# 12 th PHYSICS

## UNIT 1 & 2

## IMPORTANT FORMULAE



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# UNIT 1 - ELECTROSTATICS

1. Coulomb's law, $\vec{F}_{21} = \frac{1}{4\pi\varepsilon o} \frac{q1q2}{r^2} \hat{r}_{12}$

2. Electric field due to a point charges,

$$\vec{E} = \frac{1}{4\pi\varepsilon o} \frac{q}{r^2} \hat{r}$$

3. Electric dipole moment, $\vec{P} = 2q\vec{d}$

4. Electric field due to a dipole along its axial line,

$$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon o} \cdot \frac{\overrightarrow{2P}}{r^3}$$

5. Electric field due to a dipole along its equatorial line,

$$\vec{E}_{tot} = \frac{1}{4\pi\varepsilon o} \frac{\vec{P}}{r3}$$

6. Torque experience by an electric dipole in a uniform electric field.

$$\vec{\tau} = \vec{P} \times \vec{E}\ ;\ \tau = qE2a \sin\theta$$

7. Electric potential at a point due to a point charge,

$$V = \frac{1}{4\pi\varepsilon o} \frac{q}{r}$$

8. Electric potential at a point due to electric field,

$$V = \frac{1}{4\pi\varepsilon o} \frac{P}{r^2} cos\theta = \frac{1}{4\pi\varepsilon o} \frac{\vec{P}.\vec{r}}{r^2}$$

9. Electric field $E = -\frac{dv}{dx} = -\left[\frac{\partial v}{\partial x}\hat{\imath} + \frac{\partial v}{\partial x}\hat{\jmath} + \frac{\partial v}{\partial x}\hat{k}\right]$

10. Electrostatic potential energy between two charges is,

$$U = \frac{1}{4\pi\varepsilon o} \frac{q_1 q_2}{r}$$

11. Electrostatic potential energy between there charges is,

$$U = \frac{1}{4\pi\varepsilon o}\left[\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right]$$

12. Electrostatic potential energy stored in a dipole in an uniform electric field ,

$$U = - PE\cos\theta = -\vec{P} \cdot \vec{E}$$

13. Electrostatic potential energy difference between two angular positions

θ and $\theta^l$ of a dipole kept in an uniform electric field ,

$$\Delta U = - PE\cos\theta + PE\cos\theta^l$$

14. Electric flux , $\emptyset_E = \vec{E} . \vec{A} =$ E A cosθ

15. Total electric flux through a closed surface ,

$$\emptyset_E = \frac{Q_{net}}{\varepsilon o}$$

16. Electric field due to an infinitely long charged wire is,

$$E. = \frac{\lambda}{2\pi r \varepsilon o}$$

17. Electric field due to charged infinite plane sheet is,

$$E = \frac{\sigma}{2\varepsilon o}$$

18. Electric field due to two parallel charged infinite sheet at a point between the sheet

$$E = \frac{\sigma}{\varepsilon o}$$

19. Electric field due to uniformly charged spherical shell of radius 'R' at a point outside the shell ,

$$E = \frac{1}{4\pi\varepsilon o} \frac{Q}{r^2}$$

20. Electric field due to uniformly charged spherical shell of radius 'R' at a point on the shell ,

$$E = \frac{1}{4\pi\varepsilon o} \frac{Q}{R^2}$$

21. For a parallel plate capacitor,

Electric field , $E = \frac{Q}{\varepsilon_o A}$

Potential difference , $V = \frac{Q.d}{\varepsilon_o A}$

Capacitance , $C = \frac{\varepsilon A}{d}$

22. (a) Battery is disconnected from the capacitor and a dialectic is inserted between the plates ,

$C_0 = \frac{Q_O}{V_O}$ , $E = \frac{E_O}{\varepsilon_r}$, $V = \frac{V_O}{\varepsilon_r}$, $C = \frac{\varepsilon_r \varepsilon_o A}{d}$, $U_0 = \frac{1}{2} C_o V_o^2$ , $U = \frac{U_O}{\varepsilon_r}$

(b) Battery remains connected and a dielectric inserted between the plates of the capacitor ,

$Q = \varepsilon_r Q_O$ , $C = \varepsilon_r C_O$ , $C = \frac{\varepsilon_r \varepsilon_o A}{d}$, $U_0 = \frac{1}{2} C_o V_o^2$ , $U = \varepsilon_r U_O$

23. Capacitor in series : $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

Capacitor in parallel : $C_P = C_1 + C_2 + C_3$

24. Two charged spheres connected through a wire ,

$\frac{q_1}{r_1} = \frac{q_2}{r_2}$ , $Q = q_1 + q_2$ , $\sigma_1 r_1 = \sigma_2 r_2$.

