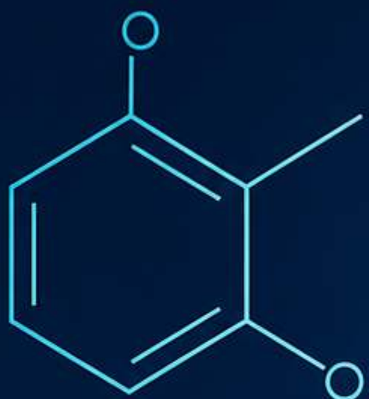
Chemistry Reference Booklet

from Alphalearn Studylab

Class 10 • CBSE Science • Board Exam 2027



How to Use This Booklet

Every chapter follows the same route. Learn it once in Chapter 1 and you know the whole book: **Mind Map → Definitions & Equations → Solved Examples → Diagram Sheets → Practice Set → Step-wise Answer Key → Exam Radar → Quick Revision.**

What makes this booklet exam-first

- Q **Question cards with competency tags.** Every practice question is tagged Remember / Understand / Apply / Analyse — the same cognitive levels CBSE uses — plus marks chips (1 / 2–3 / 5).
- ✓ **Step-wise answers with marking schemes.** Every 5-mark answer carries a breakdown table showing exactly where each half-mark and full mark sits, the way examiners award them.
- ⚙ **Assertion–Reason and Case-Study questions** in every chapter, matching the CBSE 2027 paper design.
- ★ **Exam Radar.** The eight most probable questions per chapter — and the reason each one keeps appearing.

Colour code

- **Indigo** — Definitions & master equations
- **Green** — Solved examples & answer keys
- **Slate** — Practice question cards
- **Amber** — Exam Radar
- **Red** — Mistakes & examiner tips
- **Chapter colour** — One-page revision

Contents

Strictly based on the prescribed NCERT chapters • CBSE Board Exam 2027 pattern • Competency, Assertion–Reason and Case-Study questions included

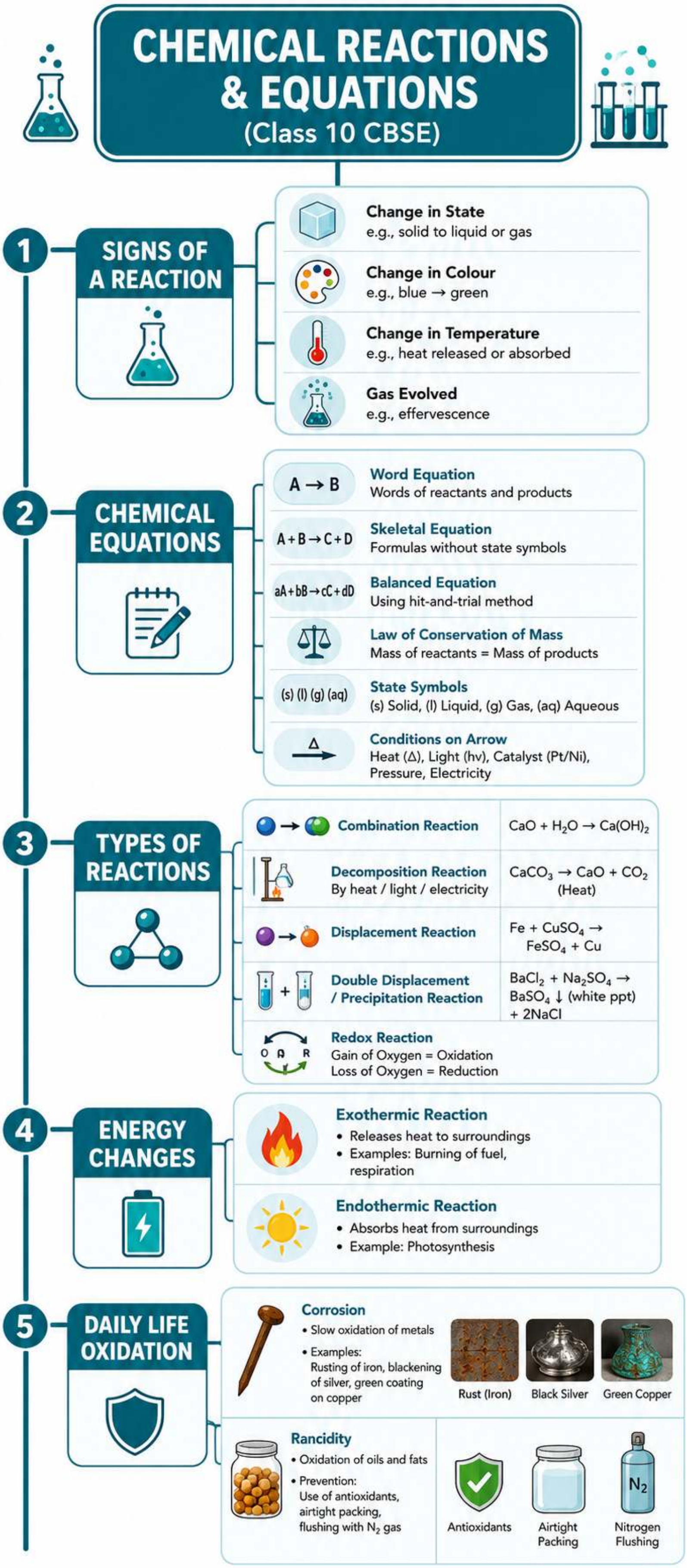
CHAPTER 1

Chemical Reactions and Equations

Balancing, five reaction types, redox, corrosion and rancidity

Mind Map | Master Equations | Solved Examples | Labelled Diagrams | 22-Q Practice + Key | Exam Radar | 1-Page Revision

CHAPTER 1 • MIND MAP — THE CHAPTER AT A GLANCE



KEY DEFINITIONS & MASTER EQUATIONS

2.1 Key Definitions (write these in exams exactly at this level of detail)

1. **Chemical equation:** A shorthand way of showing a chemical reaction using symbols and formulae of the reactants and products.

2. **Skeletal equation:** An equation written with correct formulae but with unequal numbers of atoms on the two sides.

3. **Balanced equation:** An equation in which the count of every type of atom is the same on the reactant side and the product side. Equations must be balanced because of the **Law of Conservation of Mass** — matter can neither be created nor destroyed in a reaction.

4. **Combination reaction:** Two or more substances join to form a single product.

5. **Decomposition reaction:** A single compound breaks up into two or more simpler substances when energy (heat, light or electricity) is supplied.

6. **Displacement reaction:** A more reactive element removes a less reactive element from its compound.

7. **Double displacement reaction:** Two compounds in solution exchange their ions to form two new compounds.

8. **Precipitation reaction:** Any reaction that produces an insoluble solid (precipitate).

9. **Exothermic reaction:** A reaction that releases heat along with the products.

10. **Endothermic reaction:** A reaction that absorbs energy from the surroundings.

11. **Oxidation:** Gain of oxygen or loss of hydrogen by a substance.

12. **Reduction:** Loss of oxygen or gain of hydrogen by a substance.

13. **Redox reaction:** A reaction in which one substance is oxidised while another is reduced at the same time.

14. **Corrosion:** The slow eating away of a metal surface when it is attacked by moisture, air, acids or other substances around it.

15. **Rancidity:** The unpleasant change in smell and taste of fat/oil-containing food due to oxidation.

2.2 Master List of Balanced Equations (all examinable)

Combination reactions 1. $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ (dazzling white flame) 2. $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$ + Heat (quicklime → slaked lime; exothermic) 3. $C(s) + O_2(g) \rightarrow CO_2(g)$ (burning of coal) 4. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Exothermic combustion / respiration 5. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ (natural gas burning) 6. $C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l)$ + energy (respiration)

Whitewashing chemistry (frequently asked pair) 7. $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ (shiny wall finish after 2–3 days)

Decomposition — by HEAT (thermal decomposition) 8. $2FeSO_4(s) \xrightarrow{Heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$ (green → brown; smell of burning sulphur) 9. $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$ (limestone → quicklime; used in cement industry) 10. $2Pb(NO_3)_2(s) \xrightarrow{Heat} 2PbO(s) + 4NO_2(g) + O_2(g)$ (brown fumes of NO_2)

Decomposition — by ELECTRICITY 11. $2H_2O(l) \xrightarrow{Electric\ current} 2H_2(g) + O_2(g)$ (hydrogen : oxygen collected = 2 : 1 by volume)

Decomposition — by LIGHT (photolytic) 12. $2AgCl(s) \xrightarrow{Sunlight} 2Ag(s) + Cl_2(g)$ (white → grey; basis of photography) 13. $2AgBr(s) \xrightarrow{Sunlight} 2Ag(s) + Br_2(g)$

Endothermic example 14. $6CO_2(aq) + 12H_2O(l) \xrightarrow{Sunlight,\ Chlorophyll} C_6H_{12}O_6(aq) + 6O_2(aq) + 6H_2O(l)$ (photosynthesis)

Displacement reactions 15. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$ (blue solution fades; nail turns brownish) 16. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$ 17. $Pb(s) + CuCl_2(aq) \rightarrow PbCl_2(aq) + Cu(s)$ 18. $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$ (silver refining)

Double displacement / precipitation 19. $Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s)\downarrow + 2NaCl(aq)$ (white precipitate) 20. $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s)\downarrow + 2KNO_3(aq)$ (yellow precipitate)

Redox reactions 21. $2Cu(s) + O_2(g) \xrightarrow{Heat} 2CuO(s)$ (brown copper → black coating; Cu oxidised) 22. $CuO(s) + H_2(g) \xrightarrow{Heat} Cu(s) + H_2O(l)$ (CuO reduced, H_2 oxidised) 23. $ZnO + C \rightarrow Zn + CO$ (C oxidised, ZnO reduced) 24. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$ (HCl oxidised to Cl_2, MnO_2 reduced) 25. $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$ (iron + steam; the classic balancing example)

SOLVED EXAMPLES — BOARD STYLE

Solved Example 1 (3 marks) — Balancing by hit-and-trial

Q. Balance the equation: $Fe + H_2O \rightarrow Fe_3O_4 + H_2$. Show the steps.

Answer: - Step 1 — Count atoms in the skeletal equation: Fe → LHS 1, RHS 3 | H → LHS 2, RHS 2 | O → LHS 1, RHS 4 - Step 2 — Balance oxygen first (element in the compound with most atoms, Fe_3O_4): put 4 before H_2O → $Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$ - Step 3 — Hydrogen is now 8 on the LHS, so put 4 before H_2 → $Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$ - Step 4 — Balance iron: put 3 before Fe → **$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$** - Step 5 — Recheck: Fe 3=3, H 8=8, O 4=4. Balanced. ✓ - Adding physical states: **$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$** — note (g) with H_2O because steam is used here.

Solved Example 2 (3 marks) — Identifying reaction types

Q. Identify the type of each reaction: (a) $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$ (b) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ (c) $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$ (d) $Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

Answer: (a) **Thermal decomposition** — one compound breaks into two on heating. (b) **Combination** — two elements join to form a single product. (c) **Displacement** — zinc (more reactive) pushes copper out of its salt. (d) **Double displacement (precipitation)** — Na^+/Ba^{2+} ions exchange partners; insoluble $BaSO_4$ forms.

Solved Example 3 (3 marks) — Observation-based

Q. An iron nail is dipped in copper sulphate solution and left for 20 minutes. State two observations and write the balanced equation. Name the reaction type.

Answer: - Observation 1: The blue colour of the solution fades (becomes light green) because blue $CuSO_4$ changes to green $FeSO_4$. - Observation 2: A brownish layer of copper metal deposits on the nail. - Equation: **$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$** - Type: **Displacement reaction** — iron is more reactive than copper, so it displaces copper from its salt solution.

Solved Example 4 (3 marks) — Redox identification

Q. In the reaction $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$, identify the substance oxidised, the substance reduced, and justify.

Answer: - **HCl is oxidised** → it loses hydrogen and changes to Cl_2 (loss of hydrogen = oxidation). - **MnO_2 is reduced** → it loses oxygen and changes to $MnCl_2$ (loss of oxygen = reduction). - Since oxidation and reduction happen together in the same reaction, this is a **redox reaction**.

Solved Example 5 (5 marks) — Application chain (whitewashing)

Q. A white solid 'X' is used for whitewashing. When water is added to X, a hissing sound is heard, the container becomes hot, and compound 'Y' is formed. When Y is applied on walls, it slowly reacts with a gas 'Z' from air and the wall gets a shiny finish after 2–3 days. Identify X, Y, Z; write both equations; name the reaction types and energy change involved.

