

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **26 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D, E.
- (iii) Section A - Questions 1 to 5 carry 1 mark each.
- (iv) Section B - Questions 6 to 10 carry 2 marks each.
- (v) Section C - Questions 11 to 22 carry 3 marks each.
- (vi) Section D - Question 23 carries 4 marks.
- (vii) Section E - Questions 24 to 26 carry 5 marks each.
- (viii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.

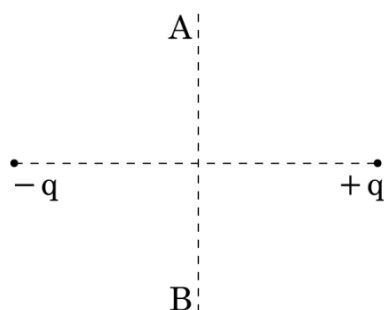
You may use the following values of physical constants wherever necessary:

$$\begin{aligned}c &= 3 \times 10^8 \text{ m/s} \\h &= 6.63 \times 10^{-34} \text{ Js} \\e &= 1.6 \times 10^{-19} \text{ C} \\\mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\\epsilon_0 &= 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\\frac{1}{4\pi\epsilon_0} &= 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}\end{aligned}$$

$$\begin{aligned}\text{Mass of electron } (m_e) &= 9.1 \times 10^{-31} \text{ kg} \\\text{Mass of neutron} &= 1.675 \times 10^{-27} \text{ kg} \\\text{Mass of proton} &= 1.673 \times 10^{-27} \text{ kg} \\\text{Avogadro's number} &= 6.023 \times 10^{23} \text{ per gm mole} \\\text{Boltzmann constant} &= 1.38 \times 10^{-23} \text{ JK}^{-1}\end{aligned}$$

Section A

1. A charge q is moved from a point A above a dipole of dipole moment p to a point B below the dipole in equatorial plane without acceleration. Find the work done in the process.

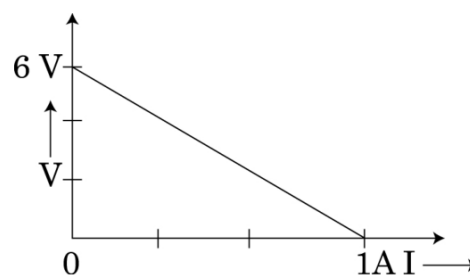


2. In what way is the behaviour of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?

3. Name the essential components of a communication system.

4. Why does sun appear red at sunrise and sunset?

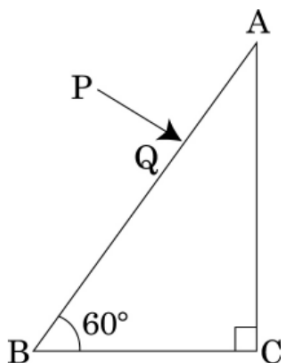
5. The plot of the variation of potential difference across a combination of three identical cells in series, versus current is shown below. What is the emf and internal resistance of each cell?



Section B

6. Define modulation index. Why is it kept low? What is the role of a bandpass filter?

7. A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. Complete the path of ray through the prism. From which face will the ray emerge? Justify your answer.



8. Calculate the de-Broglie wavelength of the electron orbiting in the $n = 2$ state of hydrogen atom.

9. Define ionization energy.

How would the ionization energy change when electron in hydrogen atom is replaced by a particle of mass 200 times that of the electron but having the same charge?

OR

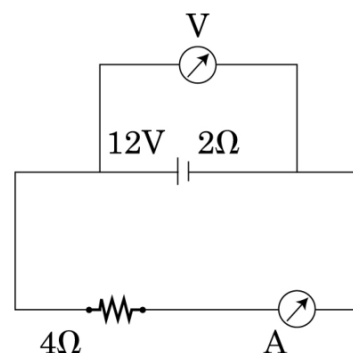
9. Calculate the shortest wavelength of the spectral lines emitted in Balmer series.

[Given Rydberg constant, $R = 10^7 \text{ m}^{-1}$]

10. A battery of emf 12 V and internal resistance 2Ω is connected to a 4Ω resistor as shown in the figure.

(a) Show that a voltmeter when placed across the cell and across the resistor, in turn, gives the same reading.

(b) To record the voltage and the current in the circuit, why is voltmeter placed in parallel and ammeter in series in the circuit?



Section C

11. Define an equipotential surface. Draw equipotential surfaces:

- (i) in the case of a single point charge and
- (ii) in a constant electric field in Z -direction.

Why the equipotential surfaces about a single charge are not equidistant?

(iii) Can electric field exist tangential to an equipotential surface? Give reason.

12. (i) State law of Malus.

(ii) Draw a graph showing the variation of intensity (I) of polarised light transmitted by an analyser with angle (θ) between polariser and analyser.

(iii) What is the value of refractive index of a medium of polarising angle 60° ?

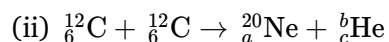
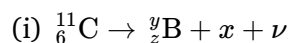
13. Sketch the graphs showing variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $\nu_A > \nu_B$.

(i) In which case is the stopping potential more and why?

