Physicsaholics

DPP – 1 & 2 (Current Electricity)

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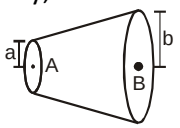
Q 1. An electric current passes through non uniform cross-section wire made of homogeneous and isotropic material. If the j_A and j_B be the current densities and E_A and E_B be the electric field intensities at A and B respectively, then



(a) $j_A > j_B$; $E_A > E_B$ (b) $j_A > j_B$; $E_A < E_B$
(c) $j_A < j_B$; $E_A > E_B$ (d) $j_A < j_B$; $E_A < E_B$

Q 2. When a potential difference (V) is applied across a conductor , the thermal speed of electrons is -
(a) zero
(b) proportional to $\sqrt{T}$
(c) proportional to (T)
(d) proportional to V

Q 3. An electric current is established in a hydrogen gas discharge tube when a high voltage is applied across the two electrodes in the tube. The gas is ionised. Electrons move towards the positive terminal and the positive ions towards the negative terminal. The magnitude of the current in the tube in which 3.1×10^{18} electrons and 1.1×10^{18} protons move past a cross-sectional area of the tube each second will be -
(a) 1.6 A (b) 3.2 A (c) 0.16 A (d) 0.672 A

Q 4. The current in a copper wire is increased by increasing the potential difference between its end. Which one of the following statements regarding n, the number of charge carriers per unit volume in the wire and v the drift velocity of the charge carriers is correct -
(a) n is unaltered but v is decreased
(b) n is unaltered but v is increased
(c) n is increased but v is decreased
(d) n is increased but v is unaltered

Q 5. A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/quantities constant along the length of the conductor is/are:
(a) current, electric field and drift speed
(b) drift speed only
(c) current and drift speed
(d) current only

Q 6. A hollow nonconductor cylindrical wire of inner radius a outer radius 2a and length h is rotating about its axis with constant angular velocity ω. If volume charge density of cylinder is ρ , current due to motion of cylinder is

(a) $\frac{5}{2}\rho\omega a^2 h$

(b) $\rho\omega a^2 h$

(c) $\frac{1}{2}\rho\omega a^2 h$

(d) $\frac{3}{2}\rho\omega a^2 h$

Q 7. Current in a uniform straight conductor wire is i and drift velocity of electrons is v. An observer is moving with velocity v in just opposite direction of current. Net current with respect to observer is

(a) 0

(b) i

(c) i/2

(d) 2i

Q 8. Mean free path of electron in metals

(a) Increases on increasing temperature

(b) Decreases on increasing temperature

(c) Does not depend on temperature

(d) None of these

Q 9. In a hollow conductor sphere current is flowing in radially outward direction from inner surface to outer surface. If E_1 and E_2 are electric field in conductor near inner and outer surfaces respectively.

(a) $E_1 > E_2$

(b) $E_1 = E_2$

(c) $E_1 < E_2$

(d) Electric field is zero inside material of sphere.

Q 10. A metal wire has coefficient of linear expansion α_1 and temperature coefficient of resistivity α_2. Apparent temperature coefficient of resistance will be

(a) α_2 (b) $\alpha_2 - \alpha_1$ (c) $\alpha_2 + \alpha_1$ (d) $\alpha_2 - 2\alpha_1$

Q 11. A uniform copper wire of mass 2.33×10^{-3} kg caries a current of 1 A, when 1.7 V is applied across it. Calculate its length and area of cross section. Density of Cu is 8.92×10^3 kg m^{-3} and resistivity is 1.7×10^{-8} Ω m.

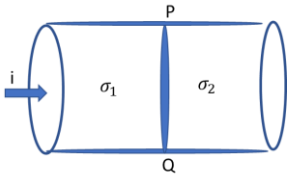
(a) 10m, $5 \times 10^{-8} m^2$

(b) 5m, $10 \times 10^{-8} m^2$

(c) 5m, $5 \times 10^{-8} m^2$

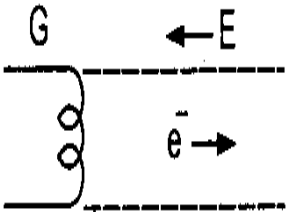
(d) 10m, $10 \times 10^{-8} m^2$

Q 12. In given figure PQ is joint of two cylindrical wires of equal cross sectional area A. Charge stored at junction PQ is



