1. A force $F$ is acting between two charges placed some distance apart in vacuum. If a brass rod is placed between these two charges, how does the force change?

2. A magnetic needle, free to rotate in a vertical plane, orients itself with its axis vertical at a certain place on the earth. What are the values of (a) horizontal component of the earth's magnetic field (b) angle of dip at this place?

3. If the number of turns of a solenoid is doubled keeping the other factors constant how does the self inductance of the solenoid change?

4. Name the characteristics of electromagnetic waves that (i) increases (ii) remains constant in the electromagnetic spectrum as one moves from radio-wave region towards ultraviolet region.

5. A ray of light incident on an equilateral prism ($n_{\text{glass}} = \sqrt{3}$) moves parallel to the base of the prism inside it. What is the angle of incidence for this ray?
6. A photodiode is illuminated by light of intensities \( I_1, I_2, I_3 \) \((I_1 > I_2 > I_3)\). Draw the \( I-V \) characteristic curves for different illumination intensities.

7. Two beams, one of red light and the other of blue light, of the same intensity are incident on a metallic surface to emit photoelectrons. Which one of the two beams emits electrons of greater kinetic energy?

8. An a.c. signal is fed into two circuits X and Y and the corresponding output in the two cases have the waveforms shown below. Name the circuit X and Y.

9. Draw the output waveform at X, using the given inputs A, B for the logic circuit shown below. Also identify the equivalent gate.

10. A circular coil of wire consisting of 100 turns, each of radius 8.0 cm carries a current of 0.40A. What is the magnitude of the magnetic field \( B \) at the centre of the coil?

11. Figure shows two identical rectangular loops (1) and (2) placed on a table along with a straight long current carrying conductor between them.
12 The voltage-current variation of two metallic wires X and Y at constant temperature are shown in figure. Assuming that the wires have the same length and the same diameter explain which of the two wires will have larger resistivity?

13. The primary coil of an ideal step up transformer has 100 turns and the transformation ratio is also 100. The input voltage and the power are 220V and 1100W respectively. Calculate (i) the number of turns in the secondary (ii) current in the primary.

14. Suppose that the electric field part of an electromagnetic wave in vacuum is \[ E = (3.1 \text{NC}^{-1} \cos(1.8 \text{radm}^{-1})y + (5.4 \times 10^5 \text{ rad s}^{-1}) \hat{j}). \]
   (a) What is the direction of propagation of the wave?
   (b) What is the wavelength?
   (c) What is the speed of the wave?

15. An infinite plane sheet of charge density $10^{-8}$ Cm$^{-2}$ is held in air. In this situation how far apart are two equipotential surfaces, whose potential difference is 5V?

OR

An electric dipole free to move is placed in a uniform electric field. Explain along with diagram its motion when it is placed (a) parallel to the field (b) perpendicular to the field.

16. A light beam is incident on the boundary between two transparent media. At a particular angle of incidence the reflected ray is perpendicular to the refracted ray. Obtain an expression for this angle of incidence. Does this angle depend on the wavelength of the light used?
17. Name any two type of transmission media that are commonly used for transmission of signals. Write the range of frequencies of signals for which these transmission media are used.

18. A conductor of length $L$ is connected to a dc source of potential $V$. If the length of the conductor is tripled by stretching it, keeping $V$ constant explain how the following factors vary in the conductor.
   (i) drift speed of electrons
   (ii) electron mobility.

19. Does the current in an ac circuit lag, lead or remain in phase with the voltage of frequency applied to the circuit when (i) $f < f_r$ (ii) $f > f_r$ where $f_r$ is the resonant frequency. Also draw the graph showing the variation of reactance with frequency in each case.

20. A slit of width 'd' is illuminated by white light. For what value of 'd' is the first minimum, for red light of $\lambda = 650$ nm, located at point P? For what value of the wavelength of light will the first diffraction maxima also fall at P?

OR.