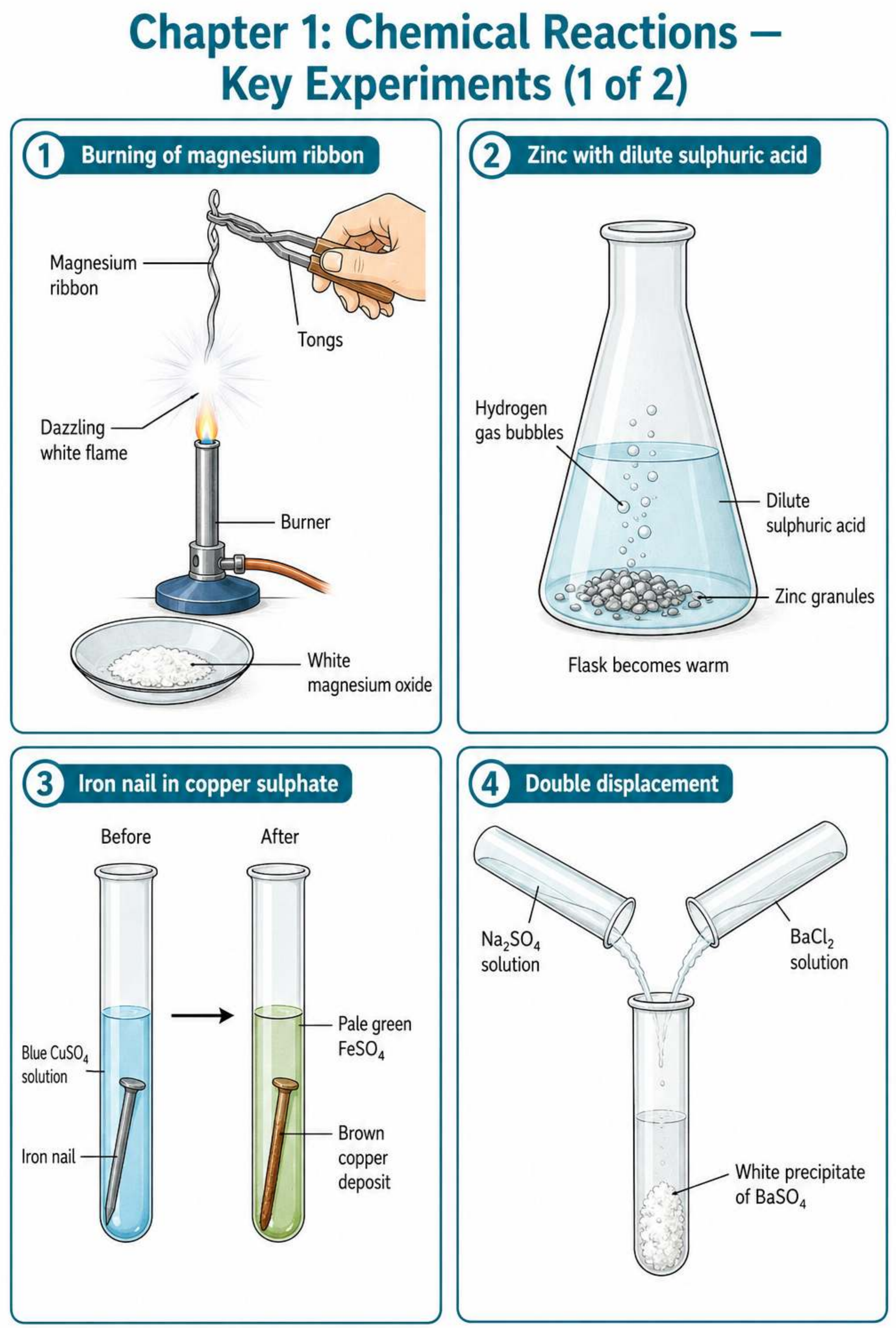
Answer: - **X = Calcium oxide (quicklime, CaO)**; **Y = Calcium hydroxide (slaked lime, $Ca(OH)_2$)**; **Z = Carbon dioxide (CO_2)**. - Equation 1: **$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$ + Heat** — a **combination** reaction; heat is released, so it is **exothermic** (this explains the hot container). - Equation 2: **$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$** — also a **combination-type reaction with a gas from air**. - The shine appears because a thin layer of **calcium carbonate ($CaCO_3$)** — the same compound as marble — forms on the wall over 2–3 days.

REAL-LIFE APPLICATION

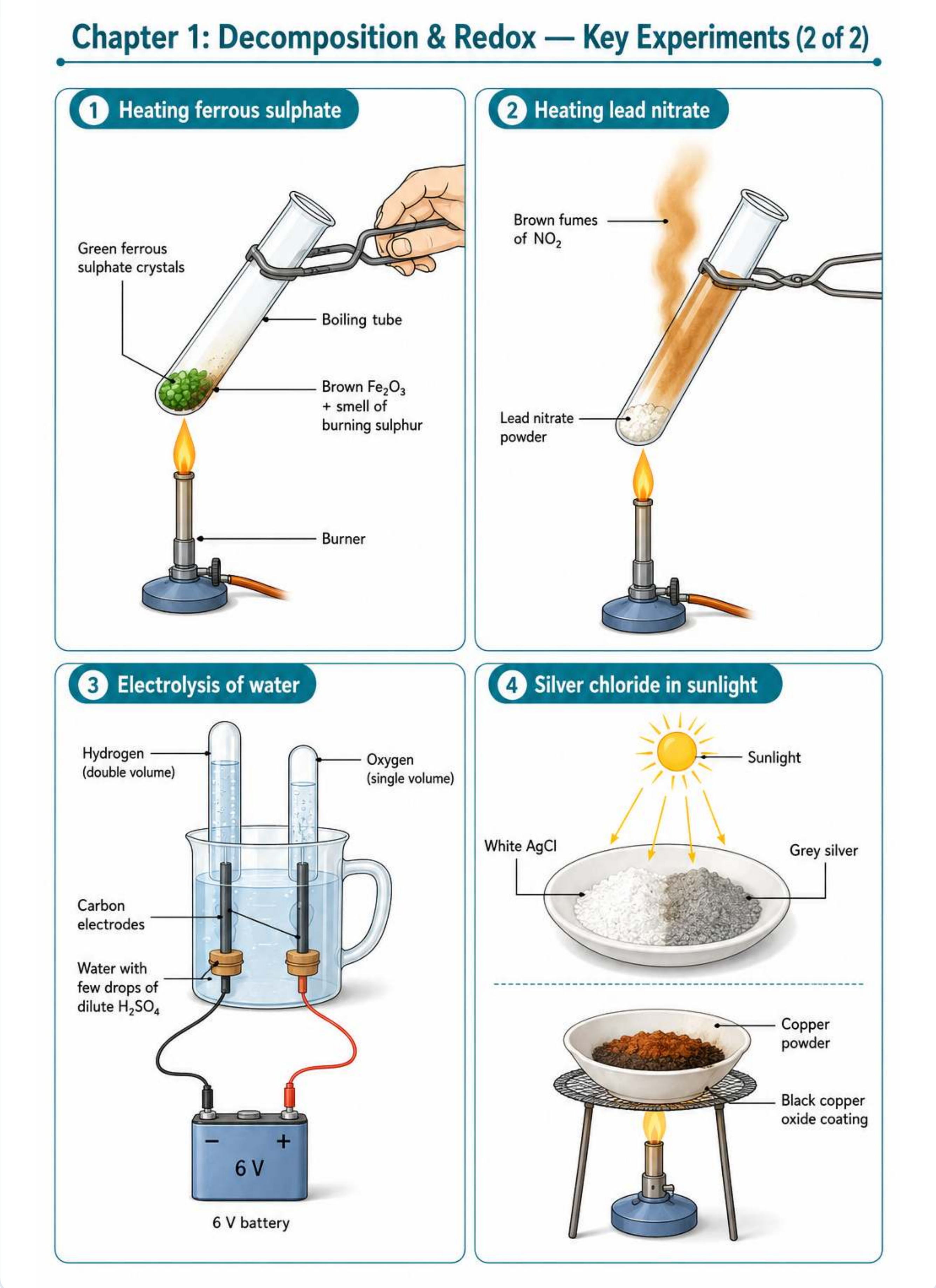
Whitewashing a house is pure chemistry in action

When quicklime (CaO) is slaked with water, the mixture becomes hot — an exothermic combination reaction. Painted on walls, the slaked lime slowly absorbs CO_2 from air and turns into a thin, shiny layer of calcium carbonate: the same compound as marble. That is why freshly whitewashed walls develop their finish only after two to three days.

CHAPTER 1 • KEY DIAGRAMS — SHEET 1



CHAPTER 1 • KEY DIAGRAMS — SHEET 2



PRACTICE SET — CBSE 2027 PATTERN

CHAPTER-WISE PRACTICE • 10 MCQ • 8 SHORT • 4 LONG (incl. CASE STUDY)

Part A — Multiple Choice Questions (1 mark each) — Q1 to Q10

Q1 1 MARK Analyse

In the reaction $2PbO(s) + C(s) \rightarrow 2Pb(s) + CO_2(g)$, which statement is INCORRECT?

(a) Lead is being reduced

(b) CO_2 is being oxidised

(c) Carbon is being oxidised

(d) PbO is being reduced (i) only

(b) (ii)

(a) and

(b) (iii)

(b) and

(d) (iv) all four

Q2 1 MARK Understand

$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$ is an example of a:

(a) combination reaction

(b) double displacement reaction

(c) decomposition reaction

(d) displacement reaction

Q3 1 MARK Apply

When dilute hydrochloric acid is added to iron filings:

(a) hydrogen gas and iron chloride form

(b) chlorine gas and iron hydroxide form

(c) nothing happens

(d) iron salt and water form

Q4 **1 MARK** Remember

Which gas is released in a 2:1 volume ratio with oxygen during electrolysis of water?

(a) Nitrogen

(b) Hydrogen

(c) Chlorine

(d) Carbon dioxide

Q5 **1 MARK** Understand

Silver chloride is stored in dark-coloured bottles because it:

(a) reacts with air

(b) is expensive

(c) decomposes in sunlight

(d) absorbs moisture

Q6 **1 MARK** Remember

The colour change when ferrous sulphate crystals are heated is:

(a) green → white

(b) blue → green

(c) green → brown

(d) white → grey

Q7 **1 MARK** Understand

Which of the following is an endothermic process?

(a) Respiration

(b) Burning of natural gas

(c) Decomposition of vegetable matter into compost

(d) Photosynthesis

Q8 1 MARK Remember

The yellow precipitate formed when lead nitrate solution is mixed with potassium iodide solution is:

(a) PbI_2

(b) KNO_3

(c) PbO

(d) KI

Q9 1 MARK Analyse (A-R) Assertion–Reason

Assertion (A): A magnesium ribbon must be cleaned with sandpaper before burning. **Reason (R):** Magnesium metal develops a protective oxide layer on its surface in air.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Q10 1 MARK Analyse (A-R) Assertion–Reason

Assertion (A): Chips packets are flushed with nitrogen gas. **Reason (R):** Nitrogen reacts with the oil in the chips and preserves it.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Part B — Short Answer Questions (2–3 marks) — Q11 to Q18

Q11 2 MARKS Understand

What is a balanced chemical equation? Why must equations always be balanced?

Q12 3 MARKS Understand

Why is respiration considered an exothermic reaction? Write the equation.

Q13 **2 MARKS** Apply

Translate into a balanced chemical equation with state symbols: "Solutions of barium chloride and sodium sulphate react to give insoluble barium sulphate and a solution of sodium chloride."

Q14 **3 MARKS** Remember

Write one balanced equation each for decomposition brought about by (a) heat, (b) light, (c) electricity.

Q15 **2 MARKS** Apply

In silver refining, silver is recovered from silver nitrate solution using copper metal. Write the balanced equation and name the reaction type.

Q16 **3 MARKS** Understand

What is a precipitation reaction? Explain with one example and equation.

Q17 **3 MARKS** Analyse

Distinguish between displacement and double displacement reactions with one equation each.

Q18 **3 MARKS** Apply

A shiny brown element 'X' turns black on heating in air. Identify X and the black compound, write the equation, and state which substance is oxidised.

Part C — Long Answer Questions (5 marks) — Q19 to Q22

Q19 **5 MARKS** Apply

(a) Balance the following equations: (i) $HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + H_2O$ (ii) $NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$ (iii) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$ (b) Translate and balance: "Potassium metal reacts with water to give potassium hydroxide and hydrogen gas."

Q20 **5 MARKS** Analyse

Define oxidation and reduction in terms of oxygen and hydrogen. In the reactions below, identify the substances oxidised and reduced with reasons: (i) $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ (ii) $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$ (iii) $ZnO + C \rightarrow Zn + CO$

Q21 **5 MARKS** **Understand**

What are exothermic and endothermic reactions? Give two examples of each with balanced equations. Why are most decomposition reactions endothermic?

Q22 **5 MARKS** **Competency (Case)**

Riya set up an experiment: she filled a plastic mug with water, added a few drops of dilute sulphuric acid, fitted two carbon electrodes connected to a 6 V battery, and inverted a water-filled test tube over each electrode. After some time, bubbles collected in both tubes, but one tube filled twice as fast as the other. When a burning candle was brought near the mouth of the faster-filling tube, the gas burnt with a pop sound. (a) Name the process taking place and the type of reaction. (1) (b) Write the balanced chemical equation. (1) (c) Identify the gases in the two test tubes and explain the 2:1 volume ratio. (2) (d) Why were a few drops of dilute sulphuric acid added to the water? (1)

EASY STEP-WISE ANSWER KEY

EASY STEP-WISE ANSWERS — WITH CBSE MARKING SCHEME FOR 5-MARKERS

Part A — MCQs

Ans. **Q1**

(i) (a) and (b) — Working: it is lead oxide (not lead) that gets reduced, so (a) is incorrect; and CO_2 is the product of oxidation — carbon is the substance oxidised — so (b) is also incorrect. Statements (c) and (d) are correct.

Ans. **Q2**

(d) Displacement — Al (more reactive) removes Fe from Fe_2O_3.

Ans. **Q3**

(a) — $Fe + 2HCl \rightarrow FeCl_2 + H_2$; active metals liberate hydrogen from dilute acids.

Ans. **Q4**

(b) Hydrogen — water contains H and O in 2:1 atom ratio, so H_2 collects at double the volume of O_2.

Ans. **Q5**

(c) — $2AgCl \xrightarrow{\text{Sunlight}} 2Ag + Cl_2$; light decomposes it, so dark bottles prevent this.

Ans. **Q6**

(c) green → brown — green $FeSO_4$ crystals give brown Fe_2O_3 on strong heating (with SO_2 + SO_3 gases).