(a) $i \in_0 \left(\frac{1}{\sigma_1} - \frac{1}{\sigma_2}\right)$
(b) $i \in_0 \left(\frac{1}{\sigma_2} - \frac{1}{\sigma_1}\right)$
(c) $i \in_0 (\sigma_1 + \sigma_2)$
(d) zero

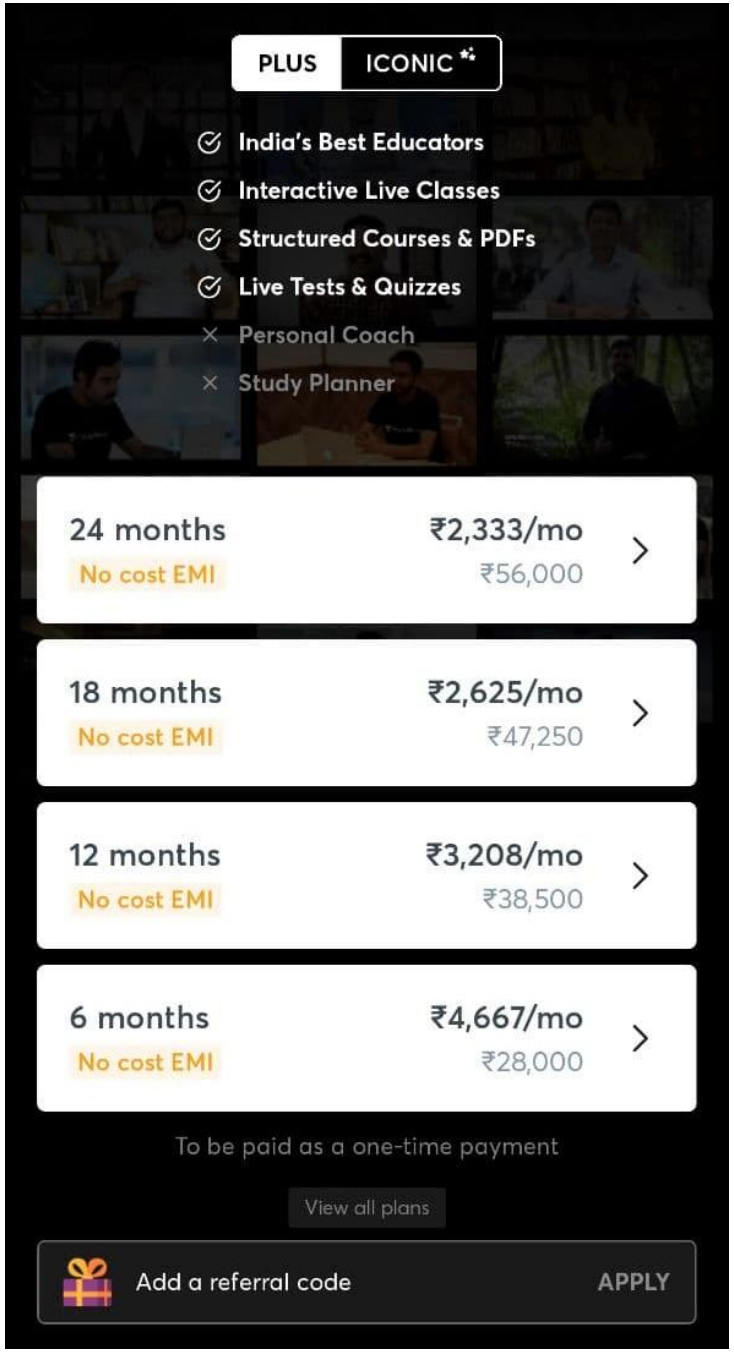
Q 13. A beam of electrons emitted from the electron gun G is accelerated by an electric field E. The area of cross-section of the beam remains constant. As the beam moves away from G,



(a) the speed of the electrons increases
(b) the current constituted by the beam increases
(c) the number of electrons per unit volume in the beam increases
(d) the number of electrons per unit volume in the beam decreases

