Physics (Theory)

Time allowed : 3 hours *Maximum Marks : 70*

General Instructions:

(i) **All questions are compulsory.**

(ii) **There are 30 questions in total. Question Nos. 1 to 8 are very short answer type questions and carry one mark each.**

(iii) **Question Nos. (to 18 carry two marks each. Questions 19 to 27 carry three marks each and questions nos. 28 to 30 carry five marks each.**

(iv) **One of the questions carrying three marks weightage is vaule based question.**

(v) **There is no overall choice. Howerver, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each weightage. You have to attempt only one of the choices in questions.**

(vi) **Use of calculators is not permitted. However, you may use log tables if necessary.**

(vii) **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

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

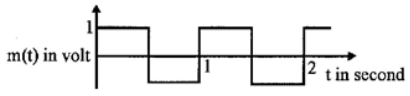
$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$ Nm^2 C^{-2}

$m_e = 9.1 \times 10^{-31}$ kg

1. **Define the term 'Mobility' of charge carriers in a conductor. Write its S.I. unit.**
2. **The carrier wave is given by**

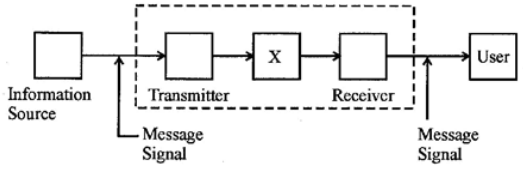
   C(t)= 2 sin (8πt) volt.

   The modulating signal is a square wave as shown. Find modulation index.

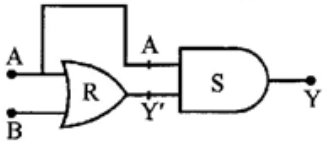


3. **"For any charge configuration, equipotential surface through a point is normal to the electric field". Justify.**

4. **Two spherical bobs, one metallic and the other of glass, of the same size are allowed to fall freely from the same height above the ground. Which of the two would reach earlier and why?**
5. **Show variation of resistivity of copper as a function of temperature in a graph.**
6. **A convex lens is placed in contact with a plane mirror. A point object at a distance of 20 cm on the axis of this combination has its image coinciding with itself.what is the focal length of the lens?**
7. **Write the expression, in a vector form , for the Lorentz magnetic force $\vec{F}$ due to a charge moving with velocity $\vec{V}$ in a magnetic field $\vec{B}$. What is the direction of the magnetic force?**
8. **The figure given below shows the block diagram of a generalized communication system. Identify the element labeled 'X' and write its function.**

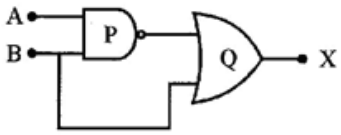


9. **Out of the two magnetic materials, 'A' has relative permeability slightly greater than unity while 'B' has less than unity. Identify the nature of the materials 'A' and 'B'. will their susceptibilities be positive or negative?**
10. **Given a uniform electric field $\overrightarrow{E} = 5 * 10^3 \hat{\imath}$ N/C, find the flux of this field through a square of 10 cm on a side whose plane is parallel to the y-z plane. What would be te flux through the same square if the plane makes a 30° angle with the x-axis?**
11. **For a single slit of a width "a", the first minimum of the interference pattern of a monochromatic light of wavelength λ occurs at an angle of λ/a. At the same angle of /a. At the same angle of λ/a, we get a maximum for two narrow slits separated by a distance "a". Explain.**
12. **Write the truth table for the combination of the gates shown. Name the gates used.**



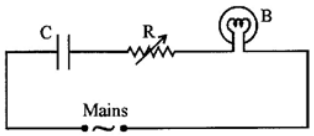
OR

Identify the logic gates marked 'P' and 'Q' in the given circuit. Write the truth table for the combination.



13. State Kirchhoff's rules. Explain briefly how these rules are justified.

14. A capacitor 'C', a variable resistor 'R' and a bulb 'B' are connected in series to the ac mains in circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change if (i) a dielectric slab is introduced between the plates of the capacitor, keeping resistance R to be the same; (ii) the resistance R is increased keeping the same capacitance?



15. State the underlying principle of a cyclotron. Write briefly how this machine is used to accelerate charged particles to high energies.

16. An electric dipole of length 4cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has charge $\pm 8nC$.

17. A proton and a deuteron are accelerated through the same accelerating potential. Which one of the two has

(a) greater value of de-Broglie wavelength associated with it, and

(b) less momentum ?

Give reasons to justify your answer.

18.

(i) Monochromatic light of frequency 6.0 x $10^{14}Hz$ is produced by a laser. The power emitted is 2.0 x $10^{-3}W$. Estimate the number of photons emitted per second on an average by the source.

(ii) Draw a plot showing the variation of photoelectric current versus the intensity of incident radiation on a given photosensitive surface.

19. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Upto which energy level the hydrogen atoms would be excited?
Calculate the wavelengths of the first member of lyman and first member of Balmer series.

