CBSE Class 12 Physics 2017 - 55/1 - 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

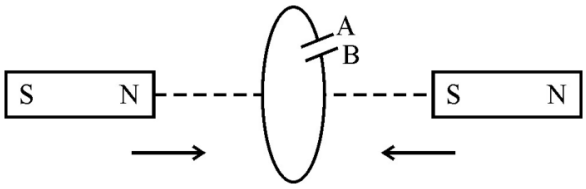
Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1}

Section A

1. A point charge +Q is placed in the vicinity of a conducting surface. Draw the electric field lines between the surface and the charge.

2. Define modulation index. Why is it generally kept less than one?

3. In the figure given, mark the polarity of plates A and B of a capacitor when the magnets are quickly moved towards the coil.



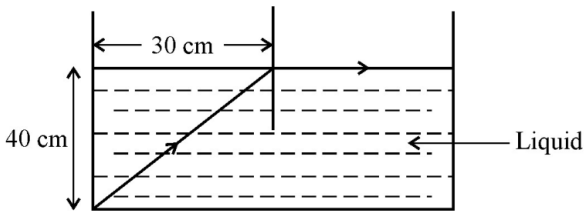
4. The objective lenses of two telescopes have the same apertures but their focal lengths are in the ratio 1 : 2. Compare the resolving powers of the two telescopes.

5. Define the conductivity of a conductor and write its SI unit.

Section B

6. (i) Define refractive index of a medium.

(ii) In the following ray diagram, calculate the speed of light in the liquid of unknown refractive index.



7. Electrons are emitted from the cathode of a photocell of negligible work function, when photons of wavelength λ are incident on it. Derive the expression for the de Broglie wavelength of the electrons emitted in terms of the wavelength of the incident light.

OR

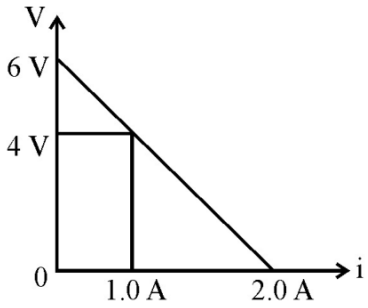
7. Using de Broglie's hypothesis, derive the Bohr's quantisation condition for angular momentum of an electron orbiting in a hydrogen atom.

8. (a) Write two characteristic features of nuclear force.

(b) Draw a plot of potential energy of a pair of nucleons as a function of their separation.

9. State the two points to distinguish between sky wave and space wave modes of propagation.

10. The figure shows a plot of terminal voltage 'V' versus the current 'i' of a given cell. Calculate from the graph (a) emf of the cell, and (b) internal resistance of the cell.



Section C

11. A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Without disconnecting the battery, the distance between the plates is tripled and a dielectric medium of $k = 10$ is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected:

(i) capacitance of the capacitor,

(ii) charge on the capacitor, and

(iii) energy density of the capacitor.

12. (a) Draw a graph showing the variation of binding energy per nucleon (BE/A) vs mass number A for the nuclei in $20 \leq A \leq 170$.

(b) A nucleus of mass number 240 and having binding energy/nucleon 7.6 MeV splits into two fragments Y, Z of mass numbers 110 and 130 respectively. If the binding energy/nucleon of Y, Z is equal to 8.5 MeV each, calculate the energy released in the nuclear reaction.

13. (a) In Young's double slit experiment, the two slits are illuminated by two different lamps having same wavelength of light. Explain with reason, whether interference pattern will be observed on the screen or not.

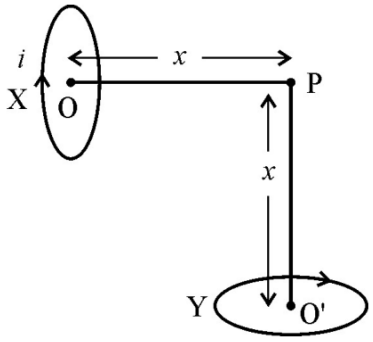
(b) Light waves from two coherent sources arrive at two points on a screen with path differences of 0 and $\lambda/2$. Find the ratio of intensities at the points.

14. Using Bohr's postulates, derive the expression for the total energy of the electron revolving in n^{th} orbit of hydrogen atom. Find the wavelength of H_α line, given the value of Rydberg constant, $R = 1.1 \times 10^7\ \text{m}^{-1}$.

15. Name the e.m. waves in the wavelength range 10 nm to 10^{-3} nm. How are these waves generated? Write their two uses.

16. (a) Draw the pattern of magnetic field lines for a circular coil carrying current.

(b) Two identical circular loops X and Y of radius R and carrying the same current are kept in perpendicular planes such that they have a common centre at P as shown in the figure. Find the magnitude and direction of the net magnetic field at the point P due to the loops.



17. State the reason, why the photodiode is always operated under reverse bias. Write the working principle of operation of a photodiode. The semiconducting material used to fabricate a photodiode, has an energy gap of 1.2 eV. Using calculations, show whether it can detect light of wavelength 400 nm incident on it.

