ELECTRIC CHARGES AND FIELDS

2015

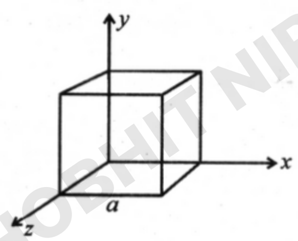
Q1. What is the electric flux through a cube of side 1 cm which encloses an electric dipole? (1M)

Ans.zero

Q2. (a) An electric dipole of dipole moment p consists of point charges +q and -q separated by a distance of 2a apart. Deduce the expression for the electric field E due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment p. Hence show that in the limit x >> a,

$$\vec{E} \to 2\vec{p}/(4\pi\varepsilon_0 x^3).$$

(b) Given the electric field in the region x is 2E , find the net electric flux through the cube and the charge enclosed by it. (5M)



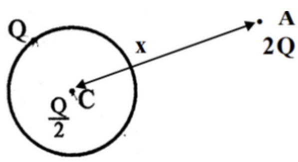
Ans. (a) $\vec{E} = \frac{2\vec{p}}{4\pi\varepsilon_0 x^3}$ (b) $\phi = q_{enclosed}/\varepsilon_0$

$q_{enclosed} = 2a^3\varepsilon_0$

Q3. (a) Explain, using suitable diagrams, the difference in the behaviour of an (i) conductor and (ii) dielectric in the presence of an external electric field. Define the terms polarisation of a dielectric and write its relation with susceptibility.

(b) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge Q/2 is placed at its centre C and another charge +2Q is placed outside the shell at a distance x from the centre as shown in the figure.

Find (i) the force on the charge at the centre of the shell and at point A and (ii) the electric flux through the shell. (5M)



Ans. (b) (i) $\frac{(K)3Q^2}{r^2}$ (ii) $\phi = \frac{Q}{\varepsilon_0}$

2016

Q1. A point charge +Q is placed at point O as shown in the figure. Is the potential difference VA – VB positive, negative or zero? (1M)

Ans. positive

Q2. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased? (1M)

Ans. does not get affected

Q3. A charge is distributed uniformly over a ring of radius 'a. Obtain an expression for the electric intensity E at a point on the axis of the ring. Hence show that for points at large distances from the ring, it behaves like a point charge. (3M)

Ans. $E = \frac{1}{4\pi\varepsilon_0} \frac{q}{x^2}$ along OP

2017

Q1. (a) Derive an expression for the electric field E due to a dipole of length '2a' at a point distant r from the centre of the dipole on the axial line. (b) Draw a graph of E versus r for r >> a. (c) If this dipole were kept in a uniform external electric field Eo, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expressions for the torque acting on the dipole in both cases. (5M)

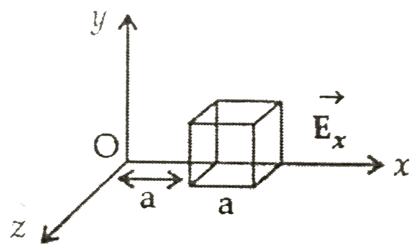
Ans. c) i) 0 ii) 0

Q2. (a) Use Gauss's theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ. (b) An infinitely large thin plane sheet has a uniform surface charge density $+\sigma$. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point, distant r, in front of the charged plane sheet. (5M)

Ans. a) $E = \dfrac{\sigma}{2\epsilon_0}$ b) $\therefore w = qEd = \dfrac{\sigma q d}{2\varepsilon_0}$

2018

Q1. Define electric flux and write its SI unit. The electric field components in the figure shown are Ex = αx, Ey = 0, Ez = 0 where α = 100 N/Cm. Calculate the charge within the cube, assuming a = 0.1m. (3M)



Ans. SI unit is Nm^2c^(− 1), q = 8.85 × 10^− 13 C

2019

Q1. Draw the pattern of electric field lines, when a point charge – Q is kept near an uncharged conducting plate. (1M)

Q2. (a) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction. (b) Derive an expression for the electric potential at any point along the axial line of an electric dipole. (3M)

Q3. (a) Derive an expression for the electric field at any point on the equatorial line of an electric dipole. (b) Two identical point charges, q each, are kept 2m apart in the air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q. (5M)

Ans. b) r = 1 m & Q=q/4

2020

Q1. If the net electric flux through a closed surface is zero, then we can infer
(A) no net charge is enclosed by the surface.
(B) uniform electric field exists within the surface.
(C) electric potential varies from point to point inside the surface. (D) charge is present inside the surface. (1M)

Ans. (A)

Q2. (a) Using Gauss law, derive expression for electric field due to a spherical shell of uniform charge distribution σ and radius R at a point lying at a distance x from the centre of shell, such that

(i) 0 < x < R, and (ii) x > R.

(b) An electric field is uniform and acts along + x direction in the region of positive x. It is also uniform with the same magnitude but acts in – x direction in the region of negative x. The value of the field is E = 200 N/C for x > 0 and E = – 200 N/C for x < 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one flat face is at x = + 10 cm and the other is at x = – 10 cm. Find : (i) The net outward flux through the cylinder. (ii) The net charge present inside the cylinder. (5M)

Ans. i) $3.14 \, Nm^2C^{-1}$ ii) $q = 2.78 \times 10^{-11} C$

2022

Q1. An electric dipole placed in a non-uniform electric field will experience:

(A) Only a force

(B) Only a torque

(C) both force and torque

(D) Neither force nor torque

Ans. (C)

Q2. Let N1 be the number of electric field lines going out of an imaginary cube of side that encloses an isolated point charge 2q and N2 be the corresponding number for an imaginary sphere of radius that encloses an isolated point charge 3q. Then (N1/N2) is:

(A) 1/π

(B) 2/3

(C) 9/4

(D) π

Ans. (A)

Q3. Infinity resistance in a resistance box has:

(A) a resistance of 105 Ω

(B) a resistance of 107 Ω

(C) a resistance of ∞ resistance

(D) a gap only

Ans. (D)

Q4. A charge Q is placed at the centre of the line joining two charges q and q. The system of the three charges will be in equilibrium if Q is:

(A) +q/3 (B) -q/3 (C) +q/4 (D) -q/4

Ans. (D)

Q5. Electric flux of an electric field E g through an area A is given by:

(A) $\vec{E} \times d\vec{A}$

(B) $\frac{\vec{E} \times d\vec{A}}{\varepsilon_0}$

(C) $\vec{E} \cdot d\vec{A}$

(D) $\frac{\vec{E} \cdot d\vec{A}}{\varepsilon_0}$

Ans. (C)

Q6. Two point charges + 16q and – 4q are located at x = 0 and x = L. The location of the point on x-axis at which the resultant electric field due to these charges is zero, is:

(A) 8 L

(B) 6 L

(C) 4 L

(D) 2 L

Ans. (D)

Q7. An electric dipole of dipole moment 4 × 10-5 C-m, kept in a uniform electric field of 10-3 NC-1, experience a torque of 2 × 10-8 Nm. The angle which the dipole makes with the electric field is:

(A) 30°

(B) 45°

(C) 60°

(D) 90°

Ans. (A)

Q8. Three identical charges are placed on x-axis from left to right with adjacent charges separated by a distance d. The magnitude of the force on a charge from its nearest neighbour charge is F. Let 1 i be the unit vector along + x axis, then the net force on each charge from left to right is :

(A) $\left(2F\hat{i},\ -2F\hat{i}, 2F\hat{i}\right)$

(B) $\left(F\hat{i}, 0, F\hat{i}\right)$

(C) $\left(-\frac{5}{4}F\hat{i}, 0 + \frac{5}{4}F\hat{i}\right)$

(D) $\left(2F\hat{i}, 0, 2F\hat{i}\right)$

Ans. (C)

Q9. Two students A and B calculate the charge flowing through a circuit. A concludes that 300 C of charges flows in 1 minute. B concludes that 3.125 × 1019 electrons flow in 1 second. If the current measured in the circuit is 5A, then the correct calculation is done by :

(A) A

(B) B

(C) both A and B

(D) neither A nor B

Ans. (C)

Q10. If a charge is moved against a coulomb force of an electric field, then the:

(A) intensity of the electric field increases

(B) intensity of the electric field decreases

(C) work is done by the electric field

(D) work is done by the external source

Ans. (D)

ELECTROSTATIC POTENTIAL AND CAPACITANCE

2015

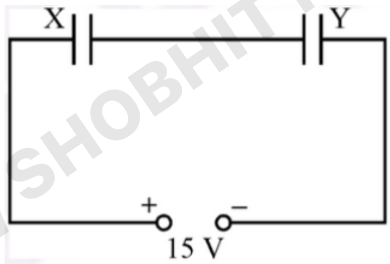
Q1. Define capacitative reactance. Write its S.I. units. (1M)

Q2. Two capacitors of unknown capacitances C1 and C2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations are 0.045 J and 0.25 J respectively, determine the value of C1 and C2. Also, calculate the charge on each capacitor in a parallel combination. (3M)

Ans. C1=38.2μF, C2=11.8μF, Q1=38.2x10^(-4)C, Q2=11.8x10^(-4)C

2016

Q1. Two parallel plate capacitors X and Y have the same area of plates and the same separation between them. X has air between the plates while Y contains a dielectric medium of εo = 4.

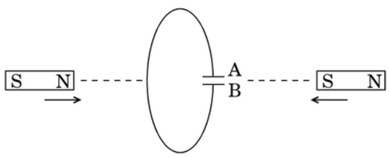


(i) Calculate the capacitance of each capacitor if the equivalent capacitance of the the combination is 4 μF. (ii) Calculate the potential difference between the plates of X and Y. (iii) Estimate the ratio of electrostatic energy stored in X and Y. (3M)

Ans. i) Cx=5μF, Cy=20μF ii) Vx=12V, Vy=3V iii) 4:1

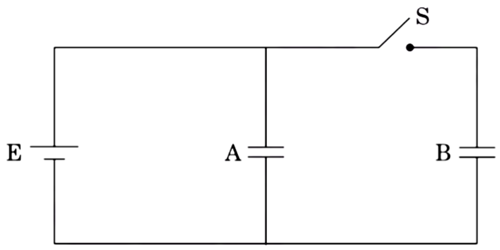
2017

Q1. Predict the polarity of the capacitor in the situation described below : (1M)



Ans. A=+ve, B=-ve

Q2. Two identical parallel plate capacitors A and B are connected to a battery of V volts with switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant K. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric. (3M)



Ans. K+1 : 2K

2018

Q1. Two point charges q and –q are located at points (0, 0, –a) and (0, 0, a) respectively. (a) Find the electrostatic potential at (0, 0, z) and (x, y, 0) (b) How much work is done in moving a small test charge from the point (5, 0, 0) to (–7, 0, 0) along the x-axis? (c) How would your answer change if the path of the test charge between the same points is not along the x-axis but along any other random path? (d) If the above point charges are now placed in the same positions in a uniform external electric field E, what would be the potential energy of the charging system in its orientation of unstable equilibrium?

