
"A journey of a thousand miles
begins with a single step"
– Confucius

Answer Writing Skills

Question No. 1

The dipole is aligned parallel to the field. Calculate work done in rotating it through 180 degrees?

Ans. *For 2 marks*

We know that work done in rotating a dipole in a uniform electric field is given by

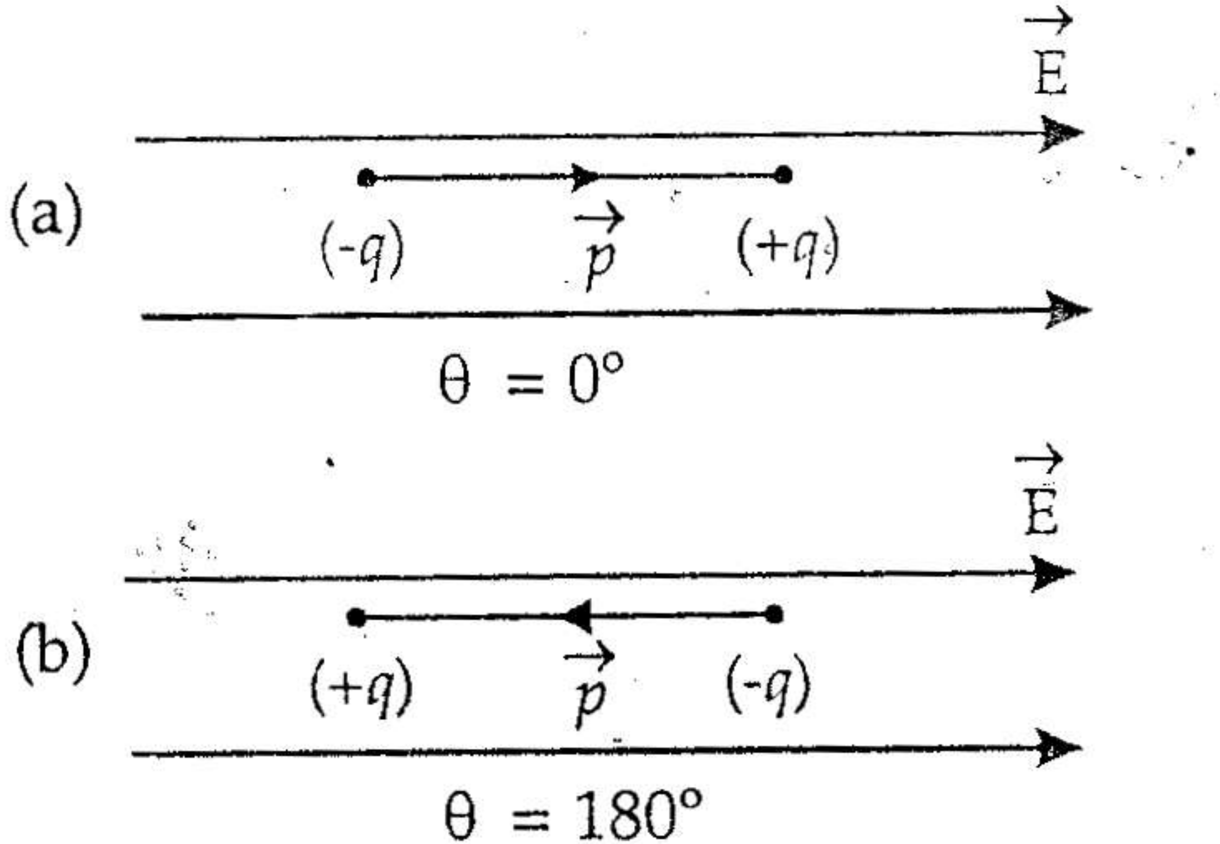
$$W = pE(\cos\theta_1 - \cos\theta_2) \quad \text{...(1)}$$

Here $\theta_1 = 0^\circ$ & $\theta_2 = 180^\circ$

$\therefore$ $W = pE(\cos 0^\circ - \cos 180^\circ)$

or $\boxed{W = 2pE}$

Ans. *For 3 marks*



Thus the work done in rotating a dipole from $\theta = 0^\circ$ to $\theta = 180^\circ$ in a uniform electric field is given by

$$W = \int_0^{180^\circ} \tau \, d\theta$$

$$\Rightarrow \quad W = \int_{0^\circ}^{180^\circ} pE \sin\theta \, d\theta$$

$$\Rightarrow \quad W = pE[-\cos\theta]_0^{180^\circ}$$

$$\Rightarrow \quad \boxed{W = 2pE}$$

Question No. 2

Explain what is meant by electric field lines ? Give their two important properties.