Answer Key

Q.1 a	**Q.2 b**	**Q.3 d**	**Q.4 b**	**Q.5 d**
Q.6 d	**Q.7 b**	**Q.8 b**	**Q.9 a**	**Q.10 b**
Q.11 c	**Q.12 b**	**Q.13 a, d**		



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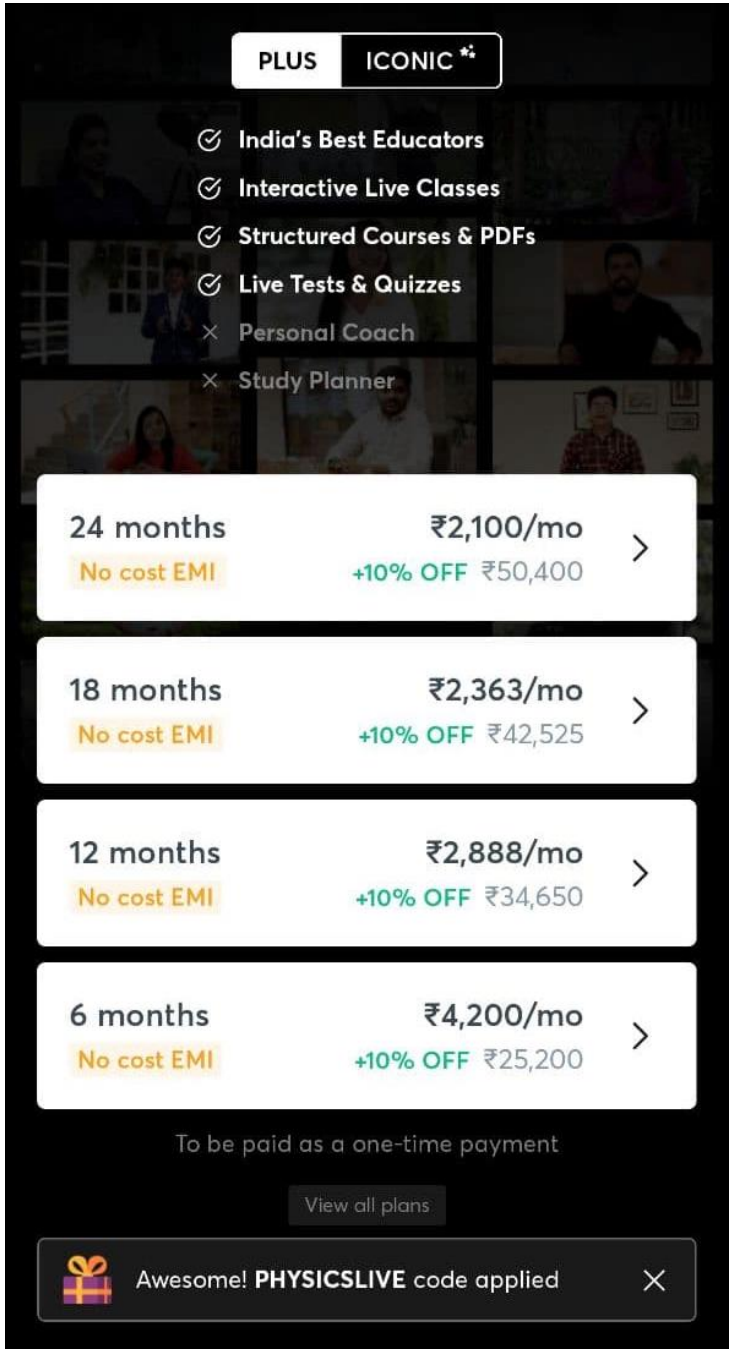


Written Solution

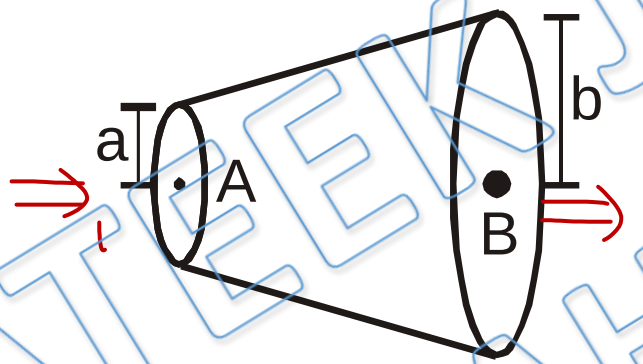
DPP- 1 & 2 Current : Current, Current Density,Drift Velocity