Justify your answer in each case. (5M)

Ans. a)Zero at both the points, b)no work, c)The answer does not change,i.e., no work, d) -2qaE

Q2. A capacitor of capacitance C1 is charged to a potential V1 while another capacitor of capacitance C2 is charged to a potential difference V2. The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other. (a) Find the total energy stored in the two capacitors before they are connected. (b) Find the total energy stored in the parallel combination of the two capacitors. (c) Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected. (5M)

Ans. a) $\frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2$ b) $\frac{1}{2}\frac{(C_1V_1 + C_2V_2)^2}{(C_1 + C_2)}$

2019

Q1. (a) Describe briefly the process of transferring the charge between the two plates of a parallel plate capacitor when connected to a battery. Derive an expression for the energy stored in a capacitor. (b) A parallel plate capacitor is charged by a battery to a potential difference V. It is disconnected from the battery and then connected to another uncharged capacitor of the same capacitance.

Calculate the ratio of the energy stored in the combination to the initial energy on the single capacitor. (5M)

Ans. 1:2

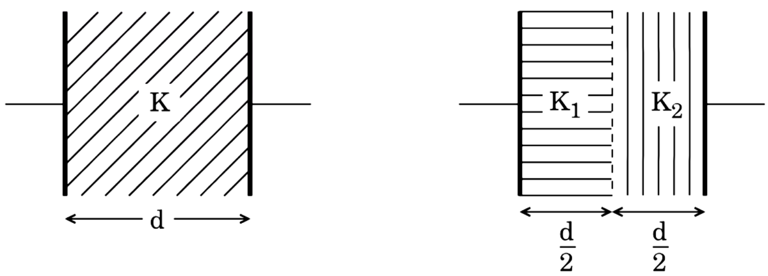
2020

Q1. An electric dipole consisting of charges + q and – q separated by a distance L is in stable equilibrium in a uniform electric field E. The electrostatic potential energy of the dipole is

(A) qLE (B) zero (C) – qLE (D) – 2 qEL (1M)

Ans. (A)

Q2. The space between the plates of a parallel plate capacitor is completely filled in two ways. In the first case, it is filled with a slab of dielectric constant K. In the second case, it is filled with two slabs of equal thickness and dielectric constants K1 and K2 respectively as shown in the figure. The capacitance of the capacitor is same in the two cases. Obtain the relationship between K, K1 and K2. (2M)



(Case 1) (Case 2)

Ans. K= (K1+K2)/2

Q3. (a) Find the expression for the potential energy of a system of two point charges q1 and q2 located at r1 and r2, respectively in an external electric field E. (b) Draw equipotential surfaces due to an isolated point charge (– q) and depict the electric field lines. (c) Three point charges + 1 μC, – 1 μC and + 2 μC are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm. (5M)

Ans. a) q1.V.(r1) + q2Vr2 + (Kq1q2)/r12 b) 7KQ^2J

2022

Q1. A capacitor and an inductor are connected in two different ac circuits with a glowing in each circuit. The bulb glows more brightly when:

(A) the number of turns in the inductor is increased

(B) the separation between the plates of the capacitor is increased

(C) an iron rod is introduced into the inductor

(D) a dielectric is introduced into the gap between the plates of the capacitor

Ans. (D)

Q2. The electric potential at a point on the axis of a short electric dipole, at a distance x from the mid -point of dipole is proportional to:

(A) 1/x^4

(B) 1/x^1/2

(C) 1/x^3

(D) 1/x^2

Ans. (D)

Q3. Let F1 be the magnitude of the force between two small spheres, charged to a constant potential in free space and F2 be the magnitude of the force between them in a medium of dielectric constant k. Then (F1 / F2) is:

(A) 1/k

(B) k

(C) k^2

(D) 1/k^2

Ans. (B)

Q4. A constant voltage is applied between the two ends of a uniform metallic wire, heat 'H' is developed in it. If another wire of the same material, double the radius and twice the length as compared to original wire is used then the heat developed in it will be-

(i) H/2

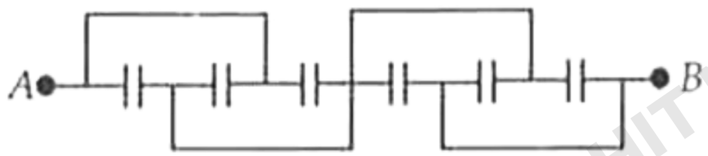
(ii) H

(iii) 2H

(iv) 4H

Ans. (iii)

Q4. In the given network all capacitors used are identical and each one is of capacitance C. Which of the following is the equivalent capacitance between the points A and B?



(A) 6C

(B) (5/2) C

(C) (3/2) C

(D) (5/6) C

Ans. (C)

Q5. A charge Q is located at the centre of a circle of radius r. The work done in moving a test charge q0 from point A to point B (at opposite ends of diameter AB) so as to complete a semicircle is [k = 1/4πεo]:

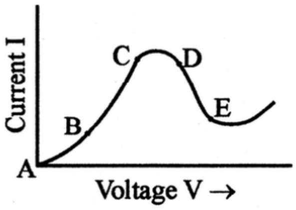
(A) (kqoQ)/r (B) (kqoQ)/r^2 (C) kqoQr (D) Zero

Ans. (D)

CURRENT ELECTRICITY

2015

Q1. Graph showing the variation of current versus voltage for a material GaAs is shown in the figure. Identify the region of (i) negative resistance (ii) where Ohm's law is obeyed. (1M)



Ans. i)DE ii)BC

Q2. Use Kirchhoff's rules to obtain conditions for the balance condition in a Wheatstone bridge. (2M)

Q3. A cell of emf 'E' and internal resistance 'r' is connected across a variable load resistor R. Draw the plots of the terminal voltage V versus (i) R and (ii) the current I.
It is found that when R = 4Ω, the current is 1 A and when R is increased to 9Ω, the current reduces to 0.5 A. Find the values of the emf E and internal resistance r. (3M)

Ans. r = 1 ohm, E = 5V

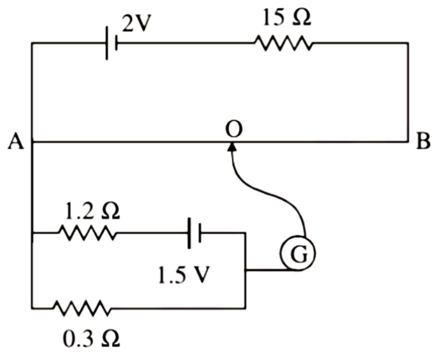
2016

Q1. Two cells of emf 1.5 V and 2.0 V having internal resistances 0.2 Ω and 0.3 Ω respectively are connected in parallel. Calculate the emf and internal resistance of the equivalent cell. (2M)

Ans. r_{eq}=0.12Ω, E_{eq} = 1.7V

Q2. (i) Define the term drift velocity. (ii) On the basis of electron drift, derive an expression for the resistivity of a conductor in terms of the number density of free electrons and relaxation time. On what factors does the resistivity of a conductor depend? (iii) Why alloys like constantan and manganin are used for making standard resistors ? (5M)

Q3. (i) State the principle of working of a potentiometer. (ii) In the following potentiometer circuit AB is a uniform wire of length 1 m and resistance 10 Ω. Calculate the potential gradient along the wire and balance length AO (= l). (5M)



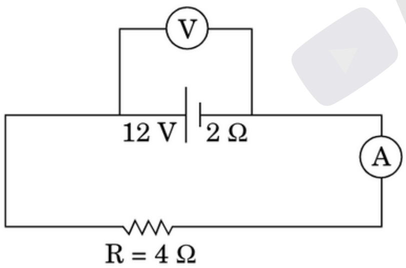
Ans. ii) 0.8V/m, 37.5cm

2017

Q1. Nichrome and copper wires of the same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more? Justify your answer. (1M)

Q2. (a) The potential difference applied across a given resistor is altered so that the heat produced per second increases by a factor of 9. By what factor does the applied potential difference change?

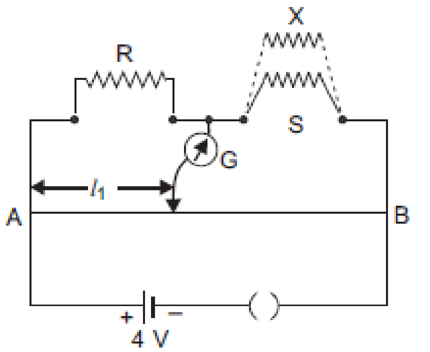
(b) In the figure shown, an ammeter A and a resistor of 4Ω are connected to the terminals of the source. The emf of the source is 12 V having an internal resistance of 2Ω. Calculate the voltmeter and ammeter readings. (3M)



Ans. a) 3, b) I=2A, V=8V

Q3. (a) Write the principle and working of a metre bridge. (b) In a metre bridge, the balance point is found at a distance L1 with resistances R and S as shown in the figure.

An unknown resistance X is now connected in parallel to the resistance S and the balance point is found at a distance of L2. Obtain a formula for X in terms of L1, L2 and S.



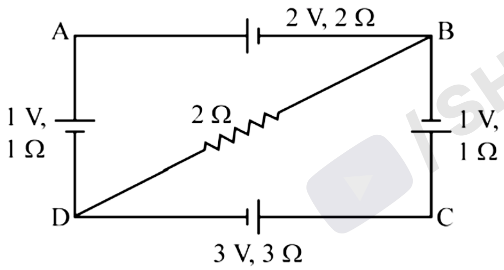
Ans. b) $X = \dfrac{S}{\dfrac{l_2}{l_1}\left(\dfrac{100-l_1}{100-l_2}\right)-1}$

2018

Q1. Two cells of emfs **ε**1 & **ε**2 and internal resistances r1 & r2 respectively are connected in parallel. Obtain expressions for the equivalent. (i) resistance and (ii) emf of the combination. (3M)

Ans. (i) $\varepsilon_{eq} = \dfrac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$ (ii) $r_{eq} = \dfrac{r_1 r_2}{r_1 + r_2}$

Q2. Using Kirchhoff's rules, calculate the potential difference between B and D in the circuit diagram as shown in the figure. (3M)



Ans. 0.153V

2019

Q1. How does the mobility of electrons in a conductor change, if the potential difference applied across the conductor is doubled, keeping the length and temperature of the conductor constant? (1M)

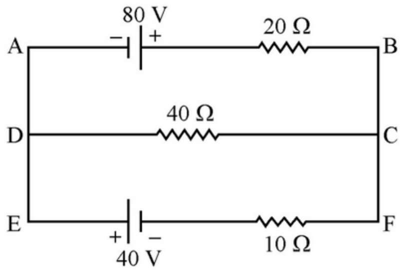
Ans. mobility gets half

Q2. Two bulbs are rated (P1, V) and (P2, V). If they are connected (i) in series and (ii) in parallel across a supply V, find the power dissipated in the two combinations in terms of P1 and P2. (2M)

$$\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2}$$

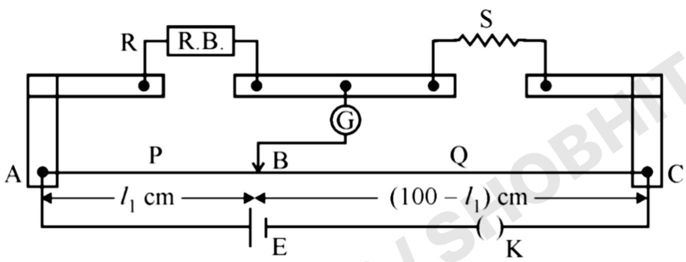
Ans. i)   , ii) P = P1 + P2

Q3. Using Kirchhoff's rules, calculate the current through the 40 Ω and 20 Ω resistors in the following circuit : (3M)



Ans. 4A, 0A

Q4. What is the end error in a metre bridge? How is it overcome? The resistances in the two arms of the metre bridge are R = 5 Ω and S respectively. When the resistance S is shunted with equal resistance, the new balance length is found to be 1.5 L1, where L1 is the initial balancing length. Calculate the value of S. (3M)



Ans. S=10 ohm

2020

Q1. A potentiometer can measure emf of a cell because
(A) the sensitivity of potentiometer is large.