Draw the diagram showing intensity distribution of light on the screen for diffraction of light at a single slit. State with reason, how would the linear widths of central maximum change if (i) monochromatic yellow light is replaced by red light (ii) distance between slit and screen is increased.

21. In the potentiometer circuit shown, the balance point is at X. State with reason where the balance point will be shifted when (i) resistance $R$ is increased keeping all parameters unchanged (ii) resistance $S$ increased keeping $R$ constant (iii) cell P is replaced by another cell whose emf is less than that of cell Q.
22. A lens combination is made from a crown glass lens and a flint glass lens as shown. The magnitude of radius of curvature of each surface of the crown glass lens is 20 cm. If the refractive indices of the crown glass and flint glass used are 1.52 and 1.66 respectively calculate the focal length and power of the lens combination.

23. State Bohr's postulate for the permitted orbits for the electron in a hydrogen atom. Use this postulate to prove that the circumference, of the \( n \)th permitted orbit for the electron can contain exactly 'n' wavelengths of the de-Broglie wave length associated with the electron in that orbit.

24. Sketch the graphs showing the variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B, having threshold frequency \( \nu_0 \) and \( \nu_0' \) (\( \nu_0 > \nu_0' \)) respectively.
   (i) Which of the two metals A and B has greater work function?
   (ii) What information do you get from the slope of the graphs?
   (iii) What does the value of the intercept of graph A on the potential axis represents?

25. The transfer characteristic of a base-biased transistor in CE configuration is as shown.

Name the region corresponding to the values (i) 0 to \( V_1 \) (ii) \( V_1 \) to \( V_2 \)
(iii) greater than \( V_2 \) of the input voltage applied to the transistor. Identify the voltage range that should not be used if the transistor had to work as a switch. What is the practical use of transistor when it is operated in this voltage? Name the source that results in a higher energy of the output of a transistor operated in this range.
26. Give the atomic number and mass number of elements on the right hand side of the decay process.

\[ {\text{86}}^{220}\text{Ru} \rightarrow \text{Po} + \text{He} \]

The graph shows the activity of a sample of radon-220 changes with time. Use the graph to determine its half-life. Calculate the value of decay constant of radon 220.

![Graph showing decay of radon-220](image)

27. What does the process of detection of amplitude modulated wave mean? The diagram, given below shows the block diagram of a detector for AM signals.

![Block diagram of AM wave detector](image)

Label the unlabelled boxes in this block diagram and show the wave form corresponding to the positions indicated by arrows (b) and (c).

28. State Gauss's theorem in electrostatics. Apply the theorem to calculate the electric field due to a uniformly charged spherical shell at a point (a) outside the shell (b) on the shell (c) inside the shell. Draw the graph showing the variation of electric field \( E \) with distance \( r \) from the centre of a uniformly charged thin spherical shell.

OR

(a) Deduce the expression for the energy stored in a charged capacitor.

(b) Show that the effective capacitance \( C_e \) of a series combination, of three capacitors, \( C_1, C_2 \) and \( C_3 \) is given by \( C_e = \frac{C_1 C_2 C_3}{C_1 C_2 + C_2 C_3 + C_3 C_1} \).

29. With the help of a neat and labelled diagram, explain the underlying principle and working of a moving coil galvanometer. What is the function of (i) uniform radial field (ii) soft iron core, in such a device?
OR

(a) State Ampere's circuit law. Show, through an example, how this law enables an easy evaluation of the magnetic field when there is a symmetry in the system.

(b) What does a toroid consist of?

(c) Show that for ideal toroid of closely wound turns, the magnetic field (i) inside the toroid is constant and (ii) in the open space inside and exterior to the toroid is zero.

30. With the help of a ray diagram, illustrate the formation of the final image of an object in a compound microscope. Derive the expression for its magnifying power. How can the magnifying power be increased?

OR

State Huygen's principle. With the help of a suitable diagram, prove Snell's law of refraction using Huygen's principle.

Draw the geometrical shape of the wavefront when (i) light diverges from a point source and (ii) light emerges out of a convex lens when a point source is placed at its focus.