By Physicsaholics Team

Q.1) An electric current passes through non uniform cross-section wire made of homogeneous and isotropic material. If the j_A and j_B be the current densities and E_A and E_B be the electric field intensities at A and B respectively, then

$J_A > J_B$

$E_A > E_B$



i = Constant

$J_A = c$

$J \propto \frac{1}{A}$

$J = \sigma E$ → Conductivity

(a) $j_A > j_B$; $E_A > E_B$

(b) $j_A > j_B$; $E_A < E_B$

(c) $j_A < j_B$; $E_A > E_B$

(d) $j_A < j_B$; $E_A < E_B$

Q.2) When a potential difference (V) is applied across a conductor , the thermal speed of electrons is -

Thermal energy $\sim KT$

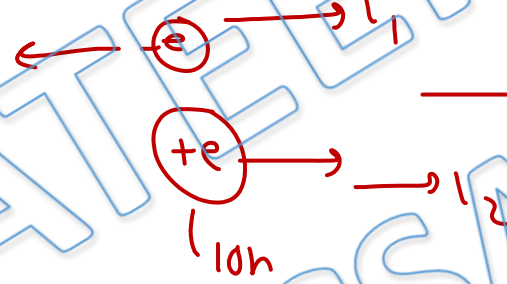
(a) zero

(b) proportional to $\sqrt{T}$

(c) proportional to (T)

(d) proportional to V

Q.3) An electric current is established in a hydrogen gas discharge tube when a high voltage is applied across the two electrodes in the tube. The gas is ionised. Electrons move towards the positive terminal and the positive ions towards the negative terminal. The magnitude of the current in the tube in which 3.1×10^{18} electrons and 1.1×10^{18} protons move past a cross-sectional area of the tube each second will be -



$i = i_1 + i_2$

$= 3.1 \times 10^{18} e + 1.1 \times 10^{18} e$

$= 4.2 \times 10^{18} \times 1.6 \times 10^{-19}$

$= 6.72 \times 10^{-1} = .672$ A

(a) 1.6 A (b) 3.2 A (c) 0.16 A (d) 0.672 A

Q.4) The current in a copper wire is increased by increasing the potential difference between its end. Which one of the following statements regarding n, the number of charge carriers per unit volume in the wire and v the drift velocity of the charge carriers is correct -

(a) n is unaltered but v is decreased

(b) n is unaltered but v is increased

(c) n is increased but v is decreased

(d) n is increased but v is unaltered

$I = nevA$ (v → drift speed; n → constant)

