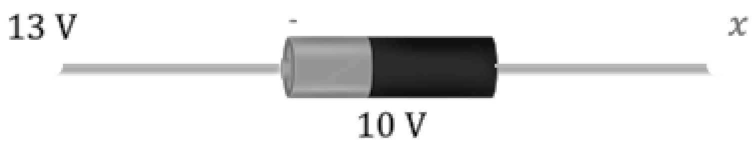
Chapter 3

CURRENT ELECTRICITY

Exercise

Q.1 What is the value of x in the figure shown below?

(A) 5 V **(B)** 4 V **(C)** 3 V **(D)** 23 V



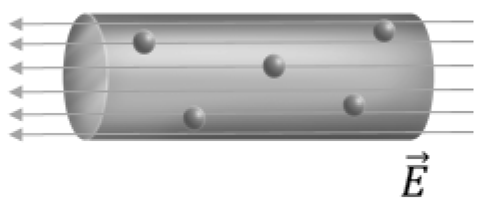
Q.2 In the presence of an applied electric field (→E) in a metallic conductor.

(A) The electrons move in the direction of →E

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

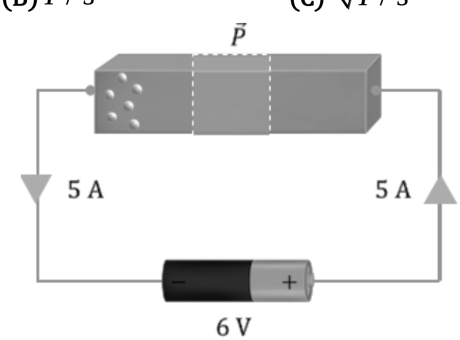
(C) The electrons may move in any direction randomly, but slowly drift in the direction of →E

(D) the electrons move randomly but slowly drift in a direction opposite to →E



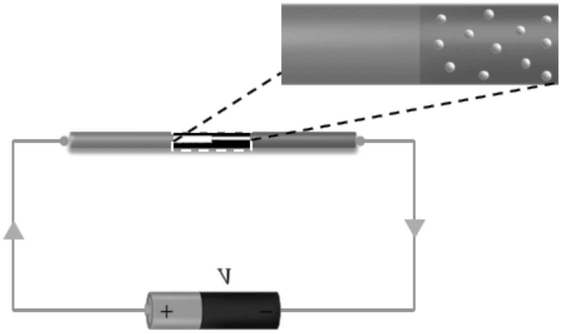
Q.3 A straight conductor of uniform cross-section carried a current I. Let s=specific charge of an electron. The momentum of all the free electrons per unit length of the conductor, due to their drift velocities only, is

(A) Is **(B)** I / s **(C)** $\sqrt{I / s}$ **(D)** $(I / s)^2$



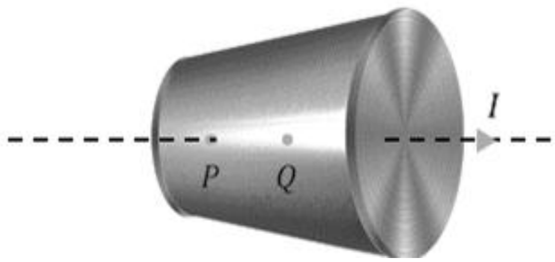
Q.4 Two wires each of radius of cross-section r but of different materials are connected together end to end (in series). If the densities of charge carriers in the two wires are in the ratio 1:4, the drift velocity of electrons in the two wires will be in the ratio

(A) $1:2$ **(B)** $2:1$ **(C)** $4:1$ **(D)** $1:4$



Q.5 A wire has non-uniform cross-section as shown in fig. steady current flows through it. The drift speed of electrons at point P and Q is vP and vQ

(A) $v_P = v_Q$ **(B)** $v_P < v_Q$ **(C)** $v_P > v_Q$ **(D)** Data insufficient



Q.6 An insulating pipe of cross-section area 'A' contains an electrolyte which has two types of ions, their charges being $-$ e and $+$ 2e. A potential difference applied between the ends of the pipe result in the drifting of the two types of ions, having drift speed $=$ v ($-$vein) and v/4 (+vein). Both ions have the same number per unit volume =n. The current flowing through the pipe is