Ans. *For 2 marks*

An electric field line may be defined as a path, (straight or curved) such that tangent drawn at any point gives the direction of electric field intensity at that point.

Properties

(i) Two electric field lines never intersect each other.

(ii) The tangent to an electric field line gives direction of field at the tangenting point.

* For 3 marks

Electric field lines are pictorial representation of an electric field. They are hypothetical lines. They are space curves.

An electric field line may be defined as the path (straight or curved) such that tangent drawn at any point gives the direction of electric field intensity at that point.

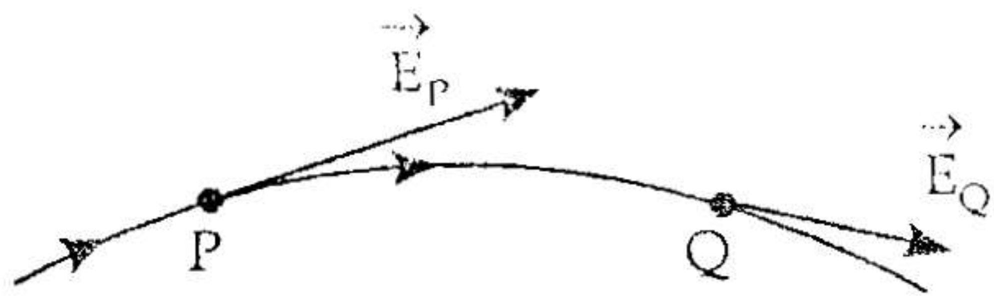
Direction

Electric field lines diverge from a positive charge and converge onto a negative charge.

Properties

(i) No two electric field lines ever intersect each other because field cannot have two directions at the same point.

(ii) The tangent to an electric field line gives direction of field at the tangenting point.



Question No. 3

What do you mean by equipotential surface? Write down its properties.

Ans. *For 2 marks*

Definition

An equipotential surface is defined as the surface on which potential at every point remains same.

Properties

(i) No work is done in moving a charge from one point to another on an equipotential surface.

(ii) Two equipotential surfaces never intersect.

(iii) Direction of electric field is normal to the surface.

Answer *For 3 marks*

Definition

It is defined as the surface on which potential at every point remains the same.

Properties

(i) No work is done in moving a charge from one point to another.

Proof:

As $$V_{AB} = \frac{W}{q}$$

$\therefore$ $$W = V_{AB}\, q$$

But $$V_{AB} = V_A - V_B = 0 \quad [\because V_A = V_B]$$

$\therefore$ $$\boxed{W = 0}$$

(ii) Direction of electric field is normal to equipotential surface

Proof:

As $$V_{AB} = \int \vec{E} \cdot \vec{dr}$$

$$\Rightarrow \quad 0 = \int \vec{E} \cdot \vec{dr} \qquad [\because V_{AB} = 0]$$

$$\Rightarrow \quad \boxed{\vec{E} \perp \vec{dr}}$$

(iii) Two equipotential surfaces never cross each other because if they cross, then at the same point, the value of potential is different which is not possible.

Question No. 4

Write down the factors affecting the resistance of a conductor.

Answer *For 2 marks*

The resistance of a conductor depends on the following factors:

(i) Length of the conductor ($R \propto l$)

(ii) Area of cross-section of the conductor ($R \propto 1/A$)

(iii) No. of electrons present in it ($R \propto 1/n$)

(iv) Temperature of the conductor ($R \propto T$)