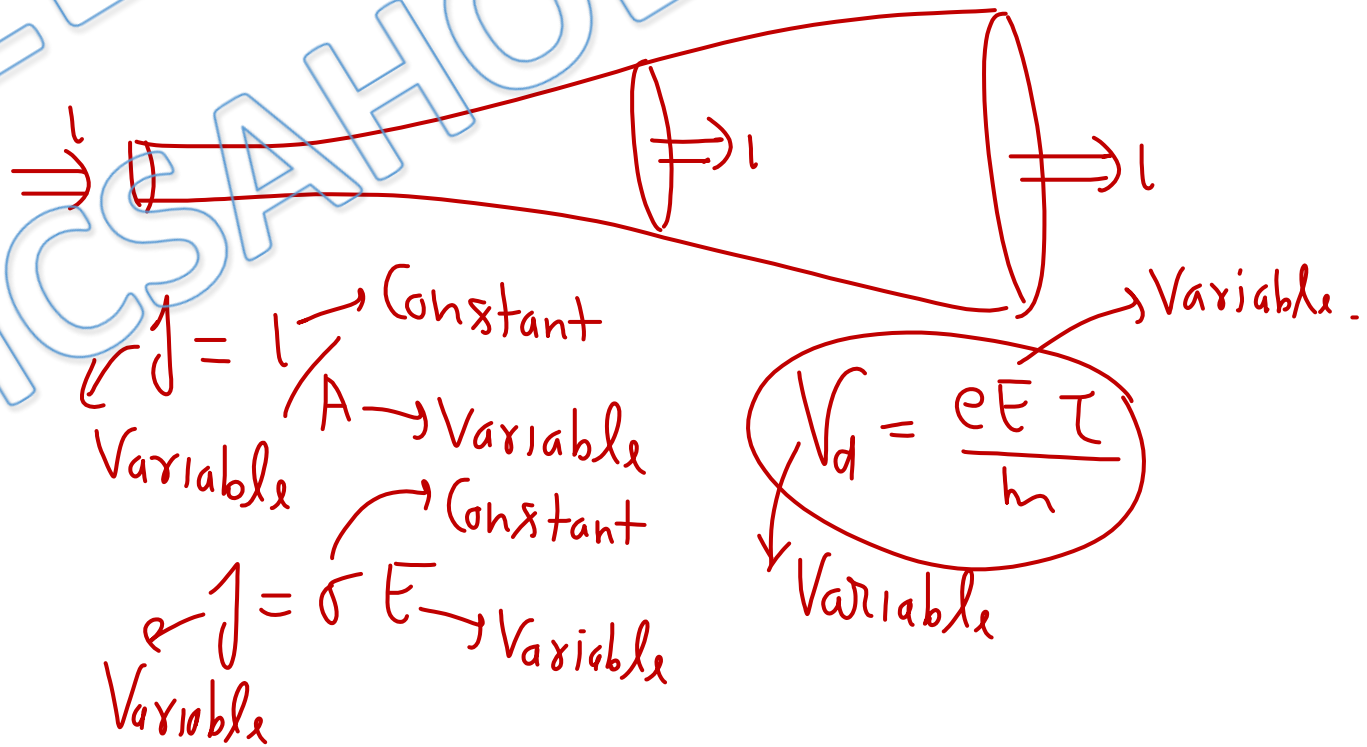
Q.5) A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/quantities constant along the length of the conductor is/are:

(a) current, electric field and drift speed

(b) drift speed only

(c) current and drift speed

(d) ~~current only~~



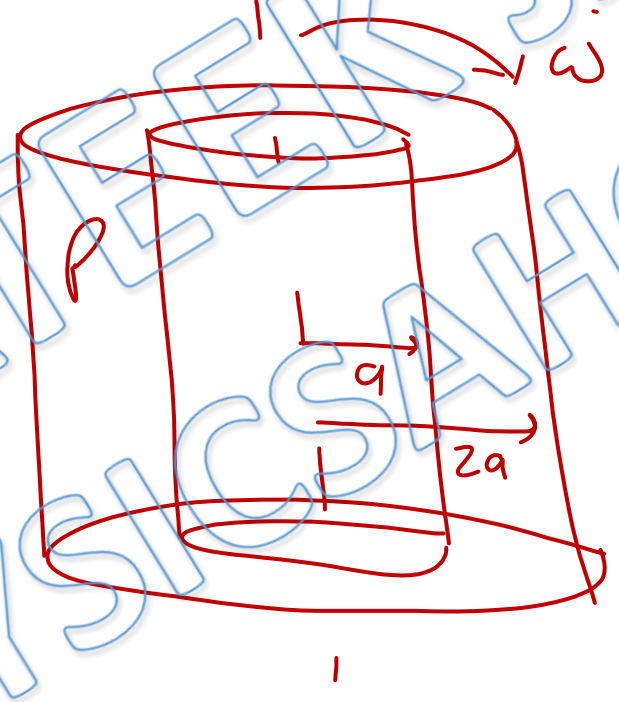
Q.6) A hollow nonconductor cylindrical wire of inner radius a outer radius 2a and length h is rotating about its axis with constant angular velocity ω. If volume charge density of cylinder is ρ , current due to motion of cylinder is