Ans. **Q7**

(d) Photosynthesis — it absorbs sunlight energy; the other three release heat.

Ans. **Q8**

(a) PbI_2 — $Pb(NO_3)_2 + 2KI \rightarrow PbI_2\downarrow$ (yellow) + $2KNO_3$.

Ans. **Q9**

(a) — The white MgO layer stops the metal from contacting oxygen; sandpapering exposes fresh metal so it burns properly. R correctly explains A.

Ans. **Q10**

(c) — A is true, but R is false: nitrogen is used precisely because it is UNreactive; it pushes out oxygen and prevents oxidation (rancidity) of the oil.

Part B — Short Answers

Ans. **Q11**

A balanced equation has an equal number of atoms of every element on both sides of the arrow. Balancing is compulsory because of the **Law of Conservation of Mass** — atoms are neither created nor destroyed in a reaction, so total mass of reactants must equal total mass of products.

Ans. **Q12**

During respiration, glucose (from digested carbohydrates) combines with oxygen in body cells and **releases energy** — since heat/energy is given out, it is exothermic. **$C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l)$ + energy**

Ans. **Q13**

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s)\downarrow + 2NaCl(aq)$ (1 mark for correct formulae and balancing; 1 mark for correct state symbols — $BaSO_4$ must be (s).)

Ans. **Q14**

(a) Heat: **$CaCO_3(s) \xrightarrow{\text{Heat}} CaO(s) + CO_2(g)$** (b) Light: **$2AgCl(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + Cl_2(g)$** (c) Electricity: **$2H_2O(l) \xrightarrow{\text{Electric current}} 2H_2(g) + O_2(g)$**

Ans. **Q15**

$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$ — a **displacement reaction**; copper is more reactive than silver, so it displaces silver from silver nitrate.

Ans. **Q16**

A precipitation reaction is any reaction that forms an **insoluble solid (precipitate)**. Example: mixing sodium sulphate and barium chloride solutions gives a white precipitate of barium sulphate: **$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s)\downarrow + 2NaCl(aq)$** The precipitate forms because Ba^{2+} ions combine with SO_4^{2-} ions to make insoluble $BaSO_4$.

Ans. **Q17**

In **displacement**, a single element replaces another element in a compound: **$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$** In **double displacement**, two compounds swap their ions: **$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$** Key difference: one reactant is a free element in displacement; both reactants are compounds in double displacement.

Ans. **Q18**

X = **Copper (Cu)**; black compound = **Copper(II) oxide (CuO)**. **$2Cu(s) + O_2(g) \xrightarrow{Heat} 2CuO(s)$** Copper gains oxygen, so **copper is oxidised**.

Part C — Long Answers

Ans. **Q19**

(a) (i) **$2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$** Working: 2 nitrate groups on RHS → $2HNO_3$; then H count (2+2=4) needs $2H_2O$. (ii) **$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$** Working: 2 Na on RHS → 2NaOH; H count 4 → $2H_2O$. (iii) **$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$** Working: 2 Cl on LHS → 2HCl on RHS; everything else already equal. (b) **$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$** Working: H_2 product forces even hydrogen count → double K, H_2O and KOH.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ Balancing (i) 2HNO3 + Ca(OH)2 → Ca(NO3)2 + 2H2O	1 m
✓ Balancing (ii) 2NaOH + H2SO4 → Na2SO4 + 2H2O	1 m
✓ Balancing (iii) BaCl2 + H2SO4 → BaSO4 + 2HCl	1 m
✓ Translating the statement into formulae	1 m
✓ Balanced: 2K + 2H2O → 2KOH + H2	1 m

Ans. **Q20**

Oxidation = gain of oxygen or loss of hydrogen. Reduction = loss of oxygen or gain of hydrogen. (i) **Na is oxidised** (gains oxygen → Na_2O); O_2 is the oxidising agent and is itself reduced. (ii) **H_2 is oxidised** (gains oxygen → H_2O); **CuO is reduced** (loses oxygen → Cu). (iii) **C is oxidised** (gains oxygen → CO); **ZnO is reduced** (loses oxygen → Zn). In each case oxidation and reduction occur together, so all three are redox reactions.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ Definitions of oxidation and reduction	1 m
✓ Reaction (i): Na oxidised, with reason	1 m
✓ Reaction (ii): H2 oxidised / CuO reduced, with reasons	1½ m
✓ Reaction (iii): C oxidised / ZnO reduced, with reasons	1½ m

Ans. **Q21**

Exothermic reactions release heat with the products; endothermic reactions absorb energy. Exothermic examples: **$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$** (burning of natural gas); **$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$ + Heat**. Endothermic examples: **$CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$**; **$6CO_2 + 12H_2O \xrightarrow{Sunlight/Chlorophyll} C_6H_{12}O_6 + 6O_2 + 6H_2O$** (photosynthesis). Most decomposition reactions are endothermic because breaking a stable compound into simpler substances **requires a continuous supply of energy** in the form of heat, light or electricity.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ Definitions of exothermic and endothermic	1 m
✓ Two exothermic examples with equations	1½ m
✓ Two endothermic examples with equations	1½ m
✓ Why most decompositions are endothermic	1 m

Ans. **Q22**

(a) **Electrolysis of water**; it is a **decomposition reaction** (brought about by electricity). (1) (b) **$2H_2O(l) \xrightarrow{Electric\ current} 2H_2(g) + O_2(g)$** (1) (c) Faster tube = **hydrogen** (burns with a pop); slower tube = **oxygen**. The ratio is 2:1 by volume because each water molecule contains two hydrogen atoms for every one oxygen atom, so twice the volume of H_2 is released. (2) (d) Pure water is a poor conductor of electricity; a few drops of dilute H_2SO_4 make the water conducting so that current can pass and electrolysis can occur. (1)

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Electrolysis of water; decomposition reaction	1 m
✓ (b) Balanced equation with condition on arrow	1 m
✓ (c) Identifying H2 and O2; explaining the 2:1 ratio	2 m
✓ (d) Role of dilute H2SO4 (making water conducting)	1 m

EXAM RADAR — TOP 8 HIGH-PROBABILITY QUESTIONS

#	Question	Why examiners love it
1	Why should a magnesium ribbon be cleaned before burning in air?	Tests understanding of the protective MgO layer — a classic 1–2 mark reasoning question asked repeatedly in boards and sample papers.
2	Balance $Fe + H_2O \rightarrow Fe_3O_4 + 4H_2$ showing hit-and-trial steps	The textbook's own worked model for balancing; perfect for testing the full method with working.
3	Iron nail in copper sulphate solution — observations + equation + type	Combines observation, equation-writing and classification in one question; ideal competency format.
4	Whitewashing chain: $CaO \rightarrow Ca(OH)_2 \rightarrow CaCO_3$	Links two equations, exothermic energy change and a daily-life application — a ready-made 5-mark or case-study question.
5	Why is respiration exothermic?	Cross-links chemistry with biology (Chapter 6) — CBSE prefers such interdisciplinary reasoning questions.
6	One decomposition equation each for heat, light and electricity	Covers all three energy sources in a single 3-mark answer — high content-per-mark, so frequently set.
7	Identify oxidised/reduced substances in given redox equations (e.g. $CuO + H_2$)	Direct test of the oxidation/reduction definitions; appears in MCQ, A-R and short-answer forms.
8	Why are food items containing oil flushed with nitrogen? / Corrosion vs rancidity	Application of oxidation to everyday life — competency-based questions are guaranteed marks in the current pattern.

COMMON MISTAKES & EXAMINER TIPS

Common mistakes students make: 1. **Changing formulae to balance equations.** You may only change coefficients (the numbers in front), never subscripts. Writing "MgO_2" to balance Mg + O_2 is a guaranteed zero. 2. **Forgetting state symbols** when the question specifically asks for them — this costs half to one full mark. 3. **Writing (l) for aqueous solutions.** A salt dissolved in water is (aq), not (l). (l) is only for pure liquids like water itself. 4. **Confusing displacement with double displacement.** Quick check: is a free element present among the reactants? If yes → displacement. If both reactants are compounds → double displacement. 5. **Saying "CO_2 is oxidised."** Products are not "oxidised" or "reduced" — the reactants are. Carbon is oxidised to CO_2. 6. **Writing the $FeSO_4$ decomposition wrongly** — remember it gives THREE products: Fe_2O_3 + SO_2 + SO_3 (many students drop SO_3). 7. **Missing the reaction condition on the arrow** (Heat / Sunlight / Electric current) for decomposition reactions — examiners award marks for it. 8. **Using unbalanced equations in answers.** Even if the equation is only supporting your explanation, it must be balanced.

Examiner tips for full marks: - In balancing questions, **show the atom-count table** (element | LHS | RHS) — it earns method marks even if the final answer slips. - Always end reaction-type questions with a **one-line reason** ("...because a more reactive metal displaces a less reactive one"). - For observation questions, give the **colour change AND the product responsible** for it. - In assertion–reason questions, first decide the truth of A and R separately, then check whether R is the actual cause of A. - Underline final balanced equations — presentation matters in board copies.

ONE-PAGE QUICK REVISION

THE CHAPTER IN 60 SECONDS

Signs of a reaction: change in state • colour • temperature • gas evolved

Balancing: Coefficients only, never subscripts → hit-and-trial method → based on Law of Conservation of Mass → add (s)(l)(g)(aq) + conditions on the arrow.

5 Reaction Types — one-line memory hooks: | Type | Pattern | Star example | |------|---------|--------------| | Combination | A + B → AB | $CaO + H_2O \rightarrow Ca(OH)_2$ + Heat | | Decomposition | AB → A + B | $CaCO_3 \xrightarrow{Heat} CaO + CO_2$ | | Displacement | A + BC → AC + B | $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ | | Double displacement | AB + CD → AD + CB | $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$ | | Redox | oxidation + reduction together | $CuO + H_2 \rightarrow Cu + H_2O$ |

Decomposition energy sources: Heat ($CaCO_3$, $FeSO_4$, $Pb(NO_3)_2$) • Light ($2AgCl \rightarrow 2Ag + Cl_2$) • Electricity ($2H_2O \rightarrow 2H_2 + O_2$, H:O = 2:1)

Energy: Exothermic = heat OUT (burning, respiration, CaO + water, composting) • Endothermic = energy IN (photosynthesis, most decompositions)

Redox one-liner: Oxidation = O gained / H lost • Reduction = O lost / H gained • Both always occur together.

Colour flashcards: - $CuSO_4$ solution: blue → fades (Fe dipped) - $FeSO_4$ crystals: green → brown Fe_2O_3 on heating - AgCl: white → grey in sunlight - PbI_2 precipitate: yellow • $BaSO_4$ precipitate: white - $Pb(NO_3)_2$ heating: brown fumes of NO_2 - Cu heated in air: brown → black CuO

Everyday oxidation: - **Corrosion** — metal attacked by moisture/air: iron → brown rust, silver → black (Ag_2S), copper → green coat. Prevent: painting iron articles blocks air + moisture. - **Rancidity** — fats/oils oxidise, taste and smell spoil. Prevent: antioxidants, airtight containers, nitrogen flushing.

Golden rule for the exam: every equation you write must be BALANCED, with conditions on the arrow and correct state symbols when asked.

AlphaLearn Studylab • Class 10 CBSE Chemistry • Chapter 1 Guide • Board Exam 2027 pattern

CHAPTER 2

Acids, Bases and Salts

Indicators, pH, neutralisation and the salt family from NaCl

Mind Map | Master Equations | Solved Examples | Labelled Diagrams | 22-Q Practice + Key | Exam Radar | 1-Page Revision

CHAPTER 2 • MIND MAP — THE CHAPTER AT A GLANCE

ACIDS, BASES & SALTS
(Class 10 CBSE)

1 IDENTIFICATION

Common Indicators

Litmus	Red in acid, Blue in base
Turmeric	Stays yellow in acid, turns reddish brown in base
Methyl orange	Red in acid, Yellow in base
Phenolphthalein	Colourless in acid, Pink in base

Olfactory Indicators

Onion, Vanilla, Clove

Change in smell in acidic or basic medium

2 REACTIONS

Acid + Metal	salt + H_2 (pop test) POP!
Acid + Carbonate	salt + CO_2 + H_2O • Lime water turns milky • Clears with excess CO_2
Neutralisation	salt + water
Oxides	Metal oxide (basic in nature); Non-metal oxide (acidic in nature)

3 THE H^+/OH^- IDEA

H^+ OH^-

- H_3O^+ Acids give H_3O^+ ions in water
- OH^- Bases give OH^- ions in water
- Alkalis are bases that are soluble in water
- Dry HCl gas is not acidic
- Always add acid to water, not water to acid (exothermic)

4 pH

pH Scale (0–14)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

< 7 Acidic | 7 Neutral | > 7 Basic

Antacids	Used to treat acidity (excess acid in stomach)
Tooth decay	Tooth decay occurs when pH in mouth < 5.5
Acid rain	Rain water is acidic when pH < 5.6
Bee sting	Bee sting is acidic; baking soda (base) gives relief

5 SALTS FROM NaCl

Chlor-alkali process	NaOH, Cl_2, H_2	Used in many industries
Bleaching powder	$Ca(ClO)_2$	Disinfecting and bleaching agent
Baking soda	$NaHCO_3$	Used in baking, antacid, fast relief
Washing soda	$Na_2CO_3 \cdot 10H_2O$	Used in cleaning, softening hard water
Plaster of Paris	$CaSO_4 \cdot \frac{1}{2}H_2O$ at 373 K	casts and moulds for fractured bones
Water of crystallisation	$CuSO_4 \cdot 5H_2O$	Blue crystals; used in labs and agriculture

KEY DEFINITIONS & MASTER EQUATIONS

2.1 Key Definitions

1. **Indicator:** A dye (or mixture of dyes) that shows the presence of an acid or base by a colour change.