$q_2 = Q \left[\frac{r_2}{r_1 + r_2}\right]$

25. In van de graaff generator , maximum potential difference created ,

$V_{max} = 10^7$ V.

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# UNIT 2- CURRENT ELECTRICITY

1. ELECTRIC CURRENT [ I ] => Ampere

   $$I = \frac{Q}{t}$$

   Q => Charge ; t =>time.

2. INSTANTANEOUS CURRENT [ I ]

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

3. DRIFT VELOCITY [ $\vec{V}_d$ ] => ms-1

   $$V_d = a\tau$$

   $$V_d = -\frac{e\tau}{m}E$$

   $$V_d = -\mu E$$

   $\mu$=> Mobility of the electron

   a => Accceleration

   $\tau$=> Mean time

   E => Electric field

   m => mass of the electron

   e => 1.6 x $10^{-19}$ C

4. RELATION BETWEEN CURRENT AND DRIFT VELOCITY

   $$I = nAeV_d$$

   n => Electrons per unit volume

   A => Area of cross section

5. CURRRENT DENSITY [ J ] =>$Am^{-2}$

   $$J = \frac{I}{A}$$

   $$J = neV_d$$

   $$J = +\sigma E$$

   $\sigma$=> Conductivity [$\Omega^{-1}$ $m^{-1}$]

   $$\sigma = \frac{n.e^2\tau}{m}$$

6. RESISTANCE [ R ] =>ohm [ Ω ]

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

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

| |
|---|
| V => Potential difference<br>V = I R |

7. RESISTIVITY [$\rho$] => ohm m [Ωm ]

$$\rho = \frac{RA}{l}$$

$$\rho = \frac{1}{\sigma} = \frac{m}{n.e^2\tau}$$

8. RESISTORS IN SERIES [ $R_S$]

$$R_s = R_1 + R_2 + R_3$$

No of resistors connected in series ,

$$R_s = nS$$

9. RESISTORS IN PARALLEL [ $R_P$]

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

No of resistors connected in parallel ,

$$R_p = \frac{R}{n}$$

10. TEMPERATURE COEFFICIENT OF RESISTIVITY [∝ ] => /°c

$$\propto = \frac{\Delta\rho}{\rho_{o\Delta T}} = \frac{\rho_T - \rho_o}{\rho_o[T - T_o]} \qquad [\ T_o = 20\ °c\ ]$$

11. RESISTANCE OF A CONDUCTOR AT TEMPERATURE => T °c

$$R_T = R_O [\ 1 + \propto [\ T - T_o]\ ]$$

$$\propto = \frac{R_T - R_o}{\rho_o[T - T_o]}$$

| |
|---|
| $R_T$ => Resistance of a conductor at T°c<br>$R_O$ => Resistance of a conductor at some [ 20 °c ] reference temperature |

12. ELECTRIC POWER [ P ] =>watt

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

13. ELECTRIC ENERGY => Watt hour

Energy = VIT

1 Kwh= 1000 wh = 3.6 x $10^6$ J

| 1 Kwh= 1 unit of electrical energy |
|---|

14. INTERNAL RESISTANCE OF A CELL [r] => Ohm ( Ω )

$$r = \left[ \frac{\xi - V}{V} \right] R$$

| $\xi$ = > EMFof the cell |
|---|

15. CELLS IN SERIES

$$I = \frac{n\xi}{nr+R}$$

a) [ r >>R ] => I $\approx \frac{\xi}{r}$ [ Advantages ]

b) [ r << R ] => I ≈ $nI_1$

16. CELLS IN PARALLEL

$$I = \frac{n\xi}{r + nR}$$

a) [ r >>R ] => I = $nI_1$ [ Advantages ]