(a) $\frac{5}{2}\rho\omega a^2 h$

(b) $\rho\omega a^2 h$

(c) $\frac{1}{2}\rho\omega a^2 h$

(d) ~~$\frac{3}{2}\rho\omega a^2 h$~~



$$i = \frac{q}{T} = \frac{q\omega}{2\pi}$$

$$= \frac{\rho(4\pi a^2 h - \pi a^2 h)\omega}{2\pi}$$

$$= \frac{3}{2}\frac{\pi a^2 \rho \omega h}{\pi}$$

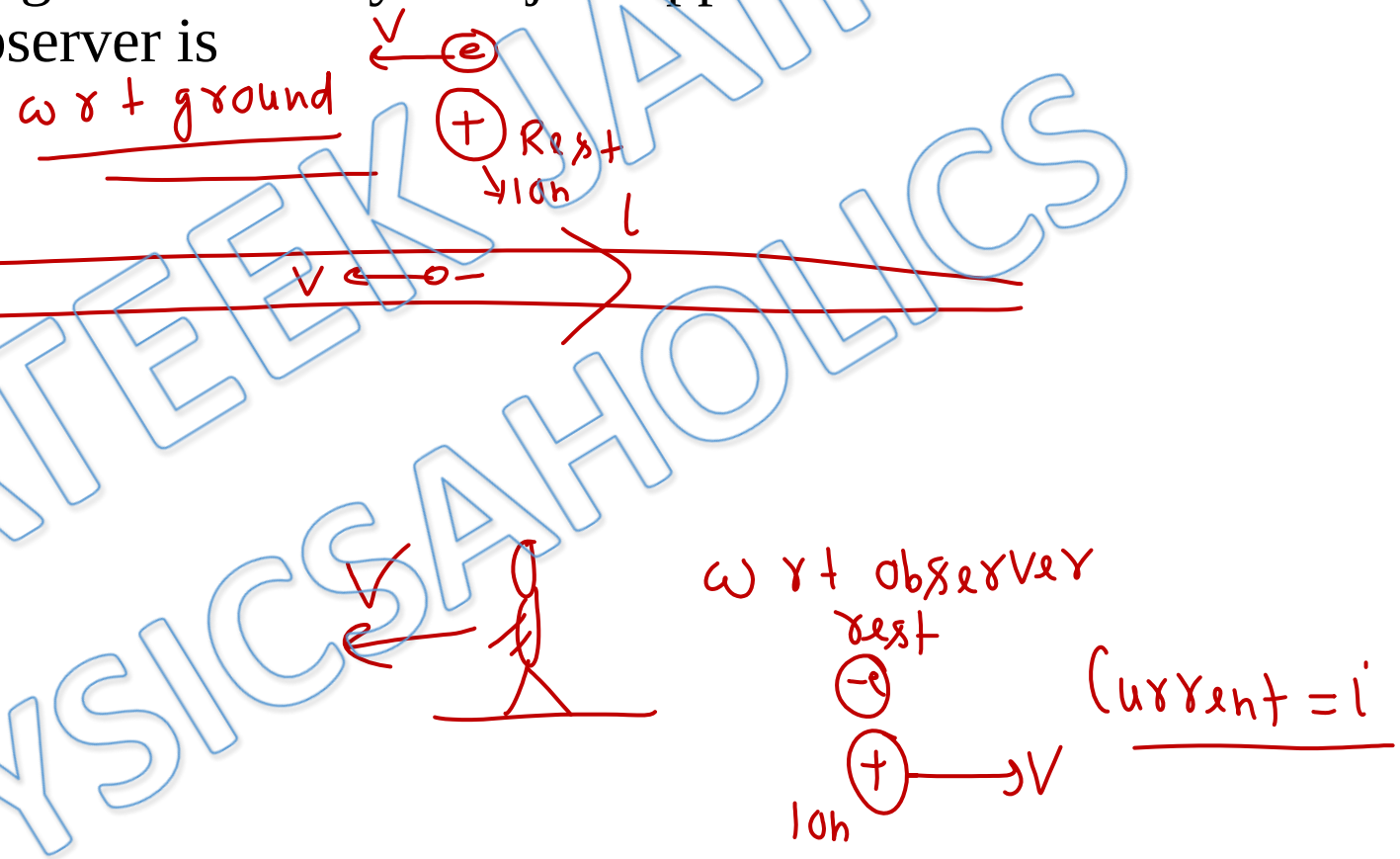
Q.7) Current in a uniform straight conductor wire is i and drift velocity of electrons is v. An observer is moving with velocity v in just opposite direction of current. Net current with respect to observer is

