Q1.

Define the term mole and explain why the mole is a useful concept in chemistry.

Q2.

A compound contains 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen by mass.

(a) Determine the empirical formula of the compound.

(b) If the relative molecular mass is 180, determine the molecular formula.

Q3.

10.0 g of calcium carbonate reacts with excess hydrochloric acid according to the equation:

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

Calculate the volume of CO_2 produced at RTP.

Q4.

Explain what is meant by the limiting reactant and describe a method to identify it using calculations.

Q5.

A student prepares a salt using a reaction that theoretically should produce 8.00 g of product.

The actual mass obtained is 6.20 g.

Calculate the percentage yield and explain two reasons why it may be less than 100%.

Q6.

Define atom economy and explain why it is important in green chemistry.

Q7.

Explain why a balanced chemical equation must be written before performing any stoichiometric calculation.

Q8.

At STP, 0.250 mol of gas X occupies a volume V.

Calculate V and state the assumptions made in your calculation.

Q9.

Describe how you would determine the empirical formula of magnesium oxide using an experimental method.

_____

_____

Q10.

Explain the difference between:

(a) empirical formula

(b) molecular formula

(c) structural formula

_____

_____

_____

SECTION B — ACIDS, BASES & TITRATIONS (Q11–25)

Q11.

Define an acid and a base according to the Brønsted–Lowry theory, using a chemical equation to illustrate your answer.

_____

_____

Q12.

Explain the difference between a strong acid and a weak acid in terms of ionisation in water.

_____

_____

_____

Q13.

The pH of a solution changes from 3 to 5.

(a) Calculate the change in hydrogen ion concentration.

(b) Explain why this change is significant.

Q14.

Derive the expression for pH and explain why the pH scale is logarithmic.

Q15.

Calculate the pH of a solution with a hydrogen ion concentration of

1.0×10^{-4} mol dm^{-3}.

Q16.

Explain why pH depends on concentration rather than acid strength alone, using an example.

Q17.

Describe the process of acid–base neutralisation, including an ionic equation.

Q18.

Explain the difference between:

(a) equivalence point

(b) end point

in a titration.

_____

_____

_____

Q19.

Sketch a titration curve for a strong acid–strong base titration.

Label:

- initial pH
- equivalence point
- steep region

Q20.

Sketch and explain the difference between:

- strong acid–strong base titration
- weak acid–strong base titration

Q21.

Explain how a buffer solution resists changes in pH when:

(a) acid is added

(b) base is added

Q22.

Describe how you would prepare a buffer solution in the laboratory.

Q23.

State the colour changes of:

- litmus
- phenolphthalein
- methyl orange
  in acidic and alkaline solutions.

Q24.

Explain why the equivalence point is not always at pH 7.

Q25.

Describe how a titration experiment can be used to determine an unknown concentration, including apparatus and key steps.

SECTION C — ORGANIC CHEMISTRY (Q26–45)

Q26.

Define the term homologous series and explain why members show similar chemical properties.

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_____

Q27.

Describe the bonding and structure of carbon, including why carbon forms such a large number of compounds.

_____

_____

Q28.

Explain the difference between saturated and unsaturated hydrocarbons, including a test to distinguish them.

_____

_____

_____

Q29.

Describe the structure and bonding in:

(a) ethane

(b) ethene

_____

_____

Q30.

Explain what is meant by electrophilic addition using the reaction of ethene with bromine.

_____

_____

Q31.

Describe the mechanism of free-radical substitution in the chlorination of methane.

Q32.

Explain the difference between substitution and elimination reactions using haloalkanes.

Q33.

Describe the elimination of ethanol to form ethene, including conditions.

Q34.

Explain oxidation and reduction in terms of:

(a) oxygen

(b) hydrogen

Q35.

Describe the oxidation of ethanol under:

(a) controlled conditions

(b) reflux

Q36.

Explain the purpose of reflux in organic chemistry experiments.

Q37.

Describe how carboxylic acids react with alcohols to form esters.

Q38.

Explain why esters have characteristic smells and give one practical use.

Q39.

Define addition polymerisation and describe the formation of poly(ethene).

Q40.

Explain condensation polymerisation, including the formation of polyesters.

Q41.

Compare addition and condensation polymerisation.

Q42.

Explain why benzene undergoes substitution rather than addition reactions.

Q43.

Describe the structure of benzene and explain its stability.

Q44.

Define isomerism and describe structural isomerism with an example.

Q45.

Explain how functional groups determine chemical reactivity.

SECTION D — DATA & GRAPH-BASED QUESTIONS (Q46–50)

Q46.

Sketch a graph showing pH vs volume of base added for a weak acid–strong base titration and explain the shape.

Q47.

A student records the following titration results (data provided).

Explain how anomalous results are identified and justify whether they should be excluded.

_____

_____

_____

Q48.

Explain how experimental uncertainties affect calculated values in titration experiments.

_____

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Q49.

Describe how a student could improve the accuracy and precision of a titration experiment.

_____

_____

Q50.

Explain why graphical analysis is useful in chemistry experiments and give two examples.

_____

_____

_____