 3/2 times the value after closing S1

(C) 3/4 times the value after closing S1

(D) 3/4 times the initial value

Answer: (B)



Before Closing:

Reading of ammeter =

$$\frac{6}{R_A + R_V} = i_1$$

Reading of voltmeter =

$$\frac{6R_V}{R_A + R_V} = V_1$$

On closing S1: Reading of ammeter = $\dfrac{6}{R_A + \dfrac{RR_V}{R+R_V}} = i_2 = 2i_1$

Reading of voltmeter $= i_2\left(\dfrac{RR_V}{R+R_V}\right) = \dfrac{V_1}{2}$

$$\Rightarrow 2i_1 \times \frac{RR_V}{R+R_V} = \frac{V_1}{2}$$

$\Rightarrow 2\left(\frac{6}{R_A+R_V}\right)\left(\frac{RR_V}{R+R_V}\right) = \left(\frac{6R_V}{R_A+R_V}\right)\frac{1}{2} \Rightarrow R_V = 3R$

$i_2 = 2i_1 \Rightarrow \frac{6}{R_A + \frac{RR_V}{R+R_V}} = 2\left(\frac{6}{R_A+R_V}\right) \Rightarrow R_A = \frac{3R}{2}$ $\quad (\because R_V = 3R)$

On closing S2: $i_3 = \frac{6}{R_A} = \frac{6}{\left(\frac{3R}{2}\right)} = \frac{4}{R}$

$i_2 = 2i_1 = 2\left(\frac{6}{\frac{3R}{2}+3R}\right) = \frac{8}{3R}$

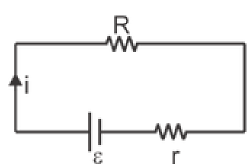
$\therefore i_3 = \frac{3}{2} i_2$

29. A cell develops the same power across two resistors r_1 and r_2 when connected separately. If r is the internal resistance of the cell then:

(A) $r = \frac{1}{2}\sqrt{r_1 r_2}$ (B) $r = \sqrt{r_1 r_2}$

(C) $r = \frac{1}{2}\sqrt{r_1 + r_2}$ (D) $r = r_1 + r_2$

Answer: (B)



Power in R $= i^2R = \frac{\varepsilon^2 R}{(R+r)^2} = P$

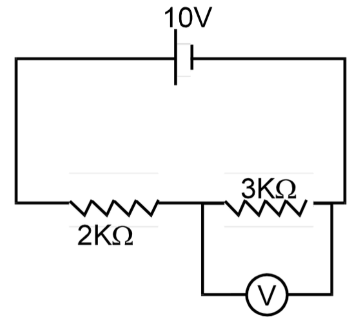
$\Rightarrow P(R^2+r^2+2Rr)=\varepsilon^2 R$

$\Rightarrow R^2+\left(2r-\frac{\varepsilon^2}{P}\right)R+r^2=0 \quad \begin{matrix}\nearrow r_1 \\ \searrow r_2\end{matrix}$

The above given quadratic equation in R has two roots r_1 & r_2

$\therefore$ Product of roots $= r_1 r_2 = r^2 \Rightarrow r=\sqrt{r_1 r_2}$

30. In the circuit shown in figure the resistance of voltmeter is 6 KΩ. The voltmeter reading will be



(A) 6V

(B) 5V

(C) 4V

(D) 3V

Answer: (B)

$R_{eq} = \frac{3 \times 6}{3 + 6} = 2k\Omega$

∴ Reading of voltmeter = 5 Volt

31. A battery of 10 volt is connected to a resistance of 20 ohm through a variable resistance R. The amount of charge which has passed in the circuit in 4 minutes, if the variable resistance R is increased at the rate of 5 ohm/min.