(B) no current is drawn from the cell at balance.

(C) no current flows in the wire of potentiometer at balance.

(D) internal resistance of cell is neglected. (1M)

Ans. (B)

Q2. Two resistors R1 and R2 of 4 Ω and 6 Ω are connected in parallel across a battery. The ratio of power dissipated in them, P1 : P2 will be

(A) 4 : 9 (B) 3 : 2 (C) 9 : 4 (D) 2 : 3 (1M)

Ans. (B)

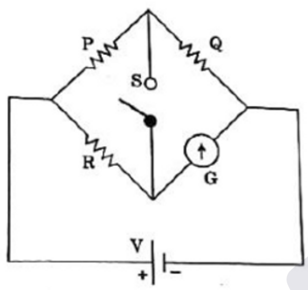
Q3. Explain the principle of working of a meter bridge. Draw the circuit diagram for determination of an unknown resistance using it. (2M)

Q4. (a) Two cells of emf E1 and E2 have their internal resistances r1 and r2, respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other. (b) In case the two cells are identical, each of emf E = 5 V and internal resistance r = 2 Ω, calculate the voltage across the external resistance R = 10 Ω. (3M)

Ans. 4.54V

2022

Q1. In the circuit given below P ≠ R and the reading of the galvanometer is same with Switch S open or closed. Then:



(A) IQ = IR

(B) IR =IG

(C) IP = IG

(D) IQ = IG

Ans. (B)

Q2. Two wires A and B, of the same material having length in the ratio 1: 2 and diameter in the ratio 2: 3 are connected in series with a battery. The ratio of the potential differences (VA/VB) across the two wires respectively is:

(A) 1/3

(B) 3/4

(C) 4/5

(D) 9/8

Ans. (A)

Q3. A battery of 15 V and negligible internal resistance is connected across a 50 Ω resistor. The amount of energy dissipated as heat in the resistor in one minute is:

(A) 122 J

(B) 270 J

(C) 420 J

(D) 720 J

Ans. (B)

Q4. In a potentiometer experiment, the balancing length with a cell is 120 cm. When the cell is shunted by a 1 Ω resistance, the balancing length becomes 40 cm. The internal resistance of the cell is:

(A) 10 Ω

(B) 7 Ω

(C) 3 Ω

(D) 2 Ω

Ans. (D)

Q5. The resistance of two wires having same length and same area of cross section are 2Ω and 8Ω respectively. If the resistivity of 2Ω wire is 2.65 × 10-8 Ω–m then the resistivity of 8Ω wire is :

(A) 10.60 × 10-8 Ω-m

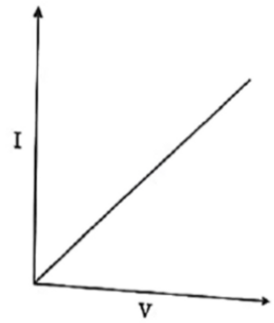
(B) 8.32 × 10-8 Ω-m

(C) 7.61 × 10-8 Ωm

(D) 5.45 × 10-8Ωm

Ans. (A)

Q6. The given figure shows I – V graph of a copper wire whose length and area of cross-section are L and A respectively. The slope of this curve becomes :



(A) less if the length of the wire is increased

(B) more if the length of the wire is increased

(C) more if a wire of steel of same dimension is used

(D) more if the temperature of wire is increased

Ans. (A)

Q7. When a potential difference V is applied across a conductor at temperature T, the drift velocity of the electrons is proportional to :

(A) T

(B) $\sqrt{T}$

(C) V

(D) $\sqrt{V}$

Ans. (C)

Q8. Two charged spheres A and B having their radii in the ratio 1: 2 are connected together with a conducting wire. The ratio of their surface charge densities **[σA/σB]** will be.

(A) 1/2

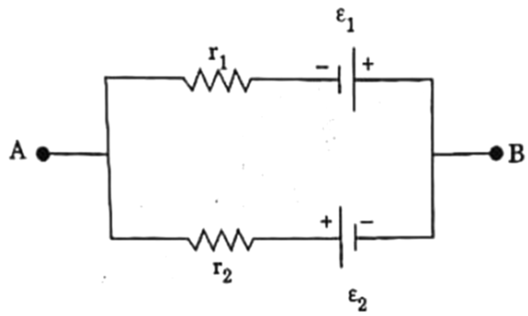
(B) 2

(C) 1/4

(D) 4

Ans. (B)

Q9. A battery is a combination of two or more cells. In the following figure, a single batter is represented in which two cells of emf Ɛ1 and Ɛ2, and internal resistance r1 and r2 respectively are connected.



Answer the following questions:

(i) The equivalent emf of this combination is :

(A) $\dfrac{\varepsilon_1 r_1 + \varepsilon_2 r_2}{r_1 + r_2}$

(B) $\dfrac{\varepsilon_1 r_1 - \varepsilon_2 r_2}{r_1 + r_2}$

(C) $\dfrac{\varepsilon_1 r_2 - \varepsilon_2 r_1}{r_1 + r_2}$

(D) $\varepsilon_1 - \varepsilon_2$

(ii) For terminal B to be negative :

(A) $\varepsilon_1 r_2 > \varepsilon_2 r_1$

(B) $\varepsilon_1 r_2 < \varepsilon_2 r_1$

(C) $\varepsilon_1 r_1 > \varepsilon_2 r_2$

(D) $\varepsilon_2 r_2 = \varepsilon_1 r_1$

(iii) The current in the internal circuit is:

(A) $\frac{\varepsilon_1 + \varepsilon_2}{r_1 + r_2}$

(B) $\frac{\varepsilon_2 - \varepsilon_1}{r_1 + r_2}$

(C) $\frac{\varepsilon_1}{r_1} - \frac{\varepsilon_2}{r_2}$

(D) $\frac{\varepsilon_1}{r_2} - \frac{\varepsilon_2}{r_1}$

(iv) The equivalent internal resistance of the combination is:

(A) $\frac{r_1 + r_2}{r_1 r_2}$

(B) $r_1 + r_2$

(C) $\frac{r_1 r_2}{r_1 + r_2}$

(D) $r_1 - r_2$

Ans. i) (A), ii) (B), iii) (A), iv) (C)

MOVING CHARGES AND MAGNETISM

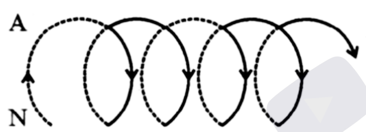
2015

Q1. State the principle and working of a galvanometer. A galvanometer of resistance G is converted into a voltmeter to measure up to V volts by connecting a resistance R1 in series with the coil. If a resistance R2 is connected in series with it, then it can measure up to V/2 volts. Find the resistance, in terms of R1 and R2, required to be connected to convert it into a voltmeter that can read up to 2 V. Also find the resistance G of the galvanometer in terms of R1 and R2. (3M)

Ans. $R = 3R_1 - 2R_2$, $G = R_1 - 2R_2$

Q2. (a) State Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside an air-cored toroid of average radius 'r' having 'n' turns per unit length and carrying a steady current I.

(b) An observer to the left of a solenoid of N turns each of cross section area 'A' and observes that a steady current in it flows in the clockwise direction. Depict the magnetic field lines due to the solenoid specifying its polarity and show that it acts as a bar magnet of magnetic moment m = NIA. (5M)

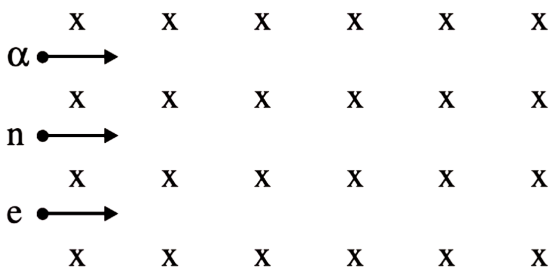


Ans. a) $B = \mu_o nI$

2016

Q1. Write the underlying principle of a moving coil galvanometer. (1M)

Q2. (a) Write the expression for the magnetic force acting on a charged particle moving with velocity v in the presence of magnetic field B.
(b) A neutron, an electron and an alpha particle moving with equal velocities enter a uniform magnetic field going into the plane of the paper as shown. Trace their paths in the field and justify your answer. (3M)



Ans. a) $F = qvB \sin\theta$

Q3. Two long straight parallel conductors carry steady current I1 and I2 separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field set up in one produces an attractive force on the other. Obtain the expression for this force. Hence define one ampere. (3M)

Ans. $F_{ab} = I_1 . l \frac{\mu_0 I_2}{2\pi d}$

2017

Q1. Find the condition under which the charged particles moving with different speeds in the presence of electric and magnetic field vectors can be used to select charged particles of a particular speed. (2M)

Q2. (a) State Biot – Savart law and express this law in vector form. (b) Two identical circular coils, P and Q each of radius R, carrying currents 1A and √3A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils. (3M)

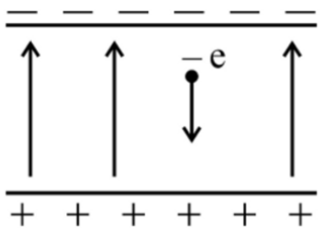
Ans. $B = \sqrt{B_1{}^2 + B_2{}^2} = \frac{\mu_o I}{R}$, $\tan^{-1}(\sqrt{3}) = 60^o$

2018

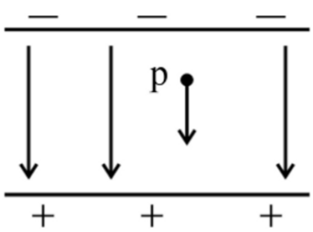
Q1. Two protons of equal kinetic energies enter a region of the uniform magnetic field. The first proton enters normal to the field direction while the second enters at 30° to the field direction. Name the trajectories followed by them. (1M)

Ans. circular, helical

Q2. An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude 2.0 × 10^4 N/C.



