

General Instructions:

1. All questions are compulsory.
2. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks. You have to attempt only one of the choices in such questions.
3. Question numbers **1** to **5** are very short answer type questions, carrying **one** mark each.
4. Question numbers **6** to **12** are short answer type questions, carrying **two** marks each.
5. Question numbers **13** to **24** are also short answer type questions, carrying **three** marks each.
6. Question numbers **25** to **27** are long answer type questions, carrying **five** marks each.
7. Use of calculators is not permitted. However, you may use log tables, if necessary.
8. You may Use the following values of physical constants wherever necessary:

PHYSICS 2005 (Outside Delhi)

Q1. An electrostatic field line cannot be discontinuous. Why?

Q2. Two wires of equal lengths are bent in the form of two loops. One of the loops is square shaped whereas the other loop is circular. These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Give reasons.

1

Q3. A bulb and a capacitor are connected in series to an a.c. source of variable frequency. How will the brightness of the bulb change on increasing the frequency of the a.c. source? Give reason.

1

Q4. Ultraviolet light is incident on two photosensitive materials having work functions W_1 and W_2 ($W_1 > W_2$), in which case will the kinetic energy of the emitted electrons be greater? Why?

1

Q5. What is the function of cladding' in a typical optical fiber?

1

Q6. Define electric field intensity. Write its S. I unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length $2a$ at the mid- point of the line joining the two charges. 2

Q7. A parallel capacitor is to be designed with a voltage rating 1 kV using a material of dielectric constant 3 and dielectric strength about 10^7 Vm^{-1} . For safety we would like the field never to exceed say, 10% of the dipole strength. What minimum area of the plates is required to have a capacitance of 50 PF? 2

Or A $4 \mu\text{F}$ capacitor is charged by a 200 V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged $2 \mu\text{F}$ capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

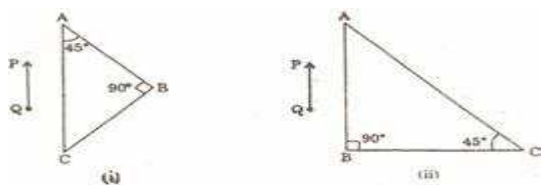
Q8. How does the resistivity of (i) a conductor and (ii) a semiconductor vary with temperature? Give reason for each case. 2

Q9. Write two characteristic properties to distinguish between diamagnetic and paramagnetic materials. 2

Q10. A circular coil of radius 8 cm and 20 turns rotates about its vertical diameter with an angular speed of 50 s^{-1} in a uniform horizontal magnetic field of magnitude $3 \times 10^{-2} \text{ T}$. Find the maximum and average value of the emf induced in the coil. 2

Q11. State the condition under which the phenomenon of resonance occurs in a series LCR circuit. Plot a graph showing variation of current with frequency of a.c. source in a series LCR circuit. 2

Q12. A right-angled crown glass prism with critical angle 41° is placed before an object PQ, in two positions as shown in the figures (i) and (ii). Trace the paths of the rays from P and Q the prisms in the two cases. 2



Q13. State Gauss' theorem. Apply this theorem to obtain the expression for the electric field intensity at a point due to an infinitely long, thin, uniformly charged straight wire. **3**

Q14. Two cells of emf 1.5 V and 2 V and internal resistance 1 ohm and 2 ohm respectively are connected in parallel to pass a current in the same direction through an external resistance of 5 ohm.

(i) Draw the circuit diagram.

(ii) Using Kirchhoff's laws, calculate the current through each branch of the circuit and potential difference across the 5 ohm resistor. **3**

Q15. What is Seebeck effect? Plot a graph showing the variation of thermo emf with temperature of the hot junction (keeping the cold junction at 0 °C) of a thermocouple. How will the (a) neutral temperature and (b) inversion temperature of the thermocouple change when the temperature of the cold junction is increased? **3**

Or State Faraday's laws of electrolysis. How does one infer from these laws that the charge per ion of any chemical element (species) is an integral multiple of e , where e is the charge on an electron?

Q16. Define self-inductance and give its S. I. unit. Derive an expression for self-inductance of a long, air-cored solenoid of length l , radius r , and having N number of turns. **3**

Q17. Name the constituent radiation of electromagnetic spectrum which

(a) Is used in satellite communication.