(a) 0

~~(b) i~~

(c) i/2

(d) 2i



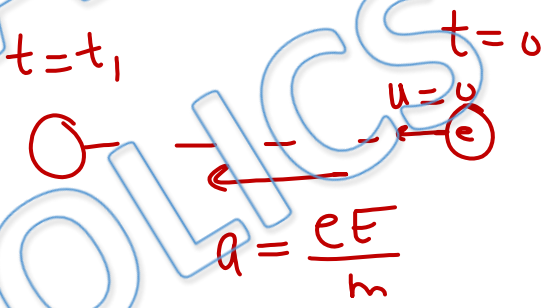
Q.8) Mean free path of electron in metals

(a) Increases on increasing temperature

(b) ~~Decreases on increasing temperature~~

(c) Does not depend on temperature

(d) None of these

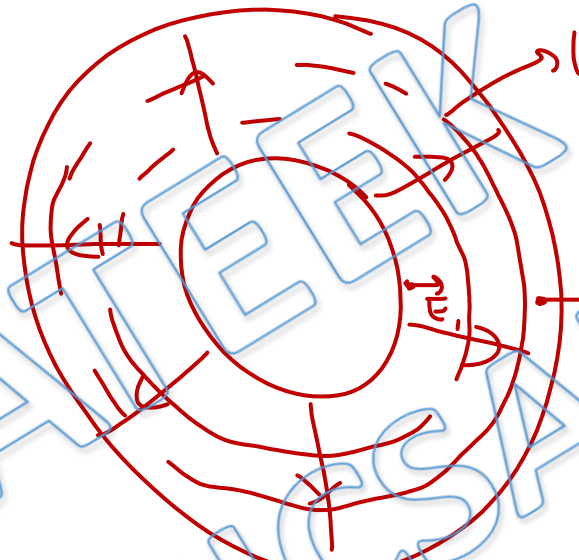


$$\delta_1 = \frac{1}{2} a t_1^2$$

$$\delta_2 = \frac{1}{2} a t_2^2$$

$$\delta_{mean} = \frac{1}{2} a t^2$$

Q.9) In a hollow conductor sphere current is flowing in radially outward direction from inner surface to outer surface. If E_1 and E_2 are electric field in conductor near inner and outer surfaces respectively.



$J = \sigma E$

$E = \frac{J}{\sigma}$

$E = \frac{i}{A\sigma}$

decreasing ↓ increasing

(a) $E_1 > E_2$

(b) $E_1 = E_2$

(c) $E_1 < E_2$

(d) Electric field is zero inside material of sphere.

Q.10) A metal wire has coefficient of linear ~~expression~~ Expansion α_1 and temperature coefficient of resistivity α_2. Apparent temperature coefficient of resistance will be

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

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \frac{\Delta \ell}{\ell} - \frac{\Delta A}{A}$$

$$\Delta \ell = \ell \alpha_1 \Delta T$$

$$\Delta A = A \beta \Delta T = A\, 2\alpha_1 \Delta T$$

$$\Delta \rho = \rho \alpha_2 \Delta T$$

Temperature Coeff of resistance $\alpha \Delta T = \alpha_2 \Delta T + \alpha_1 \Delta T - 2\alpha_1 \Delta T$

$$\alpha = \alpha_2 - \alpha_1$$

(a) α_2 (b) $\alpha_2 - \alpha_1$ (c) $\alpha_2 + \alpha_1$ (d) $\alpha_2 - 2\alpha_1$

Q.11) A uniform copper wire of mass 2.33×10^{-3} kg caries a current of 1 A, when 1.7 V is applied across it. Calculate its length and area of cross section. Density of Cu is 8.92×10^{3} kg m^{-3} and resistivity is 1.7×10^{-8} Ω m.