Calculate the time it takes to fall through this distance starting from rest. If the direction of the field is reversed (fig. b) keeping its magnitude unchanged, calculate the time taken by a proton to fall through this distance starting from rest. (3M)



Ans. 2.9 × 10^−9 sec, 1.3 × 10^−7 sec

Q3. (a) Define the SI unit of current in terms of the force between two parallel current-carrying conductors.

(b) Two long straight parallel conductors carrying steady currents Ia and Ib along the same direction are separated by a distance d. How does one explain the force of attraction between them? If a third conductor carrying a current Ic in the opposite direction is placed just in the middle of these conductors, find the resultant force acting on the third conductor. (3M)

Ans. b) $\frac{\mu_0 I_c}{\pi d}(I_a - I_b)$ to the right

Q4. (a) State Biot – Savart law and express it in vector form. (b) Using Biot – Savart law, obtain the expression for the magnetic field due to a circular coil of radius r, carrying a current I at a point on its axis distant x from the centre of the coil. (3M)

Ans. $B = \frac{\mu_0 I R^2}{2(X^2 + R^2)^{\frac{3}{2}}}$

2019

Q1. An α-particle and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field B, acting normally to the direction of motion of the particles. Calculate the ratio of radii of the circular paths described by them. (2M)

Ans. 1:1

Q2. (a) Derive the expression for the torque acting on a current-carrying loop placed in a magnetic field. (b) Explain the significance of a radial magnetic field when a current-carrying coil is kept in it (3M)

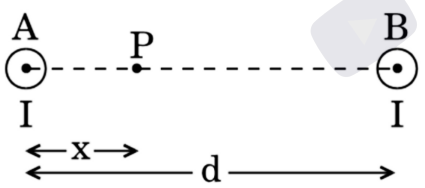
2020

Q1. The magnetic dipole moment of a current carrying coil does not depend upon
(A) number of turns of the coil.
(B) cross-sectional area of the coil.
(C) current flowing in the coil.
(D) material of the turns of the coil. (1M)
Ans. (D)

Q2. Write the mathematical form of Ampere-Maxwell circuital law. (1M)

Ans. $\nabla \times B = \mu_0 J + \mu_0 \epsilon_0 \partial t \partial E$

Q3. Two long straight parallel wires A and B separated by a distance d, carry equal current I flowing in same direction as shown in the figure. (2M)



(a) Find the magnetic field at a point P situated between them at a distance x from one wire. (b) Show graphically the variation of the magnetic field with distance x for 0 < x < d.

Ans. a) $B = \frac{\mu_0}{4\pi} . 2I \left[\frac{d-2x}{x(d-x)}\right]$

Q4. (a) Write an expression of magnetic moment associated with a current (I) carrying circular coil of radius r having N turns. (b) Consider the above mentioned coil placed in YZ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point (x, 0, 0). (3M)

Ans. a) $M = NIA = NI\pi r^2$ b) $B = \frac{\mu_0 I R^2}{2(X^2 + R^2)^{\frac{3}{2}}}$

Q5. (a) Define current sensitivity of a galvanometer. Write its expression. (b) A galvanometer has resistance G and shows full scale deflection for current Ig. (i) How can it be converted into an ammeter to measure current up to I_o ($I_o > I_g$)? (ii) What is the effective resistance of this ammeter? (3M)

Ans. a) $I_s = \frac{\theta}{I}$ b) i) $(I_0 - I_g)R_s = I_g G$ ii) $R_{eff} = \frac{R_s G}{R_s + G}$

Q6. (a) Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial? (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 x 10^–3 T acting along y-axis. Find the radius of its path. (Take mass of **α**-particle = 6·4 x 10^–27 kg). (5M)

Ans. 10m

2022

Q1. Two moving coil galvanometers G1 and G2 have the following particulars respectively: N1=30, A1 = 3.6 x 10-3 m2, B1= 0.25 T N2= 42, A2 = 1.8 x 10-3, m2, B2 = 0.50 T The spring constant is same for both the galvanometers. The ratio of current sensitivities of G1 and G2 is

(A) 5 : 7

(B) 7 : 5

(C) 1:4

(D) 1 : 1

Ans. (C)

Q2. A current I is flowing through the loop as shown in the figure (MA = R, MB = I 2R). The magnetic field at the centre of the loop is **μoI/R** times:

(A) 5/16, into the plane of the paper

(B) 5/16, out of the plane of the paper

(C) 7/16, out of the plane of the paper

(D) 7/16, into the plane of the paper

Ans. (D)

Q3. A long straight wire in the horizontal plane carries a current of 15 A in north to south direction. The magnitude and direction of magnetic field at a point 2.5 m east of the wire respectively are:

(A) 1.2 μT, vertically upward

(B) 1.2 μT, vertically downward

(C) 0.6 μT, vertically upward

(D) 0.6 μT, vertically downward

Ans. (A)

Q4. An electron is projected with velocity v along the axis of a current carrying long solenoid. Which one of the following statements is true?

(A) The path of the electron will be circular about the axis.

(B) The electron will be accelerated along the axis.

(C) The path of the electron will be helical.

(D) The electron will continue to move with the same velocity v along the axis of the solenoid.

Ans. (D)

Q5. If the speed v of a charged particle moving in a magnetic field B perpendicular to B is halved, then the radius of its path will:

(A) not change

(B) become two times

(C) become one- fourth

(D) become half

Ans. (D)

Q6. Which one of the following is not affected by the presence of a magnetic field?

(A) A current carrying conductor

(B) A moving charge

(C) A stationary charge

(D) A rectangular current loop with its parallel to the felid

Ans. (C)

Q7. In a certain region field E and magnetic field B are perpendicular to each other. An electron enters the region perpendicular to the direction of both E and B moves undeflected. The speed of the electron is :

(A) $\vec{E} . \vec{B}$

(B) $|\vec{E} \times \vec{B}|$

(C) $\frac{|\vec{E}|}{|\vec{B}|}$

(D) $\frac{|\vec{B}|}{|\vec{E}|}$

Ans. (C)

Q8. A test charge of 1.6 × 10^-19 C is moving with a velocity v = (4i + 3k) m/s in a magnetic field B(3k + 4i) T. The force on this test charge is :

(A) 24j N

(B) 24i N

(C) 24k N

(D) 0

Ans. (D)

Q9. **Assertion (A):** A bar magnet experiences a torque when placed in a magnetic field.

Reason (R): A bar magnet exerts a torque on itself due to its own magnetic field.

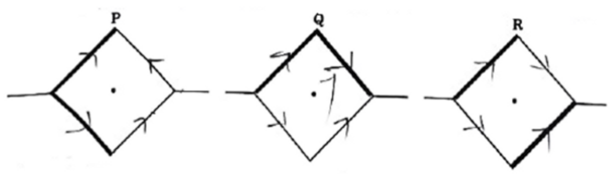
Ans. (A) is True but (R) is False

Q10. **Assertion (A):** When a charged particle moves with velocity v in a magnetic field B (v⊥B), the force on the particle does no work.

Reason (R): The magnetic force is perpendicular to the velocity of the particle.

Ans. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).

Q11. Two identical thick wires and two identical thin wires, all of the same material and the same length form a square in three different ways P, Q and R as shown. Due to the current in these loops the magnetic field at the centre of the loop will be zero in case of:



(A) P and R only

(B) Q and R only

(C) P and Q only

(D) P, Q and R

Ans. (A)

Q12. A circular current carrying coil produces a magnetic field B_o at its centre. The coil is rewound so as to have three turns and the same current is passed through it. The new magnetic field at the centre is:

(A) 3 B_o (B) $B_o/3$ (C) $B_o/9$ (D) 9 B_o

Ans. (D)

Q13. A long solenoid carrying current produces a magnetic field B along its axis. If the number of turns in the solenoid is halved and current in it is doubled, the new magnetic field will be:

(A) B/2

(B) B

(C) 2B

(D) 4B

Ans. (B)

Q14. A current carrying square loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is F, the net force on the remaining three arms of the loop will be.

(A) 3F

(B) -3F

(C) F

(D) -F

Ans. (D)

MAGNETISM AND MATTER

2017

Q1. Write two properties of a material suitable for making (a) a permanent magnet, and (b) an electromagnet. (2M)

Ans. Permanent magnet- low permeability, high retentivity

Electromagnet - high permeability, low retentivity

2019

Q1. (a) State Gauss's law for magnetism. Explain its significance. (b) Write the four important properties of the magnetic field lines due to a bar magnet. (3M)

Q2. Write three points of differences between para-, dia- and ferromagnetic materials, giving one example for each. (3M)

2020

Q1. The magnetic field and angle of dip at a place on the earth are 0·3 G and 30°, respectively. The value of vertical component of the earth's magnetic field at the place is __________. (1M)

Ans. 1.5G

2022

Q1. The vertical component of earth's magnetic field at a place is (1/√3) times the horizontal J3 component. The angle of dip at that place is:

(A) 0°

(B) 30°

(C) 45°

(D) 60°

Ans. (D)

ELECTROMAGNETIC INDUCTION

2015

Q1. (a) Define mutual inductance and write its S.I. unit.

(b) Derive an expression for the mutual inductance of two long co-axial solenoids of the same length wound one over the other.

(c) In an experiment, two coils c1 and c2 are placed close to each other. Find out the expression for the emf induced in coil c1 due to a change in the current through coil c2. (5M)

Ans. c) $\epsilon = -\frac{d\phi}{dt} = -\frac{d}{dt}(MI) = -M\frac{dI}{dt}$

2016

Q1. (i) Define mutual inductance. (ii) A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil? (3M)
Ans. ii) 30 Wb

2017

Q1. Define mutual inductance between a pair of coils. Derive an expression for the mutual inductance of two long coaxial solenoids of the same length wound one over the other. (3M)

Ans. ii) $M_{12} = \mu_0 n_1 n_2 \pi r_1^2 l$

Q2. Define the self-inductance of a coil. Obtain the expression for the energy stored in an inductor L connected across a source of emf. (3M)

Ans. ii) U=1/2LI^2

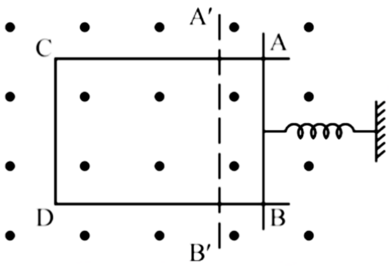
Q3. (a) Draw a labelled diagram of an ac generator. Obtain the expression for the emf induced in the rotating coil of N turns each of cross-sectional area A, in the presence of a magnetic field B. (b) A horizontal conducting rod 10 m long extending from east to west is falling with a speed of 5·0 ms–1 at right angles to the horizontal component of the Earth's magnetic field, 0·3 x 10^–4 Wb m^–2.

