CBSE Class 12 Physics 2014 - Set 55/1/3 - 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 **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. How does the random motion of free electrons in a conductor get affected when a potential difference is applied across its ends?

2. Define the term 'coherent sources' which are required to produce an interference pattern in Young's double slit experiment.

3. Draw a block diagram of a detector (demodulator) for amplitude modulated signal.

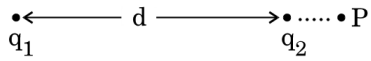
4. Relative permeability (μ_r) of a material has a value lying $1 < \mu_r < 1 + \varepsilon$ (where ε is a small quantity). Identify the nature of the magnetic material.

5. How does the effective power radiated from a linear antenna, transmitting the signals, depend on the wavelength of the signal to be transmitted?

6. A metallic piece gets hot when surrounded by a coil carrying high frequency alternating current. Why?

7. State the underlying principle of a potentiometer.

8. Two point charges 'q_1' and 'q_2' are placed at a distance 'd' apart as shown in the figure. The electric field intensity is zero at a point 'P' on the line joining them as shown. Write two conclusions that you can draw from this.



Section 2-Mark Questions

9. Draw the magnetic field lines due to a current passing through a long solenoid. Use Ampere's circuital law to obtain an expression for the magnetic field due to the current I in a long solenoid having n number of turns per unit length.

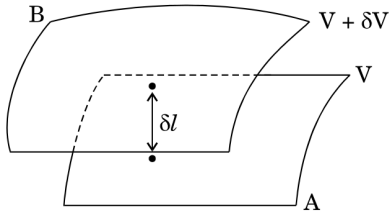
10. Two monochromatic radiations of frequencies ν_1 and ν_2 ($\nu_1 > \nu_2$) and having the same intensity are, in turn, incident on a photosensitive surface to cause photoelectric emission. Explain, giving reason, in which case (i) more number of electrons will be emitted and (ii) maximum kinetic energy of the emitted photoelectrons will be more.

11. Draw a ray diagram for the formation of image by a compound microscope. Write the expression for total magnification when the image is formed at infinity.

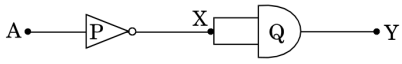
12. Two point charges q_1 and q_2 are located at $\vec{r}_1$ and $\vec{r}_2$ respectively in an external electric field $\vec{E}$. Obtain the expression for the total work done in assembling this configuration.

OR

12. Two closely spaced equipotential surfaces A and B with potentials V and V + δV, (where δV is the change in V), are kept δl distance apart as shown in the figure. Deduce the relation between the electric field and the potential gradient between them. Write the two important conclusions concerning the relation between the electric field and electric potentials.



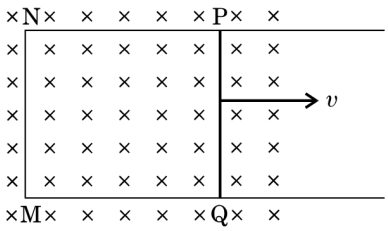
13. Name the gates 'P' and 'Q' shown in the figure of logic circuit given below. Write the truth table for the combination of the gates and identify the equivalent gate.



14. A rectangular coil of sides 'l' and 'b' carrying a current I is subjected to a uniform magnetic field $\vec{B}$ acting perpendicular to its plane. Obtain the expression for the torque acting on it.

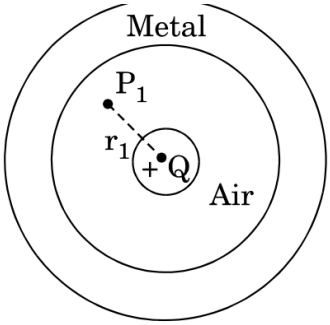
15. X-rays fall on a photosensitive surface to cause photoelectric emission. Assuming that the work function of the surface can be neglected, find the relation between the de-Broglie wavelength (λ) of the electrons emitted to the energy (E_v) of the incident photons. Draw the nature of the graph for λ as a function of E_v.

16. A rectangular loop PQMN with movable arm PQ of length 15 cm and resistance 4 Ω is placed in a uniform magnetic field of 0.25 T acting perpendicular to the plane of the loop, with arms MN, NP and MQ having negligible resistance, as shown in the figure. Calculate the (i) emf induced in the arm PQ and (ii) current induced in the loop when arm PQ is moved with velocity 25 m/s.



17. Draw a plot showing the variation of resistivity of a (i) conductor and (ii) semiconductor, with the increase in temperature. How does one explain this behaviour in terms of number density of charge carriers and the relaxation time?

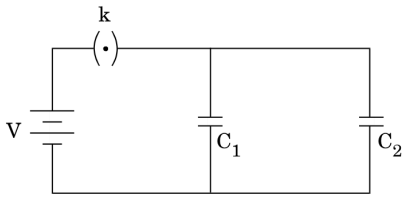
18. A small metal sphere carrying charge +Q is located at the centre of a spherical cavity in a large uncharged metallic spherical shell. Write the charges on the inner and outer surfaces of the shell. Write the expression for the electric field at the point P_1.



Section 3-Mark Questions

19. A parallel beam of monochromatic light falls normally on a narrow slit of width 'a' to produce a diffraction pattern on the screen placed parallel to the plane of the slit. Use Huygens' principle to explain that (i) the central bright maxima is twice as wide as the other maxima, and (ii) the intensity falls as we move to successive maxima away from the centre on either side.

20. Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 3C_2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key (k) is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates. Find the ratio of (i) the net capacitance and (ii) the energies stored in the combination, before and after the introduction of the dielectric slab.



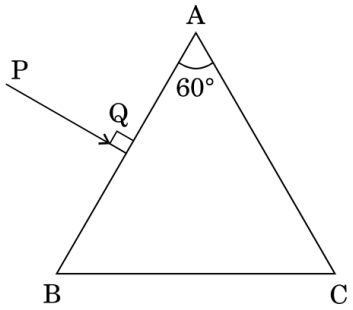
21. Answer the following questions: (i) Show, by giving a simple example, how em waves carry energy and momentum. (ii) How are microwaves produced? Why is it necessary in microwave ovens to select the frequency of microwaves to match the resonant frequency of water molecules? (iii) Write two important uses of infra-red waves.

22. A charged particle of mass 'm' and charge 'q' is moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. (a) If $\vec{v}$ is perpendicular to $\vec{B}$, show that it describes a circular path having angular frequency $\omega = qB/m$. (b) If the velocity $\vec{v}$ has a component parallel to the magnetic field $\vec{B}$, trace the path described by the particle. Justify your answer.

OR

22. Draw a schematic sketch of a moving coil galvanometer and describe briefly its working. 'Increasing the current sensitivity of a galvanometer does not necessarily increase its voltage sensitivity.' Justify this statement giving reason.

23. A ray PQ is incident normally on the face AB of a triangular prism of refracting angle 60°, made of a transparent material of refractive index $2/\sqrt{3}$, as shown in the figure. Trace the path of the ray as it passes through the prism. Also calculate the angle of emergence and angle of deviation.



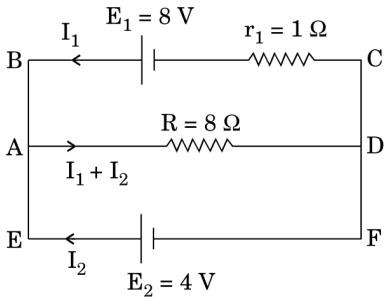
24. (a) Write the relation for binding energy (BE) (in MeV) of a nucleus of mass ${}^{A}_{Z}M$, atomic number (Z) and mass number (A) in terms of the masses of its constituents — neutrons and protons. (b) Draw a plot of BE/A versus mass number A for $2 \leq A \leq 170$. Use this graph to explain the release of energy in the process of nuclear fusion of two light nuclei.

25. (a) The orbital radius of the electron in the first excited state of hydrogen atom is 21.2×10^{-11} m. Find out its radius in the second excited state. (b) The total energy of the electron in the ground state (lowest state) is -13.6 eV. Find out (i) its kinetic energy and (ii) potential energy in the first excited state.

26. Anuj's mother was having constant headaches. After a medical check-up, she was diagnosed with a tumour. Anuj realised there was a telecommunication tower very close to their house. He enquired from the doctor if the radiation from the tower could have caused the tumour. As the doctor supported his anxiety, he lodged a complaint with the police and ultimately succeeded in getting the tower removed to a distant place away from the residential colony.

Answer the following: (i) What values were displayed by Anuj? (ii) Anuj made a rough estimate about the height of the antenna to be about 20 m from the ground. Calculate the maximum distance upto which radiations from this tower are likely to reach. Use the value of radius of the Earth $= 6400 \times 10^3$ m.

27. In the electric network shown in the figure, use Kirchhoff's rules to calculate the power consumed by the resistance R $= 8\ \Omega$.



Section 5-Mark Questions

28. A spherical convex surface has, on one side, a medium of refractive index n_1 and on the other side a medium of refractive index n_2. A point object is situated on the principal axis of the convex surface, in the medium having refractive index n_1, more rarer than the other. Draw a ray diagram to show the formation of the image. Hence derive the relation between the object distance and the image distance in terms of refractive index of the medium and the radius of curvature of the surface. Hence obtain the lens-maker formula for a thin convex lens.

OR

28. (a) Write the difference between linearly polarised light and unpolarised light. (b) Show that the light waves are transverse in nature. (c) Why does light from a clear blue portion of the sky show a rise and fall of intensity when viewed through a polaroid which is rotated? Explain by drawing the necessary diagram.

29. (a) With the help of a diagram, show how a depletion layer and barrier potential are formed in a junction diode. (b) Draw a circuit diagram of a full wave rectifier. Explain its working and draw input and output waveforms.

OR

29. (a) Explain briefly, with the help of a circuit diagram, how an n-p-n transistor in C.E. configuration is used to study input and output characteristics. (b) Describe briefly the underlying principle of a transistor amplifier working as an oscillator. Hence, use the necessary circuit diagram to explain how self sustained oscillations are achieved in the oscillator.

30. (a) A series LCR circuit is connected to an ac source of variable frequency. Draw a suitable phasor diagram to deduce the expressions for the amplitude of the current and phase angle. (b) Obtain the condition at resonance. Draw a plot showing the variation of current with the frequency of ac source for two resistances R_1 and R_2 ($R_1 > R_2$). Hence define the quality factor, Q and write its role in the tuning of the circuit.

OR

30. (a) Draw a labelled diagram of ac generator and state its working principle. (b) How is magnetic flux linked with the armature coil changed in a generator? (c) Derive the expression for maximum value of the induced emf and state the rule that gives the direction of the induced emf. (d) Show the variation of the emf generated versus time as the armature is rotated with respect to the direction of the magnetic field.

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