CBSE Class 12 Physics 2018 - 55/3 - Compartment

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:

$c = 3 \times 10^8$ 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 A

1. Define the power of a lens. Write its S.I. unit.

2. Draw a graph showing the intensity distribution of fringes due to diffraction at a single slit.

3. Two protons of equal kinetic energies enter a region of 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.

4. An electron is accelerated through a potential difference V. Write the expression for its final speed, if it was initially at rest.

5. Write the range of frequencies of electromagnetic waves which propagate through the sky wave mode.

Section B

6. (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.

7. Calculate the ratio of the frequencies of the radiation emitted due to 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.

8. 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.

OR

8. 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) number of photons emitted on an average by the source.

9. (a) Define the term magnetic susceptibility and write its relation in terms of relative magnetic permeability.

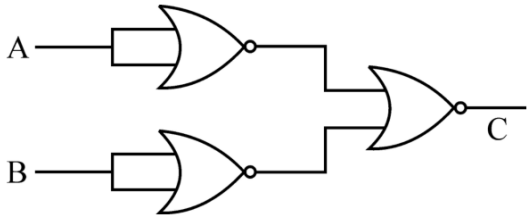
(b) Two magnetic materials A and B have relative magnetic permeabilities of 0.96 and 500. Identify the magnetic materials A and B.

10. 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 AB 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 the spring.)

Section C

11. Draw a labelled circuit diagram of an n-p-n germanium transistor in common emitter configuration. Explain briefly how this transistor is used as a voltage amplifier.

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



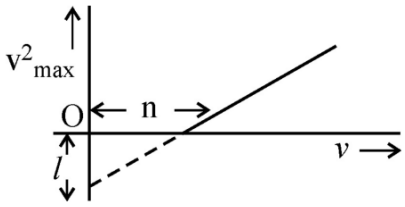
(b) Explain briefly how a photodiode operates.

13. (a) Draw a plot showing the variation of 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 $n + {}^{235}_{92}U \rightarrow {}^{a}_{54}Xe + {}^{94}_{b}Sr + 2n$, determine the values of a and b.

14. State Einstein's photoelectric equation, explaining the symbols used.

Light of frequency ν is incident on a photosensitive surface. A graph of the square of the maximum speed of the electrons (v^2_{max}) vs. ν is obtained as shown in the figure.

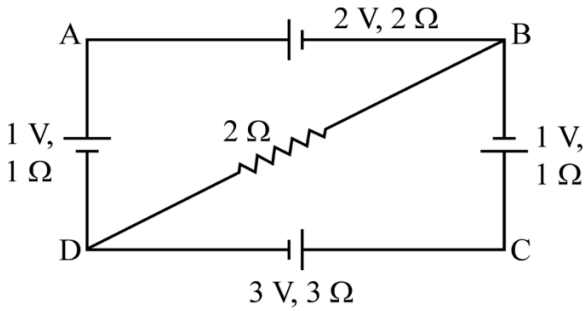


Using Einstein's photoelectric equation, obtain expressions for (i) Planck's constant and (ii) work function of the given photosensitive material in terms of the parameters l, n and mass of the electron m.

15. (i) Write two points to distinguish between interference and diffraction fringes.

(ii) In a 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.

16. Using Kirchhoff's rules, calculate the potential difference between B and D in the circuit diagram as shown in the figure.



17. (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 at a distance x from the centre of the coil.

18. (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.

19. (a) When an unpolarized light of intensity I_0 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.

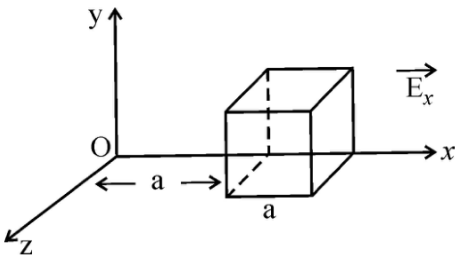
(b) A plane polarized beam of light is passed through a polaroid. Show graphically the variation of the intensity of the transmitted light with angle of rotation of the polaroid in one complete rotation.

20. (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 I_a and I_b 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 I_c in the opposite direction is placed just in the middle of these conductors, find the resultant force acting on the third conductor.

21. Two cells of emfs ε_1 and ε_2 and internal resistances r_1 and r_2 respectively are connected in parallel. Obtain expressions for the equivalent (i) resistance, and (ii) emf of the combination.

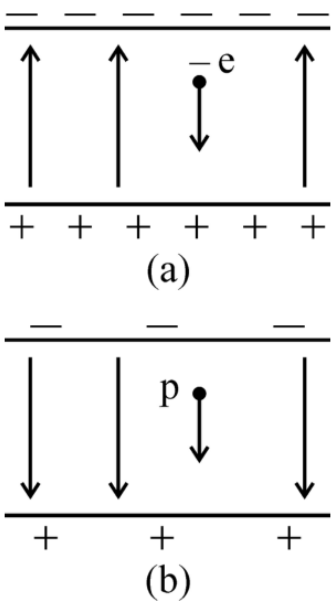
22. Define electric flux and write its SI unit. The electric field components in the figure shown are $E_x = \alpha x$, $E_y = 0$, $E_z = 0$, where $\alpha = \frac{100\ \text{N}}{\text{C m}}$. Calculate the charge within the cube, assuming $a = 0.1$ m.



OR

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



Section D

23. 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 the photograph 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.

Section E

24. (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 a device X, a current of 0.25 A flows, which lags behind the applied voltage in phase by $\frac{\pi}{2}$ 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.

OR

24. (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.

25. (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.

OR

25. (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) carrier wave, (ii) a modulating signal, and (iii) amplitude modulated wave.

26. 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 $\vec{E}$, what would be the potential energy of the charge system in its orientation of unstable equilibrium? Justify your answer in each case.

OR

26. A capacitor of capacitance C_1 is charged to a potential V_1 while another capacitor of capacitance C_2 is charged to a potential difference V_2. 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 the parallel combination in comparison to the total energy before they are connected.

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