Ans. *For 3 marks*

The resistance of a conductor is given by

$$R = \frac{ml}{ne^2\tau A} = \left(\frac{m}{ne^2\tau}\right)\cdot\frac{l}{A}$$

where, m is mass of the electron

n is electron density

e is charge of electron

τ is relaxation time

l is length of conductor

A is area of cross-section

Thus the factors affecting the resistance are

i) **Length of conductor:** If A and τ remain unchanged, then

$$\boxed{R \propto l}$$

(ii) **Area of cross section:** If l and τ remain unchanged, then

$$\boxed{R \propto \frac{1}{A}}$$

For a wire, $A = \pi r^2$, $\therefore R \propto 1/r^2$

(iii) **Temperature of conductor:** If l and n remain unchanged, then

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

but $$\tau \propto \frac{1}{T}$$ [T *is* temperature]

$$\therefore \quad \boxed{R \propto T}$$

(iv) **Nature of the conductor:** If A, l and τ are unchanged, then R depends on the number density of electrons present in it.

i.e. $$\boxed{R \propto \frac{1}{n}}$$

Question No. 5

A metallic wire of resistance 'R' is stretched so that its length is doubled. How is its resistance affected?

Ans. *For 1 mark*

Resistance of the wire will be increased by four times.

Ans. *For 2 marks*

Resistance of a wire is directly proportional to square of its length *i.e.*,

$$R \propto l^2$$

$$\therefore \qquad \frac{R_1}{R_2} = \frac{l_1^2}{l_2^2}$$

According to question, $R_1 = R$ & $l_2 = 2l_1$,

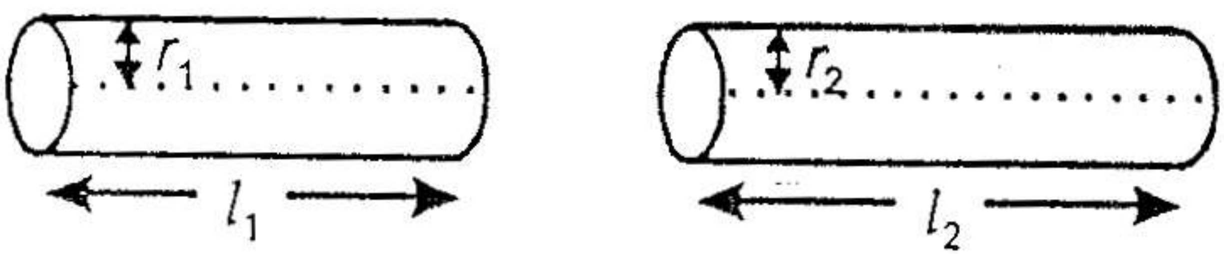
$$\therefore \qquad \frac{R}{R_2} = \frac{1}{4}$$

$$\text{or} \qquad R_2 = 4R$$

Ans For 3 Marks

When a wire is stretched, its volume remains unchanged, *i.e.*,

Initial volume = Final volume



$$\Rightarrow \quad \pi r_1^2 l_1 = \pi r_2^2 l_2$$

$$\Rightarrow \quad \frac{l_1}{l_2} = \frac{r_2^2}{r_1^2} \quad \text{...(i)}$$

But for resistance,

$$\frac{R_1}{R_2} = \frac{r_2^2}{r_1^2} \times \frac{l_1}{l_2}$$

$$\Rightarrow \quad \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{l_1}{l_2} \qquad \text{From (i)}$$

$$\Rightarrow \quad \frac{R_1}{R_2} = \frac{l_1^2}{l_2^2}$$

$$\Rightarrow \quad R \propto l^2 \qquad \text{...(ii)}$$

Thus as the length of wire is doubled, its resistance will become **four** times.

Question No. 6

Under what condition we can draw maximum current from a secondary cell?

Ans For 1 Mark

Current drawn from a secondary cell is maximum when its internal resistance is equal to external resistance.

Ans. *For 2 or marks*

The current drawn from a secondary cell is given by

$$i = \frac{E}{r+R}$$

where r is internal resistance

R is external resistance

Thus 'i' will be maximum when

$$r + R = \text{minimum}$$

$$\text{or } (\sqrt{r}^2 + \sqrt{R}^2 - 2\sqrt{rR}) + 2\sqrt{rR} = \min$$

$$\text{or} \quad (\sqrt{r} - \sqrt{R})^2 + 2\sqrt{rR} = \min$$

It is possible if

$$\sqrt{r} - \sqrt{R} = 0$$

$$\text{or} \quad \boxed{r = R}$$

So current drawn is maximum when external resistance will be equal to internal resistance of the cell.