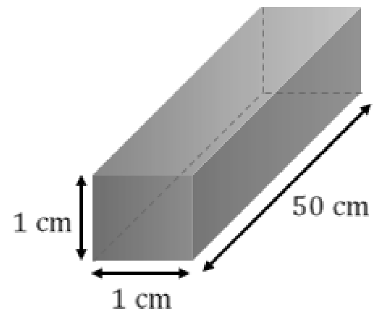
(A) $\frac{nevA}{4}$ **(B)** $\frac{5nevA}{2}$ **(C)** $\frac{nevA}{2}$ **(D)** $\frac{3nevA}{2}$

Q.7 The potential difference across a wire of 10-3 cm2 cross-sectional area and 50 cm length is 2 V, when a current of 0.25 A exists in the wire. The conductivity of the material is

(A) 2.5×10^6 mho/m **(B)** 6.25×10^5 mho/m
(C) 2.5×10^9 mho/m **(D)** 6.25×10^{10} mho/m

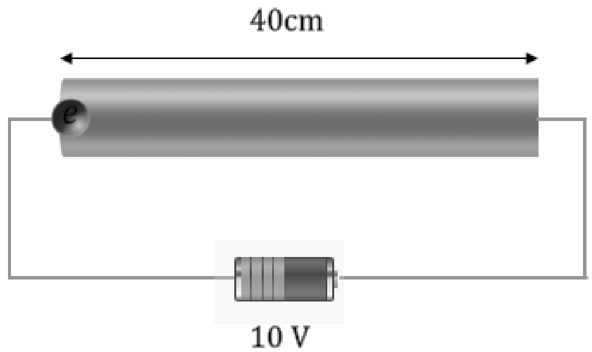
Q.8 A rectangular carbon block has dimensions 1.0cm×1.0cm×50cm. Resistance are measured first across two square ends and then across two rectangular ends, respectively. If resistivity carbon is 3.5×10−5Ωm, then value of measured resistances respectively are

(A) $\frac{35}{2}\times10^{-2}\,\Omega,\ 7\times10^{-5}\,\Omega$ **(B)** $7\times10^{-5}\,\Omega,\ \frac{15}{2}\times10^{-2}\,\Omega$
(C) $\frac{35}{2}\times10^{-4}\,\Omega,\ 7\times10^{-7}\,\Omega$ **(D)** $\frac{15}{2}\,\Omega,\ 7\times10^{-2}\,\Omega$



Q.9 Across a conductor of length 40 cm, a potential difference of 10 V is maintained. The mobility of electrons if the drift velocity of electrons is 5×10−6 m/s is

(A) 2×10^{-7} m2/Vs **(B)** 1×10^{-7} m2/Vs
(C) 4×10^{-6} m2/Vs **(D)** 0.5×10^{-7} m2/Vs

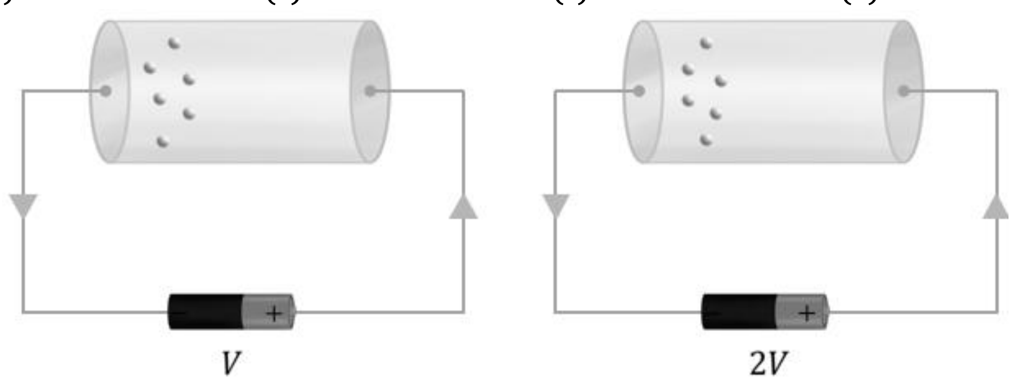


Q.10 The current density at a point is → J = (2×104^j) Am − 2. Find the rate of charge flow through a cross-sectional area →S = (2^i+3^j) cm2.