b) [ r << R ] => I = $\frac{\xi}{r}$

17. BRIDGE BALANCE CONDITION [ WHEATSTONE'S BRIDGE ]

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

| P , Q ,R and S are resistors |
|---|

18. METER BRIDGE

The value of unknown resistance

$$P = Q\frac{l_1}{l_2}$$

$\ell_1, \ell_2$ => Balancing length

Resistivity of the material

$$\rho = P\frac{\pi r^2}{l}$$

a => Radius of the wire

$\ell$ => length of the wire

19. POTENTIOMETER

EMF of the cell

$$\xi = Irl$$

Comparison of the two cells

$$\frac{\xi_1}{\xi_2} = \frac{l_1}{l_2} ; \xi_1 = \xi_2\frac{l_1}{l_2} ; \xi_2 = \xi_1\frac{l_2}{l_1}$$

Internal resistance

$$r = R\left[\frac{l_1 - l_2}{l_2}\right]$$

20. JOULE 'S LAW [ HEAT ]

$$H = VIt$$

$$H = I^2Rt$$

21. ONE AMPERE

$$1A = \frac{1C}{1s}$$

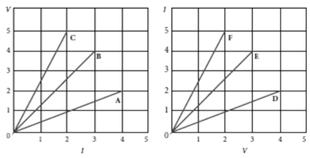
22. ONE OHM

$$1\Omega = \frac{1V}{1A}$$

# CURRENT ELECTRICITY

## UNSOLVED PROBLEMS

1. **The following graphs represent the current versus voltage and voltage versus current for the six conductors A, B, C, D, E and F. Which conductor has least resistance and which has maximum resistance?**




<u>Solution</u>

According to ohm's law,

$$V = IR; \quad R = \frac{V}{I}$$

GRAPH 1:

A : slope = $R_A = \frac{\Delta V}{\Delta I} = \frac{2}{4} = 0.5\Omega$

B : slope = $R_B = \frac{\Delta V}{\Delta I} = 4/3 = 1.33\Omega$

C : slope = $R_C = \frac{\Delta V}{\Delta I} = \frac{5}{2} = 2.5\Omega$

GRAPH: 2

D : $\frac{1}{\text{slope}} = R_D = \frac{\Delta V}{\Delta I} = 4/2 = 2\Omega$

E : $\frac{1}{\text{slope}} = R_E = \frac{\Delta V}{\Delta I} = 3/4 = 0.75\Omega$

F : $\frac{1}{\text{slope}} = R_E = \frac{\Delta V}{\Delta I} = \frac{2}{5} = 0.4\Omega$

Least Resistance, $R_F = 0.4\Omega$

Maximum Resistance, $R_C = 2.5\Omega$

**2. Lightning is very good example of natural current. In typical lightning, there is $10^9$ J energy transfer across the potential difference of $5 \times 10^7$ V during a time interval of 0.2 s.**

Solution

N = $10^9$ J ; V= 5 X $10^7$ V ; t =0.2 s = 2 X $10^{-1}$ s.

1. Total amount of charge :

$W = V \cdot q$

$q = \frac{W}{V} = \frac{10^9}{5 \times 10^7} = 0.2 \times 10^2$

$q = 20\,C$

2. CURRENT : $I = Q/t$

$= \frac{20}{2 \times 10^{-1}} = 100\,A$

3. POWER : $P = VI$

$= 5 \times 10^7 \times 10^2 = 5 \times 10^9\,W$

$P = 5\,GW$

**3. A copper wire of $10^{-6}$ m$^2$ area of cross section, carries a current of 2 A. If the number of free electrons per cubic meter in the wire is $8 \times 10^{28}$, calculate the current density and average drift velocity of electrons.**

Solution

SOLUTION:

$J = I/A = 2/10^{-6} = 2 \times 10^6\,A\,m^{-2}$.

$J = n e V_d$

$V_d = \frac{J}{ne} = \frac{2 \times 10^6}{8 \times 10^{28} \times 1.6 \times 10^{-19}}$

$= \frac{10^{-3}}{6.4} = 1.56 \times 10^{-4}\,m/s$.