(A) 120 coulomb

(B) 120 loge2 coulomb

(C) $\frac{120}{\log_e 2}$ coulomb

(D) $\frac{60}{\log_e 2}$ coulomb

Answer: (B)

$I = \frac{dq}{dt} = \frac{V}{R}$

$\frac{dq}{dR} \cdot \frac{dR}{dt} = \frac{V}{R}$

$dq = 12\,V \frac{dR}{R}$

$q = 12\,V \int_{20}^{40} \frac{dR}{R} = 12\,V (\log_e 40 - \log_e 20)$

$= 12 \times 10 \times \log_e 2$

32. What is total resistance of wire?

(A) 11.5 Ω (B) 115 Ω

(C) 1150Ωm (D) 120 Ω

Answer: (D)

Resistance per unit length of wire = 11.5Ω/m

Length of wire = 10 m

∴ Resistance of wire = 11.5 × 10 = 115

∴ Total resistance = 115 + 5 = 120

33. A wire carries a current of 2.0 A. What is the charge that has flowed through its cross–section in 1.0 s. How many electrons does this correspond to?

(A) 3.0 C, 1.25 × 1019 (B) 2.0 C, 1.25 × 1019

(C) 4.0 C, 1.25 × 1019 (D) 2.0 C, 5.25 × 1019

Answer: (B)

$i = \frac{q}{t}$

∴ q = it = (2.0 a) (1.0s) = 2.0 C

$q = ne$

$\therefore \quad n = \frac{q}{e} = \frac{2.0}{1.6\times10^{-19}} = 1.25\times10^{19}$

34. A dry cell delivering 2 A has terminal voltage 1.14V. What is the internal resistance of the cell if its open–circuit voltage is 1.59 V?

(A) 5.09Ω (B) 6.09Ω

(C) 7.09Ω (D) 0.09Ω

Answer: (D)

The open–circuit voltage is simply the emf of the cell, so

$V = E - ir$ with

$V = 1.41$ V, $i = 2$ A,

$E = 1.59$ V. $1.41 = 1.159 - 2r$, and $r = 0.09\Omega$

35. The sensitivity of a galvanometer of resistance 406 ohm is increased by 30 times. The shunt used is

(A) 88 Ω (B) 14 Ω (C) 6 Ω (D) 16 Ω.

Answer: (B)

$\frac{i}{ig} = 30$. The shunt $S = \frac{Gi_g}{i - i_g} = \frac{226}{29} = 14\Omega$.

36. When cells are arranged in parallel

(A) the current capacity decreases

(B) the current capacity increases

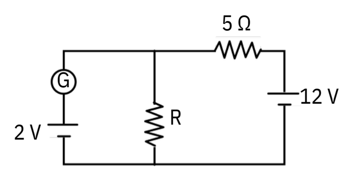
(C) the e.m.f. increases

(D) the e.m.f. decreases.

Answer: (B)

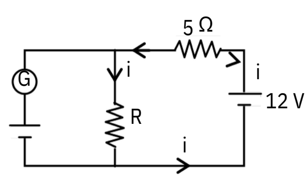
When cells are connected in parallel, the current capacity increases.

37. For what value of R will the current in galvanometer zero?



(A) 5Ω (B) 2 Ω (C) 7Ω (D) 1 Ω

Answer: (D)



$i = \frac{12}{R+5}$

Potential difference across R = 2 V = $\frac{12}{R+5} \times R$

$\therefore \quad 2 = \frac{12}{R+5} \times R$

$\Rightarrow R + 5 = 6R$

$\Rightarrow R = 1\ \Omega$

38. Kirchhoff's first law is based on the law of conservation of -

(A) charge (B) energy
(C) momentum (D) sum of mass and energy

Answer: (A)

At any junction in the circuit $\sum i = 0$

39. A wire of resistance R is stretched till its length is double of the original wire. Then, the resistance of the stretched wire is -

(A) 2R (B) 4R (C) 8R (D) 16R

Answer: (B)

