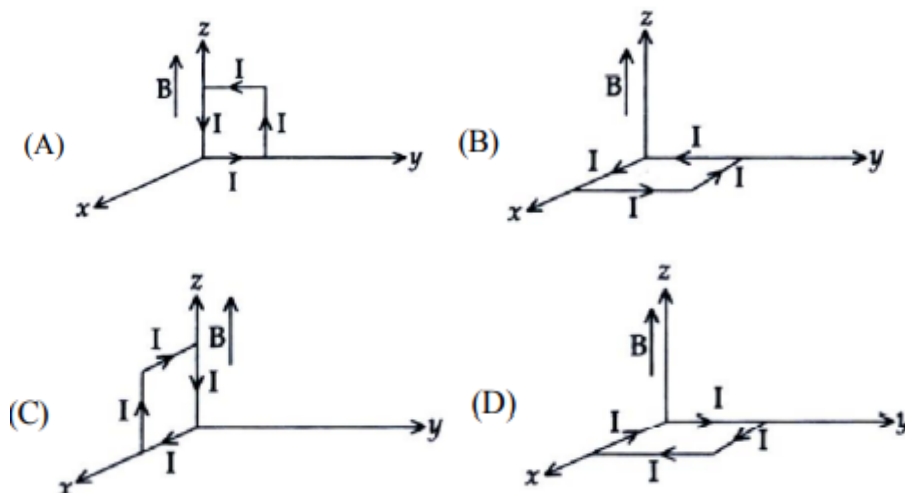




29-SEP-2022

Roll No:

- 3 A piece of copper and silicon are cooled from room temperature to 100 K. The resistance of 1
- a. Each of them increases b. each of them decreases.
- c. copper increases and that of silicon decreases d. copper decreases and that of silicon increases
- 4 Phosphor-bronze wire is used in suspension because it has 1
- a. high conductivity b. high resistivity
- c. large couple per unit twist d. small couple per unit twist
- 5 A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figures below : 1

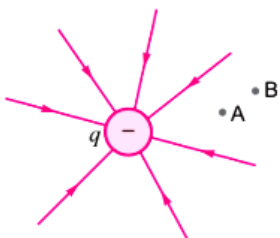


If there is a uniform magnetic field of 0.3 T in the positive z -direction in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium?

- a. (B) and (D), respectively b. (B) and (C), respectively
- c. (A) and (B), respectively d. (A) and (C), respectively
- 6 An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true? 1
- a. The electron will be accelerated along the axis. b. The electron path will be circular about the axis.
- c. The electron will experience a force at 45° to the axis and hence execute a helical path. d. The electron will continue to move with uniform velocity along the axis of the solenoid.
- 7 The maximum current that can be measured by a galvanometer of resistance $40\ \Omega$ is 10 mA. It is converted into voltmeter that can read up to 50 V. The resistance to be connected in the series with the galvanometer is 1
- a. $2010\ \Omega$ b. $5040\ \Omega$
- c. $4960\ \Omega$ d. $4050\ \Omega$
- 8 The angle of minimum deviation for an equilateral glass prism is 30° . Refractive index of the prism is: 1
- a. $1/\sqrt{3}$ b. 2
- c. $\sqrt{2}$ d. 0

- 9 Which of the following is a necessary condition for total internal reflection? 1
- a. The angle of incidence in the denser medium must be greater than the critical angle for the two media
- b. the angle of incidence in the denser medium must be less than the critical angle for the two media
- c. The angle of incidence in the rarer medium must be greater than the critical angle for the two media
- d. the angle of reflection in the denser medium must be greater than the critical angle for the two media
- 10 If f_o is the focal length of the objective and f_e is the focal length of the eyepiece, then magnification of a refracting (M) telescope can be determined as 1
- a. f_e/f_o
- b. $f_o - f_e$
- c. $f_o + f_e$
- d. f_o/f_e