$V_d = 15.6 \times 10^{-5}\,m s^{-1}$

**4. The resistance of a nichrome wire at $20^0$C is 10 Ω. If its temperature coefficient of resistivity of nichrome is $0.004/^0$C, find the resistance of the wire at boiling point of water. Comment on the result.**

Solution

$$\alpha = \frac{R_T - R_0}{R_0[T - T_0]}$$

$$0.004 = \frac{R_{100} - 10}{10[100 - 20]}$$

$$= \frac{R_{100} - 10}{10[80]}$$

$$[0.004 \times 800] = R_{100} - 10$$

$$3.2 + 10 = R_{100}$$

$$\boxed{R_{100} = 13.2\ \Omega}$$

[OR]

$$R_t = R_0[1 + \alpha(T - T_0)]$$

$$R_{100} = 10[1 + 0.004[100 - 20]]$$

$$R_{100} = 10[1 + 0.32] = 13.2\ \Omega$$

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**5. The rod given in the figure is made up of two different materials.**


**Both have square cross sections of 3 mm side. The resistivity of the first material is $4 \times 10^{-3}$ Ωm and that of second material has resistivity of $5 \times 10^{-3}$ Ωm. What is the resistance of rod between its ends?**

Solution

$\rho_1 = 4 \times 10^{-3}\ \Omega m$ ; $l_1 = 25\ cm$.

$\rho_2 = 5 \times 10^{-3}\ \Omega m$ ; $l_2 = 70\ cm$.

side length $= 3\ mm$.

Area $A = [3 \times 10^{-3} m]^2$

$A = 9 \times 10^{-6}\ m^2$.

SOLUTION:

$R_s = R_1 + R_2$

$R_1 = \dfrac{\rho_1 l_1}{A} = \dfrac{4 \times 10^{-3} \times 25 \times 10^{-2}}{9 \times 10^{-6}}$

$= \dfrac{4 \times 25 \times 10^{-5}}{9 \times 10^{-6}} = \dfrac{1000}{9}\ \Omega$

$R_2 = \dfrac{\rho_2 l_2}{A} = \dfrac{5 \times 10^{-3} \times 70 \times 10^{-2}}{9 \times 10^{-6}}$

$= \dfrac{5 \times 70 \times 10^{-5}}{9 \times 10^{-6}} = \dfrac{3500}{9}\ \Omega$

$R_s = \dfrac{1000}{9} + \dfrac{3500}{9} = \dfrac{4500}{9}$

$R_s = 500\ \Omega$

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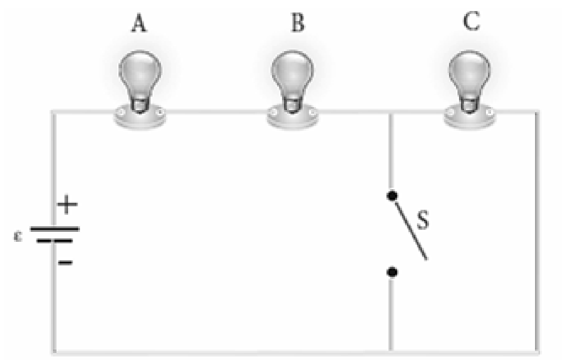
**6. Three identical lamps each having a resistance *R* are connected to the battery of emf ε as shown in the figure.**



**Suddenly the switch S is closed. (a) Calculate the current in the circuit when S is open and closed (b) What happens to the intensities of the bulbs A,B and C. (c) Calculate the voltage across the three bulbs when S is open and closed (d) Calculate the power delivered to the circuit when S is opened and closed (e) Does the power delivered to the circuit decrease, increase or remain same?**

Solution

a) CURRENT:

ohm's law : $V = IR$

$\xi = V$.

$R_1 = R_2 = R_3 = R$

Three lamps are connected in series, $R_S = R_1 + R_2 + R_3$.

$R_S = R + R + R = 3R$.

Switch is open:

$I = V/R_S = \xi/3R$.

Switch is closed:

No current flow through lamp 'c'.

$I = \xi/2R$.

b) INTENSITIES:

Switch is open:

All bulbs having equal intensities.

Switch is closed:

A and B equal intensiti But 'c' will not glow. because no current.

c) VOLTAGE:

Switch is open:

$I = \varepsilon/3R$

$V_A = IR = \varepsilon/3R \times R = \varepsilon/3$.

$V_B = IR = \varepsilon/3R \times R = \varepsilon/3$.

