CBSE Class 12 Physics 2014 - Set 55/3

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 **30 questions**. All questions are compulsory.

(ii) Questions 1 to 8 carry 1 mark each; Questions 9 to 18 carry 2 marks each; Questions 19 to 27 carry 3 marks each; Questions 28 to 30 carry 5 marks each.

(iii) One of the questions carrying 3 marks is value based.

(iv) There is no overall choice. An internal choice is provided in one question of 2 marks, one question of 3 marks and all three questions of 5 marks. Attempt only one alternative in each such question.

(v) Use of calculators is not permitted. Log tables may be used, if necessary.

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

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) $= 9.1 \times 10^{-31}$ kg

Mass of neutron $= 1.675 \times 10^{-27}$ kg

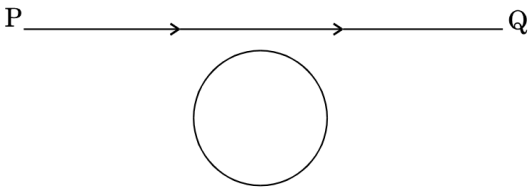
Mass of proton $= 1.673 \times 10^{-27}$ kg

Avogadro's number $= 6.023 \times 10^{23}$ per gm mole

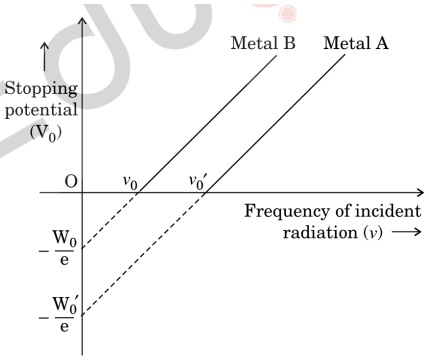
Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1}

Section 1-Mark Questions

1. A conducting loop is held below a current carrying wire PQ as shown. Predict the direction of the induced current in the loop when the current in the wire is constantly increasing.



2. The graph shows variation of stopping potential V_0 versus frequency of incident radiation ν for two photosensitive metals A and B. Which of the two metals has higher threshold frequency and why ?



3. Using the concept of force between two infinitely long parallel current carrying conductors, define one ampere of current.

4. A biconcave lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens ? Give reason.

5. Why do the electric field lines never cross each other ?

6. To which part of the electromagnetic spectrum does a wave of frequency 5×10^{19} Hz belong ?

7. Why is it found experimentally difficult to detect neutrinos in nuclear β-decay ?

8. Why is the use of a.c. voltage preferred over d.c. voltage ? Give two reasons.

Section 2-Mark Questions

9. Considering the case of a parallel plate capacitor being charged, show how one is required to generalize Ampere's circuital law to include the term due to displacement current.

10. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 2.5×10^{-7} m^2 carrying a current of 2.7 A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}.

11. A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing variation of terminal voltage 'V' of the cell versus the current 'I'. Using the plot, show how the emf of the cell and its internal resistance can be determined.

12. A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

13. Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron ?

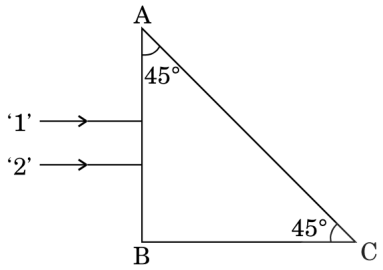
OR

13. Using Bohr's postulates of the atomic model, derive the expression for radius of n^{th} electron orbit. Hence obtain the expression for Bohr's radius.

14. Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature ?

15. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier.

16. Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the two rays '1' and '2' are respectively 1.38 and 1.52. Trace the path of these rays after entering through the prism.



17. Draw a circuit diagram of n-p-n transistor amplifier in CE configuration. Under what condition does the transistor act as an amplifier ?

18. Write the functions of the following in communication systems :

(i) Receiver

(ii) Demodulator

Section 3-Mark Questions

19. A convex lens of focal length 20 cm is placed coaxially with a convex mirror of radius of curvature 20 cm. The two are kept 15 cm apart. A point object is placed 40 cm in front of the convex lens. Find the position of the image formed by this combination. Draw the ray diagram showing the image formation.