(A) 6 **(B)** 7 **(C)** 15 **(D)** 20

Q.11 A potential difference V is applied to a copper wire of length l and radius r. If V is doubled, the drift velocity

(A) is doubled **(B)** is halved **(C)** remains same **(D)** becomes zero

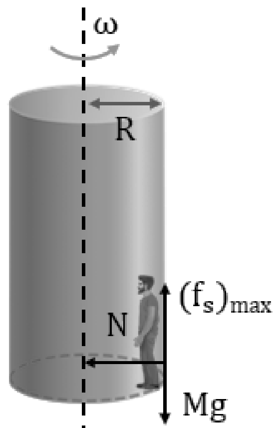


WORKSHEET

Angular Velocity

Q.1 A person stands in contact against the wall of a cylindrical drum of radius R rotating with an angular velocityω. If the coefficient of friction between the wall and the person is μ, the minimum rotational speed of the cylinder which enables the person to remain stuck to the wall when the floor is suddenly removed is

(A) $\omega_{min} = \sqrt{\frac{g}{\mu R}}$ **(B)** $\omega_{min} = \sqrt{\frac{\mu R}{g}}$ **(C)** $\omega_{min} = \sqrt{\frac{2g}{\mu R}}$ **(D)** $\omega_{min} = \sqrt{\frac{gR}{\mu}}$



Motion under variable acceleration

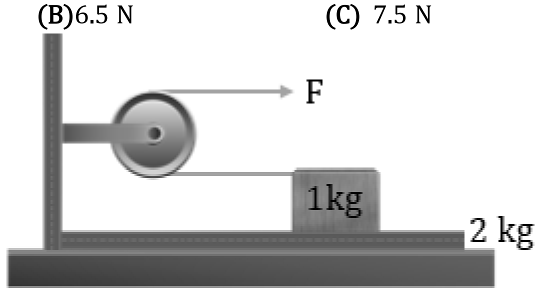
Q.2 A particle moves along a straight line. Its position at any instant is given by $\mathbf{x} = \mathbf{32t} - \frac{\mathbf{8t^3}}{\mathbf{3}}$ where xis in m and t in s. The acceleration of the particle at the instant when the particle is at rest will be

(A) $-16\ m/s^2$ **(B)** $-32\ m/s^2$ **(C)** $16\ m/s^2$ **(D)** $32\ m/s^2$

Static friction

Q.3 A block of mass 1 kg rests on a plank of mass 2 kg as shown in the figure. The coefficient of friction between block and plank are $\mu_s = 0.75$ and$\mu_k = 0.60$. The plank rests on a frictionless surface. The maximum force F that can be applied, if the block is not to slide on the plank is

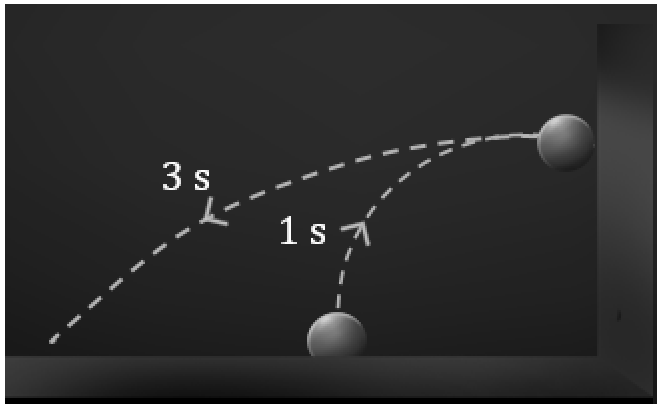
(A) 5.5 N **(B)** 6.5 N **(C)** 7.5 N **(D)** 8.5 N



Projectile Time, Height and Range

Q.4 A stone is projected from the ground and hits a smooth vertical wall after 1 s and again falls back on the ground as shown in the figure. The time taken by the stone to reach the ground after the collision is 3 s. The maximum height reached by the same stone if the vertical wall is not present will be (Take $\mathbf{g = 10\ m/s2}$)

(A) 14 m **(B)** 16 m **(C)** 18 m **(D)** 20 m



Apparent Depth

Q.5 Determine the apparent shift in the position of the coin.

(A) 2.5 cm **(B)** 2 cm **(C)** 1.5 cm **(D)** 3.5 cm

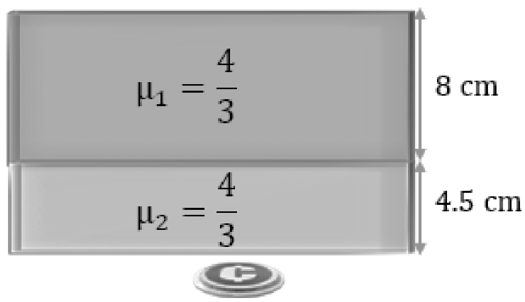
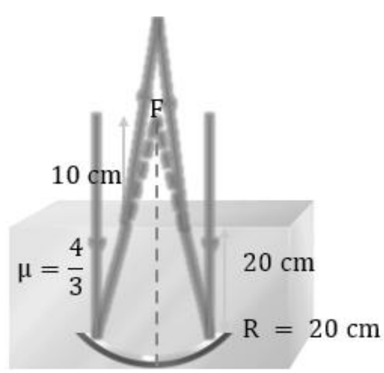