$V_C = IR = \varepsilon/3R \times R = \varepsilon/3$

Switch is closed:

$V_A = IR = \varepsilon/2R \times R = \varepsilon/2$

$V_B = IR = \varepsilon/2R \times R = \varepsilon/2$

$V_C = IR = 0 \times R = 0$.

[Bulb 'c' is in parallel]

d) POWER:

Switch is open:

$P_A = V_A I_A = \varepsilon/3 \times \varepsilon/3R$

$= \varepsilon^2/9R$.

$P_A = P_B = P_C$. [Power is same]

Switch is closed:

$P_A = V_A I_A = \varepsilon/2 \times \varepsilon/2R$

$P_A = \varepsilon^2/4R$.

$P_B = V_B I_B = \varepsilon^2/4R$.

$P_C = V_C I_C = 0$.

∴ Total power will increase.

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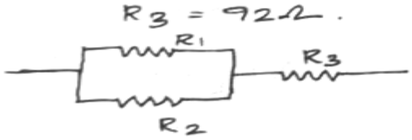
7. **An electronics hobbyist is building a radio which requires 150 Ω in her circuit. But she has only 220 Ω, 79 Ω and 92 Ω resistors available. How can she connect the available resistors to get the desired value of resistance?**

<u>Solution</u>

Resistance required $R = 150\,\Omega$

$R_1 = 220\,\Omega$, $R_2 = 79\,\Omega$

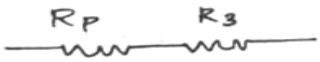
$R_3 = 92\,\Omega$.




$$R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{220 \times 79}{220 + 79}$$

$$R_p = \frac{17380}{299} = 58\,\Omega$$

Now,




$$R_s = R_p + R_3 = 58 + 92$$

$$\therefore R_s = 150\,\Omega$$

Therefore , parallel combination of 230 Ω and 79 Ω in series with 92 Ω

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**8. A cell supplies a current of 0.9 A through a 2 Ω resistor and a current of 0.3 A through a 7 Ω resistor. Calculate the internal resistance of the cell.**

<u>Solution</u>

$I_1 = 0.9$ A ; $R_1 = 2\,\Omega$ ; $I_2 = 0.8$ A ; $R_2 = 7\,\Omega$ ; $r = ?$

$$I_1 = \frac{\varepsilon}{R_1 + r}, \quad \varepsilon = I_1[R_1 + r]$$

$$I_2 = \frac{\varepsilon}{R_2 + r}; \quad \varepsilon = I_2[R_2 + r]$$

$$I_1 R_1 + I_1 r = I_2 R_2 + I_2 r$$

$$I_1 r - I_2 r = I_2 R_2 - I_1 R_1$$

$$r[I_1 - I_2] = I_2 R_2 - I_1 R_1$$

$$r = \frac{I_2 R_2 - I_1 R_1}{I_1 - I_2}$$

$$= \frac{0.3 \times 7 - 0.9 \times 2}{0.9 - 0.3}$$

$$= \frac{2.1 - 1.8}{0.6} = \frac{0.3}{0.6} = \frac{1}{2}$$

$$r = 0.5\,\Omega$$

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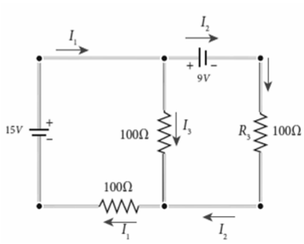
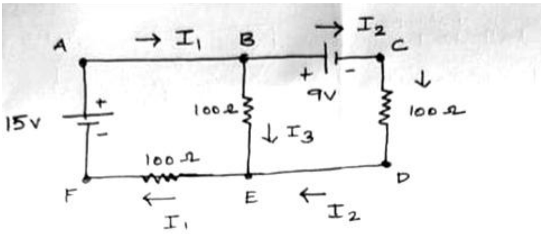
9. Calculate the currents in the following circuit.




<u>Solution</u>




$I_1 = ?$ ; $I_2 = ?$ ; $I_3 = ?$

Applying Kirchoff's current rule at junction 'B'.