(a) 10m, $5 \times 10^{-8} m^2$

(b) 5m, $10 \times 10^{-8} m^2$

(c) 5m, $5 \times 10^{-8} m^2$

(d) 10m, $10 \times 10^{-8} m^2$

$R = \frac{V}{I} = \frac{1.7}{1} = 1.7\ \Omega = \rho \frac{l}{A}$

$\Rightarrow 1.7 = 1.7 \times 10^{-8} \frac{l}{A}$

$\frac{l}{A} = 10^{8}$ — (1)

$m = \rho A l \Rightarrow 2.33 \times 10^{-3} = 8.92 \times 10^{3} A l$

$\Leftarrow A l = \frac{2.33}{8.92} \times 10^{-6}$ — (11)

$l^2 = \frac{2.33}{8.92}\ m^2$

$l = 5\ m$

$A = l \times 10^{-8} = 5 \times 10^{-8}\ m^2$

Q.12) In given figure PQ is joint of two cylindrical wires of equal cross sectional area A. Charge stored at junction PQ is

(a) $i\,\epsilon_0\left(\frac{1}{\sigma_1}-\frac{1}{\sigma_2}\right)$

(b) $i\,\epsilon_0\left(\frac{1}{\sigma_2}-\frac{1}{\sigma_1}\right)$

(c) $i\,\epsilon_0\,(\sigma_1+\sigma_2)$

(d) zero

$J = \sigma E$

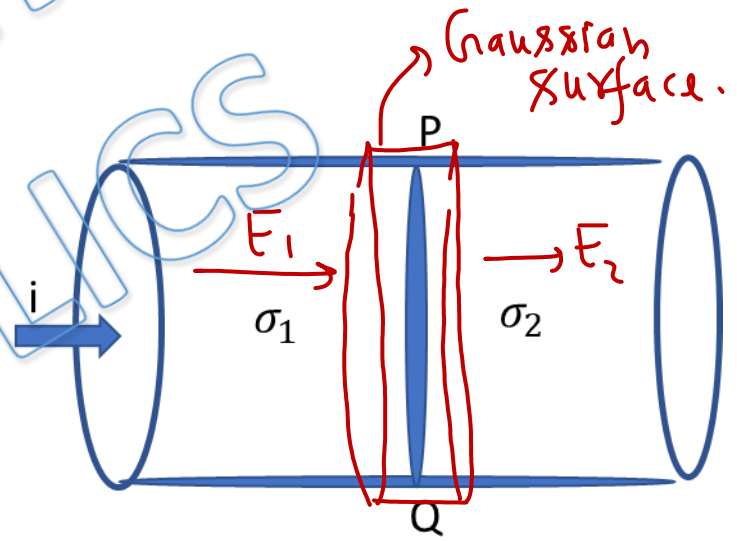
$E = \frac{J}{\sigma} = \frac{i}{A\sigma}$

$\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$

$\Rightarrow E_2 A - E_1 A = \frac{q_{in}}{\epsilon_0}$

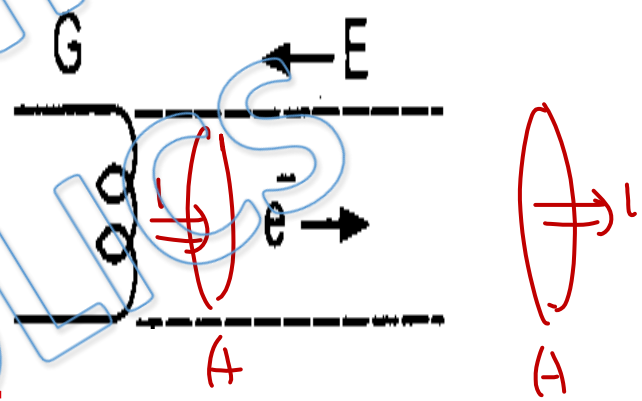
$\Rightarrow \frac{i}{\sigma_2} - \frac{i}{\sigma_1} = \frac{q_{in}}{\epsilon_0}$

$\Rightarrow q_{in} = i\epsilon_0\left(\frac{1}{\sigma_2}-\frac{1}{\sigma_1}\right)$



Q.13) A beam of electrons emitted from the electron gun G is accelerated by an electric field E. The area of cross-section of the beam remains constant. As the beam moves away from G,

$i = neAv_d$ — increase; Constant; decreases



(a) the speed of the electrons increases

(b) the current constituted by the beam increases

(c) the number of electrons per unit volume in the beam increases

(d) the number of electrons per unit volume in the beam decreases

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