20. An electron microscope uses electrons accelerated by a voltage of 50 kV. Determine the de-Broglie wavelength associated with the electrons. Taking other factors, such as numerical aperture etc. to be same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light ?

21. Write any two distinguishing features between conductors, semiconductors and insulators on the basis of energy band diagrams.

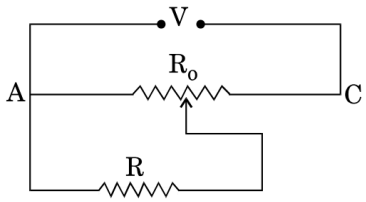
22. Write two basic modes of communication. Explain the process of amplitude modulation. Draw a schematic sketch showing how amplitude modulated signal is obtained by superposing a modulating signal over a sinusoidal carrier wave.

23. Answer the following :

(a) Why are the connections between the resistors in a meter bridge made of thick copper strips ?

(b) Why is it generally preferred to obtain the balance point in the middle of the meter bridge wire ?

(c) Which material is used for the meter bridge wire and why ?



OR

23. A resistance of $R\,\Omega$ draws current from a potentiometer as shown in the figure. The potentiometer has a total resistance $R_0\,\Omega$. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer.

24. For the past some time, Aarti had been observing some erratic body movement, unsteadiness and lack of coordination in the activities of her sister Radha, who also used to complain of severe headache occasionally. Aarti suggested to her parents to get a medical check-up of Radha. The doctor thoroughly examined Radha and diagnosed that she has a brain tumour.

(a) What, according to you, are the values displayed by Aarti ?

(b) How can radioisotopes help a doctor to diagnose brain tumour ?

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25. (a) A rod of length l is moved horizontally with a uniform velocity 'v' in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive the expression for the emf induced across the ends of the rod.

(b) How does one understand this motional emf by invoking the Lorentz force acting on the free charge carriers of the conductor ? Explain.

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26. (a) Show, giving a suitable diagram, how unpolarized light can be polarised by reflection.

(b) Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I_0 is incident on P_1. A third polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of 60° with that of P_1. Determine the intensity of light transmitted through P_1, P_3 and P_2.

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27. A voltage $V = V_0 \sin \omega t$ is applied to a series LCR circuit. Derive the expression for the average power dissipated over a cycle.

Under what condition is (i) no power dissipated even though the current flows through the circuit, (ii) maximum power dissipated in the circuit ?

Section 5-Mark Questions

28. (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.

(b) The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9 : 25. Find the ratio of the widths of the two slits.

OR

28. (a) Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light. Hence obtain the conditions for the angular width of secondary maxima and secondary minima.

(b) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture 2×10^{-6} m. The distance between the slit and the screen is 1.5 m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

29. (a) Deduce an expression for the frequency of revolution of a charged particle in a magnetic field and show that it is independent of velocity or energy of the particle.

(b) Draw a schematic sketch of a cyclotron. Explain, giving the essential details of its construction, how it is used to accelerate the charged particles.

OR

29. (a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following :

(i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer ?

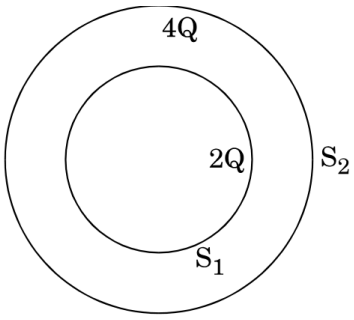
(ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

30. Draw a labelled diagram of Van de Graaff generator. State its working principle to show how by introducing a small charged sphere into a larger sphere, a large amount of charge can be transferred to the outer sphere. State the use of this machine and also point out its limitations.

OR

30. (a) Deduce the expression for the torque acting on a dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$.

(b) Consider two hollow concentric spheres, S_1 and S_2, enclosing charges $2Q$ and $4Q$ respectively as shown in the figure. (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'ε_r' is introduced in the space inside S_1 in place of air ? Deduce the necessary expression.



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