Find the instantaneous value of the emf induced in the rod. (5M)

Ans. a) E=NBAwsinwt b) 1.5mV

2018

Q1. A rectangular frame of wire is placed in a uniform magnetic field directed outwards, normal to the paper. AB is connected to a spring which is stretched to A’B’ and then released at time t = 0. Explain qualitatively how induced e.m.f. in the coil would vary with time. (Neglect damping of oscillations of spring). (2M)

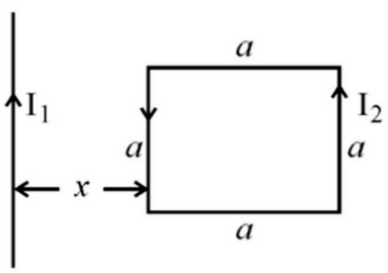


Q2. (a) Define the term magnetic susceptibility and write its relation in terms of relative magnetic permeability. (b) Two magnetic materials A and B have relative magnetic permeabilities of 0.96 and 500. Identify the magnetic materials A and B.

Ans. a) $X_m = \mu_r - 1$, b) A is a diamagnetic material , B is a ferromagnetic material

2019

Q1. (a) Define mutual inductance and write its S.I. unit. (b) A square loop of side ‘a’ carrying a current I2 is kept at distance x from an infinitely long straight wire carrying a current I1 as shown in the figure. Obtain the expression for the resultant force acting on the loop. (3M)



Ans. b) $F = \frac{\mu_0}{4\pi}\frac{2I_1I_2\,a^2}{x(x+a)}$

2020

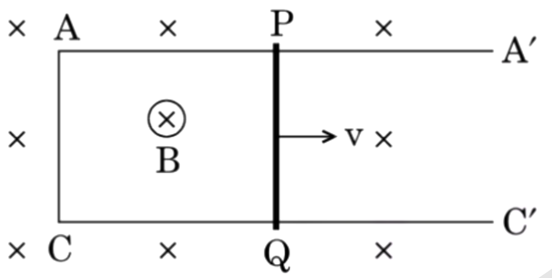
Q1. Laminated iron sheets are used to minimize __________ currents in the core of a transformer. (1M)

Ans. eddy

Q2. The number of turns of a solenoid are doubled without changing its length and area of cross-section. The self-inductance of the solenoid will become __________ times. (1M)

Ans. four

Q3. A conducting rod PQ of length 20 cm and resistance 0·1 rests on two smooth parallel rails of negligible resistance AA' and CC'. It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field B = 0·4 T. The rails, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short-circuited, find the (i) external force required to move the rod with uniform velocity v = 10 cm/s, and (ii) power required to do so. (3M)



Ans. i) $6.4 \times 10^{-3} N$, ii) $0.64 \times 10^{-3} W$

2022

Q1. Lenz's law is the consequence of the law of conservation of:

(A) energy

(B) charge

(C) mass

(D) momentum

Ans. (D)

Q2. The emf induced in a 10 H inductor in which current changes from 11 A to 2 A in 9x10-1s is:

(A) 10^4 V

(B) 10^3 V

(C) 10^2 v

(D) 10 v

Ans. (B)

Q3. A metal plate is getting heated. Which one of following statements is incorrect?

(A) It is placed in a space-varying magnetic field that does not vary with time.

(B) A direct current is passing through the plate.

(C) An alternating current is passing through the plate.

(D) It is placed in a time-varying magnetic field.

Ans. (A)

Q4. **Assertion (A):** Induced emf in two coils made of wire of the same length and the same thickness, one of copper and another of aluminium is same. The current in copper coil is more than the aluminium coil.

Reason (R): Resistance of aluminium coil is more than that of copper coil.

Ans. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).

Q5. The magnetic flux linked with a coil is given by ϕ = 5t^2 + 3t + 16, where is ϕ in webers and t in seconds. The induced emf in the coil at t = 5 s will be:

(A) 53 V

(B) 43 V

(C) 10V

(D) 6V

Ans. (C)

ALTERNATING CURRENT

2015

Q1. An inductor L of inductance XL is connected in series with a bulb B and an ac source. How would the brightness of the bulb change when (i) the number of turns in the inductor is reduced, (ii) an iron rod is inserted in the inductor and (iii) a capacitor of reactance XC = XL is inserted in series in the circuit. Justify your answer in each case. (3M)

Q2. A group of students while coming from the school noticed a box marked "Danger H.T. 2200 V" at a substation in the main street. They did not understand the utility of such a high voltage, while they argued, the supply was only 220 V. They asked their teacher this question the next day. The teacher thought it to be an important question and therefore explained it to the whole class.

Answer the following questions:

(i) What device is used to bring the high voltage down to the low voltage of a.c. current and what is the principle of its working? (ii) Is it possible to use this device for bringing down the high d.c. voltage to the low voltage? Explain. (iii) Write the values displayed by the students and the teacher. (5M)

2016

Q1. Define the ‘quality factor’ of resonance in a series LCR circuit. What is its SI unit? (1M)

Ans. ii) no SI unit

Q2. An a.c. source of voltage V = V0 sin ωt is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for the impedance of the circuit and phase angle between voltage and current.

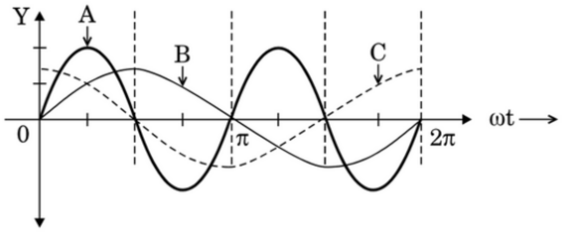
(i) Find the condition when the current will be in phase with the voltage. What is the circuit in this condition called?

(ii) In a series LR circuit XL = R and the power factor of the circuit is P1. When a capacitor with capacitance C such that XL = XC is put in series, the power factor becomes P2. Calculate P1/P2 (5M)

Ans. i) Resonant circuit ii) $\frac{1}{\sqrt{2}}$

2017

Q1. A device ‘X’ is connected to an ac source V = V0sin ωt. The variation of voltage, current and power in one cycle is shown in the following graph:



(a) Identify the device ‘X’. (b) Which of the curves A, B and C represent the voltage, current and power consumed in the circuit? Justify your answer. (c) How does its impedance vary with the frequency of the ac source? Show graphically. (d) Obtain an expression for the current in the circuit and its phase relation with ac voltage. (5M)

Ans. a) Capacitor b) B → Voltage. C → Current A → Power Consumed c) $x_c \propto \frac{1}{\nu}$ d) $I = \frac{E_0}{1/\omega c}\sin\left(\omega t+\frac{\pi}{2}\right)=I_0\sin\left(\omega t+\frac{\pi}{2}\right)$

2018

Q1. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with the frequency of the applied ac source. (b) Draw the phasor diagram for a series RC circuit connected to an ac source. (c) An alternating voltage of 220 V is applied across device X, and a current of 0.25 A flows, which lags behind the applied voltage in phase by $\pi/2$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage. (i) Name the devices X and Y. (ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y. (5M)

Ans. (c) (i) X is inductance and y is resistance

(ii) 0.177A

Q2. (a) State the principle of working of a transformer. (b) Define efficiency of a transformer. (c) State any two factors that reduce the efficiency of a transformer. (d) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is 440 **Ω**. (5M)

Ans. a)mutual induction d)1/180A

2019

Q1. (a) In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with the frequency of an ac source.
(b) What is the phase difference between the voltages across the inductor and the capacitor at resonance in the LCR circuit?
(c) When an inductor is connected to a 200 V dc voltage, a current of 1A flows through it. When the same inductor is connected to a 200 V, 50 Hz ac source, only 0.5 A current flows. Explain, why? Also, calculate the self-inductance of the inductor. (5M)
Ans. b) 180° c) (√12 /π)H

Q2. (a) Draw the diagram of a device which is used to decrease high ac voltage into a low ac voltage and state its working principle. Write four sources of energy loss in this device.

(b) A small town with a demand of 1200 kW of electric power at 220 V is situated 20 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5 Ω per km. The town gets the power from the line through a 4000-220 V step-down transformer at a substation in the town. Estimate the line power loss in the form of heat. (5M)

Ans. b)1800kW

2020

Q1. A resistance R and a capacitor C are connected in series to a source V = V0 sin ωt. Find : (a) The peak value of the voltage across the (i) resistance and (ii) capacitor.

(b) The phase difference between the applied voltage and current. Which of them is ahead? (3M)

Ans. a) i) $V_R = I_0 R = \frac{V_0 R}{\sqrt{R^2 + X_C^2}}$ ii) $V_C = I_0 X_C = \frac{V_0 X_C}{\sqrt{R^2 + X_C^2}}$,

b) $\phi = tan^{-1}(\frac{X_C}{R})$, current

Q2. With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following : (i) The core of the transformer is laminated. (ii) Thick copper wire is used in windings. (2M)

2022

Q1. A pure inductor of 318 mH and a pure resistor of 75 Ω are connected in series to an ac source Of 50 Hz. The voltage across 75 Ω resistor is found to be 150 V. The source voltage is:

(A) 150 V

(B) 175 V

(C) 220 V

(D) 250 V

Ans. (D)

Q2. In an ac circuit the applied voltage and resultant current are E = E0 sin ωt and $I = I_o \sin(\omega t + \pi/2)$ respectively. The average power consumed in the circuit is:

(A) E_oI_o

(B) $(E_oI_o)/2$

(C) $(E_oI_o)/\sqrt{2}$

(D) Zero

Ans. (D)

Q3. In a series LCR circuit, at resonance the current is equal to :

(A) $\frac{V}{R}$

(B) $\frac{V}{X_c}$

(C) $\frac{V}{X_L - X_C}$

(D) $\frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$

Ans. (A)

Q4. The frequency of an ac source for which a 10 μF capacitor has a reactance of 1000Ω is :

(A) 1000/π Hz (B) 50 Hz (C) 50/π Hz (D) 100/π Hz

Ans. (C)

Q5. **Assertion (A):** In a series LCR circuit connected to an ac source, resonance can take place. **Reason (R):** At resonance XL = XC.

Ans. Both (A) and (R) are true, and (R) is the correct explanation of (A)

Q6. **Assertion (A):** A transformer is used to increase or decrease ac voltage only.

Reason (R): A transformer works on the basis of mutual induction.

Ans. Both (A) and (R) are true, and (R) is the correct explanation of (A)

Q7. Which one of the following statements is true?

(A) An inductor has infinite resistance in a dc circuit.

(B) A inductor and a capacitor both cannot conduct in a dc circuit.

(C) A capacitor can conduct in a dc circuit but not an inductor.

(D) An inductor can conduct in a dc circuit but not a capacitor.