Image Formation in Concave Mirror

Q.6 A concave mirror of radius of curvature 60 cm is placed at the bottom of a tank containing water upto a height of 20 cm. The mirror focuses upwards with its axis vertical, light falls normally on the surface of water and the image of the sun is formed. If $\mu = \frac{4}{3}$, then with the observer in air, the distance of the image from the surface of water is

(A) 30 cm **(B)** 20 cm **(C)** 7.5 cm below **(D)** 7.5 cm above



Electric Field as Gradient of Electric Potential

Q.7 For a given $\vec{E} = 2x\hat{i} + 3y\hat{j}$. Find the potential V at (2, 2), when V at origin is 5 volts.

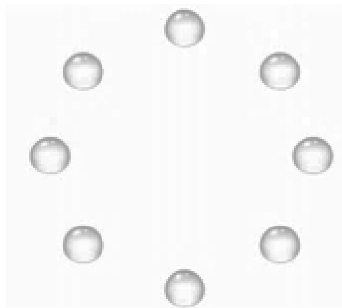
(A) 1 V **(B)** 8 V **(C)** -4 V **(D)** -5 V

Understanding Electrostatic Potential Energy

Q.8 One thousand similar electrified raindrops merge into one bigger drop, so that their total charge remains unchanged. Find the total electrostatic energy of the bigger drop, assuming that the drops are spherical and that small drops are at large distances from one another.

(A) Increases by 50 times **(B)**Decreases by 50 times

(C) Increases by 100 times **(D)**Decreases by 100 times



Dipole Moment

Q.9 Three point charges +q, −2q and +q are placed at points$(x = 0, y = a, z = 0)$, $(x = 0, y = 0, z = 0)$ and $(x = a, y = 0, z = 0)$ respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are:

(A)$\sqrt{2}$qa Along + x direction

(B)$\sqrt{2}$qa Along +y direction

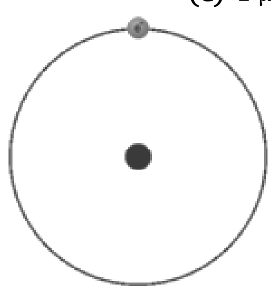
(C) $\sqrt{2}$qa Along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$

(D)qa Along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$

The Flow of Electrons as Electric Current

Q.10 In a hydrogen atom, the electron makes 6.6×10^{15} revolutionsper second around the nucleus in an orbit of radius 0.5×10^{-10} m. It is equivalent to a current nearly

(A)1 A **(B)**1 mA **(C)** 1 μA **(D)**1.6×10^{-19} A



Current and Drift Velocity Relation

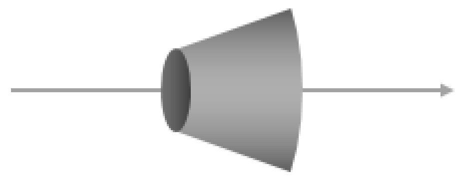
Q.11 A current passes through a wire of no uniform cross-section. Which of the following quantities is independent of the cross-section?

(A) The charge crossing in a given time interval

(B) Drift speed

(C) Current density

(D) None of these



Current and Drift Velocity Relation

Q.12 In a wire of cross-section radiusr, free electrons travel with drift velocity v when a current Iflows through the wire. What is the current in another wire of half the radius and of the same material when the drift velocity is2v?

(A)2I **(B)**I **(C)** I/2 **(D)**I/4

Current and Drift Velocity Relation

Q.13 A current I flows through a uniform wire of diameter d when the mean electron drift velocity is v. The same current will flow through a wire of diameter d/2 made of the same material if the mean drift velocity of the electron is

(A)v/4 **(B)**v/2 **(C)** 2v **(D)**4v

Drift Velocity

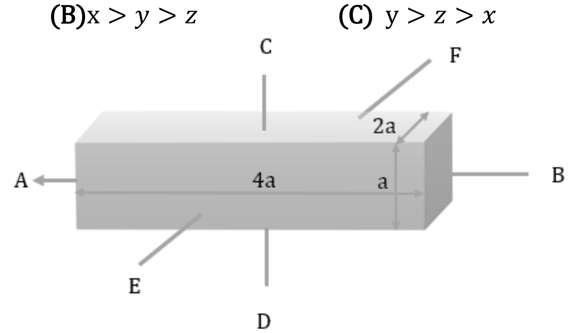
Q.14 A current of 1.34 A exists in a copper wire of cross-section1 mm^2. Assuming that each copper atom contributes one free electron, the drift speed of the free electrons in the wire will be: (Densityof copper is 8990 kg/m^3, atomic mass is 63.50 and charge on electron is 1.6×10^{-19} C)

