CBSE Class 12 Physics 2014 - Set 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 **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

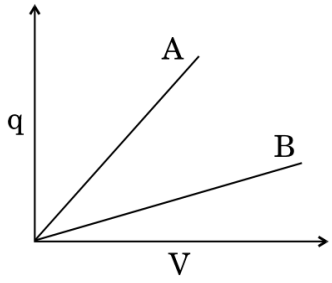
Mass of proton $= 1.673 \times 10^{-27}$ kg

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

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

Section 1-Mark Questions

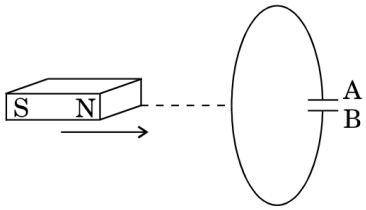
1. The given graph shows variation of charge 'q' versus potential difference 'V' for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that of C_1. Which line (A or B) corresponds to C_1 and why?



2. What does the term 'demodulation' in communication system mean?

3. A plane wave is incident on a concave mirror. Draw the shape of the wavefront coming out after reflection.

4. If a magnet is moved towards a capacitor plate A, as shown in the figure, predict the polarity of the plate A of the capacitor.



5. Write the expression for the drift velocity of charge carriers in a conductor of length 'l' across which a potential difference 'V' is applied.

6. Write the condition under which an electron will move undeflected in the presence of crossed electric and magnetic fields.

7. Distinguish between 'point-to-point' and 'broadcast' modes of communication.

8. How is increase in resistivity of a metal with increase of temperature explained?

Section 2-Mark Questions

9. (i) State Biot-Savart law in vector form expressing the magnetic field due to an element $\vec{dl}$ carrying current I at a distance $\vec{r}$ from the element. (ii) Write the expression for the magnitude of the magnetic field at the centre of a circular loop of radius r carrying a steady current I. Draw the field lines due to the current loop.

10. (a) How is an electromagnet different from a permanent magnet? (b) Write two properties of a material which make it suitable for making electromagnets.

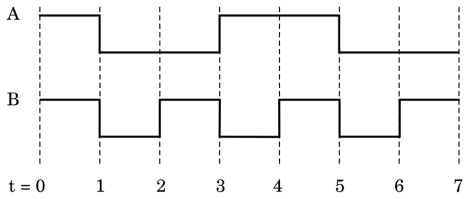
11. Two point charges q and $-2q$ are kept 'd' distance apart. Find the location of the point relative to charge 'q' at which potential due to this system of charges is zero.

OR

11. An electric dipole is placed in a uniform electric field $\vec{E}$ with its dipole moment $\vec{p}$ parallel to the field. Find (i) the work done in turning the dipole till its dipole moment points in the direction opposite to $\vec{E}$. (ii) the orientation of the dipole for which the torque acting on it becomes maximum.

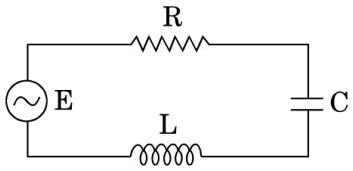
12. Distinguish between emf (ε) and terminal voltage (V) of a cell having internal resistance 'r'. Draw a plot showing the variation of terminal voltage (V) vs the current (I) drawn from the cell. Using this plot, how does one determine the internal resistance of the cell?

13. (i) Write the truth table for an AND gate and draw its logic symbol. (ii) The input waveforms A and B, shown in the figure, are fed into a NAND gate. Find the output waveform.



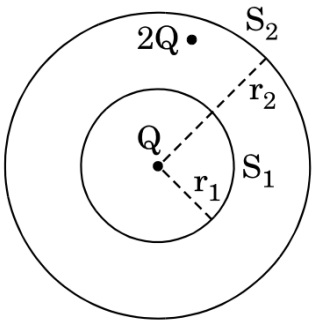
14. Write the conditions for observing a rainbow. Show, by drawing suitable diagrams, how one understands the formation of a rainbow.

15. The figure shows a series LCR circuit connected to a variable frequency 220 V source with L = 80 mH, C = 50 μF and R = 60 Ω. Determine (i) the source frequency which drives the circuit in resonance; (ii) the quality factor (Q) of the circuit.



16. An electron is revolving around the nucleus with a constant speed of 2.5×10^8 m/s. Find the de Broglie wavelength associated with it.

17. A sphere S_1 of radius r_1 encloses a net charge Q. If there is another concentric sphere S_2 of radius r_2 ($r_2 > r_1$) enclosing charge 2Q, find the ratio of the electric flux through S_1 and S_2. How will the electric flux through sphere S_1 change if a medium of dielectric constant K is introduced in the space inside S_2 in place of air?



18. (i) Define the term 'threshold frequency' as used in the photoelectric effect. (ii) Plot a graph showing the variation of photoelectric current as a function of anode potential for two light beams having the same frequency but different intensities I_1 and I_2 ($I_1 > I_2$).

Section 3-Mark Questions

19. (i) Define the term 'mass defect' of a nucleus. How is it related with its binding energy? (ii) Determine the Q-value of the following reaction: ${}_1^1H + {}_1^3H \rightarrow {}_1^2H + {}_1^2H$. Given $m({}_1^2H) = 2.014102$ u, $m({}_1^3H) = 3.016049$ u, $m({}_1^1H) = 1.00783$ u, 1 u = 931.5 MeV/c^2.