Ans. (D)

ELECTROMAGNETIC WAVES

2015

Q1. How are side bands produced ? (1M)

Q2. Name the parts of the electromagnetic spectrum which is (a) suitable for radar systems used in aircraft navigation. (b) used to treat muscular strain. (c) used as a diagnostic tool in medicine. Write in brief, how these waves can be produced. (3M)

Ans. a)Microwaves or short radio waves b) Infrared waves c) X rays

Q3. Draw a block diagram of a detector for AM signal and show, using necessary processes and the waveforms, how the original message signal is detected from the input AM wave. (3M)

2016

Q1. Why are microwaves considered suitable for radar systems used in aircraft navigation? (1M)

Q2. How are em waves produced by oscillating charges? Draw a sketch of linearly polarized em waves propagating in the Z-direction. Indicate the directions of the oscillating electric and magnetic fields. (3M)

Q3. Write Maxwell's generalisation of Ampere's Circuital Law. Show that in the process of charging a capacitor, the current produced within the plates of the capacitor is

$$i = \varepsilon_0 \frac{d\Phi_E}{dt}$$

where Φe is the electric flux produced during the charging of the capacitor plates. (3M)

2017

Q1. Do electromagnetic waves carry energy and momentum? (1M)

Ans. Yes

Q2. Identify the electromagnetic waves whose wavelengths vary as:

(a) $10^{-12}\,\mathrm{m} < \lambda < 10^{-8}\,\mathrm{m}$

(b) $10^{-3}\,\mathrm{m} < \lambda < 10^{-1}\,\mathrm{m}$

Write one use for each. (2M)

Ans. a) X rays b) Micro Waves

2018

Q1. Write the range of frequencies of electromagnetic waves which propagate through sky wave mode. (1M)

Ans. 5 MHz to 25 MHz

Q2. (a) Give one use of electromagnetic radiations obtained in nuclear disintegrations. (b) Give one example each to illustrate the situation where there is (i) displacement current but no conduction current and (ii) only conduction current but no displacement current. (2M)

Q3. Mrs Rajlakshmi had a sudden fall and was thereafter unable to stand straight. She was in great pain. Her daughter Rita took her to the doctor. The doctor took a photograph of Mrs Rajlakshmi's bones and found that she had suffered a fracture. He advised her to rest and take the required treatment. (a) Name the electromagnetic radiation used to take photographs of the bones. (b) How is this radiation produced? (c) Mention the range of the wavelength of this electromagnetic radiation. (d) Write two values displayed by Rita. (4M)

Ans. (a) X-rays
(b) X-rays are produced by Bombarding a metal target with high energy electrons.
(c) The range of wavelength is 10 nm to 10^{-4} nm
(d) Alertness and empathy.

2019

Q1. On what factors does the range of coverage in ground wave propagation depend? (1M)

Ans. transmitted power and frequency

Q2. (a) Identify the part of the electromagnetic spectrum used in (i) radar and (ii) eye surgery. Write their frequency range. (b) Prove that the average energy density of the oscillating electric field is equal to that of the oscillating magnetic field. (3M)

Ans. (i)Microwaves; 1 GHz to 300 GHz or 3 × 1011 to 1 × 109 Hz. (ii) Ultraviolet rays; 8 × 1014 to 5 × 1017 Hz.

2020

Q1. (a) Write the expression for the speed of light in a material medium of relative permittivity **ε**r and relative magnetic permeability **ε**r.

(b) Write the wavelength range and name of the electromagnetic waves which are used in (i) radar systems for aircraft navigation, and (ii) Earth satellites to observe the growth of the crops. (3M)

Ans. a) $$v = \frac{1}{\sqrt{\in_0 \in_r \mu_0 \mu_r}} = \frac{e}{\sqrt{\in_r \mu_r}}$$

b) (i) Electromagnetic waves; 1 mm to 10 cm. (ii) Infrared waves; 700 nm to 1 mm.

RAY OPTICS AND OPTICAL INSTRUMENTS

2015

Q1. A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens? (1M)

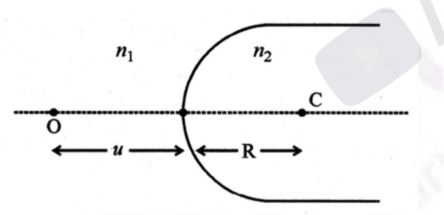
Ans. Converging

Q2. Use the mirror equation to show that an object placed between f and 2f of a concave mirror produces a real image beyond 2f. (2M)

Q3. A giant refracting telescope has an objective lens with a focal length of 15 m. If an eyepiece of focal length 1.0 cm is used, what is the angular magnification of the telescope?

(ii) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is 3.48 × 106 m and the radius of the lunar orbit is 3.8 x 108 m. (3M)
Ans. i) 1500, ii) 13.74 cm

Q4. A point object 'O' is kept in a medium of refractive index n1 in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n2 from the first one, as shown in the figure. Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in terms of n1, n2 and R.



(b) When the image formed above acts as a virtual object for a concave spherical, surface separating the medium n2 from n1 (n2>n1), draw this ray diagram and write the similar (similar to (a)) relation. Hence obtain the expression for the lens maker's formula. (5M)

Ans. a) $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ b) $\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

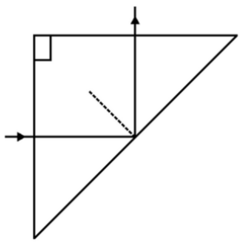
2016

Q1. (a) Calculate the distance of an object of height h from a concave mirror of radius of curvature 20 cm, so as to obtain a real image of magnification 2. Find the location of the image also. (b) Using the mirror formula, explain why a convex mirror always produces a virtual image. (3M)

Ans. a) -30cm, in front of mirror

Q2. Draw a schematic ray diagram of a reflecting telescope showing how rays coming from a distant object are received at the eye-piece. Write two important advantages over a refracting telescope. (3M)

Q3. (i) Plot a graph to show the variation of the angle of deviation as a function of the angle of incidence for light passing through a prism. Derive an expression for the refractive index of the prism in terms of the angle of minimum deviation and the angle of the prism. (ii) What is the dispersion of light? What is its cause? (iii) A ray of light incident normally on one face of a right isosceles prism is totally reflected as shown in fig. What must be the minimum value of the refractive index of glass? Give relevant calculations. (5M)



Ans. i)

$$i = \frac{A + D_m}{2}$$

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\frac{A}{2}}$$

ii)$\sqrt{2}$

2017

Q1. How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced by red light? Give reason. (1M)

Q2. (a) Monochromatic light of wavelength 589 nm is incident from the air on a water surface. If μ for water is 1·33, find the wavelength, frequency and speed of the refracted light.

(b) A double convex lens is made of a glass of refractive index 1·55, with both faces of the same radius of curvature. Find the radius of curvature required, if the focal length is 20 cm. (3M)

Ans. a) 444nm, 5.09x10^14 Hz, 2.26x10^8 m/s b) 22cm

Q3. (a) Draw a ray diagram depicting the formation of the image by an astronomical telescope in normal adjustment. (b) You are given the following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope? Give reason. (3M)

Lenses	Power (D)	Aperture (cm)
L_1	3	8
L_2	6	1
L_3	10	1

Q4. (a) Draw a ray diagram to show the image formation by a combination of two thin convex lenses in contact. Obtain the expression for the power of this combination in terms of the focal lengths of the lenses. (b) A ray of light passing from the air through an equilateral glass prism undergoes minimum deviation when the angle of incidence is 3/4th of the angle of the prism. Calculate the speed of light in the prism. (5M)

Ans. a) $P = \frac{f_1+f_2}{f_1 f_2}$ b) 2.12x10^8 m/s

2018

Q1. Define the power of a lens. Write its S.I. unit. (1M)

Ans. Diopter

Q2. (a) With the help of a ray diagram, show how a concave mirror is used to obtain an erect and magnified image of an object. (b) Using the above ray diagram, obtain the mirror formula and the expression for linear magnification. (3M)

Ans. b) $\frac{B'A'}{BA} = \frac{B'P}{BP} = \frac{-v}{u}$

2019

Q1. Calculate the radius of curvature of an equi-concave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of –5D. (2M)

Ans. 2.857 cm

Q2. An equilateral glass prism has a refractive index of 1.6 in air. Calculate the angle of minimum deviation of the prism, when kept in a medium of refractive index 4√2/5. (2M)

Ans. 30°

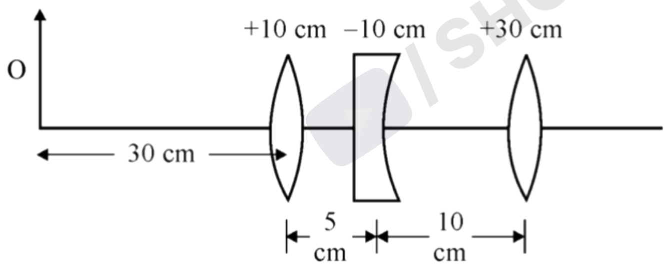
Q3. Define the term, "refractive index" of a medium. Verify Snell's law of refraction when a plane wavefront is propagating from a denser to a rarer medium. (3M)

Q4. Draw a labelled ray diagram of an astronomical telescope in the near-point adjustment position.

A giant refracting telescope at an observatory has an objective lens of focal length 15 m and an eyepiece of focal length 1.0 cm. If this telescope is used to view the Moon, find the diameter of the image of the Moon formed by the objective lens. The diameter of the Moon is 3.48 × 10^6 m and the radius of the lunar orbit is 3.8 × 10^8m. (3M)

Ans. 13.7 cm

Q5. (a) Under what conditions is the phenomenon of total internal reflection of light observed? Obtain the relation between the critical angle of incidence and the refractive index of the medium. (b) Three lenses of focal lengths +10 cm, –10 cm and +30 cm are arranged coaxially as in the figure given below. Find the position of the final image formed by the combination. (5M)



Ans. a) $\mu = \dfrac{1}{\sin C}$ b)30cm

2020

Q1. Larger aperture of objective lens in an astronomical telescope

(A) increases the resolving power of telescope.

(B) decreases the brightness of the image.

(C) increases the size of the image.

(D) decreases the length of the telescope. (1M)

Ans. (A)

Q2. A biconvex lens of glass having refractive index 1·47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is

(A) 1·47 (B) 1·62 (C) 1·33 (D) 1·51. (1M)

Ans. (A)

Q3. For a glass prism, the angle of minimum deviation will be smallest for the light of

(A) red colour. (B) blue colour. (C) yellow colour. (D) green colour. (1M)

Ans. (A)

Q4. A ray of light on passing through an equilateral glass prism, suffers a minimum deviation equal to the angle of the prism. The value of refractive index of the material of the prism is __________. (1M)

Ans. √3

Q5. Using lens maker's formula, derive the thin lens formula $1/f = 1/v - 1/u$ for a biconvex lens. (2M)

Q6. (a) Draw the ray diagram of an astronomical telescope when the final image is formed at infinity. Write the expression for the resolving power of the telescope.
(b) An astronomical telescope has an objective lens of focal length 20 m and eyepiece of focal length 1 cm.
(i) Find the angular magnification of the telescope.
(ii) If this telescope is used to view the Moon, find the diameter of the image formed by the objective lens. Given the diameter of the Moon is $3{\cdot}5 \times 10^{6}$ m and radius of lunar orbit is $3{\cdot}8 \times 10^{8}$ m. (5M)
Ans. b) i)2000 ii)0.184m

Q7. (a) An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation $1/f = 1/u + 1/v$.
(b) An object is placed 30 cm in front of a plano-convex lens with its spherical surface of radius of curvature 20 cm. If the refractive index of the material of the lens is 1·5, find the position and nature of the image formed. (5M)
Ans. b) -12cm, virtual

WAVE OPTICS

2015

Q1. Find an expression for the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids. In which position of the polaroid sheet will the transmitted intensity be maximum? (2M)

Ans. $I_3 = (I_0/2)(\sin^2 2\theta/4)$, θ=45°

Q2. Answer the following questions:

(a) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits.

