रोल नं.
Roll No. | | | | | | | |

XII PHYSICS (Theory)

Time allowed : 3 hours *Maximum Marks : 70*

- Please check that this question paper contains 5 printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **26** questions.
- **Please write down the Serial Number of the question before attempting it.**

General Instructions :

(i) *All questions are compulsory.*

(ii) *There are 26 questions in total. Questions No. **1** to 5 are very short answer type questions and carry **one** mark each.*

(iii) *Questions No. 6 to **10** carry **two** marks each, questions no. **11** to 22 carry **three** marks each and questions no. 24 to 26 carry **five** marks each.*

(iv) *One of the questions carrying four marks weightage is value based question.*

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

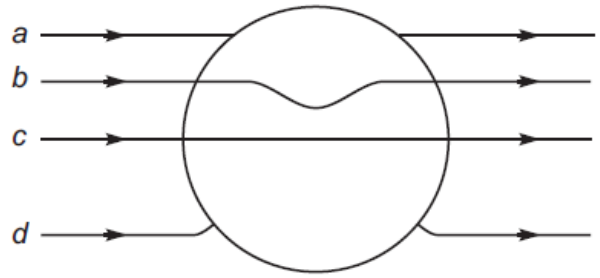
$\mu_o = 4\pi \times 10^{-7}$ T mA^{-1}

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

$m_e = 9{\cdot}1 \times 10^{-31}$ kg

One Mark Questions

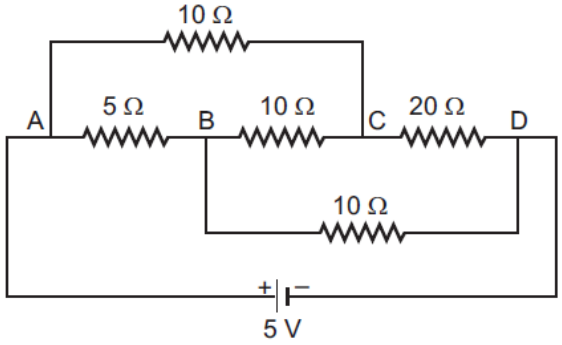
1. Plot a graph showing the variation of resistance of a conducting wire as a function of its radius, keeping the length of the wire and its temperature as constant.
2. A metallic sphere is placed in a uniform electric field. Which path is followed by the lines of force and why?



3. What is the length of a telescope in normal adjustment?
4. State the conditions under which a microwave oven heats up a food item containing water molecules.
5. Two materials Si and Cu are cooled from 300 K to 60 K. What will be the effect on their resistivity?

Two Marks Questions

6. For a glass prism ($\mu = \sqrt{3}$), the angle of minimum deviation is equal to the angle of the prism. Find the angle of the prism.
7. Calculate the value of the current drawn from a 5 V battery in the circuit as shown.



8. Two radioactive nuclei X & Y initially contain equal number of atoms. Their half lives are 1 hour and 2 hour respectively. Calculate the ratio of their rates of disintegration after 2 hour.
9. A 4cm thick glass ($\mu = 1.5$) slab is lying at the bottom of a container. The container contains two immiscible liquids A and B of depths 6 cm and 8 cm respectively. What is the apparent position of a scratch on the outer surface of the bottom of the glass slab when viewed through the container? Refractive index of A and B are 1.4 and 1.3 respectively.
10. A parallel plate capacitor, each of plate area A and separation 'd' between the two plates, is charged with charges + Q and – Q on the two plates. Deduce the expression for the energy stored in the capacitor.

Three Marks Questions

11. Write three important factors which justify the need of modulating a message signal. Show diagrammatically how an amplitude modulated wave is obtained when a modulating signal is superimposed on a carrier wave.

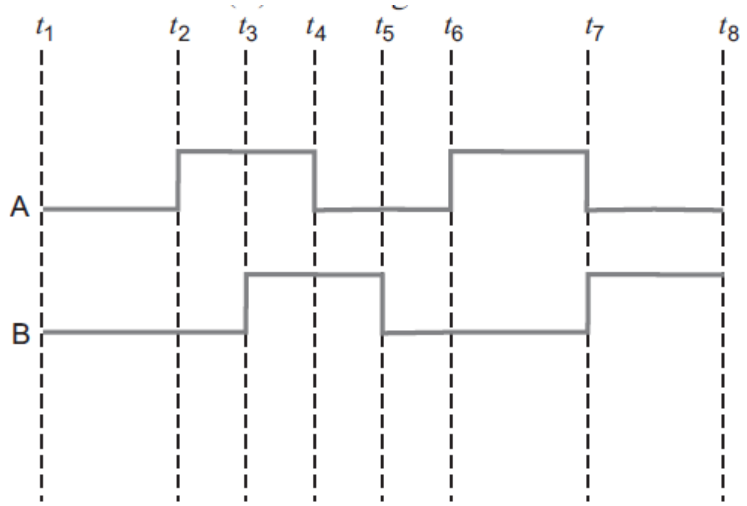
12. (a) State, with the help of a suitable diagram, the principle on which the working of a meter bridge is based.
    (b) Answer the following:
    (i) Why are the connections between resistors in a meter bridge made of thick copper strips?
    (ii) Why is it generally preferred to obtain the balance point near the middle of the bridge wire in meter bridge experiments?
13. An electric power station (100 MW) transmits power to a distant load through long and thin cables. Which of the two modes of transmission would result in lesser power wastage: power transmission at (a) 20,000 V or (b) 200V? Also find the ratio of power losses in above cases.

OR

A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two-wire line carrying power is 0.5 Ω per km. The town gets power from the line through a 4000-220 V step-down transformer at a substation in the town.

(a) Estimate the line power loss in the form of heat.
(b) How much power must the plant supply, assuming there is negligible power loss due to leakage?
(c) Characterize the step-up transformer at the point.