20. When sunita, a class XII student , came to know that her parents are planning to rent out the top floor of their house to a mobile company she protested. She tried hard to convince her parents that this move would be a health hazard.
Ultimately her parents agreed:
(1) In what way can the setting up of the transmission tower by a mobile company in a residential colony prove to be injurious to health?
(2) By objecting to this move of her parents, what value did sunita display?
(3) Estimate the range of e.m. waves which can be transmitted by an antenna of height 20 m.(given radius of the earth = 6400 km)

21. A potentiometer wire of length 1 m has a resistance of 10 Ω. It is connected to a 6v battery in series with a resistance of 5Ω. Determine the emf of the primary cell which give s a balance point at 40 cm.

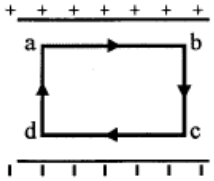
22.
(a) Draw a labeled ray diagram showing the formation of a final image by a compound microscope at least distance of distinct vision.
(b) The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focused on a certain object. The distance between the objective and eyepiece is observed to be 14 cm. if least distance vision is 20 cm, calculate the focal length of the objective and the eye piece.

23.
(a) A mobile phone lies along the principal axis of a concave mirror. Show, with the help of a suitable diagram, the formation of its image. Explain why magnification is not uniform.
(b) Suppose the lower half of the concave mirror's reflecting surface is covered with an opaque material. What effect this will have on the image of the object?
Explain.

24.

(a) Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

(b) The electric field inside a parallel plate capacitor is E. find the amount of work done in moving a charge q over a closed rectangular loop a b c d a.



OR

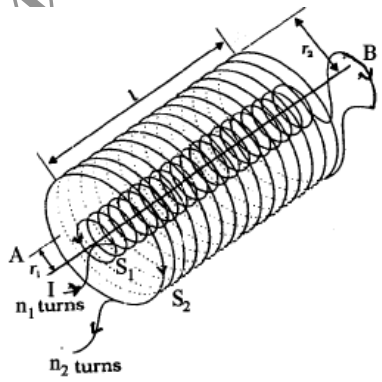
(a) Derive the expression for the capacitance of a parallel plate capacitor having palte area A and plate separation d.

(b) Two charged spherical conductors of radii $R_1 and\ R_2$ when connected by a conducting wire acquire $q_1\ and\ q_2$ respectively. Find the ratio of their surface charge densities in terms of their radii.

25.

(a) State Ampere's circuital law, expressing it in the integral form.

(b) Two long coaxial insulated solenoids $S_1 and\ S_2$ of equal lengths are wound one over the other as shown in the figure. A steady current "I" flow through the inner solenoid S_1 to the other end B, which is connected to the outer solenoid S_2 through which the same current "I" flows in the opposite direction so as to come out at end A. If $n_1 and\ n_2$ are the number of turns per unit length. Find the magnitude and direction of the net magnetic field at a point (i) inside on the axis and (ii) outside the combined system.



26. Answer the following :

(a) Name the em waves which are suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves.

(b) If the earth did not have atmosphere, would its average surface temperature be higher or lower than what it is now? Explain.

(c) An em wave exerts pressure on the surface on which it is incident. Justify.

27.

(a) Deduce the expression, N= $N_\circ e^{-\lambda t}$, for the law of radioactive delay.

(b)

(i) Write symbolically the process expressing the β^+ *decay of* $^{22}_{11}Na$. Also write the basic nuclear process underlying this decay.

(ii) Is the nucleus formed in the decay of the nucleus $^{22}_{11}Na$, an isotope or isobar?

28.

(a)

(i) 'Two independent monochromatic sources of light cannot produce a sustained interference pattern'. Give reason.

(ii) Light waves each of amplitude "a" and frequency "ω" , emanating from two coherent light sources superpose at a point. If the displacements due to these waves is given by $y_1 = a\ \cos\omega t\ \ and\ y_2 = a\ \cos(\omega t + \phi)$ where ϕ is the phase difference between the two, obtain the expression for the resultant intensity at the point.

(b) In Young's double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. Find out the intensity at appoint where path difference is λ/3.

OR

(a) How does one demonstrate using a suitable diagram, that unpolarised light when passed through a Polaroid gets polarized?

(b) A beam of unpolarised light is incident on a glass- air interface. Show, using a suitable ray diagram, that light reflected from the interface is totally polarized , when μ=tan i_B, where μ is the refractive index of glass with respect to air and i_B is the Brewster's angle.

29.

(a) Describe a simple experiment (or activity) to show that the polarity of emf induced in a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.

(b) The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of

(i) Magnetic flux versus the current

(ii) Induced emf versus dI/dt

(iii) Magnetic potential energy stored verus the current.

OR

(a) Draw a schematic sketch of an ac generator describing its basic elements. State briefly its working principle. Show a plot of variation of

(i) Magnetic flux and

(ii) Alternating emf versus time generated by a loop of wire rotating in a magnetic field.

(b) Why is choke coil needed in the use of fluorescent tubes with ac mains?

30.

(a) State briefly the processes involved in the formation of p-n junction explaining clearly how the depletion region s formed.

(b) Using the necessary circuit diagrams, show how the V-I characterustics of a p-n junction are obtained in

(i) Forward biasing

(ii) Reserve biasing

How are these characteristics made use of in rectification?

OR

(a) Differentiate between three segments of a transistor on the basis of their size and level of doping.

(b) How is a transistor biased to be in active state?

(c) With the help of necessary circuit diagram, describe how n-p-n transistor in CE configuration amplifies a small sinusoidal input voltage. Write the expression for the ac current gain.