Question No. 7

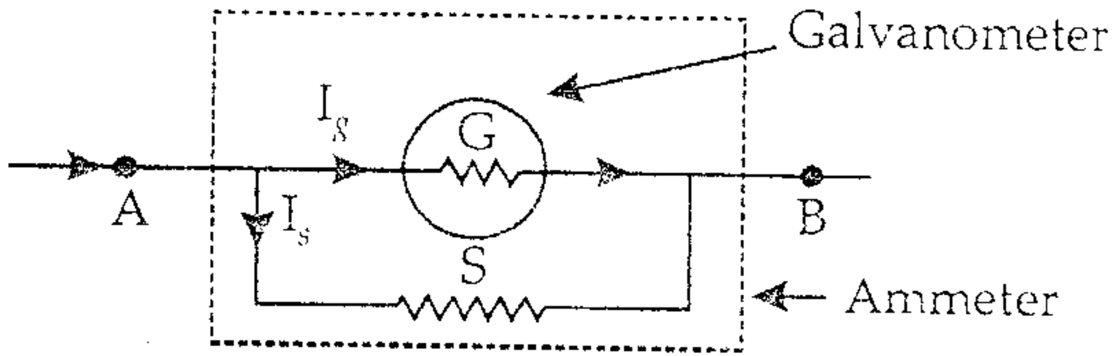
How can a moving coil galvanometer be converted in to an ammeter?

Ans *For 1 mark*

To convert moving coil galvanometer in to ammeter, a low resistance is connected in parallel

Ans 3 marks

To convert the moving coil galvanometer into an ammeter, a low value resistance called shunt is connected with it in parallel.



$$V_A - V_B = I_g G = I_s S$$

& $$I = I_g + I_S$$

[From Kirchoff's current law]

$$\boxed{I_g = \frac{S}{S+G} I}$$

The above ammeter is of the range (0 – I)

Question No. 8

What do you mean by depletion layer of p-n junction diode? How does its width vary?

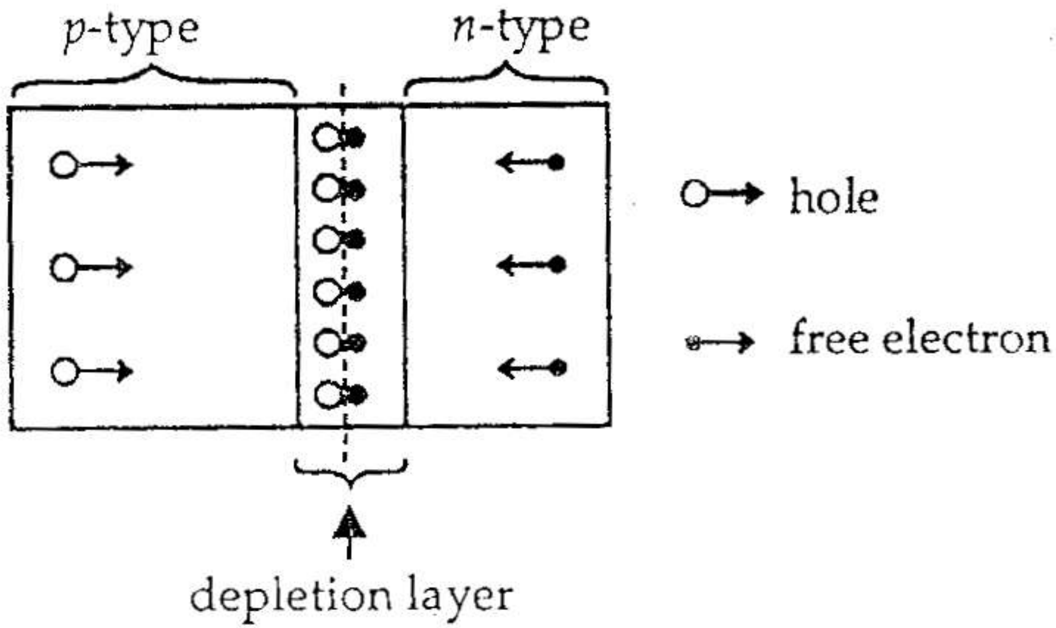
Answer **For 2 marks**

Depletion Layer : The thin region around the junction containing immobile positive and negative charges is known as depletion layer.