14. Show the output waveforms (Y) for the following inputs A and B of
    (i) OR gate and (ii) NAND gate



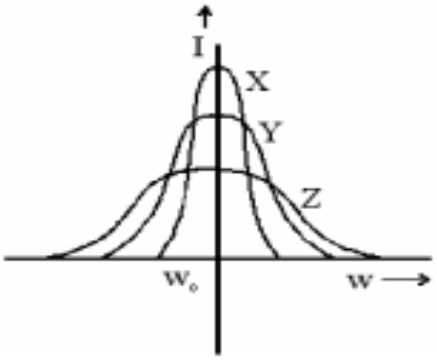
15. Two towers are built on hills 40 km apart and the line joining them passes 50 m above a hill half way in between. What is the longest wavelength of radio waves which can be sent between the towers without serious diffraction effects?
16. (a) A toroidal solenoid with an air core has an average radius of 15cm., area of cross section 12cm^2, and 1200 turns. Obtain the self inductance of the toroid. Ignore field variations across the cross section of the toroid.
    (b) A second coil of 300 turns is wound closely on the toroid above. If the current in the primary coil is increased from 0 to 2 A in 0.05 s, obtain the induced emf in the second coil.
17. What is GPS. Mention any three applications of GPS.

18. In certain cases when an object and screen are separated by a distance d, two positions *x* of the converging lens relative to the object will give an image on the screen. Show that these two values are: $\boldsymbol{x = \frac{d}{2}\left[1 \pm \left(1 - \frac{4f}{d}\right)^{1/2}\right]}$.

19. In a series LCR circuit connected to a variable frequency of 230 V source. L = 5H, C = 80 μF, R = 40 Ω.
    (a) Determine the source frequency which drives the circuit in resonance.
    (b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.
    (c) Determine the rms potential drops across three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.

20. Mention the important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of an LED if it is required to emit light in the visible range?

21. Three students X, Y, and Z performed an experiment for studying the variation of alternating currents with angular frequency in a series LCR circuit and obtained the graphs shown below. They all used a.c. sources of the same r.m.s. value and inductances of the same value. What can we (qualitatively) conclude about the (i) capacitance value (ii) resistance values used by them? In which case will the quality factor be maximum? What can we conclude about nature of the impendence of the set up at frequency ω_o?



22. Suppose India has a target of producing by 2020 A.D. , 2 x 10^5 MW of electric power, ten percent of which is to be obtained from nuclear power plants. Suppose we are given that, on an average, the efficiency of utilization (i.e., conversion to electrical energy) of thermal energy produced in a reactor is 25%. How much amount of fissionable uranium would our country need per year at the turn of this century?
    Take the heat energy per fission of U-235 to be 200 MeV. Avogadro's number = 6.023 x 10^{23} mol^{-1}.

4 Mark Questions (Value Based)

23. Kamal's uncle was advised by his doctor to undergo an MRI scan test of his chest and gave him an estimate of the cost. Not knowing much about the significance of this test and finding it to be too expensive he first hesitated. When Kamal learnt about this, he decided to take help of his family, friends and neighbours and arranged for the cost. He convinced his uncle to undergo this test so as to enable the doctor to diagnose the disease. he got the test done and the resulting information greatly helped the doctor to give him proper treatment.
    (a) What, according to you, are the values displayed by Kamal, his family, friends and neighbours?
    (b) Assuming that the MRI scan test involved a magnetic field of 0.1 T, find the maximum and minimum values of the force that this field could exert on a proton moving with a speed of 10^4 ms^{-1}. State the condition under which the force can be minimum.

5 Marks Questions

24. (a) A monochromatic source of light of wavelength λ illuminates a narrow slit of width d to produce a diffraction pattern on the screen. Obtain the conditions when secondary wavelets originating from the slit interfere to produce maxima and minima on the screen.
    (b) How would the diffraction pattern be affected when:
    (i) the width of the slit is decreased? (ii) the monochromatic source of light is replaced by white light?

    OR

    (i) A plane wavefront approaches a plane surface separating two media. If medium 'one' is optically denser and medium 'two' is optically rarer, using Huygens' principle, explain and show how a refracted wavefront is constructed.
    (ii) Hence verify Snell's law.
    (iii) When a light wave travels from rarer to denser medium, the speed decreases. Does it imply reduction in its energy? Explain.
25. (a) Define electric flux. Write its S.I. units.
    (b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.
    (c) How is the field directed if (i) the sheet is positively charged, (ii) negatively charged?

    OR

    Using Gauss' law deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point (i) outside and (ii) inside the shell.
    Plot a graph showing variation of electric field as a function of $r > R$ and $r < R$. (r being the distance from the centre of the shell)
26. Electrons in hydrogen like atoms (Z = 3) make transitions from the 5^{th} to the 4^{th} orbit and from the 4^{th} to the 3^{rd} orbit. The resulting radiations are incident normally on a metal plate and eject photoelectrons. The stopping potential of the photoelectrons ejected by the short wavelength is 3.95 V. Calculate the work function of the metal and the stopping potential for the photoelectrons ejected by the longer wavelength.

    OR

    Light from a discharge tube containing hydrogen atoms falls on the surface of piece of sodium. The kinetic energy of the fastest photoelectrons emitted from sodium is 0.73 eV. The work function for sodium is 1.82 eV. Find:
    (a) The energy of the photons causing the photoelectric emission,
    (b) The quantum numbers of the two levels involved in the emission of these photons,
    (c) The change in the angular momentum of the electrons in the hydrogen atom in the above transition, and
    (d) The recoil speed of the emitting atom assuming it to be at rest before the transition (ionization potential of hydrogen is 13.6 eV).