

(ENGLISH VERSION)

SECTION - II

GROUP - B

[Short Answer Type Questions - I]

Answer the following questions in short (Alternatives are to be noted) :

2 × 5 = 10

1. Why there is no work done in moving a charge from one point to another on an equipotential surface ? 2

OR

Draw the equipotential surfaces due to an isolated point charge ($-q$) and depict the electric field \vec{E} lines. 1 + 1

2. State Kirchhoff's rules of electric circuits. 2

OR

A battery of e.m.f. 1.5 V and internal resistance 0.2Ω is being charged with a current of 2A. What is the potential difference between the terminals of the battery ? 2

3. A series L-C-R circuit is connected to AC source. Using the phasor diagram, derive the expression for the impedance of the circuit. 2

OR

The instantaneous current and voltage of an AC circuit are given by $I = 10 \sin(314t)$ A and $V = 200 \sin(314t)$ V. What is the average power dissipation over a complete cycle in the circuit ? 2

4. How are electromagnetic waves produced ? How are the magnitudes of the electric and magnetic fields related to velocity of the electromagnetic wave ? 1 + 1

OR

Draw a diagram showing the propagation of an electromagnetic wave along the X-direction, indicating clearly the directions of the oscillating electric and magnetic fields associated with it. 1 + 1

5. Calculate the ratio of the accelerating potential required to accelerate a proton and an α -particle to have the same de Broglie wavelength associated with them. 2

OR

Derive an expression for the de Broglie wavelength associated with an electron accelerated through a potential V . 2

GROUP - C

[Short Answer Type Questions - II]

Answer the following questions in short (Alternatives are to be noted) :

3 × 9 = 27

6. State Gauss's theorem for electrostatics. Applying this theorem, find the expression for the electric field at any point due to a long thin wire of uniform linear charge density λ . 1 + 2

OR

An electric dipole of dipole moment \vec{p} is placed in a uniform electric field \vec{E} . Prove that the torque $\vec{\tau}$ acting on the dipole is given by $\vec{\tau} = \vec{p} \times \vec{E}$.

Show diagrammatically the orientation of the dipole in the field for which the torque is half of the maximum value. 2 + 1

7. Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points with positions r_1 and r_2 respectively in presence of external electric field \vec{E} . 3

OR

A parallel plate capacitor is charged to a potential difference V by a DC source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state the reason, how the following will change.

- (i) Capacitance, (ii) Electric field between the plates, (iii) Energy stored in the capacitor. 1 + 1 + 1

8. Define the term 'angle of dip'. The horizontal component of the earth's magnetic field at a place is B and angle of dip is 60° . What is the value of vertical component of the earth's magnetic field at that place? 1 + 2

OR

The electron in the hydrogen atom circles around the proton with a speed of 2.18×10^6 m/s in an orbit of radius 5.3×10^{-11} m. What is the equivalent dipole moment? 3

9. Derive an expression for the coefficient of self-inductance of a long air-cored solenoid of length l and number of turns N . 3

OR

A coil of number of turns N , area A is rotated at a constant angular speed ω in a magnetic field \vec{B} and connected to a resistor R . Deduce expression for (i) maximum *emf* induced in the coil, (ii) Power dissipation in the coil. 2 + 1

10. (a) Deduce the relation $\mu = \frac{\sin \frac{A + \delta_m}{2}}{\sin \left(\frac{A}{2} \right)}$, where the symbols have their usual meaning.

- (b) A thin prism of 6° angle gives a deviation of 3° . What is the refractive index of the material of the prism? 2 + 1

OR

A converging lens has a focal length of 24 cm when immersed in water. What is its nature and focal length, if refractive index from air to glass is 1.6 and from air to water is $\frac{4}{3}$? 3

11. (a) Draw a ray diagram to show, how an image is formed by a compound microscope.
(b) Write the expression for its magnifying power. 2 + 1

OR

- (a) Draw a ray diagram of a reflecting type telescope.
(b) State two advantages of this telescope over a refracting telescope. 2 + 1

12. Draw a graph between the frequency (ν) and the maximum kinetic energy of the electrons emitted from the surface of a photosensitive material. State clearly how this graph can be used to determine the (i) Planck's constant and (ii) Work function of the material. 1 + 1 + 1

OR

Draw a graph showing the variation of photoelectric current with collector plate potential for two different frequencies ν_1 and ν_2 , $\nu_2 > \nu_1$ of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer by using Einstein's photoelectric equation. 1 + 2

13. What is the distance of closest approach? An α -particle having kinetic energy of 5.5 MeV is projected towards the nucleus ($Z = 79$). Calculate the distance of closest approach. 1 + 2

OR

Draw a plot showing the variation of binding energy per nucleon with mass number A of the atoms. Explain with the help of this plot, the release in energy in the processes of nuclear fusion and fission. 1 + 1 + 1

- ✓14. Explain briefly with the help of a circuit diagram, charges and depletion layer, how V-I characteristics of a p - n junction diode are obtained in reverse bias. Draw the shape of the curves obtained.

Why is the current under reverse bias almost independent of the applied potential up to a critical voltage? 1 + 1 + 1

OR

Why should a photodiode be operated at a reverse bias? Draw the biasing circuit of an illuminated photodiode and characteristic curves.

1 + 1 + 1

GROUP - D

[Long Answer Type Questions]

Answer the following questions (Alternatives are to be noted): 5 × 3 = 15

15. (a) Define relaxation time of the free electron drifting in a conductor. 1
 (b) Derive an expression for the resistivity of a good conductor, in terms of the relaxation time of the free electrons. 2
 (c) Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area $2.5 \times 10^{-7} \text{ m}^2$ carrying a current of 1.8 A. Assume the density of conduction electrons to be $9 \times 10^{28} \text{ m}^{-3}$. <https://www.westbengalboard.com> 2

OR

- (a) State the principle of a potentiometer. 1
 (b) A potentiometer wire of length 1.0 m has a resistance of 15 Ω . It is connected to a 5 V battery in series with a resistance of 5 Ω . Determine the *emf* of the primary cell which gives a balance point at 0.6 m. 2

- (c) Describe briefly with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a cell. 2
16. (a) State Ampere's circuital law. 1
- (b) Use Ampere's circuital law to obtain the magnetic field inside a toroid. 2
- (c) A solenoid of length 1.0 m has a radius of 0.01 m and has a total of 1000 turns wound on it. It carries a current of 5 A. Calculate the magnitude of the axial magnetic field inside the solenoid. 2

OR

- (a) Derive an expression for the maximum force experienced by a straight conductor of length l carrying a current i and kept in a uniform magnetic field \vec{B} . 3
- (b) When a galvanometer having 25 division scale of 100Ω resistance is connected in series to a battery of emf 3 V through a resistance of 200Ω , it shows full scale deflection. Find the figure of merit of the galvanometer. 2
17. (a) In Young's double slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence, obtain the expression for the fringe width. 1 + 2
- (b) A beam of light consisting of two wavelengths 560 nm and 420 nm is used to obtain interference fringes in a Young's double slit experiment. Find the least distance from the central maxima, where the bright fringes, due to both the wavelengths coincide. The distance between the two slits is 4.0 mm and the screen is at a distance of 1 m from the slit. 2

OR

- (a) A single slit of width a is illuminated by monochromatic light of wavelength λ at normal incidence. Establish the condition of first minima $a \sin \theta = \lambda$. 3
- (b) Draw the intensity distribution curve observed on the screen due to diffraction. 2