The width of depletion layer decreases in forward bias and increases in reverse bias

Ans. *For 3 marks*

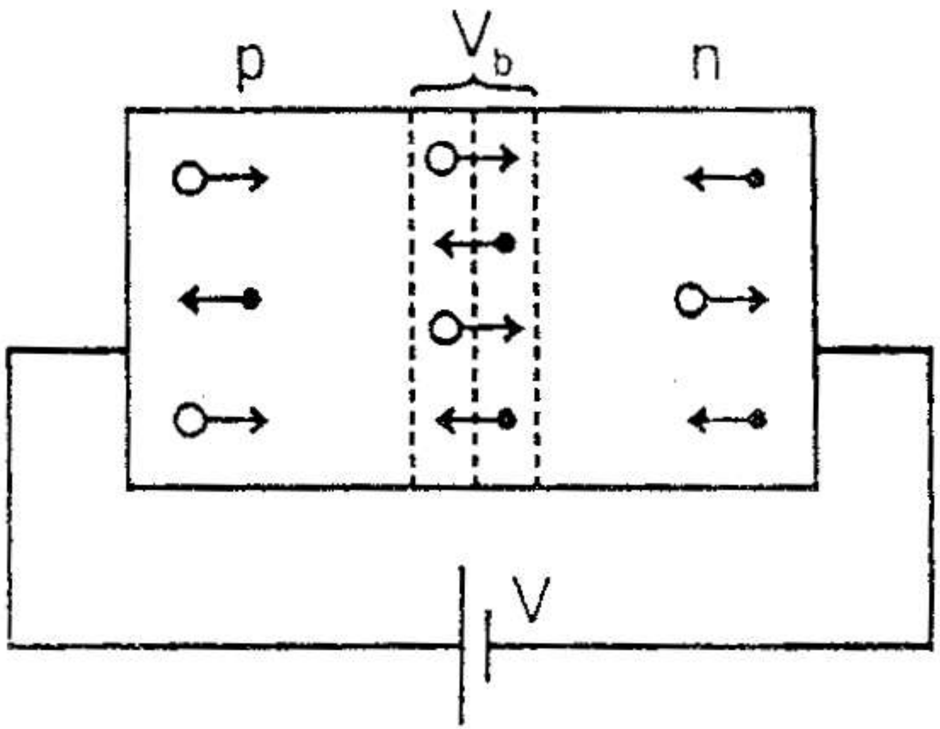
Depletion layer: Same as in 2 marks



Variation in Width of Depletion Layer:

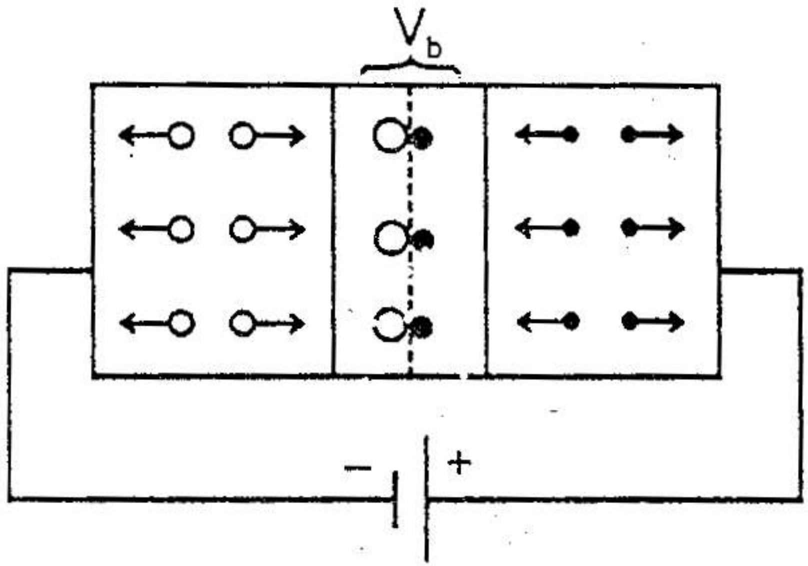
The width of depletion layer depends on biasing of diode.

(i) **Forward bias:**



In forward bias, holes and free electrons start penetrating the junction, so width decreases with increase in applied potential.

(ii) **Reverse bias:**



In reverse bias, holes and free electrons move towards negative and positive terminal of battery. So the width of depletion layer increases with increase in applied voltage upto certain limit.