(ii) Does the slope of the graph depend on the nature of the material used? Explain.

14. (a) Write the basic nuclear process involved in the emission of β^+ in a symbolic form, by a radioactive nucleus.

(b) In the reactions given below:



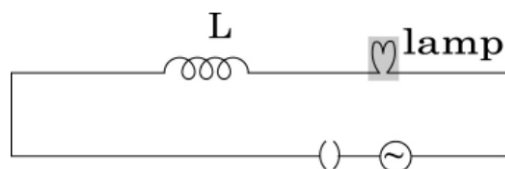
Find the values of x , y , and z and a , b and c .

15. (i) Derive an expression for drift velocity of free electrons.

(ii) How does drift velocity of electrons in a metallic conductor vary with increase in temperature? Explain.

16. (i) When an AC source is connected to an ideal inductor show that the average power supplied by the source over a complete cycle is zero.

(ii) A lamp is connected in series with an inductor and an AC source. What happens to the brightness of the lamp when the key is plugged in and an iron rod is inserted inside the inductor? Explain.



17. (i) Explain with the help of a diagram the formation of depletion region and barrier potential in a pn junction.

(ii) Draw the circuit diagram of a half wave rectifier and explain its working.

18. (i) Which mode of propagation is used by shortwave broadcast services having frequency range from a few MHz upto 30 MHz? Explain diagrammatically how long distance communication can be achieved by this mode.

(ii) Why is there an upper limit to frequency of waves used in this mode?

19. (i) Identify the part of the electromagnetic spectrum which is:

(a) suitable for radar system used in aircraft navigation,

(b) produced by bombarding a metal target by high speed electrons.

(ii) Why does a galvanometer show a momentary deflection at the time of charging or discharging a capacitor? Write the necessary expression to explain this observation.

20. For a CE-transistor amplifier, the audio signal voltage across the collector resistance of $2\text{ k}\Omega$ is 2 V . Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is $1\text{ k}\Omega$.

21. Define the term wave front. State Huygen's principle.

Consider a plane wave front incident on a thin convex lens. Draw a proper diagram to show how the incident wave front traverses through the lens and after refraction focusses on the focal point of the lens, giving the shape of the emergent wave front.

OR

21. Explain the following, giving reasons:

(i) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency as the incident frequency.

(ii) When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave?

(iii) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determines the intensity in the photon picture of light?

22. Use Biot-Savart law to derive the expression for the magnetic field on the axis of a current carrying circular loop of radius R .

Draw the magnetic field lines due to a circular wire carrying current I .

23. Ram is a student of class X in a village school. His uncle gifted him a bicycle with a dynamo fitted in it. He was very excited to get it. While cycling during night, he could light the bulb and see the objects on the road. He, however, did not know how this device works. He asked this question to his teacher. The teacher considered it an opportunity to explain the working to the whole class.

Answer the following questions:

- (a) State the principle and working of a dynamo.
 - (b) Write two values each displayed by Ram and his school teacher.
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Section E

24. (i) Draw a labelled diagram of a step-down transformer. State the principle of its working.
(ii) Express the turn ratio in terms of voltages.
(iii) Find the ratio of primary and secondary currents in terms of turn ratio in an ideal transformer.
(iv) How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V – 550 W refrigerator?

OR

24. (a) Explain the meaning of the term mutual inductance. Consider two concentric circular coils, one of radius r_1 and the other of radius r_2 ($r_1 < r_2$) placed coaxially with centres coinciding with each other. Obtain the expression for the mutual inductance of the arrangement.
(b) A rectangular coil of area A , having number of turns N is rotated at f revolutions per second in a uniform magnetic field B , the field being perpendicular to the coil. Prove that the maximum emf induced in the coil is $2\pi f N B A$.

25. (i) Derive the mathematical relation between refractive indices n_1 and n_2 of two media and radius of curvature R for refraction at a convex spherical surface. Consider the object to be a point since lying on the principal axis in rarer medium of refractive index n_1 and a real image formed in the denser medium of refractive index n_2 . Hence, derive lens maker's formula.
(ii) Light from a point source in air falls on a convex spherical glass surface of refractive index 1.5 and radius of curvature 20 cm. The distance of light source from the glass surface is 100 cm. At what position is the image formed?

OR

25. (a) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power.
(b) You are given three lenses of power 0.5 D, 4 D and 10 D to design a telescope.
(i) Which lenses should be used as objective and eyepiece? Justify your answer.
(ii) Why is the aperture of the objective preferred to be large?

26. (i) Use Gauss's law to find the electric field due to a uniformly charged infinite plane sheet. What is the direction of field for positive and negative charge densities?
(ii) Find the ratio of the potential differences that must be applied across the parallel and series combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in the two cases becomes the same.

OR

26. (i) If two similar large plates, each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, find the expressions for
(a) field at points between the two plates and on outer side of the plates. Specify the direction of the field in each case.
(b) the potential difference between the plates.
(c) the capacitance of the capacitor so formed.
(ii) Two metallic spheres of radii R and $2R$ are charged so that both of these have same surface charge density σ . If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

- End of Question Paper -