(A)0.5 mm/s **(B)**0.3 mm/s **(C)** 0.1 mm/s **(D)**0.05 mm/s

Resistance and Resistors

Q.15 A conductor with a rectangular cross-section has dimensions a × 2a × 4a as shown in the figure. Resistance across AB is x, across CD is y and across EF is z. Then

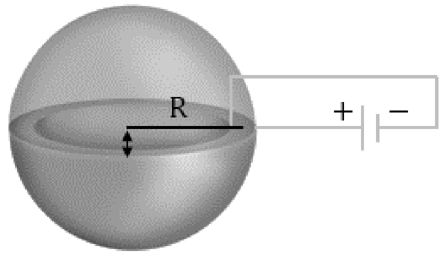
(A)x = y = z **(B)**$x > y > z$ **(C)** $y > z > x$ **(D)**$x > z > y$



Conductivity and Resistivity

Q.16 A spherical shell made of material of conductivity $\frac{10^9}{\pi}$ $(\Omega m)^{-1}$ has a thickness t = 2 mm and radius of shell is R = 10 cm. In an arrangement, it's inside surface is kept at a lower potential with respect to its outer surface. The resistance offered by the shell is equal to:

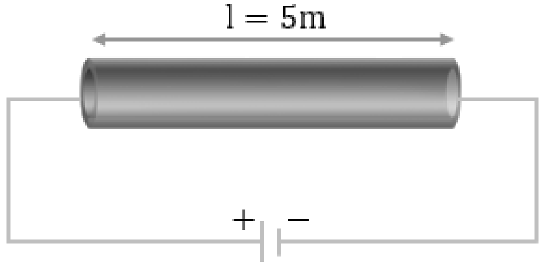
(A)$5\pi \times 10^{-12}$ Ω**(B)**2.5×10^{-11} Ω **(C)** $\times 10^{-12}$ Ω **(D)**5×10^{-11} Ω



Conductivity and Resistivity

Q.17 A hollow copper tube of length 5 m has got external diameter equal to 10 cm and the walls are 5 mm thick. If the specific resistance of copper is $1.7 \times 10^{-8}\ \Omega - \text{m}$, the resistance of the tube across its ends will be:

(A) $5.77 \times 10^{5}\ \Omega$ **(B)** $5.77 \times 10^{-5}\ \Omega$ **(C)** $7.77 \times 10^{7}\ \Omega$ **(D)** $5.90 \times 10^{5}\ \Omega$



The Flow of Electrons as Electric Current

Q.18 Calculate the amount of charge flowing in 2 min in a wire of resistance 10 Ω when a potential difference of 20 V is applied between its ends.

(A) 120 C **(B)** 240 C **(C)** 120 C **(D)** 4 C

Current Density Vector

Q.19 An electron beam has an aperture $1.0\ \text{mm}^2$. A total of 6.0×10^{16} electrons go through any perpendicular cross-section per second. Find (a) the current and (b) the current density in the beam.

(A) 9.6×10^{-3} A & $9.6 \times 10^{3}\ \text{A/m}^2$ **(B)** 9.6×10^{3} A & $9.6 \times 10^{-3}\ \text{A/m}^2$

(C) 6.3×10^{-3} A & $6.3 \times 10^{3}\ \text{A/m}^2$ **(D)** 3.2×10^{-3} A & $3.2 \times 10^{3}\ \text{A/m}^2$

Stefan-Boltzmann's Law

Q.20 Suppose the sun expands so that its radius becomes 100 times its present radius and its surface temperature becomes half of its present value. Then, the total energy emitted by it in the same time will increase by a factor of [neglect surrounding temperature]

(A) 10^4 **(B)** 625 **(C)** 16 **(D)** 256

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(D)	(B)	(C)	(C)	(C)	(B)	(A)	(A)	(B,C)

WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(B)	(A)	(D)	(D)	(D)	(D)	(C)	(C)	(B)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(A)	(C)	(D)	(C)	(D)	(D)	(B)	(B)	(A)	(B)