$I_1 - I_2 - I_3 = 0$ ; $I_3 = I_1 - I_2 \rightarrow (1)$

Applying Kirchoff's Voltage rule for closed Path ABEFA, $100 I_1 + 100 I_3 = 15$

$100 I_1 + 100 [I_1 - I_2] = 15$

$100 I_1 + 100 I_1 - 100 I_2 = 15$.

$200 I_1 - 100 I_2 = 15 \rightarrow (2)$

Applying Kirchoff's Voltage rule for closed path BCDEB,

$100 I_2 - 100 I_3 = -9$

$100 I_2 - 100 [I_1 - I_2] = -9$

$100 I_2 - 100 I_1 + 100 I_2 = -9$

$200 I_2 - 100 I_1 = -9$

$-100 I_1 + 200 I_2 = -9 \rightarrow (3)$

$(2) \Rightarrow \quad 200 I_1 - 100 I_2 = 15$.

$(3) \times 2 \Rightarrow -200 I_1 + 400 I_2 = -18$.

$300 I_2 = -3$

$I_2 = \frac{-3}{300} = \frac{-1}{10^2} = -1 \times 10^{-2} \Rightarrow \boxed{I_2 = -0.01 \text{ A}}$

$(2) \Rightarrow$

$200 I_1 - 100 \times -\frac{1}{100} = 15$

$200 I_1 + 1 = 15$

$200 I_1 = 14$ ; $I_1 = 14/200$

$\boxed{I_1 = 0.07 \text{A}}$

$(1) \Rightarrow I_3 = I_1 - I_2$

$= 0.07 - [-0.01]$

$\boxed{I_3 = 0.08 \text{ A}}$

**10. A potentiometer wire has a length of 4 m and resistance of 20 Ω. It is connected in series with resistance of 2980 Ω and a cell of emf 4 V. Calculate the potential gradient along the wire.**

GIVEN:

$l = 4m$, $r = 20\Omega$

$\xi = 4V$, $r' = 2980\Omega$.

$E = ?$

SOLUTION:

Effective resistance for two resistors in series combination. $R_s = r + r'$

$R_s = 20 + 2980$

$R_s = 3000\Omega$

$I = \xi / R = 4/3000$ A.

∴ Potential drop across the wire,

$V = IR$ ; $V = Ir = \frac{4}{3000} \times 20 = 4/150$ Volt

∴ Potential gradient, $E = V/l$

$= \frac{4}{150} \times \frac{1}{4} = 1/150 = \frac{1}{15 \times 10} = 0.066 \times 10^{-1}$

$E = 0.66 \times 10^{-2}\ V m^{-1}$

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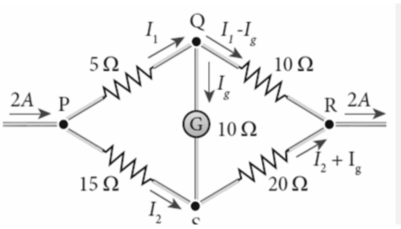
**11. Determine the current flowing through the galvanometer (G) as shown in the figure.**



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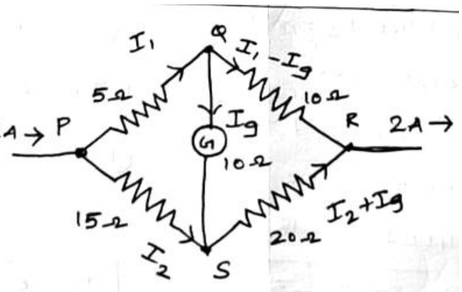
Solution

GIVEN:




$I_g = ?$

SOLUTION:

Applying kirchoff's current rule at junction 'P'.

$I - I_1 - I_2 = 0$

$I - I_1 = I_2 \rightarrow (1)$

Apply kirchoff's Voltage rule for closed path PQSP,

$5I_1 + 10I_g - 15I_2 = 0.$

$(1) \Rightarrow \quad 5I_1 + 10I_g - 15[I - I_1] = 0.$

$5I_1 + 10I_g - 15I + 15I_1 = 0$

$I = 2A, \quad 20I_1 + 10I_g - 15 \times 2 = 0$

$20I_1 + 10I_g = 30. \rightarrow (2)$

Apply kirchoff's Voltage rule for closed path QRSP.