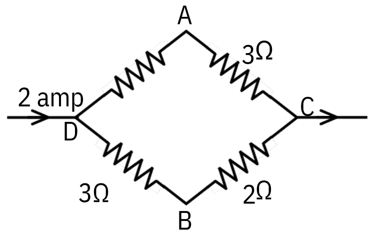
$R \propto \lambda 2$, (on stretching)

$\frac{R'}{R} = \left(\frac{\lambda'}{\lambda}\right)^2 = \left(\frac{2\lambda}{\lambda}\right)^2 = 4$

$\therefore R' = 4R$

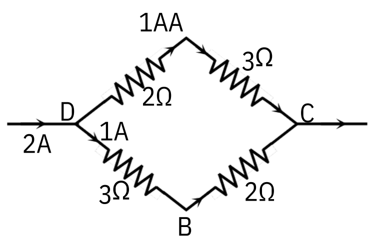
40. A current of 2 ampere flows in a system of conductors as shown in the following figure. The potential difference (VA – VB) will be - (in volt)

2Ω



(A) +2 (B) +1 (C) –1 (D) –2

Answer: (B)

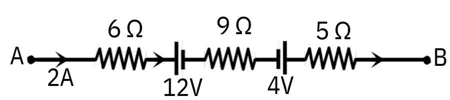


$V_A - V_C = i R = 1 \times 3 = 3V$ ....(i)

$V_B - V_C = 1 \times 2 = 2V$ ....(ii)

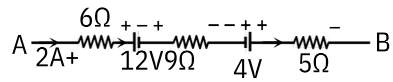
$V_A - V_B = 3 - 2 = 1V$

41. The potential difference between A and B in the following figure is -



(A) 32 V (B) 48 V (C) 24 V (D) 14 V

Answer: (B)



$V_A - 2 \times 6 - 12 - 2 \times 9 + 4 - 2 \times 5 = V_B$

$\therefore V_A - V_B = 48$ V

42. At room temperature, copper has free electron density of 8.4 × 1028 m–3. The electron drift velocity in a copper conductor of cross-sectional area 10–6 m2 and carrying a current of 5.4 A, will be -

(A) 4 ms-–1 (B) 0.4 ms–1

(C) 4 cms–1 (D) 0.4 mms–1

Answer: (D)

Use $i = neAv_d$

$\therefore v_d = \frac{i}{neA}$

43. For a metallic wire, the ratio V/I (V = applied potential difference, I = current flowing)-

(A) increases or decreases as the temperature rises, depending upon the metal

(B) decreases as the temperature rises

(C) independent of temperature

(D) increases as the temperature rises

Answer: (D)

$\frac{V}{I} = R$

and for metals R ↑, on ↑ the temperature.

44. A potential difference of 30 V is applied between the ends of a conductor of length 100 m and resistance 0.5 Ω and uniform area of cross-section. The total linear momentum of free electrons is -

(A) 3.4×10^{-6} kg/s (B) 4.3×10^{-6} kg/s

(C) 3.4×10^{-8} kg/s (D) 4.3×10^{-8} kg/s

Answer: (C)

Current, $I = \frac{V}{R} = \frac{30}{0.5} = 60$ A

Total no. of free e^- s, $N = nA\lambda$

and linear momentum of each e^-s, $P = mv_\alpha$

∴ Total momentum of all free e^-s,

$P = (nA\lambda)(m\upsilon_\alpha)$

But $I = neA\upsilon_\alpha$, so $nA\upsilon_\alpha = \frac{I}{e}$

∴ $P = \frac{I\lambda m}{e} = \frac{60 \times 100 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19}}$

3.4×10^{-8} kg/s

45. Resistivity of iron is 1 × 10−7 ohm-metre. The resistance of the given wire of a particular thickness and length is 1 Ω. If the diameter and length of the wire both are doubled, the resistivity will be -

(A) 1 × 10−7 (B) 2 × 10−7

(C) 4 × 10−7 (D) None of these

Answer: (A)

Resistivity does not depend on length & cross section area.