SECTION B

- 11 A charge experiences a force of 32N as it is placed at a certain distance on the axial line of an electric dipole, what will be the force on the charge if its distance from the dipole is halved? 1
- 12 A positive point charge (+q) is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines originating from the point on to the surface of the plate. 1
- 13 An electric dipole of dipole moment 20×10^{-6} C-m is enclosed by a sphere of radius 2m. What is the net flux coming out of the surface of the sphere? 1
- 14 The field lines of a negative point charge is shown in the figure. Does the kinetic energy of a small negative charge increase or decrease in going from B to A? Give reason. 1
- 
- 15 Draw an equipotential surface for a system consisting of two charges Q and -Q separated by a distance r in air. Locate the points where the potential due to the dipole is zero. 1
- 16 A metal plate is introduced between the plates of a charged parallel plate capacitor. What is its effect on the capacitance of the capacitor? Justify 1
- 17 Define current sensitivity of a galvanometer. Write its SI unit. 1

OR

Why does Phosphor- bronze material is used as a suspension wire in moving coil galvanometer?

- 18 Draw a graph to show a variation of resistance of a metal wire as a function of its diameter keeping its length and material is constant. 1

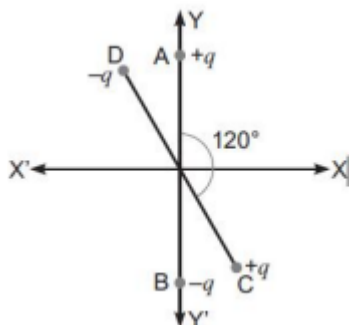
OR

Is Ohm's law universally applicable for all conducting elements? Justify your answer with suitable example

- 19 In a certain region of space, electric field E and magnetic field B are perpendicular to each other. An electron enters in the region perpendicular to the directions of both B and E and moves undeflected. Find the velocity of the electron. 1
- 20 Write the expression for the magnetic moment due to a planar square loop of side ' l ' carrying a steady current I in a vector form. 1

SECTION C

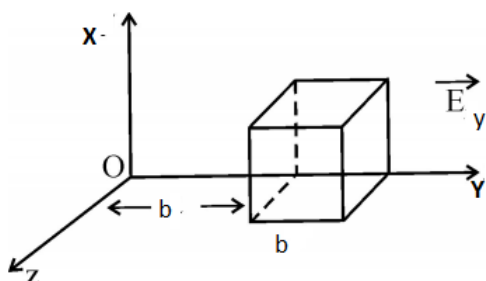
- 21 Two small identical electrical dipoles AB and CD , each of dipole moment ' p ' are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination? If this system is subjected to electric field E , directed along $+X$ direction, what will be the magnitude and direction of the torque acting on this? 2



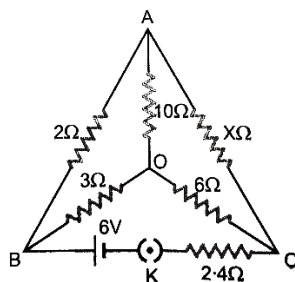
- 22 A square plane sheet of side 10 cm is inclined at an angle of 30° with the direction of a uniform electric field of 200 NC^{-1} . Calculate the electric flux passing through the sheet. 2

OR

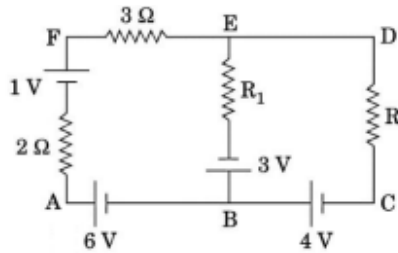
The electric field components in the figure shown are : $E_x = 0$, $E_y = \beta y$, $E_z = 0$ where $\beta = 200 \text{ N/Cm}$. Calculate the electric flux through the cube.



