General Instructions:

1. All questions are compulsory.
2. There are 30 questions in total. Q. 1. to 8 are very short answer type questions and carry one mark each.
3. Questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each and questions 28 to 30 carry five marks each.
4. There is no overall choice. However, an internal choice has been provided in one question of two marks. One question of three marks and all three questions of five marks. You have to attempt only one of the given choice in such questions.

1. A ray of light incident on an equilateral glass prism ($\mu_{\text{glass}} = \sqrt{3}$) moves parallel to the base of the prism, inside it. What is the angle of incidence for this ray?

2. A capacitor of capacitance $C$, is being charged up by connecting it across a d.c. voltage source of voltage $V$. How do the conduction and displacement currents, in this set-up compare with each other:
   (a) during the charging up process?
   (b) after the capacitor gets fully charged?

3. How will the intensity of maxima and minima, in the Young's double slit experiment change, if one of the two slits is covered by a transparent paper which transmits only half of the light intensity?

4. The short wavelength limits of Lyman, Paschen and Balmer series, in the hydrogen spectrum, are denoted by $\lambda_L$, $\lambda_p$ & $\lambda_B$ respectively. Arrange the wavelengths in increasing order.

5. Charges of magnitudes $2Q$ and $-Q$ are located at a points $(a, 0, 0)$ and $(4a, 0, 0)$. Find the ratio of the flux of electric field, due to these charges, through concentric spheres of radii $2a$ and $8a$ centered at the origin.

6. How does the mutual inductance of a pair of coils change, when (i) distance between the coils is increased (ii) number of turns in each coil is decreased?

7. A resistance $R$ is connected across a cell of emf, $E$ and internal resistance $r$. A potentiometer now measure the p.d. between the terminals of the cell, as $V$. State the expression for $r$ in terms of $E'$, $V'$ and $R'$.

P.T.O.
8. The mean life of a radioactive sample is $T_m$. What is the time in which 50% of this sample would get decayed?

9. Find the amount of work done in rotating an electric dipole, of dipole moment $3 \times 10^{-8}$ cm, from its position of stable equilibrium, to the position of unstable equilibrium, in a uniform electric field of intensity $10^4$ N/C.

10. Find the magnitude of the force on each segment of the wire shown below, if a magnetic field of 0.30 T, is applied parallel to $AB$ and $DE$. Take the value of current flowing in the wire as 1 ampere.

11. The intensity, at the central maxima 'O' in a Young's double slit set up is $I_0$. If the distance $OP$ equals one third of the fringe width of the pattern, show that the intensity, at point $P$ would equal $I_0/4$.

12. An electric heater is connected, turn by turn, to a d.c. and a.c. sources of equal voltages. Will the rate of heat production be same in the two cases? Explain.

13. Inputs A and B are applied to the logic gate set up as shown below. Complete the truth table given below and name the equivalent gate formed by this set-up.

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(2)
14. Find the amount of work done in arranging the three point charges, on the vertices of an equilateral triangle $ABC$, of side 10 cm, as shown in fig.

15. Write the relation for current sensitivity and voltage sensitivity of a moving coil galvanometer. Using these relations, explain the fact that increasing the current sensitivity may not necessary increase the voltage sensitivity.

Or

Using the relation for potential energy of a current carrying planar loop, in a uniform magnetic field, obtain the expression for the work done in moving the planar loop from its unstable (equilibrium) position to its stable (equilibrium) position.

16. A straight conductor $PQ$ is moving in a uniform and time independent magnetic field as shown below. Assuming that there is no loss of energy due to friction, deduce an expression for the power spent by an external agency to move the arm $PQ$, with a constant speed $v$, in terms of the magnetic field, the length $PQ$ & speed $v$.

17. Light of wavelength 2000 Å, falls on a metal surface of work function 4.2 eV. What is the kinetic energy (in eV) of (i) the fastest (ii) the slowest photoelectrons emitted from the surface?

18. (a) If the magnetic monopoles were to exist, how would the Gauss Law of magnetism get modified?