2. **Olfactory indicator:** A substance whose **smell** changes in an acidic or basic medium (onion, vanilla, clove oil).

3. **Acid:** A substance that produces **H^+(aq) ions** when dissolved in water. H^+ cannot exist alone; it attaches to water as the **hydronium ion (H_3O^+)**.

4. **Base:** A substance that produces **OH^-(aq) ions** in water.

5. **Alkali:** A base that dissolves in water (e.g. NaOH, KOH). All alkalis are bases, but not all bases are alkalis.

6. **Neutralisation reaction:** An acid and a base react to give a salt and water: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$.

7. **Strong acid/base:** Produces a larger number of H^+/OH^- ions in solution (HCl, H_2SO_4, HNO_3 / NaOH, KOH).

8. **Weak acid/base:** Produces fewer H^+/OH^- ions (acetic acid, citric acid / NH_4OH).

9. **Dilution:** Adding water to an acid or base, which lowers the concentration of ions (H_3O^+/OH^-) per unit volume.

10. **pH scale:** A 0–14 scale that measures hydrogen-ion concentration; pH 7 is neutral, below 7 acidic, above 7 basic. Higher H^+ concentration → lower pH.

11. **Water of crystallisation:** The fixed number of water molecules present in one formula unit of a salt (e.g. 5 in $CuSO_4 \cdot 5H_2O$).

12. **Chlor-alkali process:** Electrolysis of brine (aqueous NaCl) giving NaOH, chlorine and hydrogen — named after its products (chlor = chlorine, alkali = NaOH).

2.2 Master List of Balanced Equations

Acid + Metal → Salt + Hydrogen 1. $Zn(s) + H_2SO_4(dil.) \rightarrow ZnSO_4(aq) + H_2(g)$ 2. $Mg(s) + 2HCl(dil.) \rightarrow MgCl_2(aq) + H_2(g)$ 3. $2Al(s) + 3H_2SO_4(dil.) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$ 4. $Fe(s) + 2HCl(dil.) \rightarrow FeCl_2(aq) + H_2(g)$ Test for H_2: bring a burning candle near — the gas burns with a pop sound.

Base + Metal (only some metals) 5. $2NaOH(aq) + Zn(s) \rightarrow Na_2ZnO_2(s) + H_2(g)$ (sodium zincate)

Acid + Carbonate / Hydrogencarbonate → Salt + CO_2 + H_2O 6. $Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$ 7. $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

Lime-water test for CO_2 (two stages — very frequently asked) 8. $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s)\downarrow + H_2O(l)$ (milkiness appears) 9. $CaCO_3(s) + H_2O(l) + CO_2(g, excess) \rightarrow Ca(HCO_3)_2(aq)$ (milkiness disappears — soluble salt forms)

Neutralisation 10. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ 11. In ionic form: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Metal oxide (basic) + Acid 12. $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$ (black CuO dissolves; blue-green solution)

Ionisation in water 13. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$ 14. $NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$; $Mg(OH)_2(s) \xrightarrow{H_2O} Mg^{2+}(aq) + 2OH^-(aq)$

Chemicals from common salt 15. **Chlor-alkali:** $2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electrolysis}} 2NaOH(aq) + Cl_2(g) + H_2(g)$ (Cl_2 at anode, H_2 at cathode, NaOH near cathode) 16. **Bleaching powder:** $2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(ClO)_2 + CaCl_2 + 2H_2O$ (chlorine on dry slaked lime) 17. **Baking soda (manufacture):** $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$ 18. **Baking soda on heating:** $2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + H_2O + CO_2$ (why cakes rise) 19. **Baking powder in action:** $NaHCO_3 + H^+$ (from tartaric acid) $\rightarrow CO_2 + H_2O$ + sodium salt of acid 20. **Washing soda:** $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3{\cdot}10H_2O$ (recrystallisation)

Water of crystallisation / Plaster of Paris 21. **Making PoP:** $CaSO_4{\cdot}2H_2O$ (gypsum) $\xrightarrow{\text{Heat at 373 K}} CaSO_4{\cdot}\frac{1}{2}H_2O + 1\frac{1}{2}H_2O$ 22. **Setting of PoP:** $CaSO_4{\cdot}\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4{\cdot}2H_2O$ (hard solid mass — gypsum re-forms)

2.3 Indicator Colour Table (memorise)

Indicator	In acid	In base
Blue litmus	Turns red	Stays blue
Red litmus	Stays red	Turns blue
Turmeric	Yellow (no change)	Reddish-brown
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink

2.4 Uses Table (direct 2–3 mark questions)

Compound	Formula	Key uses
Bleaching powder	$Ca(ClO)_2$	Bleaching cotton/linen/wood pulp; oxidising agent in industry; disinfecting drinking water
Baking soda	$NaHCO_3$	Baking powder (with tartaric acid); antacid; soda-acid fire extinguishers
Washing soda	$Na_2CO_3{\cdot}10H_2O$	Glass, soap and paper industries; making borax; domestic cleaning; removing permanent hardness of water
Plaster of Paris	$CaSO_4{\cdot}\frac{1}{2}H_2O$	Supporting fractured bones; toys; decoration material; smoothing surfaces

SOLVED EXAMPLES — BOARD STYLE

Solved Example 1 (3 marks) — Gas identification

Q. A metal compound 'A' reacts with dilute HCl producing effervescence. The gas evolved extinguishes a burning candle. If one product is calcium chloride, identify A and the gas, and write the balanced equation.

Answer: - The gas extinguishes a burning candle → it is $\mathbf{CO_2}$. A compound giving CO_2 with acid must be a carbonate; since the salt formed is $CaCl_2$, **A = calcium carbonate ($CaCO_3$)**. - $\mathbf{CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)}$ - Confirmatory test: passing the gas through lime water turns it milky: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3\downarrow + H_2O$.

Solved Example 2 (3 marks) — Why acids conduct but glucose doesn't

Q. Solutions of HCl and H_2SO_4 make a bulb glow in a conductivity set-up, but glucose and alcohol solutions do not — even though all four contain hydrogen. Explain.

Answer: - Electric current is carried through a solution by **ions**. - Acids ionise in water to give H^+(aq) (as H_3O^+) ions, so their solutions conduct and the bulb glows. - Glucose and alcohol contain hydrogen atoms but **do not release H^+ ions in water** — they stay as neutral molecules — so no current flows. - Conclusion: it is not hydrogen itself but **ionisable hydrogen (H^+)** that makes a substance an acid.

Solved Example 3 (3 marks) — pH reasoning

Q. Equal lengths of magnesium ribbon are placed in test tube A (dilute HCl) and test tube B (dilute acetic acid) of the same concentration. In which tube is fizzing more vigorous, and why?

Answer: - Fizzing is caused by hydrogen gas: $Mg + 2HCl \rightarrow MgCl_2 + H_2$. - HCl is a **strong acid** — it ionises completely, giving a high concentration of H^+ ions. - Acetic acid is a **weak acid** — it ionises only partially, giving fewer H^+ ions at the same concentration. - More H^+ → faster reaction → **fizzing is more vigorous in test tube A (HCl)**.

Solved Example 4 (3 marks) — Dilution safety

Q. Why must concentrated acid always be added slowly to water, and never water to acid?

Answer: - Dissolving a concentrated acid in water is a **highly exothermic** process. - If water is added to concentrated acid, the small amount of water heats up instantly; the mixture may **boil and splash out**, causing acid burns, and the glass container may crack due to intense local heating. - Adding acid slowly to a large amount of water with constant stirring spreads the heat safely through the water.

Solved Example 5 (5 marks) — Plaster of Paris chain

Q. A salt 'P' with two molecules of water of crystallisation is heated at 373 K to form compound 'Q', used by doctors to support fractured bones. When Q is mixed with water it sets into a hard mass of P again. Identify P and Q, write both equations, explain why the temperature must not exceed 373 K, and state why Q is stored in moisture-proof containers.

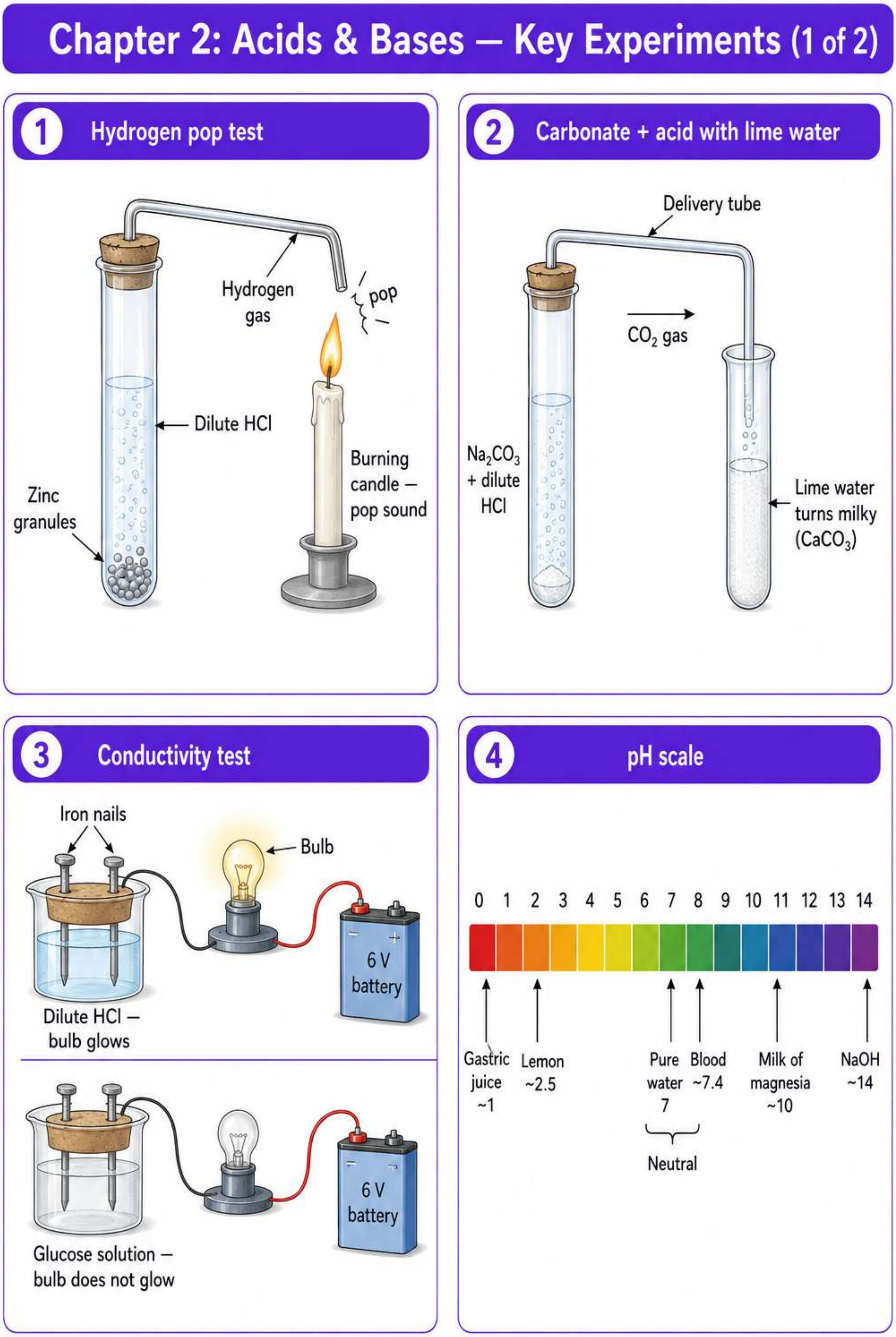
Answer: - **P = Gypsum ($CaSO_4 \cdot 2H_2O$); Q = Plaster of Paris ($CaSO_4 \cdot \frac{1}{2}H_2O$, calcium sulphate hemihydrate)**. - Making Q: **$CaSO_4 \cdot 2H_2O \xrightarrow{373\ K} CaSO_4 \cdot \frac{1}{2}H_2O + 1\frac{1}{2}H_2O$** - Setting of Q: **$CaSO_4 \cdot \frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4 \cdot 2H_2O$** (hard solid mass). - The "half molecule" of water means two formula units of $CaSO_4$ share one water molecule. - Temperature control: heating gypsum beyond 373 K would remove all the water, giving anhydrous calcium sulphate, which does not set like Plaster of Paris. - Moisture-proof storage: PoP absorbs moisture from the air and slowly turns back into hard gypsum, becoming useless.

REAL-LIFE APPLICATION

Why an antacid tablet works within minutes

Your stomach produces hydrochloric acid to digest food. Overeating or stress can push acid production too high, causing the burning feeling of acidity. An antacid like milk of magnesia is a mild base — it neutralises the extra acid right inside the stomach: $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$. The same neutralisation idea explains baking soda on a bee sting.