- 23 Find the value of the unknown resistance X , in the following circuit, if no current flows through the section AO . Also calculate the current drawn by the circuit from the battery of emf 6 V and negligible internal resistance 2

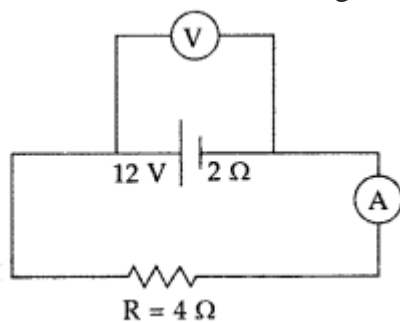


- 24 Use Kirchhoff's rules to determine the potential difference between the points A and D when no current flows in the arm BE of the electric network shown in the figure. 2

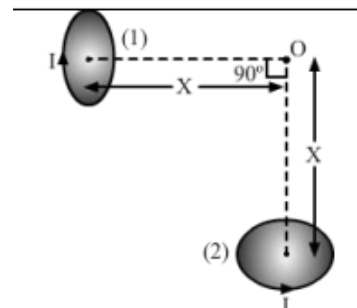


OR

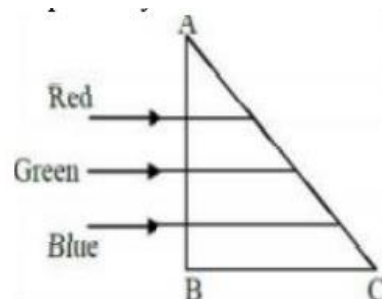
In the figure shown, an ammeter A and a resistor of $40\ \Omega$ are connected to the terminals of the source. The emf of the source is 12 V having an internal resistance of $2\ \Omega$. Calculate the voltmeter and ammeter readings.



- 25 Two very small identical circular loops, (1) and (2), carrying equal currents I are placed vertically (with respect to the plane of the paper) with their geometrical axes perpendicular to each other as shown in the figure. Find the magnitude and direction of the net magnetic field produced at the point O. 2



- 26 Prove that the current flowing through the coil of a moving coil galvanometer is directly proportional to its deflection. 2
- 27 In the figure given below, light rays of blue, green, red wavelengths are incident on an isosceles right-angled prism. Explain with reason, which ray of light will be transmitted through the face AC. The refractive index of the prism for red, green, blue light is 1.39, 1.424, and 1.476 respectively 2

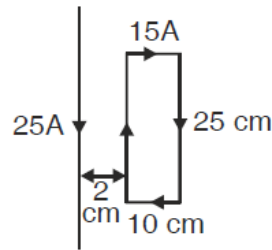


SECTION D

- 28 Four identical cells of e.m.f 2 V are joined in parallel providing supply of current to external circuit consisting of two 15 ohm resistors joined in parallel. The terminal voltage of cells as read by an ideal voltmeter is 1.6 V . Calculate the internal resistance of each cell. 3

- 29 a) What is the effect of heating of a conductor on the drift velocity of free electrons? 3
 b) The number density of free electrons in a copper conductor is $8.5 \times 10^{28} \text{ m}^{-3}$. How long does an electron take to drift from one end of a wire of 3m long to its other end? The area of cross section of the wire is $2 \times 10^{-6} \text{ m}^2$ and it is carrying a current of 3 A.

- 30 A rectangular loop of sides 25 cm and 10 cm carrying current of 15A is placed with its longer side parallel to a long straight conductor 2.0 cm apart carrying a current of 25A. What is the torque acting on the loop and the new force on the loop?



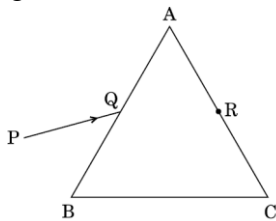
- 31 Two parallel uniformly charged infinite plane sheets 1 and 2 have charge densities $+\sigma$ and $-\sigma$ respectively. Give the magnitude and direction of the net electric field at a point
 (i) in between the two sheets
 (ii) outside near sheet 1 3

OR

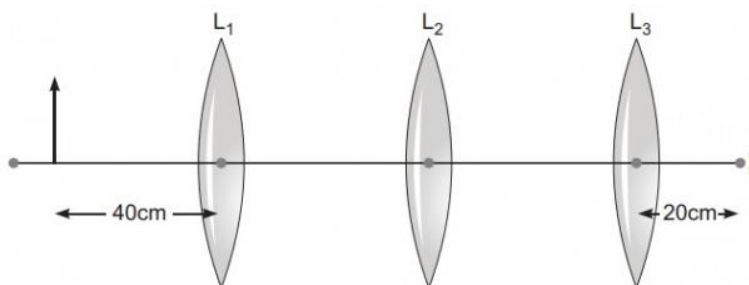
A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q . a charge q is placed at the centre of the shell