(b) How will the angle of dip vary when one goes from a place, where the acceleration due to gravity is maximum, to a place where it is minimum, on the surface of earth?
19. A resistor of resistance 400 Ω and the capacitor of reactance 200 Ω, are connected in series to 200 V, 50 Hz a.c. source. If the current in the ckt is 0.49 ampere. Find (i) voltage across the resistor and capacitor (ii) value of inductance required, so that voltage and current are in phase.

20. The energy levels of a hypothetical atom are as shown below. Which of the shown transitions will result in the emission of a photon of wavelength 275 nm? Which of these transition corresponds to emission of radiation of (i) maximum and (ii) minimum wavelength?

![Energy Levels Diagram]

21. An a.c. signal is fed into two ckt X and Y and the corresponding output in the two cases have the wave forms shown below. Name the ckt X and Y. Also draw their detailed ckt dig.

![Wave Form Diagram]

22. A 5 cm. long needle is placed 10 cm from a convex mirror of focal length 40 cm. Find the position, nature and size of the image of the needle.

What happens to the size of image when the needle is moved farther away from the mirror?

23. State various modes of propagation of E.M. waves. Explain using a proper dig. the mode of propagation used in the frequency range from a few MHz upto 40 MHz.

24. A potentiometer ckt is set up as shown. The potentiometer gradient across the potentiometer wire in 0.025 V/cm & the ammeter present in the ckt reads 0.1 A, when the two way key is completely switched off. The balance point when the key
between the terminals (i) 1 and 2 (ii) 1 and 3 is plugged in, are found to be at lengths 40 cm and 100 cm respectively. Find the values of $R$ and $X$.

In the meter bridge experiment, a student observed a balance point at the point $J$. Where $AJ = I$, Draw the equivalent Wheatstone bridge ckt dig. for this set up.

The values of $R$ and $X$ are both doubled and then interchanged what would be the new position of the balance point? If, in this set up the galvanometer and battery are interchanged at the balance point position, how will the balance point get affected?

25. Two convex lenses, of equal focal length, but of aperture $A_1$ and $A_2$ ($A_2 < A_1$) are used as the objective lenses in two astronomical telescope having identical eyepieces. Compare the ratio of their (i) resolving power, (ii) normal magnifying power and (iii) intensity of images formed by them. Which one of the two telescope should be preferred? Why?

26. Find the potential difference across each cell and the rate of energy dissipated in $R$. 

(5)
27. A wire $AB$ is carrying a current of 12 A and is lying on the table. Another wire $CD$, carrying a current of 5A, is arranged just above $AB$ at a height of 1 mm. What should be the weight, per unit length of this wire, so that $CD$ remains suspended at its position? Indicate the direction of current in $CD$ and the nature of force between the two wires.

28. State the principle of the machines that can be build up higher voltage of the order of few million volts. Also explain the construction and working of this machine.

Or

Three identical parallel plate (air) capacitors $C_1$, $C_2$, $C_3$ have capacitances $C$ each. The space between their plates is now filled with dielectric as shown in fig. If all the three capacitors, still have equal capacitances, obtain the relation between the dielectric constants $K_1$, $K_2$, $K_3$ and $K_4$.

29. Draw a ray dig. for a compound microscope. Derive an expression for the magnifying power when the final image is formed at the least distance of distinct vision. State the expression for the magnifying power when the image is formed at infinity. Why is the focal length of the objective lens of the compound microscope kept quite small?

Or

Derive the lens formula giving the relation between $u$, $v$ and $f$ for a thin convex lens. Define the term 'linear magnification' and draw a graph showing the variation of linear magnification with image distance for a thin convex lens. How can this graph be used for finding the focal length of the lens?
30. The set up, shown below, can produce an a.c. output without any external input signal, identify the components X and Y of this set up. Draw the ckt dig. for this set up and briefly describe its working.

![Circuit Diagram](image)

Explain the formation of the depletion region for a p-n junction. How does the width of this region change when the junction is:

(i) Forward biased,
(ii) Reverse biased,
(iii) How does an increase in the doping concentration affect the width of the depletion region?