1. Define moment of inertia and Radius of gyration. Explain their physical significance. A uniform thin rod of mass M and length L is bent to make an equilateral triangle. What is its moment of inertia about an axis passing through centre of mass and perpendicular to the plane of triangle?
(6 Marks)

2. Obtain an expression for the kinetic energy of a rotating body. A solid sphere of mass M and radius R rolls on a horizontal surface. What fraction of its total kinetic energy is rotational?
(6 Marks)

3. State and prove the law of conservation of angular momentum. A flywheel of mass 100 kg and radius 0.1 m is rotating with a speed of 180 rpm. Determine the torque required to bring it to rest in 1 min.
(6 Marks)

4. State Kepler's laws of planetary motion and discuss its limitations.
(6 Marks)

5. Normalize the given wave function for a particle in an infinite potential well (a one dimensional box) of length L. Given that $\psi_n(x) = A \sin\left(\dfrac{n\pi x}{L}\right)$.
(6 Marks)

6. An excited atomic state has lifetime $10^{-8}$ s. Find spectral line width of the spectrum obtained during the de-excitation.
(6 Marks)

7. A solid uniform cylinder of mass M and radius R is suspended horizontally by a thin vertical wire attached to its centre. The wire has a length L, radius r and rigidity modulus $\eta$. The cylinder is rotated through an angle $\theta_0$ in the horizontal plane and released. Find the maximum angular velocity $\omega_{max}$ of the cylinder.
(6 Marks)

8. Find the pressure inside an air bubble of radius 0.1 mm at 10 cm depth in water (Surface tension of water is 0.075 N/m, Atmospheric Pressure is $10^5$ Pa.)
(6 Marks)

9. Calculate the work done when one mole of an ideal gas expands isothermally at 27°C to triple its original volume (given, R = 8.3 J/deg mole and $\log_{10} 3 \approx 1.1$) (4 Marks)

10. The temperature of the heat sink in a Carnot engine with 40% efficiency is 27°C. If the efficiency is to be increased by an additional 30%, by how much must the temperature of the source be raised? (4 Marks)

11. Draw a P-V diagram for both adiabatic and isothermal processes starting from the same initial state. Determine which process has a steeper slope and validate your conclusion by deriving the expressions for the slopes of both processes. (6 Marks)

12. A circuit consist of capacitance $0.1\mu F$, Inductance 10 mH and resistance 200 Ω connected in series. Prove that the circuit is oscillatory in nature. Also show that the frequency of the oscillation is $\dfrac{3 \times 10^4}{2\pi} Hz$. (6 Marks)

13. (a) Why is the alternating current (AC) flowing through a pure capacitor referred to as "wattless current"?

 (b) Prove mathematically that the average power consumed in a purely capacitive circuit over a complete cycle is zero. (6 Marks)

14. What is the glancing angle on the (100) plane of a cubic crystal of unit cell edge 0.45 nm for the first order diffraction maximum if the wavelength of the electromagnetic wave incident on it is 0.154 nm? (4 Marks)

15. (a) With the help of Weiss's postulate, arrive at Curie-Weiss law of ferromagnetism using the expression $M = NB\mu^2/3kT$, M is the magnetisation, $\mu$ is the magnetic moment of the dipole, N is the number density of dipoles, B is the magnetic induction, k is the Boltzmann constant, and T the absolute temperature.

 (b) What is the significance of the Curie temperature in the expression obtained? (6 Marks)

16. (a) Which are the two mutually independent fundamental properties of type I superconductors? Show that this superconducting phase is a characteristic phase of the material in which it cannot sustain steady electric and magnetic fields.

(b) What happens to a type II superconductor when a magnetic field is applied?                                                             (6 Marks)

17. Compare the output waveforms of a half-wave and a full-wave rectifier. Give any two advantages of a full-wave rectifier over a half-wave rectifier?
                                                                    (4 Marks)

18. Explain Zener diode as a voltage regulator. Draw the circuit diagram and its working.                                               (6 Marks)

19. Discuss the working of an RC phase shift oscillator with circuit diagram.
                                                                    (6 Marks)

20. Find the binary equivalent of $(17.25)_{10}$.                  (4 Marks)

21. What do you understand by ROM, RAM, EPROM and EEPROM? Classify them as non - volatile and volatile type of memory.               (4 Marks)

22. Write down the functions of accumulator in INTEL 8085.         (4 Marks)

23. Subtract $(-23)_{10}$ from $(+50)_{10}$ using 2's complement arithmetic. Represent the result in 2's complement binary as well as in decimal.       (5 Marks)

24. A logic system has three inputs $X$, $Y$ and $Z$ and a single output given by function $\overline{X}Y + Y\overline{Z} + YZ + X\overline{Y}\,\overline{Z}$. Show that the minimized logical output using Boolean laws is $Y + X\overline{Z}$.                           (5 Marks)

25. Explain the concept of multiple trace in an oscilloscope.      (4 Marks)

26. What is a transducer? Distinguish between active and passive transducers. Explain about a strain gauge.                                  (6 Marks)

27. Discuss about systematic errors and random errors.            (6 Marks)

28. Explain the three reasons why electrons cannot be present in a nucleus.

(4 Marks)

29. Explain Nuclear Fission, on the basis of Bohr-Wheeler theory.     (6 Marks)

30. Define :
    (a)     half-life period of a radio-active element and

    (b)     disintegration constant. The disintegration constant of a radioactive element is 0.00693 per day. Calculate the half-life period.

(6 Marks)

31. How are the layers of the Earth's atmosphere distinguished on the basis of temperature variation? Explain.     (5 Marks)

32. Discuss the origin and significance of ionospheric electric fields.

(5 Marks)

33. Explain the working principle of a Helium–Neon (He–Ne) laser. Describe how population inversion is achieved and how laser action takes place.

(6 Marks)

34. Compare and contrast Step-index and graded-index optical fibers with respect to refractive index profile, dispersion and application.     (6 Marks)

35. Calculate the optical output power of an LED operating with forward electron current of 8 mA. The LED emits light of wavelength 620 nm and the external quantum efficiency of the LED is 50%. (Given that : $hc \approx$ 1240 eV/nm, electronic charge, e = 1.6 $\times$ $10^{-19}$ C.)     (4 Marks)

36. What are the advantages of PIN photodiode over the ordinary p-n junction photodiode?     (4 Marks)

37. Why the properties of materials at the nanoscale are different from that in the bulk form?     (5 Marks)

38. Explain the principle and method of nanolithography.     (5 Marks)

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