(b) Light of wavelength 5000 Å. propagating in the air gets partly reflected from the surface of the water. How will the wavelengths and frequencies of the reflected and refracted light be affected? (3M)

Ans. a) 3.44x10^-4 cm, b) 3750Å, 6x10^14 Hz

Q3. (a) Using Huygens's construction of secondary wavelets explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.

(b) Show that the angular width of the first diffraction fringe is half that of the central fringe.

(c) Explain why the maxima at = θ = (n+1/2) λ/a become weaker and weaker with increasing n (5M)

2016

Q1. State Brewster's law. The value of the Brewster angle for a transparent medium is different for the light of different colours. Give reason. (2M)

Q2. (i) In Young's double slit experiment, deduce the condition for (a) constructive, and (b) destructive interference at a point on the screen. Draw a graph showing the variation of intensity in the interference pattern against position 'x' on the screen. (ii) Compare the interference pattern observed in Young's double-slit experiment with the single-slit diffraction pattern, pointing out three distinguishing features. (5M)

2017

Q1. Draw the intensity pattern for single-slit diffraction and double-slit interference. Hence, state two differences between interference and diffraction patterns. (2M)

Q2. Unpolarised light is passed through a polaroid P1. When this polarised beam passes through another polaroid P2 and if the pass axis of P2 makes angle θ with the pass axis of P1, then write the expression for the polarised beam passing through P2. Draw a plot showing the variation of intensity when θ varies from 0 to 2π. (2M)

Ans. $I = \frac{I_0}{2}\cos^2\theta$

Q3. (a) Define wavefront. Use Huygens' principle to verify the laws of refraction. (b) How is linearly polarised light obtained by the process of scattering of light? Find the Brewster angle for air – the glass interface, when the refractive index of glass = 1·5. (5M)

Ans. b) $i_B = \tan^{-1}(1.5) = 56.3^o$

2018

Q1. Draw a graph showing the intensity distribution of fringes due to diffraction at a single slit. (1M)

Q2. (a) When an unpolarized light of intensity Io is passed through a polaroid, what is the intensity of the linearly polarized light? Does it depend on the orientation of the polaroid? Explain your answer. (b) A plane-polarized beam of light is passed through a polaroid. Show graphically the variation of the intensity of the transmitted light with the angle of rotation of the polaroid in complete one rotation. (3M)

Q3. (i) Write two points to distinguish between interference and diffraction fringes. (ii) In Young's double-slit experiment, fringes are obtained on a screen placed a certain distance away from the slits. If the screen is moved by 5 cm towards the slits, the fringe width changes by 30 μm. Given that the slits are 1 mm apart, calculate the wavelength of the light used. (3M)

Ans. 6000 Å

2019

Q1. What is the speed of light in a denser medium with a polarising angle of 30°? (1M)

Ans. 2×10^8 m/s

Q2. Define the term wavefront. Using Huygen's wave theory, verify the law of reflection. (3M)

Q3. (a) Describe any two characteristic features which distinguish between interference and diffraction phenomena. Derive the expression for the intensity at a point of the interference pattern in Young's double-slit experiment.

(b) In the diffraction due to a single slit experiment, the aperture of the slit is 3 mm. If monochromatic light of wavelength 620 nm is incident normally on the slit, calculate the separation between the first-order minima and the 3rd-order maxima on one side of the screen. The distance between the slit and the screen is 1.5 m. (5M)

Ans. b) 3.1×10^{-4} m, 7.75×10^{-4} m

2020

Q1. Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a denser to rarer medium. (2M)

Q2. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations? Justify your answers. (a) The screen is moved away from the plane of the slits. (b) The separation between slits is increased. (c) The source slit is moved closer to the plane of double slit. (3M)

DUAL NATURE OF RADIATION AND MATTER

2015

Q1. A proton and an α-particle have the same de-Broglie wavelength. Determine the ratio of (i) their accelerating potentials and (ii) their speeds. (2M)

Ans. 2:1, 4:1

Q2. Write Einstein's Photoelectric equation and mention which important features in the photoelectric effect can be explained with the help of this equation.

The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ1 to λ2. Derive the expressions for the threshold wavelength λ0 and work function for the metal surface. (3M)

Ans. $\phi_0 = \frac{hc}{\lambda_0} = \frac{hc(2\lambda_2 - \lambda_1)}{\lambda_1\lambda_2}$

2016

Q1. Plot a graph showing the variation of de-Broglie wavelength λ versus 1/√V, where V is the accelerating potential for two particles A and B carrying the same charge but of masses m1, m2 (m1>m2). Which one of the two represents a particle of smaller mass and why? (2M)

Ans. lower mass (m2) will have greater slope.

Q2. Write three characteristic features in the photoelectric effect which cannot be explained on the basis of the wave theory of light, but can be explained only using Einstein's equation. (3M)

2017

Q1. Name the phenomenon which shows the quantum nature of electromagnetic radiation. (1M)

Ans. Photoelectric effect

Q2. Using a photon picture of light, show how Einstein's photoelectric equation can be established. Write two features of the photoelectric effect which cannot be explained by the wave theory. (3M)

2018

Q1. An electron is accelerated through a potential difference V. Write the expression for its final speed if it was initially at rest. (1M)

Ans. ✓evm

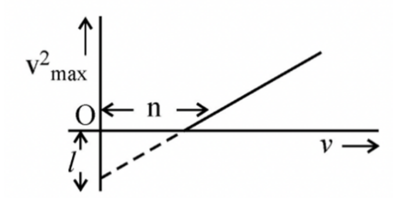
Q2. Find the frequency of light which ejects electrons from a metal surface, fully stopped by a retarding potential of 3.3 V. If photoelectric emission begins in this metal at a frequency of 8 × 10^14 Hz, calculate the work function (in eV) for this metal. (2M)

Ans. 1.6 × 10^15 Hz

Q3. Monochromatic light of frequency 6.0 × 10^14 Hz is produced by a laser. The power emitted is 2.0 × 10^–3 W. Calculate the (i) energy of a photon in the light beam and (ii) the number of photons emitted on average by the source. (2M)

Ans. i)2.48 ev ii)5x10^`5

Q4. State Einstein's photoelectric equation explaining the symbols used.



Light of frequency **v** is incident on a photosensitive surface. A graph of the square of the maximum speed of the electrons (**v^2 max**) vs. **v** is obtained as shown in the figure. Using Einstein's photoelectric equation, obtain expressions for

(i) Planck's constant

(ii) the work function of the given photosensitive material in terms of parameters l, n and mass of the electron m. (3M)

Ans. i) $h = \frac{lm}{2n}$ ii) $\phi = \frac{lm}{2}$

2019

Q1. Define the term "threshold frequency", in the context of photoelectric emission. (1M)

Q2. Why is the wave theory of electromagnetic radiation not able to explain the photoelectric effect? How does a photon picture resolve this problem? (2M)

Q3. Plot a graph showing the variation of de Broglie wavelength (λ) associated with a charged particle of mass m, versus 1/✓ V, where V is the potential difference through which the particle is accelerated. How does this graph give us information regarding the magnitude of the charge of the particle? (2M)

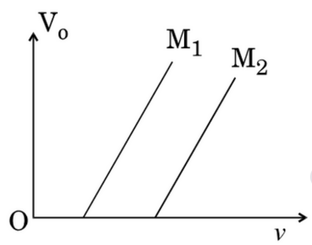
2020

Q1. Photons of energies 1 eV and 2 eV are successively incident on a metallic surface of work function 0·5 eV. The ratio of kinetic energy of most energetic photoelectrons in the two cases will be

(A) 1 : 2 (B) 1 : 1 (C) 1 : 3 (D) 1 : 4. (1M)

Q2. A proton and an electron have equal speeds. Find the ratio of de Broglie wavelengths associated with them. (1M)

Q3. The variation of the stopping potential (Vo) with the frequency (v) of the light incident on two different photosensitive surfaces M1 and M2 is shown in the figure. Identify the surface which has greater value of the work function. (1M)



Q4. (a) Write two main observations of photoelectric effect experiment which could only be explained by Einstein's photoelectric equation. (b) Draw a graph showing variation of photocurrent with the anode potential of a photocell. (2M)

2022

Q1. The speed acquired by a free electron when accelerated from rest through a potential difference of 100 V is :
(A) 6×10^6 ms^{-1}
(B) 3×10^6 ms^{-1}
(C) 4×10^5 ms^{-1}
(D) 2×10^3 ms^{-1}
Ans. (A)

ATOMS

2015

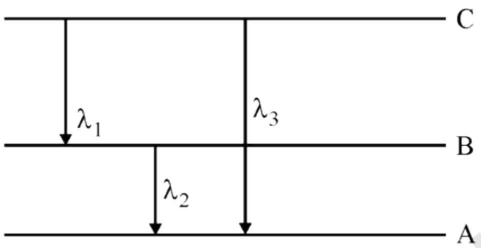
Q1. Show that the radius of the orbit in a hydrogen atom varies as n2, where n is the principal quantum number of the atom. (2M)

Q2. In the study of the Geiger-Marsdon experiment on the scattering of particles by a thin foil of gold, draw the trajectory of -particles in the Coulomb field of the target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study.

From the relation R = R0 A^(1/3), where R0 is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A. (3M)

2016

Q1. State Bohr's quantisation condition for defining stationary orbits. How does de Broglie's hypothesis explain the stationary orbits? (ii) Find the relation between the three wavelengths λ1, λ2 and λ3 from the energy level diagram shown below. (3M)



Ans. $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = R\left(\frac{1}{n_{1^2}} - \frac{1}{n_{3^2}}\right) = \frac{1}{\lambda_3}$

2017

Q1. A 12·5 eV electron beam is used to excite a gaseous hydrogen atom at room temperature. Determine the wavelengths and the corresponding series of the lines emitted. (2M)

Ans. λ=102.5nm→ Lyman series and λ=656.33nm→Balmer series

2018

Q1. Calculate the ratio of the frequencies of the radiation emitted due to the transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level and (ii) highest permitted energy level to the second permitted level. (2M)

Ans. 3:1

2019

Q1. Define the term "Intensity" in the photon picture of electromagnetic radiation. (1M)

Q2. State Bohr's quantisation condition of angular momentum. Calculate the shortest wavelength of the Bracket series and state to which part of the electromagnetic spectrum does it belong. (2M)

Ans. $(\lambda = 1.46 \times 10^{-6} m)$, infrared

Q3. Calculate the orbital period of the electron in the first excited state of the hydrogen atom. (2M)

Ans. 2.46 × 10–15 s.