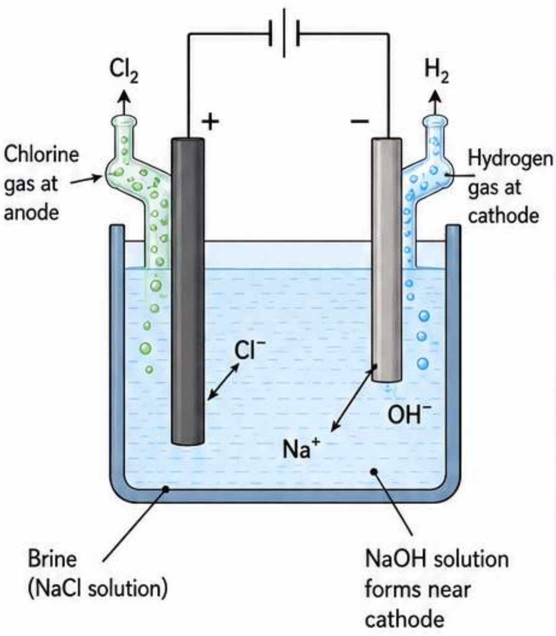
CHAPTER 2 • KEY DIAGRAMS — SHEET 1



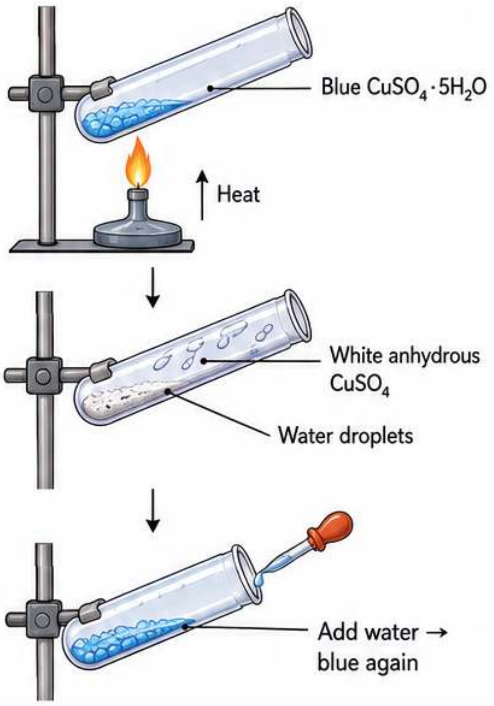
CHAPTER 2 • KEY DIAGRAMS — SHEET 2

Chapter 2: Salts from Common Salt (2 of 2)

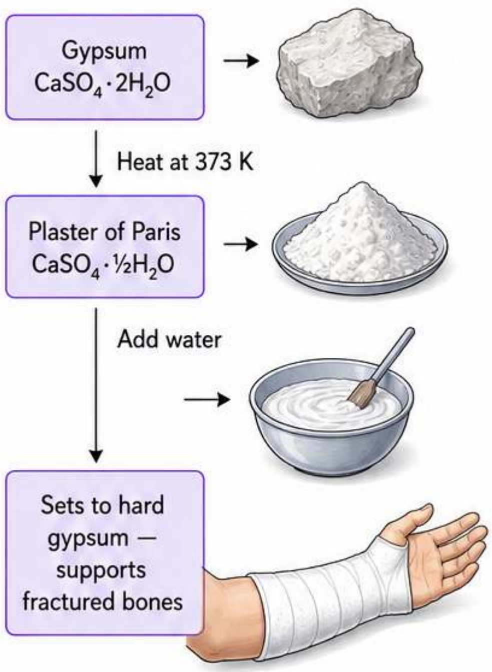
1 Chlor-alkali process



2 Water of crystallisation



3 Plaster of Paris cycle



4 Uses

PRACTICE SET — CBSE 2027 PATTERN

CHAPTER-WISE PRACTICE • 10 MCQ • 8 SHORT • 4 LONG (incl. CASE STUDY)

Part A — Multiple Choice Questions (1 mark each) — Q1 to Q10

Q1 1 MARK Understand

A solution turns red litmus blue. Its pH is likely to be:

(a) 1

(b) 4

(c) 5

(d) 10

Q2 1 MARK Apply

A solution reacts with crushed egg-shells to give a gas that turns lime water milky. The solution contains:

(a) NaCl

(b) HCl

(c) LiCl

(d) KCl

Q3 1 MARK Apply (Numerical)

10 mL of NaOH solution is completely neutralised by 8 mL of a given HCl solution. The volume of the same HCl needed to neutralise 20 mL of the same NaOH is:

(a) 4 mL

(b) 8 mL

(c) 12 mL

(d) 16 mL

Q4 1 MARK Remember

The medicine used for treating indigestion is an:

(a) antibiotic

(b) analgesic

(c) antacid

(d) antiseptic

Q5 **1 MARK** Remember

Which of these is an olfactory indicator?

(a) Litmus

(b) Turmeric

(c) Onion

(d) Phenolphthalein

Q6 **1 MARK** Remember

Tooth decay begins when the pH of the mouth falls below:

(a) 7

(b) 6.5

(c) 5.5

(d) 5.6

Q7 **1 MARK** Remember

In the chlor-alkali process, the gas released at the anode is:

(a) hydrogen

(b) chlorine

(c) oxygen

(d) carbon dioxide

Q8 **1 MARK** Remember

The number of water molecules of crystallisation in washing soda is:

(a) 2

(b) 5

(c) 7

(d) 10

Q9 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): Dry HCl gas does not turn dry blue litmus paper red. **Reason (R):** HCl produces H^+ ions only in the presence of water.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Q10 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): During summer, a milkman adds a little baking soda to fresh milk. **Reason (R):** Baking soda makes the milk acidic so that it sets into curd quickly.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Part B — Short Answer Questions (2–3 marks) — Q11 to Q18

Q11 **2 MARKS** Understand

Why should curd and sour substances not be kept in brass and copper vessels?

Q12 **3 MARKS** Understand

Which gas is usually liberated when an acid reacts with a metal? Give one equation and the test for this gas.

Q13 **2 MARKS** Apply

Why does distilled water not conduct electricity while rain water does?

Q14 **3 MARKS** Analyse

Five solutions A, B, C, D, E show pH values 4, 1, 11, 7 and 9 respectively with universal indicator. Classify each as neutral, strongly acidic, weakly acidic, strongly alkaline or weakly alkaline, and arrange them in increasing order of H^+ concentration.

Q15 2 MARKS Understand

Fresh milk has pH 6. How will the pH change as it turns into curd? Explain.

Q16 3 MARKS Understand

What happens when a solution of sodium hydrogencarbonate is heated? Write the equation. Name one household use of this compound.

Q17 3 MARKS Remember

Name the sodium compound used for softening hard water. Give its formula and two other uses.

Q18 3 MARKS Understand

What is the common name of $Ca(ClO)_2$? How is it prepared (equation)? Give two uses.

Part C — Long Answer Questions (5 marks) — Q19 to Q22

Q19 5 MARKS Apply

Write word equations and balanced chemical equations for the reaction of: (a) dilute sulphuric acid with zinc granules (b) dilute hydrochloric acid with magnesium ribbon (c) dilute sulphuric acid with aluminium powder (d) dilute hydrochloric acid with iron filings Also state the general pattern these reactions follow.

Q20 5 MARKS Apply

(a) What is a neutralisation reaction? Give its general ionic equation. (b) Explain with equations how neutralisation is used in: (i) treating indigestion, (ii) getting relief from a bee sting, (iii) preventing tooth decay.

Q21 5 MARKS Understand

Describe the chlor-alkali process with a balanced equation. Name the products formed at the anode and cathode, and give one use of each of the three products. Why is the process given this name?

Q22 5 MARKS Competency (Case)

In the school laboratory, Aman set up the apparatus from Activity 2.5: he placed sodium carbonate in test tube A and sodium hydrogencarbonate in test tube B, and added dilute HCl to both. Brisk effervescence occurred in both tubes, and the gas from each was passed through lime water, which turned milky. When Aman continued passing the gas in excess through the lime water, the milkiness disappeared. (a) Write the balanced equations for the reactions in test tubes A and B. (2) (b) Write the equation for the milkiness appearing in lime water. (1) (c) Explain, with an equation, why the milkiness disappears with excess gas. (1) (d) State the general rule for the reaction of metal carbonates and hydrogencarbonates with acids. (1)

EASY STEP-WISE ANSWER KEY

EASY STEP-WISE ANSWERS — WITH CBSE MARKING SCHEME FOR 5-MARKERS

Part A — MCQs

Ans. **Q1**

(d) 10 — Turning red litmus blue means the solution is basic, so pH must be above 7; only 10 fits.

Ans. **Q2**

(b) HCl — Egg-shells are calcium carbonate. Only an acid reacts with a carbonate to release CO_2 (the gas that turns lime water milky).

Ans. **Q3**

(d) 16 mL — Working: double the volume of the same NaOH needs double the volume of the same HCl → 8 × 2 = 16 mL.

Ans. **Q4**

(c) Antacid — a mild base (e.g. milk of magnesia, $Mg(OH)_2$) that neutralises excess stomach acid.

Ans. **Q5**

(c) Onion — its smell changes in a basic medium; litmus, turmeric and phenolphthalein work by colour, not smell.

Ans. **Q6**

(c) 5.5 — below this pH, mouth acids start corroding tooth enamel (calcium hydroxyapatite).

Ans. **Q7**

(b) Chlorine — Cl_2 at the anode, H_2 at the cathode, NaOH forms near the cathode.

Ans. **Q8**

(d) 10 — washing soda is $Na_2CO_3 \cdot 10H_2O$.

Ans. **Q9**

(a) — Without water, HCl stays as molecules and cannot release H^+ ions, so it shows no acidic behaviour; R correctly explains A.

Ans. **Q10**

(c) — A is true but R is false: baking soda makes milk **slightly alkaline**, so the lactic acid formed takes longer to make it sour/curdle — it delays curd setting, not speeds it up.

Part B — Short Answers

Ans. **Q11**

Curd and sour foods contain acids. These acids react with the copper (and the brass, which contains copper) of the vessel, forming poisonous salts that make the food unsafe to eat.

Ans. **Q12**

Hydrogen gas is usually liberated. Example: **$Zn(s) + H_2SO_4(dil.) \rightarrow ZnSO_4(aq) + H_2(g)$**. Test: bring a burning candle near the mouth of the tube — hydrogen burns with a **pop sound**.

Ans. **Q13**

Distilled water has no dissolved ions, so it cannot carry current. Rain water dissolves acidic gases (like CO_2) from the air, forming ions in solution, which allow it to conduct electricity.

Ans. **Q14**

D (pH 7) = **neutral**; B (pH 1) = **strongly acidic**; A (pH 4) = **weakly acidic**; C (pH 11) = **strongly alkaline**; E (pH 9) = **weakly alkaline**. Increasing H^+ concentration = decreasing pH order: **C (11) < E (9) < D (7) < A (4) < B (1)**.

Ans. **Q15**

The pH will **decrease** (fall below 6). Bacteria convert milk sugar into **lactic acid** during curd formation; the acid increases the H^+ concentration, making the pH more acidic.

Ans. **Q16**

On heating, sodium hydrogencarbonate decomposes: **$2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2$** The CO_2 released makes cakes and bread rise, making them soft and spongy. (Other uses: ingredient in antacids; soda-acid fire extinguishers.)

Ans. **Q17**

Washing soda, $Na_2CO_3{\cdot}10H_2O$, removes the **permanent hardness** of water. Other uses: in the glass, soap and paper industries; manufacture of borax; domestic cleaning agent. (Any two.)

Ans. **Q18**

Common name: **bleaching powder**. Preparation — chlorine acting on dry slaked lime: **$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(ClO)_2 + CaCl_2 + 2H_2O$** Uses (any two): bleaching cotton and linen in textiles / bleaching wood pulp in paper factories; oxidising agent in chemical industries; disinfecting drinking water.

Part C — Long Answers

Ans. **Q19**

General pattern: **Acid + Metal → Salt + Hydrogen gas** (the metal displaces hydrogen from the acid). (a) Sulphuric acid + Zinc → Zinc sulphate + Hydrogen: **$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$** (b) Hydrochloric acid + Magnesium → Magnesium chloride + Hydrogen: **$Mg + 2HCl \rightarrow MgCl_2 + H_2$** (c) Sulphuric acid + Aluminium → Aluminium sulphate + Hydrogen: **$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$** Working: $Al_2(SO_4)_3$ contains 3 sulphate groups → $3H_2SO_4$; 6 H atoms → $3H_2$; 2 Al balances aluminium. (d) Hydrochloric acid + Iron → Iron(II) chloride + Hydrogen: **$Fe + 2HCl \rightarrow FeCl_2 + H_2$**

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ General pattern: Acid + Metal → Salt + H2	1 m
✓ Word + balanced equation for Zn + H2SO4	1 m
✓ Word + balanced equation for Mg + 2HCl	1 m
✓ Word + balanced equation for 2Al + 3H2SO4	1 m
✓ Word + balanced equation for Fe + 2HCl	1 m

Ans. **Q20**

(a) Neutralisation is the reaction of an acid with a base to form a salt and water. Ionic form: **$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$**. (b) (i) **Indigestion:** the stomach makes excess HCl; an antacid like milk of magnesia neutralises it — $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$. (ii) **Bee sting:** the sting injects an acid into the skin; rubbing a mild base like **baking soda ($NaHCO_3$)** neutralises the acid and relieves the pain. (iii) **Tooth decay:** mouth bacteria produce acids from leftover sugar; when pH drops below 5.5, enamel corrodes. Basic **toothpaste** neutralises the excess acid and protects the teeth.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Definition + ionic equation $H^+ + OH^- \rightarrow H2O$	2 m
✓ (b)(i) Antacid neutralising HCl, with equation	1 m
✓ (b)(ii) Bee sting + baking soda explanation	1 m
✓ (b)(iii) Toothpaste neutralising mouth acids	1 m

