1. Calculate the number of molecules in 5.6 g of carbon monoxide. [Mass of carbon = 12 g/mol, Mass of oxygen = 16 g/mol] (5 Marks)

2. Write down the electronic configuration of elements with atomic numbers 24 and 28. (5 Marks)

3. Explain the shape of $SnCl_2$ on the basis of VSEPR theory. (5 Marks)

4. Compare the bond order of O_2, O_2^+ and O_2^-, which would have the shortest bond length? (5 Marks)

5. Define entropy. Derive an equation to express the change in entropy quantitatively for a perfect gas accompanying isothermal expansion from a volume V_i to a volume V_f. (5 Marks)

6. Explain the origin of colligative properties and how they affect the freezing point and boiling point of a solvent. Give mathematical expressions. (5 Marks)

7. Explain Hess's law and apply it to calculate the standard enthalpy of combustion of propene. Given the thermochemical equations : (5 Marks)

	$\Delta H(kJ)$
$C_3H_{6(g)} + H_{2(g)} \rightarrow C_3H_{8(g)}$	–124
$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$	–2220
$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$	–286

8. Give the cell reaction and the electrode half-reactions of the cell given below : (5 Marks)

$$Ag(s) \mid AgNO_3(aq, b_L) \mid\mid AgNO_3(aq, b_R) \mid Ag(s)$$

What change in potential would you expect from the cell if the molar concentration of silver nitrate in the left-hand compartment increased?

9. Differentiate between galvanic and fuel cells. Salt bridges are often employed in electrochemical cell measurements: Justify. (5 Marks)

10. Write the Arrhenius equation, the mathematical expression for the dependence of reaction rate on temperature. How can you determine the value of ln A and $-\frac{E_a}{RT}$ from the general form of an Arrhenius plot? How does the rate of a reaction with zero activation energy change with temperature? (5 Marks)

11. Applying Le Chatelier's principle, predict the changes that can be observed in the equilibrium composition of an endothermic and an exothermic reaction. Also, explain why nitrogen monoxide (nitric oxide) is formed in significant quantities in the hot exhausts of jet engines. (5 Marks)

12. Write the formulation of Langmuir adsorption isotherm. Describe the conditions under which fractional coverage (θ) reaches 1 and $\frac{1}{2}$. (5 Marks)

13. Explain the hybridization and shape of cuprammonium ion. (5 Marks)

14. The stability constant of $[Fe(CN)_6]^{3-}$ is about 10^{31} and that of $[Fe(CN)_6]^{4-}$ is only about 10^6. Explain. (5 Marks)

15. The density of copper metal is 8.95 g cm^{-3} and the radius of copper atom is 127.8 pm. At mass of Cu is 63.54 g mol^{-1} and NA = 6.02 10^{23} mol^{-1}. Illustrate with suitable calculations that the copper unit cell in copper metal is Face Centered Cubic (FCC). (5 Marks)

16. Calculate the angle at which the first order Bragg reflection is observed from (110) plane in a simple cubic unit cell of side 3.24 A°, when Chromium $K\alpha$ radiation of wavelength 2.29 A° is used. (5 Marks)

17. What is radio activity? Explain different types of decay processes. (5 Marks)

18. Explain briefly carbon dating. An old wooden bowl is found to contain 25% of the original carbon-14 compared to a living tree. The half-life of carbon-14 is 5,730 years. Estimate the age of the wooden bowl. (5 Marks)

19. What is VSEPR theory? Explain the structure of $BeCl_2$, BF_3 and CH_4 based on VSEPR theory. (5 Marks)

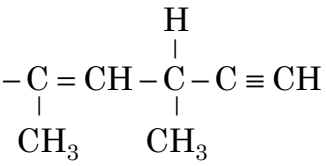
20. Why ionic and covalent bonds are formed in molecules? Make a comparative study on it. (5 Marks)

21. How will you synthesise 1,3,5-tribromobenzene from aniline? (5 Marks)

22. Give the IUPAC name of the following compounds. (5 Marks)

(a) $CH_3 - CH_2 - CO - CH_2 - CH_2 - COOCH_3$

(b) $CH_2 = CH - CH_2 - CH_2 - CO - NH_2$

(c) 

23. How many stereoisomers are possible for 2,3-butanediol? Draw the Fischer projections of each and state the stereochemical relationship between each pair of structures. (5 Marks)

24. Assign and justify the relative basic strengths of NH_3, CH_3NH_2 and NF_3. (5 Marks)

25. Mention any two tests used to distinguish between aniline and ethylamine. (5 Marks)

26. Compound A ($C_4H_{10}O$), undergoes oxidation to give Compound B (C_4H_8O). Compound B forms oxime but does not give Tollens' test. Compound B reacts with iodine and KOH to give iodoform. Deduce the structure of Compound A and Compound B. (5 Marks)

27. What is meant by a chiral centre? Can a carbon radical act as a chiral centre? Explain. (5 Marks)

28. Describe a method for converting acetic acid into propanoic acid. (5 Marks)

29. How will you synthesise: (5 Marks)

    (a) Diphenyl methane from benzophenone

    (b) Salicylaldehyde from phenol?

30. What happens when acetone is treated with NaOH followed by heating? Predict the product and write the reaction. (5 Marks)

31. Compare the glycosidic linkages in starch and cellulose (diagram not needed). How these linkages affect structure and digestibility. (5 Marks)

32. Explain the secondary structure of proteins with labelled diagrams. (5 Marks)

33. How does gel electrophoresis enable the separation of DNA fragments? (5 Marks)

34. Illustrate the process of translation in protein synthesis and write the Roles of mRNA, tRNA, and rRNA in this process. (5 Marks)

35. (a) What is quantum yield of a photochemical reaction? (2 Marks)

    (b) Why certain reactions exhibit high quantum yield values and some other reactions exhibit low quantum yield values? (3 Marks)

36. (a) Analyse the difference between fluorescence and phosphorescence. (3 Marks)

    (b) Explain briefly the photochemistry of vision. (2 Marks)

37. (a) Identify the type of catalysis of the following reaction and explain its mechanism. (3 Marks)

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{NO} 2SO_{3(g)}$$

(b) According to Michaelis – Menten mechanism, how an enzyme convert a substrate into product? (2 Marks)

38. (a) Why real gases deviate from ideal behaviour? (3 Marks)

(b) Write Van der Waal's equation for '*n*' moles of a gas and explain the terms. (2 Marks)

39. Outline the principles of green chemistry. (5 Marks)

40. Differentiate the top-down and bottom-up approaches for nanomaterial synthesis, and provide a brief explanation of the sol-gel method. (5 Marks)

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