



Attempt all questions before checking the answer key.
Use $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$. Atomic masses: H 1, C 12, N 14, O 16, Na 23, S 32, Cl 35.5, Ca 40.

A. Very short answers - 1 mark each

1. Define one mole in terms of elementary entities.
2. State the law of conservation of mass.
3. What is the difference between empirical and molecular formulae?
4. How many significant figures are in 0.004070?
5. Define molarity and state its unit.
6. Why does molality not change with temperature for a solution of fixed composition?

B. Short answers / practice - 2 marks each

7. Calculate the number of molecules in 9 g of water.
8. Find the mass of 0.25 mol of Na_2CO_3 .
9. Calculate the percentage of oxygen by mass in CaCO_3 .
10. Find molarity when 4 g NaOH is dissolved to make 500 mL solution.
11. Distinguish 0.5 mol of NaCl from 0.5 M NaCl solution.
12. State the law of multiple proportions and illustrate it using CO and CO_2 .
13. Find moles in 11 g CO_2 .
14. Find mass of 0.50 mol H_2SO_4 .
15. Does one mole of O_2 contain one mole of oxygen atoms?
16. Find molarity of 0.10 mol solute in 250 mL solution.
17. Find mass percentage of carbon in CH_4 .
18. A 100 mL 1 M solution is diluted to 500 mL. Find final molarity.

C. Short answers - 3 marks each

19. A compound has 40.0% C, 6.67% H and 53.33% O. Find its empirical formula; if molar mass is 180 g/mol, find its molecular formula.
20. Find molality and mole fraction of glucose in a solution of 18 g glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, in 180 g water.
21. What volume of 2.0 M HCl is needed to prepare 250 mL of 0.20 M HCl? State the dilution relation used.

22. For $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$, 14 g N_2 reacts with 6 g H_2 . Identify the limiting reagent and find theoretical mass of ammonia.

23. A 10 g impure CaCO_3 sample gives 3.52 g CO_2 on complete reaction with excess acid. Find the percentage purity.

24. A 200 mL solution contains 0.20 mol NaCl and is mixed with 300 mL containing 0.15 mol NaCl. Assuming additive volumes, find the final molarity.

D. Long answers - 5 marks each

25. Balance the combustion equation of propane. For 22 g C_3H_8 burning completely, calculate required oxygen mass, water mass and number of CO_2 molecules formed.

26. A 5.0 g mixture of CaCO_3 and an inert impurity is heated to constant mass of 3.24 g. Calculate CaCO_3 mass, purity and moles of gas evolved, explaining the stoichiometry.

27. A compound contains 52.17% C, 13.04% H and 34.79% O and has molar mass 46 g/mol. Determine empirical and molecular formulae and mass of carbon in 9.2 g compound.

28. For $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, 5 g H_2 and 32 g O_2 are mixed. Find the limiting reagent, mass of water, excess reagent remaining and percentage yield if 27 g water is collected.

29. A solution is 10% NaOH by mass and has density 1.10 g/mL. Calculate molarity, molality and solute mole fraction using a suitable sample basis.

30. Explain systematic errors, random errors and significant figures. Round 12.786 to three significant figures, evaluate $12.11 + 0.3 + 1.024$ appropriately, and calculate 2.5×3.42 with justified precision.

ANSWER KEY - Numerical / short answers

4) 4 significant figures. 7) 3.011×10^{23} molecules. 8) 26.5 g. 9) 48%. 10) 0.20 mol/L. 13) 0.25 mol. 14) 49 g. 15) No; it contains two moles of O atoms. 16) 0.40 M. 17) 75%. 18) 0.20 M. 19) CH_2O ; $\text{C}_6\text{H}_{12}\text{O}_6$. 20) 0.556 mol/kg; glucose mole fraction $1/101 \approx 0.00990$. 21) 25 mL. 22) N_2 limiting; 17 g NH_3 . 23) 80%. 24) 0.70 M. 25) $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$; O_2 80 g; H_2O 36 g; CO_2 9.033×10^{23} molecules. 26) CaCO_3 4.0 g; purity 80%; gas 0.040 mol. 27) $\text{C}_2\text{H}_6\text{O}$ for both; carbon 4.8 g. 28) O_2 limiting; 36 g water; 1 g H_2 remains; yield 75%. 29) 2.75 M; 2.778 mol/kg; $x_{\text{NaOH}} = 1/21 \approx 0.04762$. 30) 12.8; 13.4; 8.6.