Ans. **Q21**

When electricity is passed through **brine** (aqueous NaCl solution), it decomposes: **$2NaCl(aq) + 2H_2O(l)$ — Electrolysis→ $2NaOH(aq) + Cl_2(g) + H_2(g)$** - **Anode:** chlorine gas; **Cathode:** hydrogen gas; **NaOH** forms in solution near the cathode. - Uses: Cl_2 — making bleaching powder / disinfecting water; H_2 — as a fuel; NaOH — making soaps and detergents / paper. (Any suitable use each.) - Name: "chlor" for the **chlorine** and "alkali" for the **sodium hydroxide** produced.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ Balanced chlor-alkali equation	1½ m
✓ Products at anode and cathode + NaOH	1½ m
✓ One use each of Cl2, H2 and NaOH	1½ m
✓ Reason for the name chlor-alkali	½ m

Ans. **Q22**

(a) Tube A: **$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$** Tube B: **$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$** (2) (b) **$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s)\downarrow + H_2O(l)$** — insoluble white $CaCO_3$ makes the lime water milky. (1) (c) With excess CO_2, the insoluble carbonate changes into **soluble calcium hydrogencarbonate**, so the milkiness clears: **$CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$** (1) (d) **Metal carbonate / hydrogencarbonate + Acid → Salt + Carbon dioxide + Water.** (1)

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Equations for tubes A and B	2 m
✓ (b) Lime water milkiness equation	1 m
✓ (c) Milkiness clearing with Ca(HCO3)2 equation	1 m
✓ (d) General carbonate + acid rule	1 m

EXAM RADAR — TOP 8 HIGH-PROBABILITY QUESTIONS

#	Question	Why examiners love it
1	Lime-water milkiness appearing and then disappearing with excess CO_2 (two equations)	Tests a two-stage reaction and careful observation — the single most repeated question from this chapter.
2	Why is dry HCl gas not acidic / why does the bulb glow with acid but not glucose?	Directly tests the core concept that acidity = H^+ ions in water; ideal for A–R and competency formats.
3	Acid-to-water dilution rule with reason	A safety-plus-concept question (exothermic dissolution) — quick 2 marks, asked very often.
4	pH classification of given solutions and ordering by H^+ concentration	Numerically checks pH understanding; the inverse pH–H^+ relation trips many students, so it discriminates well.
5	Full Plaster of Paris story: preparation at 373 K, setting reaction, storage	Packs formula, equation, condition and application into one 5-mark question.
6	Chlor-alkali process: equation, electrode products, uses	Industrial-process question with a diagram-friendly answer — a favourite for 3 and 5 markers.
7	Baking soda vs washing soda: preparation, formula, uses	Compare-and-contrast on daily-life chemicals fits the competency-based pattern perfectly.
8	pH in everyday life: tooth decay, antacids, bee sting, soil pH	Real-life application questions are guaranteed in the current CBSE design; this cluster supplies them all.

COMMON MISTAKES & EXAMINER TIPS

Common mistakes students make: 1. **Reversing the pH–H^+ relationship.** Lower pH = MORE H^+ ions. Many students order solutions by pH when asked for H^+ concentration — read the question twice. 2. **Writing "acid + metal → salt + water".** With metals, acids give salt + **hydrogen**; it is with metal **oxides** and bases that water forms. 3. **Forgetting that the acid–carbonate reaction gives THREE products** (salt + CO_2 + H_2O). Dropping the water loses a mark. 4. **Calling every base an alkali.** Only water-soluble bases are alkalis; $Cu(OH)_2$ is a base but not an alkali. 5. **Wrong PoP formula.** It is $CaSO_4 \cdot \frac{1}{2}H_2O$ — writing $CaSO_4 \cdot 2H_2O$ gives gypsum instead. Remember: half a water molecule is shared between two $CaSO_4$ units. 6. **Mixing up the milkman question.** Baking soda delays curdling by making milk slightly **alkaline** — it does not help it set faster. 7. **Saying "hydrogen makes a substance acidic."** Glucose and alcohol contain hydrogen but are not acids; only **ionisable H^+ in water** counts. 8. **Unbalanced Al + H_2SO_4.** The correct balance is $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ — practise this one specifically.

Examiner tips for full marks: - When asked for a gas test, give the **observation AND the equation** (pop sound for H_2; lime water milky for CO_2 with the $CaCO_3$ equation). - In pH questions, state the classification first, then justify with "more/fewer H^+ ions." - For industrial processes (chlor-alkali, bleaching powder), name **raw material → condition → products → one use each** — that sequence covers the full marking scheme. - Write conditions (Heat, 373 K, Electrolysis) **on the arrow**, not in brackets after the equation. - If a question mentions temperature 373 K, the answer almost certainly involves Plaster of Paris.

ONE-PAGE QUICK REVISION

THE CHAPTER IN 60 SECONDS

Core idea: Acids → $H^+(aq)/H_3O^+$ in water • Bases → $OH^-(aq)$ • Water-soluble bases = alkalis • Ions make solutions conduct • No water → no ions → no acidity (dry HCl).

Five reaction patterns: | Pattern | Products | Star equation | |---------|----------|---------------| | Acid + Metal | Salt + H_2 | $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ | | Acid + Carbonate/HCO_3 | Salt + CO_2 + H_2O | $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$ | | Acid + Base | Salt + H_2O | $HCl + NaOH \rightarrow NaCl + H_2O$ | | Acid + Metal oxide | Salt + H_2O | $CuO + 2HCl \rightarrow CuCl_2 + H_2O$ | | Base + Non-metal oxide | Salt + H_2O | $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ |

Gas tests: H_2 → pop sound • CO_2 → lime water milky (excess CO_2 → milkiness clears: $Ca(HCO_3)_2$)

pH ladder: 0 ←strong acid • 7 = neutral • strong base→ 14 | Lower pH = more H^+ **pH in life:** stomach HCl → antacid $Mg(OH)_2$ • tooth decay below 5.5 • acid rain below 5.6 • bee sting acid → baking soda • plants need specific soil pH

Safety: Always add **acid to water**, never water to acid (highly exothermic).

The Salt Factory (all from NaCl): 1. **NaOH** — chlor-alkali: $2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2(anode) + H_2(cathode)$ 2. **Bleaching powder $Ca(ClO)_2$** — Cl_2 + dry slaked lime → bleaching textiles/paper, disinfecting water 3. **Baking soda $NaHCO_3$** — $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$; heat → $Na_2CO_3 + H_2O + CO_2$; uses: baking, antacid, fire extinguisher 4. **Washing soda $Na_2CO_3 \cdot 10H_2O$** — recrystallised Na_2CO_3; uses: glass/soap/paper, removes permanent hardness

Water of crystallisation: $CuSO_4 \cdot 5H_2O$ (blue → white on heating, blue restored with water) • Gypsum $CaSO_4 \cdot 2H_2O$ **Plaster of Paris:** gypsum —373 K→ $CaSO_4 \cdot \frac{1}{2}H_2O$; + water → sets back to gypsum; store moisture-proof.

Indicator flashcards: phenolphthalein → pink in base • methyl orange → red in acid • turmeric → reddish-brown in base • onion/vanilla/clove = olfactory.

AlphaLearn Studylab • Class 10 CBSE Chemistry • Chapter 2 Guide • Board Exam 2027 pattern

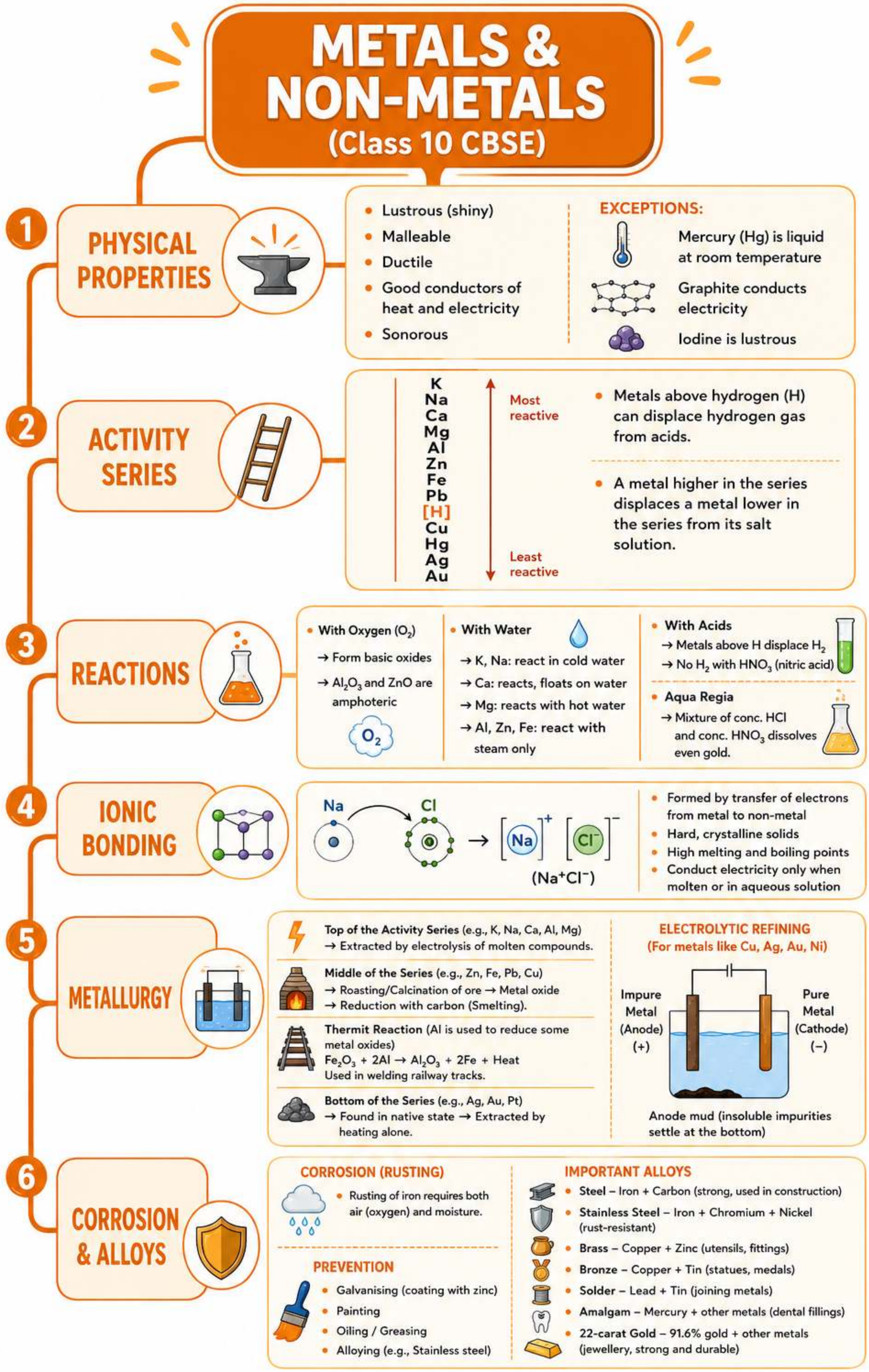
CHAPTER 3

Metals and Non-metals

Activity series, ionic bonding, metallurgy, corrosion and alloys

Mind Map | Master Equations | Solved Examples | Labelled Diagrams | 22-Q Practice + Key | Exam Radar | 1-Page Revision

CHAPTER 3 • MIND MAP — THE CHAPTER AT A GLANCE



KEY DEFINITIONS & MASTER EQUATIONS

2.1 Key Definitions

1. **Malleability:** The property by which metals can be beaten into thin sheets.

2. **Ductility:** The property by which metals can be drawn into thin wires.

3. **Sonority:** The ringing sound produced when a metal is struck.

4. **Amphoteric oxide:** A metal oxide that reacts with both acids and bases to give salt and water (Al_2O_3, ZnO).

5. **Activity (reactivity) series:** A list of metals arranged in decreasing order of reactivity.

6. **Ionic (electrovalent) compound:** A compound formed by the transfer of electrons from a metal to a non-metal.

7. **Mineral:** An element or compound occurring naturally in the earth's crust.

8. **Ore:** A mineral from which a metal can be extracted profitably.

9. **Gangue:** The earthy impurities (soil, sand) mixed with an ore.

10. **Metallurgy:** The complete process of extracting a metal from its ore and refining it for use.

11. **Roasting:** Heating a sulphide ore strongly in **excess air** to convert it into the metal oxide.

12. **Calcination:** Heating a carbonate ore strongly in **limited air** to convert it into the metal oxide.

13. **Thermit reaction:** The highly exothermic reduction of iron(III) oxide by aluminium, producing molten iron used to join railway tracks.

14. **Anodising:** Electrolytically thickening the natural oxide layer on aluminium to improve corrosion resistance.

15. **Galvanisation:** Coating iron or steel with a thin layer of zinc to prevent rusting.

16. **Alloy:** A homogeneous mixture of two or more metals, or a metal and a non-metal. An alloy containing mercury is an **amalgam**.

17. **Corrosion:** The eating away of a metal surface by moisture, air, acids or other substances around it.