20. Arnab was talking on his mobile to his friend for a long time. After his conversation was over, his sister Anita advised him that if his conversation was of such a long duration, it would be better to talk through a land line. Answer the following questions: (a) Why is it considered harmful to use a mobile phone for a long duration? (b) Which values are reflected in the advice of his sister Anita? (c) A message signal of frequency 10 kHz is superposed to modulate a carrier wave of frequency 1 MHz. Determine the sidebands produced.

21. (i) A hydrogen atom initially in the ground state absorbs a photon which excites it to the n = 4 level. Determine the wavelength of the photon. (ii) The radius of innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. Determine its radius in n = 4 orbit.

22. (a) How is a toroid different from a solenoid? (b) Use Ampere's circuital law to obtain the magnetic field inside a toroid. (c) Show that in an ideal toroid, the magnetic field (i) inside the toroid and (ii) outside the toroid at any point in the open space, is zero.

OR

22. Derive an expression for the magnetic moment ($\vec{\mu}$) of an electron revolving around the nucleus in terms of its angular momentum ($\vec{l}$). What is the direction of the magnetic moment of the electron with respect to its angular momentum?

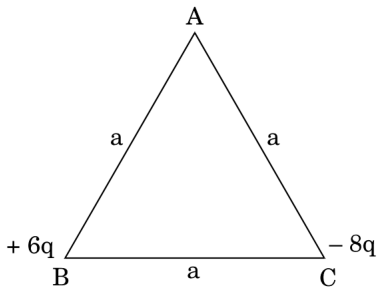
23. (a) Unpolarised light of intensity I_0 passes through two polaroids P_1 and P_2 such that pass axis of P_2 makes an angle θ with the pass axis of P_1. Plot a graph showing the variation of intensity of light transmitted through P_2 as the angle θ varies from zero to 180°. (b) A third polaroid P_3 is placed between P_1 and P_2 with pass axis of P_3 making an angle β with that of P_1. If I_1, I_2 and I_3 represent the intensities of light transmitted by P_1, P_2 and P_3, determine the values of angle θ and β for which $I_1 = I_2 = I_3$.

24. (a) Two monochromatic waves emanating from two coherent sources have the displacements represented by $y_1 = a\cos\omega t$ and $y_2 = a\cos(\omega t + \phi)$, where φ is the phase difference between the two displacements. Show that the resultant intensity at a point due to superposition of these waves is given by $I = 4I_0\cos^2(\phi/2)$, where $I_0 = a^2$. (b) Hence obtain the conditions for constructive and destructive interference.

25. (a) A capacitor is connected in series to an ammeter across a d.c. source. Why does the ammeter show a momentary deflection during the charging of the capacitor? What would be the deflection when it is fully charged? (b) How is the generalized form of Ampere's circuital law obtained to include the term due to displacement current?

26. (a) State the underlying principle on which a potentiometer works. Why is it necessary to (i) use a long wire, (ii) have uniform area of cross-section of the wire and (iii) use a driving cell whose emf is taken to be greater than the emfs of the primary cells? (b) In a potentiometer experiment, if the area of cross-section of the wire increases uniformly from one end to the other, draw a graph showing how potential gradient would vary as the length of the wire increases from one end.

27. Two point charges +6q and −8q are placed at the vertices 'B' and 'C' of an equilateral triangle ABC of side 'a' as shown in the figure. Obtain the expression for (i) the magnitude and (ii) the direction of the resultant electric field at the vertex A due to these two charges.



Section 5-Mark Questions

28. (a) A point object is placed in front of a double convex lens (of refractive index $n = n_2/n_1$ with respect to air) with its spherical faces of radii of curvature R_1 and R_2. Show the path of rays due to refraction at first and subsequently at the second surface to obtain the formation of the real image of the object. Hence obtain the lens-maker's formula for a thin lens. (b) A double convex lens having both faces of the same radius of curvature has refractive index 1.55. Find out the radius of curvature of the lens required to get the focal length of 20 cm.

OR

28. (a) Draw a labelled ray diagram showing the image formation of a distant object by a refracting telescope. Deduce the expression for its magnifying power when the final image is formed at infinity. (b) The sum of focal lengths of the two lenses of a refracting telescope is 105 cm. The focal length of one lens is 20 times that of the other. Determine the total magnification of the telescope when the final image is formed at infinity.

29. (a) Draw the circuit arrangement for studying the V-I characteristics of a p-n junction diode in (i) forward bias and (ii) reverse bias. Briefly explain how the typical V-I characteristics of a diode are obtained and draw these characteristics. (b) With the help of necessary circuit diagram explain the working of a photo diode used for detecting optical signals.

OR

29. (a) Draw the circuit diagram of an n-p-n transistor with emitter-base junction forward biased and collector-base junction reverse biased. Describe briefly how the motion of charge carriers in the transistor constitutes the emitter current (I_E), the base current (I_B) and the collector current (I_C). Hence deduce the relation $I_E = I_B + I_C$. (b) Explain with the help of circuit diagram how a transistor works as an amplifier.

30. (a) Draw a schematic arrangement for winding of primary and secondary coils in a transformer when the two coils are wound on top of each other. (b) State the underlying principle of the working of a transformer and obtain the expression for the ratio of voltage in the secondary coil to voltage in the primary coil in terms of (i) number of turns in the secondary and primary coils and (ii) currents in the primary and secondary coils. (c) State the main assumption used in deriving the above relations. (d) Write any two reasons due to which energy losses may occur in actual transformers.

OR

30. A metallic rod of length l and resistance R is rotated with a frequency ν, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius l, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. (a) Derive the expression for the induced emf and current in the rod. (b) Due to the presence of the current in the rod and of the magnetic field, find the expression for the magnitude and direction of the force acting on this rod. (c) Hence obtain the expression for the power required to rotate the rod.

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