(b) Is used for studying crystal structure.

(c) Is similar to the radiations emitted during decay of radioactive nuclei?

(d) Has its wavelength range between 390 nm and 770 nm.

(e) Is absorbed from sunlight by ozone layer.

(f) Produces intense heating effect. **3**

Q18. (a) Draw a labelled ray diagram to show the formation of an image by a compound microscope. Write the expression for its magnifying power.

(b) How does the resolving power of a compound microscope change, when (i) refractive index of the medium between the object and the objective lens increases; and (ii) wavelength of the radiation used is increased? 3

Q19. Mention the significance of Davisson-Germer experiment. An α particle and a proton are accelerated from rest through the same potential difference V. Find the ratio of de-Broglie wavelengths associated with them. 3

Q20. (a) Draw the energy level diagram showing the emission of β -particles followed by γ -rays by a ${}^{60}_{27}\text{Co}$ nucleus.

(b) Plot the distribution of kinetic energy of J articles and state why the energy spectrum is continuous. 3

Q21. A radioactive sample contains 2.2 mg of pure ${}^{11}_6\text{C}$ which has half-life period of 1224 seconds. Calculate

(i) The number of atoms present initially.

(ii) The activity when 5% of the sample will be left. 3

Q22. On the basis of the energy band diagrams distinguish between metals, insulators and semiconductors. 3

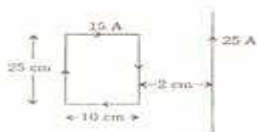
Q23. Distinguish between analog and digital communication. Write any two modulation techniques employed for the digital data. Describe briefly any one of the techniques used. 3

Q24. A ground receiver station is receiving a signal at (a) 5 MHz and (b) 100 MHz, transmitted from a ground transmitter at a height of 300 m located at a distance of 100 km. Identify whether it is coming via space wave or sky wave propagation or satellite transponder. (Given the value of radius of the earth is 6400 km and maximum electron density, $N_{\text{max}} = 10^{12} \text{ m}^{-3}$) 3

Q25. Explain the principle and working of a cyclotron with the help of a Labeled diagram. A cyclotron's oscillator frequency is 10 MHz. What should be the operating magnetic field for accelerating protons? If the radius of its 'dees' is 60 cm, what is the kinetic energy of the proton beam produced by the accelerator? Express your answer in units of MeV. ($e = 1.6 \times 10^{-19} \text{ C}$, $m_p = 1.67 \times 10^{-27} \text{ Kg}$, $1 \text{ MeV} = 1.602 \times 10^{-13} \text{ J}$) 5

Or Depict the magnetic field lines due to two straight, long, parallel conductors carrying currents I_1 and I_2 in the same direction. Hence deduce an expression for the force acting per unit length on one conductor due to the other is this force attractive or repulsive?

Figure shows a rectangular current-carrying loop placed 2 cm away from a long, straight, current-carrying conductor. What is the direction and magnitude of the net force acting on the loop?



Q26. Using Huygen's principle, draw a diagram to show propagation of a wave-front originating from a monochromatic point source.

Describe diffraction of light due to a single slit. Explain formation of a pattern of fringes obtained on the screen and plot showing variation of intensity with angle θ in single slit diffraction.

Or What is meant by a linearly polarized light? Which type of waves can be polarised? Briefly explain a method for producing polarised light.

Two Polaroids are placed at 90° to each other and the intensity of transmitted light is zero. What will be the intensity of transmitted light when one more Polaroid is placed between these two bisecting the angle between them? Take intensity of unpolarised light as I .

Q27. (a) With the help of a circuit diagram explain the working of transistor as oscillator.

(b) Draw a circuit diagram for a two input OR gate and explain its working with the help of input, output waveforms.

Or (a) Explain briefly with the help of a circuit diagram how $V - I$ characteristics of a p-n junction diode are obtained in (i) forward bias, and (ii) reverse bias.

(b) A photodiode is fabricated from a semiconductor with a band gap of 2.8 eV. Can it detect wave length of 6000 nm? Justify.