2020

Q1. Which of the following statements is not correct according to Rutherford model?
(A) Most of the space inside an atom is empty.
(B) The electrons revolve around the nucleus under the influence of coulomb force acting on them.
(C) Most part of the mass of the atom and its positive charge are concentrated at its centre.
(D) The stability of atom was established by the model. (1M)
Ans. (D)

Q2. According to Bohr's atomic model, the circumference of the electron orbit is always an __________ multiple of de Broglie wavelength. (1M)

Ans. integral

Q3. Using Bohr's atomic model, derive the expression for the radius of nth orbit of the revolving electron in a hydrogen atom. (2M)

NUCLEI

2015

Q1. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released.

Calculate the energy release in MeV in the deuterium-tritium fusion reaction : (3M)

$$ {}_1^2H + {}_1^3H \rightarrow {}_2^4He + n $$

Using the data :

$m({}_1^2H) = 2.014102$ u

$m({}_1^3H) = 3.016049$ u

$m({}_2^4He) = 4.002603$ u

$m_n = 1.008665$ u

$1\ u = 931.5\ MeV/c^2$

Ans. 17.589MeV

2016

Q1. A nucleus with mass number A = 240 and BE/A = 7.6 MeV breaks into two fragments each of A = 120 with BE/A = 8.5 MeV. Calculate the released energy. (2M)

Ans. 216 MeV

Q2. Calculate the energy in the fusion reaction : (2M)

$$ {}_1^2H + {}_1^2H \longrightarrow {}_2^3He + n, \text{ where BE of } {}_1^2H = 2.23 \text{ MeV and of } {}_2^3He = 7.73 \text{ MeV.} $$

Ans. 3.27 MeV

2017

Q1. Asha's mother read an article in the newspaper about a disaster that took place at Chernobyl. She could not understand much from the article and asked a few questions from Asha regarding the article. Asha tried to answer her mother's questions based on what she learnt in Class XII Physics.
(a) What was the installation at Chernobyl where the disaster took place? What, according to you, was the cause of this disaster? (b) Explain the process of release of energy in the installation at Chernobyl. (c) What, according to you, were the values displayed by Asha and her mother? (4M)
Ans. (a)Nuclear power plant
(b) Nuclear fission.
(c) Asha has scientific aptitude and her mother was curious.

2018

Q1. (a) Draw a plot showing the variation of the potential energy of a pair of nucleons as a function of their separation. Mark the regions where the nuclear force is (i) attractive and (ii) repulsive. (b) In the nuclear reaction

$$n + {}^{235}_{92}U \longrightarrow {}^{a}_{54}Xe + {}^{94}_{b}Sr + 2n$$

determine the values of a and b. (3M)

Ans. a=140, b=48

2019

Q1. Define the term 'decay constant' of a radioactive sample. The rate of disintegration of a given radioactive nucleus is 10000 disintegrations/s and 5,000 disintegrations/s after 20 hr. and 30 hr. respectively from start. Calculate the half-life and initial number of nuclei at t = 0. (3M)

Ans. 10hr, 2.08x10^9

2020

Q1. In β-decay, the parent and daughter nuclei have the same number of ____________. (1M)

Ans. Mass Number

Q2. **The nuclear radius of ${}^{27}_{13}Al$ is 3·6 fermi. Find the nuclear radius of ${}^{64}_{29}Cu$.**

Ans. 4.8 fermi

Q3. Define the term 'Half-life' of a radioactive substance. Two different radioactive substances have half-lives T1 and T2 and number of undecayed atoms at an instant, N1 and N2, respectively. Find the ratio of their activities at that instant. (2M)

Ans. $\frac{N_1 T_2}{N_2 T_1}$

Q4.

The nucleus $^{235}_{92}Y$, initially at rest, decays into $^{231}_{90}X$ by emitting an α-particle

$$^{235}_{92}Y \longrightarrow {}^{231}_{90}X + {}^{4}_{2}He + \text{energy.}$$

The binding energies per nucleon of the parent nucleus, the daughter nucleus and **α**-particle are 7·8 MeV, 7·835 MeV and 7·07 MeV, respectively. Assuming the daughter nucleus to be formed in the unexcited state and neglecting its share in the energy of the reaction, find the speed of the emitted **α**-particle. (Mass of **α**-particle = 6·68 x 10^–27 kg)

Ans. 1.57x10^7 ms^-1

SEMICONDUCTORS

2015

Q1. Distinguish between 'intrinsic' and 'extrinsic' semiconductors. (2M)

Q2. With what considerations in view, a photodiode is fabricated? State its working with the help of a suitable diagram. Even though the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is the reason? (3M)

Q3. Draw a circuit diagram of a transistor amplifier in CE configuration.

Define the terms: (i) Input resistance and (ii) Current amplification factor. How are these determined using typical input and output characteristics? (3M)

2016

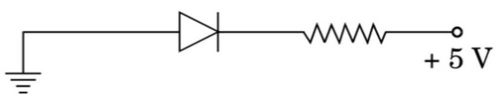
Q1. (i) Write the functions of three segments of a transistor. (ii) Draw the circuit diagram for studying the input and output characteristics of the n-p-n transistor in a common emitter configuration. Using the circuit, explain how input, and output characteristics are obtained. (3M)

Q2. Meeta's father was driving her to school. At the traffic signal, she noticed that each traffic light was made of many tiny lights instead of a single bulb. When Meeta asked this question to her father, he explained the reason for this.

Answer the following questions based on the above information : (i) What were the values displayed by Meeta and her father? (ii) What answer did Meeta's father give? (iii) What are the tiny lights in traffic signals called and how do these operate ? (5M)

2017

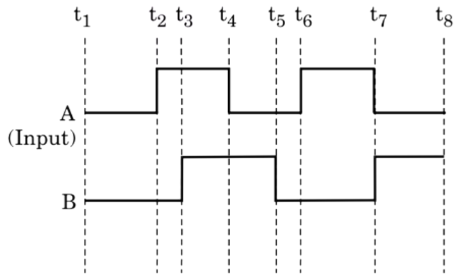
Q1. (a) In the following diagram, is the junction diode forward-biased or reverse-biased?



(b) Draw the circuit diagram of a full wave rectifier and state how it works. (3M)

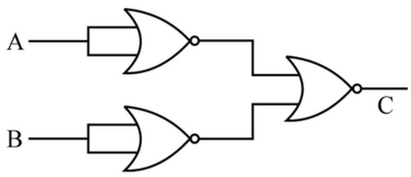
Ans. a)reverse biased

Q2. (a) Write the functions of the three segments of a transistor. (b) The figure shows the input waveforms A and B for the 'AND' gate. Draw the output waveform and write the truth table for this logic gate.



2018

Q1. (a) Write the truth table for the combination of the gates shown in the figure.



(b) Explain briefly how a photodiode operates. (3M)

Q2. Draw a labelled circuit diagram of an n-p-n germanium transistor in a common emitter configuration. Explain briefly, how this transistor is used as a voltage amplifier. (3M)

Q3. (a) Explain with the help of a suitable diagram, the two processes which occur during the formation of a p-n junction diode. Hence define the terms (i) depletion region and (ii) potential barrier. (b) Draw a circuit diagram of a p-n junction diode under forward bias and explain its working. (5M)

2019

Q1. (a) Three photo diodes D1, D2 and D3 are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which of them will not be able to detect light of wavelength 600 nm?

(b) Why photodiodes are required to operate in reverse bias? Explain. (3M)

Ans. a)D1 and D3

Q2. (a) Describe briefly the functions of the three segments of the n-p-n transistor. (b) Draw the circuit arrangement for studying the output characteristics of the n-p-n transistor in CE configuration. Explain how the output characteristics are obtained. (3M)

Q3. Draw the circuit diagram of a full wave rectifier and explain its working. Also, give the input and output waveforms. (3M)

2020

Q1. How does an increase in doping concentration affect the width of depletion layer of a p-n junction diode? (1M)

Q2. Why cannot we use Si and Ge in fabrication of visible LEDs? (1M)

Q3. Explain the terms ‘depletion layer’ and ‘potential barrier’ in a p-n junction diode. How are the (a) width of depletion layer, and (b) value of potential barrier affected when the p-n junction is forward biased? (2M)

Q3. (a) Draw circuit diagram and explain the working of a zener diode as a dc voltage regulator with the help of its I-V characteristic. (b) What is the purpose of heavy doping of p- and n-sides of a zener diode? (3M)

2022

Q1. By increasing the temperature, the specific resistance of a conductor and a semiconductor-

(A) increases for both.

(B) decreases for both.

(C) increases for a conductor and decreases for a semiconductor.

(D) decreases for a conductor and increases for a semiconductor.

Ans. (C)

Q2. We use alloys for making standard resistors because they have

(A) low temperature coefficient of resistivity and high specific resistance

(B) high temperature coefficient of resistivity and low specific resistance

(C) low temperature coefficient of resistivity and low specific resistance

(D) high temperature coefficient of resistivity and high specific resistance

Ans. (A)

COMMUNICATION SYSTEMS

2016

Q1. Explain the terms (i) Attenuation and (ii) Demodulation used in Communication Systems. (2M)

Q2. (a) Explain any two factors which justify the need of modulating a low-frequency signal. (b) Write two advantages of frequency modulation over amplitude modulation. (3M)

2017

Q1. (a) How is amplitude modulation achieved? (b) The frequencies of two side bands in an AM wave are 640 kHz and 660 kHz respectively. Find the frequencies of the carrier and modulating signal. What is the bandwidth required for amplitude modulation? (3M)

Ans. 650 kHz, 10 kHz, 20 kHz

Q2. Draw a block diagram of a generalised communication system. Write the functions of each of the following : (a) Transmitter (b) Channel (c) Receiver (3M)

2018

Q1. (a) Describe briefly three factors which justify the need for modulation of audio frequency signals over long distances in communication. (b) Draw the waveforms of (i) a carrier wave, (ii) a modulating signal and (iii) amplitude modulated wave. (5M)

2019

Q1. In the sky wave mode of propagation, why is the frequency range of transmitting signals restricted to less than 30 MHz? (1M)

Q2. Why a signal transmitted from a TV tower cannot be received beyond a certain distance? Write the expression for the optimum separation between the receiving and the transmitting antenna. (2M)

Q3. (a) If A and B represent the maximum and minimum amplitudes of an amplitude modulated wave, write the expression for the modulation index in terms of A & B.

(b) A message signal of frequency 20 kHz and peak voltage 10 V is used to modulate a carrier of frequency 2 MHz and peak voltage of 15 V. Calculate the modulation index. Why the modulation index is generally kept at less than one? (3M)

Ans. a) $\mu = \frac{A-B}{A+B}$ b) $\mu = \frac{2}{3}$