2.2 Master List of Balanced Equations

Metals + Oxygen → (basic) metal oxides 1. $2Cu + O_2$ —Heat→ $2CuO$ (black coating) 2. $4Al + 3O_2 \rightarrow 2Al_2O_3$ 3. $2Mg + O_2 \rightarrow 2MgO$ (dazzling white flame)

Amphoteric behaviour of Al_2O_3 (both acid AND base) 4. $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ 5. $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ (sodium aluminate)

Metal oxides that dissolve → alkalis 6. $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$ 7. $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

Metals + Water (order of vigour) 8. $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$ + heat (H_2 catches fire) 9. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ + heat 10. $Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ (Ca floats — H_2 bubbles stick to it) 11. $2Al(s) + 3H_2O(g, steam) \rightarrow Al_2O_3(s) + 3H_2(g)$ 12. $3Fe(s) + 4H_2O(g, steam) \rightarrow Fe_3O_4(s) + 4H_2(g)$

Metals + Dilute acids → Salt + H_2 (reactivity: Mg > Al > Zn > Fe; Cu — no reaction) 13. $Fe + H_2SO_4(dil.) \rightarrow FeSO_4 + H_2$

Metals + Salt solutions (displacement → activity series) 14. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$ 15. $Zn(s) + FeSO_4(aq) \rightarrow ZnSO_4(aq) + Fe(s)$ (green colour fades)

Non-metal + Oxygen → acidic oxide 16. $S(s) + O_2(g) \rightarrow SO_2(g)$ (SO_2 turns moist blue litmus red)

Extraction — LOW reactivity (heating alone) 17. $2HgS(s) + 3O_2(g)$ —Heat→ $2HgO(s) + 2SO_2(g)$ 18. $2HgO(s)$ —Heat→ $2Hg(l) + O_2(g)$ 19. $2Cu_2S + 3O_2(g)$ —Heat→ $2Cu_2O(s) + 2SO_2(g)$ 20. $2Cu_2O + Cu_2S$ —Heat→ $6Cu(s) + SO_2(g)$

Extraction — MIDDLE reactivity 21. Roasting: $2ZnS(s) + 3O_2(g)$ —Heat→ $2ZnO(s) + 2SO_2(g)$ 22. Calcination: $ZnCO_3(s)$ —Heat→ $ZnO(s) + CO_2(g)$ 23. Reduction by carbon: $ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

Thermit-type reactions (metal as reducing agent) 24. $3MnO_2(s) + 4Al(s) \rightarrow 3Mn(l) + 2Al_2O_3(s)$ + Heat 25. $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s)$ + Heat (thermit reaction — joining railway tracks)

Extraction — TOP reactivity (electrolysis of molten chloride) 26. At cathode: $Na^+ + e^- \rightarrow Na$ | At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Ion formation (electron transfer) 27. Na (2,8,1) → Na^+ (2,8) + e^- | Cl (2,8,7) + e^- → Cl^- (2,8,8) → NaCl 28. Mg (2,8,2) → Mg^{2+} (2,8) + $2e^-$ → with $2Cl^-$ gives $MgCl_2$

2.3 The Activity Series (must be memorised in order)

K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag > Au - Above hydrogen → can displace H_2 from dilute acids. - A metal displaces any metal **below** it from a salt solution. - Top (K–Al): extracted by **electrolysis** | Middle (Zn–Pb): **carbon reduction** | Bottom (Cu–Au): found free / obtained by **heating alone**.

2.4 Alloy Table (direct 1–2 mark questions)

Alloy	Composition	Special property / use
Steel	Fe + ~0.05% C	Hard and strong (pure iron is too soft)
Stainless steel	Fe + Ni + Cr	Hard, does not rust
Brass	Cu + Zn	Poor electrical conductor compared to Cu
Bronze	Cu + Sn	Poor electrical conductor compared to Cu
Solder	Pb + Sn	Low melting point — welding electrical wires
Amalgam	Any metal + Hg	Mercury-containing alloy
22-carat gold	22 parts Au + 2 parts Cu/Ag	Hard enough for jewellery (pure 24-carat is too soft)

SOLVED EXAMPLES — BOARD STYLE

Solved Example 1 (3 marks) — Activity series logic

Q. Four metals A, B, C and D were tested with salt solutions. A displaces metal from copper(II) sulphate but shows no reaction with iron(II) sulphate... (data as in NCERT in-text Q3): A: no reaction with $FeSO_4$, displacement with $CuSO_4$; B: displacement with $FeSO_4$, no reaction with $ZnSO_4$; C: no reaction with $FeSO_4$, $CuSO_4$, $ZnSO_4$ but displaces silver from $AgNO_3$; D: no reaction with any. (i) Which is most reactive? (ii) What happens if B is added to $CuSO_4$? (iii) Arrange A–D in decreasing reactivity.

Answer: - (i) **B is the most reactive** — it displaces iron from $FeSO_4$, so it lies above iron (and above A, which cannot). - (ii) B, being more reactive than iron and therefore than copper, will **displace copper**: the blue colour of the solution fades and reddish-brown copper deposits on B. - (iii) Logic: B > Fe (displaces it); A is between Fe and Cu (displaces Cu but not Fe); C is between Cu and Ag (displaces only Ag); D displaces nothing → least reactive. **Order: B > A > C > D.**

Solved Example 2 (3 marks) — Why no H_2 with nitric acid

Q. Hydrogen gas is not evolved when most metals react with dilute nitric acid. Why? Name two exceptions.

Answer: - HNO_3 is a **strong oxidising agent**. It oxidises the hydrogen gas produced in the reaction to **water**, and is itself reduced to nitrogen oxides (N_2O, NO or NO_2). So no H_2 escapes. - Exceptions: **magnesium (Mg) and manganese (Mn)** react with **very dilute** HNO_3 to evolve hydrogen gas.

Solved Example 3 (3 marks) — Ionic bond formation

Q. Show the formation of MgO by electron transfer. Name the ions present and state why MgO has a high melting point.

Answer: - Mg (2,8,2) loses 2 electrons → $\mathbf{Mg^{2+}}$ (2,8); O (2,6) gains those 2 electrons → $\mathbf{O^{2-}}$ (2,8). - The oppositely charged ions attract strongly to form the ionic compound **MgO**; ions present: Mg^{2+} and O^{2-}. - High melting point: a large amount of energy is needed to break the **strong electrostatic attraction between the ions** (inter-ionic attraction), so ionic compounds like MgO melt only at very high temperatures.

Solved Example 4 (3 marks) — The fake goldsmith (aqua regia)

Q. A man posing as a goldsmith dipped a lady's gold bangles in a particular solution. The bangles sparkled like new but their weight dropped drastically. Identify the solution and explain what happened.

Answer: - The solution was **aqua regia** — a freshly prepared 3:1 mixture of concentrated hydrochloric acid and concentrated nitric acid. - Aqua regia is one of the very few reagents that can **dissolve gold**. - The outer, tarnished layer of gold dissolved into the solution, exposing a fresh shiny surface — which is why the bangles sparkled but lost weight. The "goldsmith" kept the dissolved gold.

Solved Example 5 (5 marks) — Metallurgy of zinc

Q. Zinc occurs in nature as zinc blende (ZnS) and calamine ($ZnCO_3$). Describe, with equations, how zinc metal is obtained from each ore, naming each process. Why are sulphide and carbonate ores converted into oxides first?

Answer: - Conversion to oxide first, because it is **much easier to reduce a metal oxide** than a sulphide or carbonate. - **From ZnS — Roasting** (strong heating in excess air): $2ZnS(s) + 3O_2(g) \xrightarrow{Heat} 2ZnO(s) + 2SO_2(g)$ - **From $ZnCO_3$ — Calcination** (strong heating in limited air): $ZnCO_3(s) \xrightarrow{Heat} ZnO(s) + CO_2(g)$ - **Reduction** of the oxide with carbon (a middle-reactivity metal, so carbon works): $ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$ - The impure zinc can then be purified by **electrolytic refining** (impure Zn anode, pure Zn cathode, zinc-salt solution as electrolyte).

REAL-LIFE APPLICATION

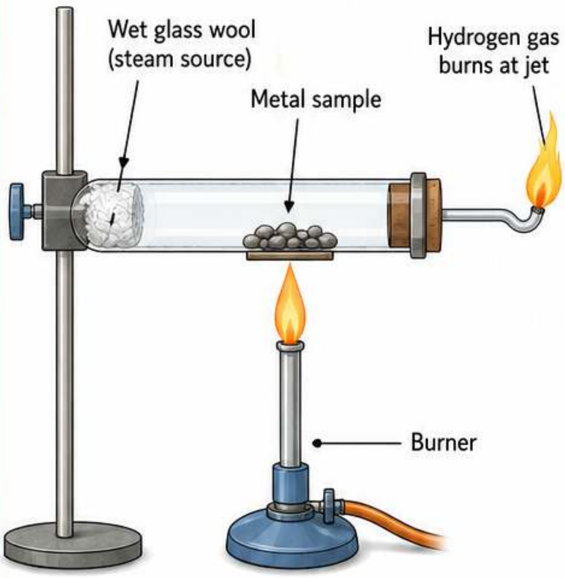
The 1600-year-old iron pillar that refuses to rust

The Iron Pillar near Qutub Minar in Delhi has stood in open air for over 1600 years without significant rusting — evidence of the remarkable quality of iron-working achieved in ancient India. Modern engineers fight the same battle with galvanising, painting and alloying, because rusting needs both air and moisture to attack iron.

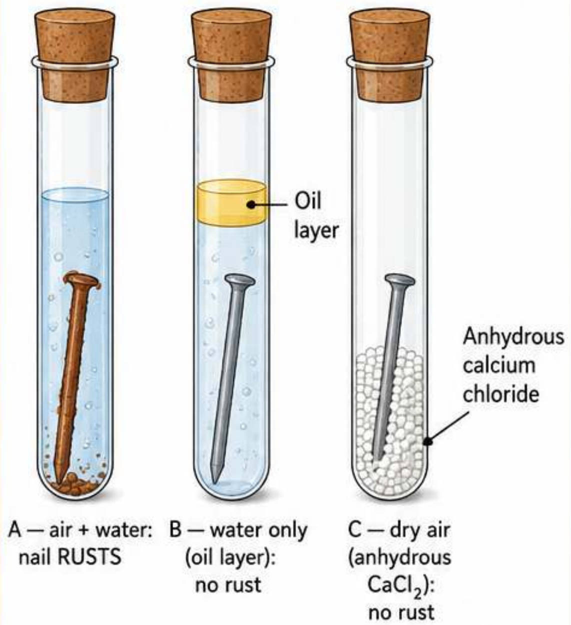
CHAPTER 3 • KEY DIAGRAMS — SHEET 1

Chapter 3: Metal Reactivity — Key Experiments (1 of 2)

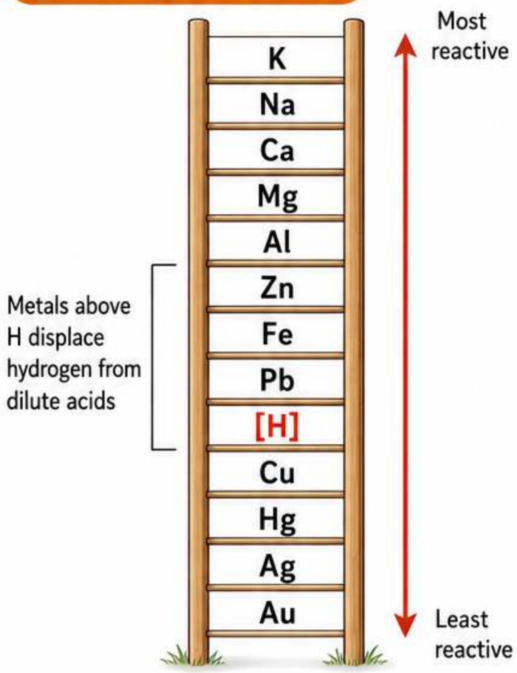
1 Metal + steam apparatus



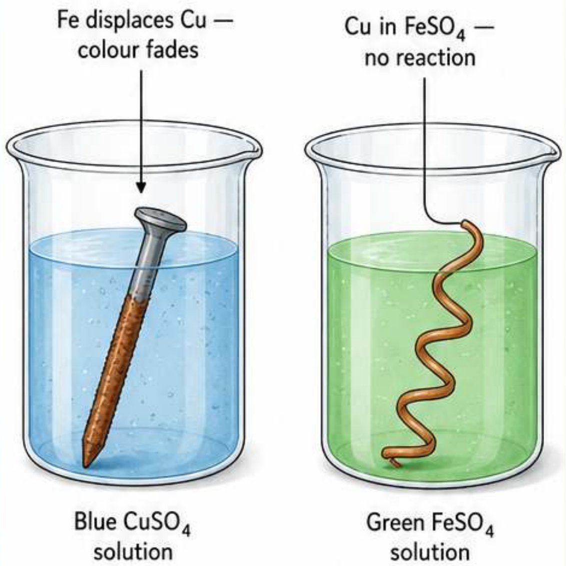
2 Rusting conditions



3 Activity series ladder



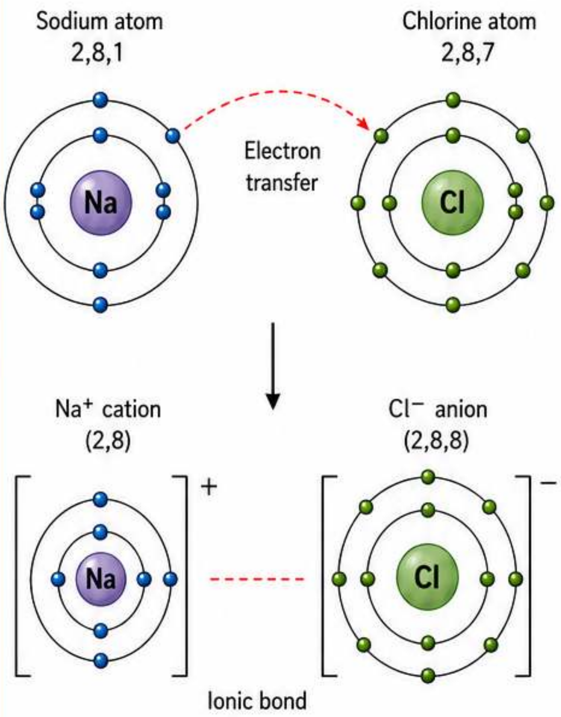
4 Displacement in beakers



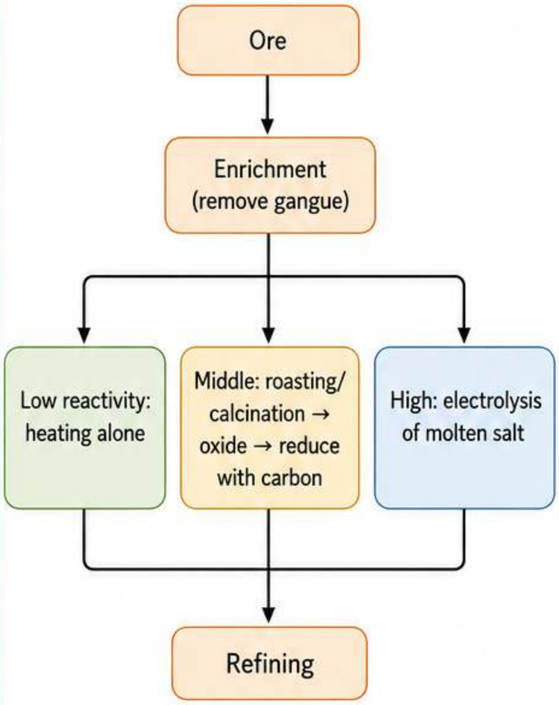
CHAPTER 3 • KEY DIAGRAMS — SHEET 2

Chapter 3: Ionic Bonding & Metallurgy (2 of 2)