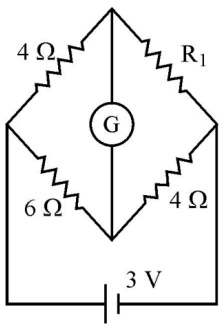
18. Draw the circuit diagram of a common emitter transistor amplifier. Write the expression for its voltage gain. Explain, how the input and output signals differ in phase by 180°.

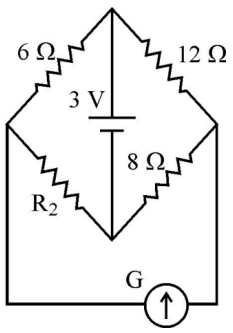
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18. Draw the circuit diagram of a full wave rectifier. Explain its working principle. Draw the input and output waveforms.

19. Briefly explain the three factors which justify the need of modulating a low frequency signal into high frequencies.

20. Define the term current sensitivity of a galvanometer. In the circuits shown in the figures, the galvanometer shows no deflection in each case. Find the ratio of R_1 and R_2.





21. The current through two inductors of self-inductance 12 mH and 30 mH is increasing with time at the same rate. Draw graphs showing the variation of the:

(a) emf induced with the rate of change of current in each inductor,

(b) energy stored in each inductor with the current flowing through it.

Compare the energy stored in the coils, if the power dissipated in the coils is the same.

22. (a) Explain how the intensity of diffraction pattern changes as the order (n) of the diffraction band varies.

(b) Two wavelengths of sodium light 590 nm and 596 nm are used in turn to study the diffraction at a single slit of size 4 mm. The distance between the slit and screen is 2 m. Calculate the separation between the positions of the first maximum of the diffraction pattern obtained in the two cases.

Section D

23. Mr Kamath, the chief mechanical engineer, in Northern railways went to Tokyo to attend a seminar on fast moving trains. His friend Mr Hiorki explained how Japanese people are concentrating on energy conservation and saving fossil fuels using maglev trains. Mr Kamath travelled from Tokyo to Osaka in maglev train and found that the sound is less, travel is smooth and understood the Japanese technology in mass transporting systems. Maglev trains work on the principle of Meissner's effect.

(a) Mention two values which Mr Kamath found in Mr Hiorki.

(b) Which values in Mr Kamath do you appreciate?

(c) What is Meissner's effect? Write the value of magnetic permeability for perfect diamagnetism.

Section E

24. (a) State Gauss' law. Using this law, obtain the expression for the electric field due to an infinitely long straight conductor of linear charge density λ.

(b) A wire AB of length L has linear charge density $\lambda = kx$, where x is measured from the end A of the wire. This wire is enclosed by a Gaussian hollow surface. Find the expression for the electric flux through this surface.

OR

24. (a) Derive the expression for the electric potential at any point P, at distance r from the centre of an electric dipole, making angle α with its axis.

(b) Two point charges $4\,\mu$C and $+1\,\mu$C are separated by a distance of 2 m in air. Find the point on the line-joining the charges at which the net electric field of the system is zero.

25. (a) Prove that an ideal capacitor connected in an ac circuit does not dissipate power.

(b) An inductor of 200 mH, a capacitor of $400\,\mu$f and a resistor of $10\,\Omega$ are connected in series to a variable frequency 50 V ac source. Calculate:

(i) the angular frequency at which the power dissipation in the circuit is maximum and the corresponding value of effective current, and

(ii) the value of Q-factor in the circuit.

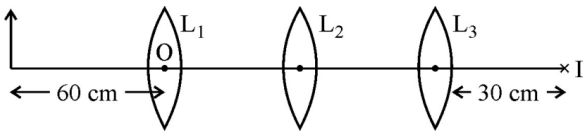
OR

25. (a) A metallic rod of length l is moved perpendicular to its length with velocity v in a magnetic field $\vec{B}$ acting perpendicular to the plane in which the rod moves. Derive the expression for the induced emf.

(b) A wheel with 15 metallic spokes each 60 cm long, is rotated at 360 rev/min in a plane normal to the horizontal component of earth's magnetic field. The angle of dip at that place is 60°. If the emf induced between the rim of the wheel and the axle is 400 mV, calculate the horizontal component of earth's magnetic field at the place. How will the induced emf change, if the number of spokes is increased?

26. (a) Explain with reason, how the power of a diverging lens changes, when (i) it is kept in a medium of refractive index greater than that of the lens, (ii) incident red light is replaced by violet light.

(b) Three lenses L_1, L_2 and L_3 each of focal length 30 cm are placed coaxially as shown in the figure. An object is held at 60 cm from the optic centre of lens L_1. The final real image is formed at the focus of L_3. Calculate the separation between (i) L_1 and L_2, and (ii) L_2 and L_3.



OR

26. (a) Deduce the expression, by drawing a suitable ray diagram, for the refractive index of a triangular glass prism in terms of the angle of minimum deviation (D) and the angle of prism (A). Draw a plot showing the variation of the angle of deviation with the angle of incidence.

(b) Calculate the value of the angle of incidence when a ray of light incident on one face of an equilateral glass prism produces the emergent ray, which just grazes along the adjacent face. Refractive index of the prism is $\sqrt{2}$.

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