$10[I_1 - I_g] - 20[I_2 + I_g] - 10I_g = 0.$

$10I_1 - 10I_g - 20I_2 - 20I_g - 10I_g = 0.$

$(1) \Rightarrow 10I_1 - 40I_g - 20[I - I_1] = 0.$

$10I_1 - 40I_g - 20I + 20I_1 = 0.$

$I = 2A, \quad 30I_1 - 40I_g - 20[2] = 0.$

$30I_1 - 40I_g = 40 \rightarrow (3)$

$(2) \times 3 \Rightarrow 60I_1 + 30I_g = 90.$

$(3) \times 2 \Rightarrow 60I_1 - 80I_g = 80$

[−] [+] [−]

$110 I_g = 10$

$I_g = \frac{10}{110} = 1/11$

$$\boxed{I_g = 1/11 \ A}$$

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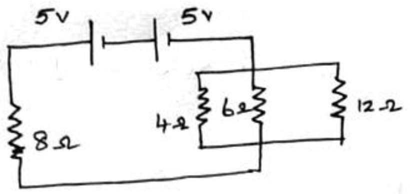
**12. Two cells each of 5V are connected in series with a 8 Ω resistor and three parallel resistors of 4 Ω, 6 Ω and 12 Ω. Draw a circuit diagram for the above arrangement. Calculate i) the current drawn from the cells (ii) current through each resistor**

Solution




$I = ?$

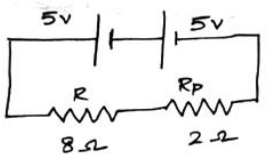
SOLUTION:

$R_1 = 4\Omega$ ; $R_2 = 6\Omega$ ; $R_3 = 12\Omega$

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} = \frac{3+2+1}{12}$

$\frac{1}{R_P} = 6/12 \ \Omega = 2\Omega$

$R_P = 2\Omega$




$R_S = R + R_P$.

$R_S = 8 + 2 = 10\Omega$

$R_S = 10\Omega$

$\xi = \xi_1 + \xi_2 = 5 + 5 = 10V$.

∴ current drawn from each cell,

$I = \xi / R_S = 10/10 = 1A$.

Potential difference through 8 Ω resistor is $V = IR$

$V = 1 \times 8 = 8V$

∴ Potential through 2 Ω ; $V = IR = 1 \times 2 = 2V$

(i) CURRENT through 8 Ω ; $I = V/R = 8/8$ ; $I = 1A$

(ii) CURRENT through 4 Ω, 6 Ω, 12 Ω;

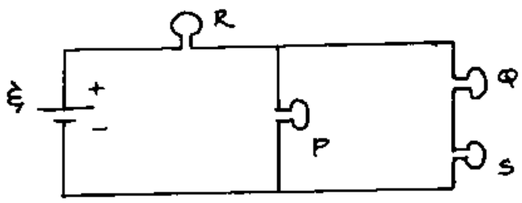
$R = 4\Omega$ ; $I = V/R = \frac{2}{4}$ ; $I = 0.5A$ | $R = 6\Omega$ ; $I = V/R = 2/6$ ; $I = 0.33A$ | $R = 12\Omega$ ; $I = V/R = \frac{2}{12}$ ; $I = 0.166A$

**13. Four bulbs P, Q, R, S are connected in a circuit of unknown arrangement. When each bulb is removed one at a time and replaced, the following behaviour is observed.**

| | P | Q | R | S |
|---|---|---|---|---|
| P removed | * | on | on | on |
| Q removed | on | * | on | off |
| R removed | off | off | * | off |
| S removed | on | off | on | * |

**Draw the circuit diagram for these bulbs.**

Solution




**14. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63 cm, what is the emf of the second cell?**

Solution

GIVEN: $\varepsilon_1 = 1.25\,V$ ; $\varepsilon_2 = ?$   $\varepsilon_1 = 5/4\,V$.

$l_1 = 35\times10^{-2}\,m$ ; $l_2 = 63\times10^{-2}\,m$.

SOLUTION:

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1} \; ; \; \varepsilon_2 = \varepsilon_1 \times \frac{l_2}{l_1}$$

$$\varepsilon_2 = \frac{5}{4} \times \frac{63\times10^{-2}}{35\times10^{-2}} = \frac{9}{4} = 2.25$$

$$\boxed{\varepsilon_2 = 2.25\ \text{Volt}}$$