- a) What is the surface charge density on the (i) inner surface (ii) outer surface of the shell?
 b) Write the expression for the electric field at a point $x > r_2$ from the centre of the shell.
 32 A ray PQ incident on the face AB of a prism ABC, as shown in the figure, emerges from the face AC such that $AQ = AR$. 3

Draw the ray diagram showing the passage of the ray through the prism. If the angle of the prism is 60° and refractive index of the material of the prism is $\sqrt{3}$, determine the values of angle of incidence and angle of deviation



- 33 You are given three lenses L_1 , L_2 and L_3 each of focal length 20cm. An object is kept at 40cm in front of L_1 , as shown. The final real image is formed at the focus 'I' of L_3 . Find the separations between L_1 , L_2 and L_3 . 3



- 34 a) Draw a labelled diagram for the formation of image by a compound microscope with image at the least distance of distinct vision . 3
- b) You are given the following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct a compound microscope?

Lenses	Power (D)	Aperture (cm)
L ₁	3	8
L ₂	6	1
L ₃	10	1

OR

A person with a normal near point (25cm) using a compound microscope with objective of focal length 8mm and an eye piece of focal length 2.5cm can bring an object placed at 9mm from the objective in sharp focus. What is the separation between the two lenses? Calculate the magnifying power of the microscope.

SECTION E

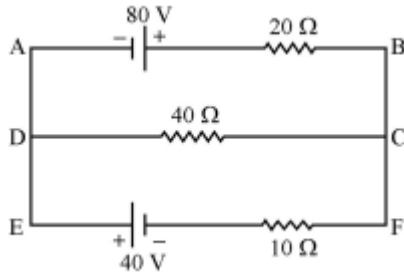
- 35 a) Write two properties of equipotential surfaces. Depict equipotential surfaces due to an isolated point charge. Why do the equipotential surfaces get closer as the distance between the equipotential surface and the source charge decreases? 5
- b) An electric dipole of length 2 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $8\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has a charge of ± 4 nC.

OR

- a) Derive an expression for the capacitance of a parallel plate capacitor.
- b) On charging a parallel plate capacitor to a potential V, the spacing between the plates is halved, and a dielectric medium of $k = 10$ is introduced between the plates, without disconnecting the d.c. source. Explain, using suitable expressions, how the
- capacitance,
 - electric field and
 - energy density of the capacitor change.
- 36 a) Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons. 5
- b) A potential difference V is applied across the ends of copper wire of length l and diameter D. What is the effect on drift velocity of electrons if
- V is halved
 - D is halved
 - l is doubled

OR

- a) Two cells of emfs E₁ and E₂ and internal resistances r₁ and r₂ are connected in parallel. Derive an expression for the (i) emf and (ii) internal resistance of a single equivalent.
- b) Using Kirchhoff's rules, calculate the current through the 40 Ω and 20 Ω resistors in the following circuit :



- 37 a) Derive the expression for the torque acting on a rectangular current carrying coil placed in uniform magnetic field
- b) An α -particle is accelerated through a potential difference of 10 kV and moves along x-axis. It enters in a region of uniform magnetic field $B = 2 \times 10^{-3}$ T acting along y-axis. Find the radius of its path. (Take mass of α -particle = 6.4×10^{-27} kg)

5

OR

- a) A straight thick long wire of uniform cross section of radius ' a ' is carrying a steady current I . Use Ampere's circuital to obtain a relation showing the variation of the magnetic field inside and outside the wire with distance r , ($r < a$) and ($r > a$) of the field point from the centre of its cross section.
- b) A current carrying conductor PQ of length 1m, mass 4.4×10^{-3} kg and resistance 50 mili-ohm is kept in a uniform magnetic field of 1.8mT as shown. Calculate the potential V that must be applied to the conductor PQ so that it remains in equilibrium in the magnetic field.