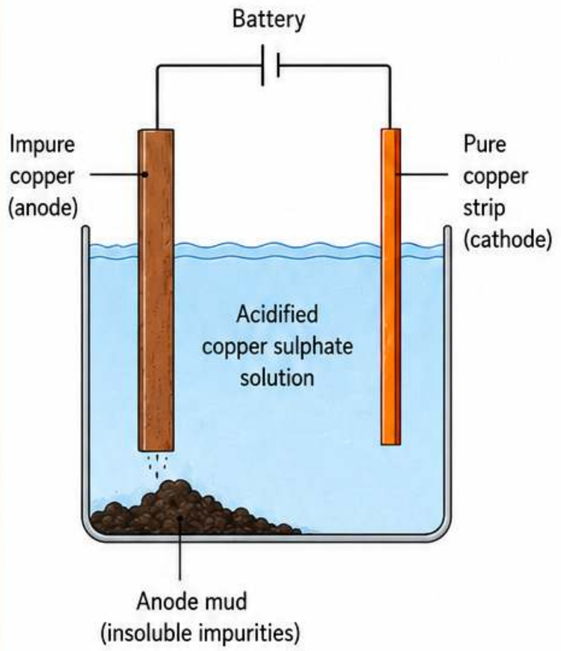
1 Formation of NaCl



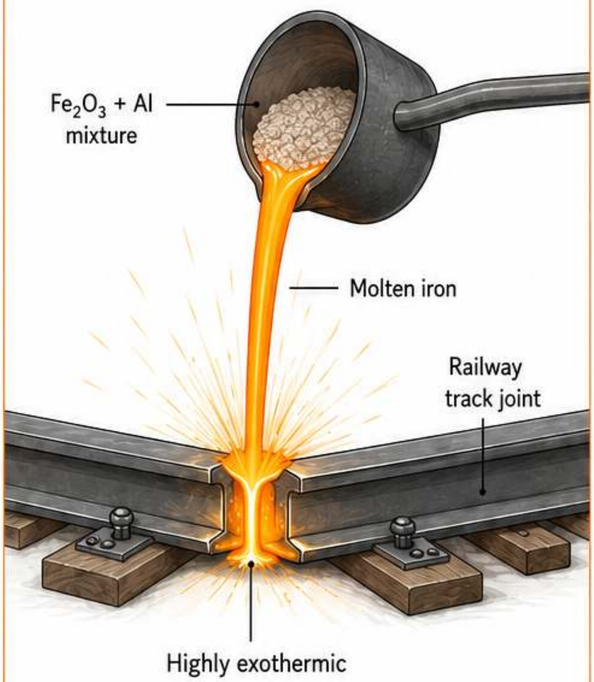
2 Extraction flowchart



3 Electrolytic refining of copper



4 Thermit reaction



PRACTICE SET — CBSE 2027 PATTERN

CHAPTER-WISE PRACTICE • 10 MCQ • 8 SHORT • 4 LONG (incl. CASE STUDY)

Part A — Multiple Choice Questions (1 mark each) — Q1 to Q10

Q1 1 MARK Apply

Which pair will give a displacement reaction?

(a) NaCl solution + copper

(b) $MgCl_2$ solution + aluminium

(c) $FeSO_4$ solution + silver

(d) $AgNO_3$ solution + copper

Q2 1 MARK Apply

Which method is suitable for preventing an iron frying pan from rusting?

(a) Applying grease

(b) Applying paint

(c) Coating with zinc

(d) All of the above

Q3 1 MARK Analyse

An element reacts with oxygen to give a compound with a high melting point that is soluble in water. The element is likely:

(a) calcium

(b) carbon

(c) silicon

(d) iron

Q4 1 MARK Understand

Food cans are coated with tin, not zinc, because:

(a) zinc is costlier

(b) zinc has a higher melting point

(c) zinc is more reactive than tin

(d) zinc is less reactive than tin

Q5 1 MARK Remember

The only metal that is liquid at room temperature is:

(a) sodium

(b) gallium

(c) mercury

(d) bromine

Q6 1 MARK Remember

In electrolytic refining, the impure metal is made the:

(a) cathode

(b) anode

(c) electrolyte

(d) anode mud

Q7 1 MARK Understand

Which oxide is amphoteric?

(a) Na_2O

(b) MgO

(c) Al_2O_3

(d) CuO

Q8 1 MARK Remember

Solder, used for welding electrical wires, is an alloy of:

(a) Cu and Zn

(b) Cu and Sn

(c) Pb and Sn

(d) Fe and Cr

Q9 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): Sodium and potassium are stored immersed in kerosene oil. **Reason (R):** They react so vigorously with air that they can catch fire when kept in the open.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Q10 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): Ionic compounds conduct electricity in the solid state. **Reason (R):** In a solid ionic compound, the ions are held in fixed positions in a rigid structure.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Part B — Short Answer Questions (2–3 marks) — Q11 to Q18

Q11 **3 MARKS** Understand

Write equations for the reactions of (i) iron with steam, (ii) calcium with water. Why does calcium start floating during its reaction?

Q12 **3 MARKS** Understand

What are amphoteric oxides? Give two examples with one equation showing reaction with an acid and one with a base.

Q13 **2 MARKS** Apply

Name two metals that will displace hydrogen from dilute acids and two that will not. State the rule involved.

Q14 **2 MARKS** Apply

What would you observe when zinc is added to iron(II) sulphate solution? Write the equation.

Q15 **3 MARKS** Understand

Give reasons: (a) Platinum, gold and silver are used to make jewellery. (b) Aluminium is highly reactive, yet it is used for cooking utensils.

Q16 **3 MARKS** Understand

Why are carbonate and sulphide ores usually converted into oxides before reduction? Name both conversion processes with one equation each.

Q17 **2 MARKS** Apply

Tarnished copper vessels are cleaned with lemon or tamarind juice. Explain why.

Q18 **3 MARKS** Remember

In the electrolytic refining of a metal M, what are the anode, cathode and electrolyte? Where do the insoluble impurities collect?

Part C — Long Answer Questions (5 marks) — Q19 to Q22

Q19 **5 MARKS** Understand

(a) Show the formation of Na_2O and MgO by transfer of electrons (electron-dot structures described in words are acceptable). Name the ions in each. (b) List any three properties of ionic compounds and explain why they conduct electricity in molten state but not in solid state.

Q20 **5 MARKS** Analyse

Explain the extraction of metals belonging to the top, middle and bottom of the activity series with one example and equation for each category. Why can carbon not reduce the oxides of sodium or aluminium?

Q21 **5 MARKS** Apply

(a) What is corrosion? Describe the activity (three test tubes with iron nails) that proves both air and moisture are needed for rusting. (b) State any four methods of preventing rusting. Why does a galvanised article stay protected even if the zinc coating is broken?

Q22 5 MARKS Competency (Case)

Pratyush heated sulphur powder on a spatula and collected the gas by inverting a test tube over it. He then tested the gas with dry and moist blue litmus papers. Meanwhile his teacher explained that oxides of metals and non-metals behave differently, and that this difference is one of the chemical tests to distinguish the two families of elements. (a) Write the balanced equation for the burning of sulphur. (1) (b) What is the action of the collected gas on (i) dry litmus, (ii) moist blue litmus? Why the difference? (2) (c) What type of oxides do non-metals form? How do metal oxides differ? (1) (d) Based on this, state one chemical-property difference between metals and non-metals. (1)

EASY STEP-WISE ANSWER KEY

EASY STEP-WISE ANSWERS — WITH CBSE MARKING SCHEME FOR 5-MARKERS

Part A — MCQs

Ans. **Q1**

(d) $AgNO_3$ solution + copper — copper is above silver in the activity series, so it displaces it: $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$. In (a), (b), (c) the free metal is LESS reactive than the metal in the salt, so nothing happens.

Ans. **Q2**

(a) Applying grease — a frying pan is heated and used for food, so paint and zinc coatings are unsuitable; grease is the practical choice. (Note: "all of the above" is wrong precisely because of the food/heat context.)

Ans. **Q3**

(a) Calcium — CaO is a metal oxide with a very high melting point (2850 K) and dissolves in water to form $Ca(OH)_2$. Carbon and silicon oxides don't fit; iron oxide is insoluble.

Ans. **Q4**

(c) Zinc is more reactive than tin — a more reactive coating would react with the food acids, making the food unsafe.

Ans. **Q5**

(c) Mercury — the only metal liquid at room temperature (bromine is a liquid but a non-metal).

Ans. **Q6**

(b) Anode — impure metal = anode; pure metal strip = cathode; metal-salt solution = electrolyte.

Ans. **Q7**

(c) Al_2O_3 — it reacts with both HCl (→ $AlCl_3$) and NaOH (→ $NaAlO_2$), the defining test of an amphoteric oxide. Na_2O and MgO are basic; CuO is basic.

Ans. **Q8**

(c) Pb and Sn — solder's low melting point suits wire welding.

Ans. **Q9**

(a) — Na and K are so reactive towards oxygen/air that open storage risks fire; kerosene keeps air away. R correctly explains A.

Ans. **Q10**

(d) — A is false: solid ionic compounds do NOT conduct because the ions cannot move; R is true and is exactly the reason solids fail to conduct.

Part B — Short Answers

Ans. **Q11**

(i) **$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$** (iron reacts only with steam). (ii) **$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$**. Calcium floats because the **bubbles of hydrogen gas stick to its surface** and lift it up.

Ans. **Q12**

Amphoteric oxides are metal oxides that react with **both acids and bases** to give salt and water. Examples: **Al_2O_3 and ZnO**. With acid: **$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$** With base: **$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$**

Ans. **Q13**

Will displace H_2: **magnesium and zinc** (any metals above H). Will not: **copper and silver** (any metals below H). Rule: only metals placed **above hydrogen in the activity series** can displace hydrogen from dilute acids.

Ans. **Q14**

Zinc is more reactive than iron, so it displaces it: the **green colour of the $FeSO_4$ solution fades** and grey iron is deposited. **$Zn(s) + FeSO_4(aq) \rightarrow ZnSO_4(aq) + Fe(s)$**

Ans. **Q15**

(a) Platinum, gold and silver are at the bottom of the activity series — they are **least reactive**, do not corrode or tarnish easily, and stay lustrous, making them ideal for jewellery. (b) Aluminium instantly develops a **thin protective layer of aluminium oxide** on its surface, which shields the metal underneath from further attack — so aluminium utensils are safe despite the metal's high reactivity.

Ans. **Q16**

Because a metal is **much more easily obtained from its oxide** than from its sulphide or carbonate. Sulphide → oxide by **roasting** (excess air): **$2ZnS + 3O_2$ —Heat→ $2ZnO + 2SO_2$** Carbonate → oxide by **calcination** (limited air): **$ZnCO_3$ —Heat→ $ZnO + CO_2$**

Ans. **Q17**

The dull coating on tarnished copper is **basic copper carbonate** (formed by corrosion). Lemon and tamarind contain **acids** that react with and dissolve this basic coating, exposing the shiny metal beneath.

Ans. **Q18**

Anode: a thick block of **impure metal M**. Cathode: a **thin strip of pure M**. Electrolyte: a **solution of a salt of M** (e.g. acidified copper sulphate for copper). Pure metal dissolves from the anode and deposits on the cathode; **insoluble impurities settle below the anode as anode mud** (soluble impurities pass into the solution).

Part C — Long Answers

Ans. **Q19**

(a) **Na_2O:** each Na (2,8,1) gives its single outer electron to oxygen; two sodium atoms supply the two electrons O (2,6) needs → ions **$2Na^+$ and O^{2-}** combine as Na_2O. **MgO:** Mg (2,8,2) transfers both outer electrons to O (2,6) → ions **Mg^{2+} and O^{2-}** combine as MgO. (b) Properties (any three): (i) hard, brittle solids; (ii) high melting and boiling points (strong inter-ionic attraction takes much energy to break); (iii) soluble in water, insoluble in kerosene/petrol; (iv) conduct electricity in solution or molten state. Conduction needs **moving charged particles**. In the solid, ions are locked in a rigid structure and cannot move → no conduction. On melting, heat overcomes the electrostatic attraction, the ions become free to move → the melt conducts.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Electron transfer in Na2O with ions named	1½ m
✓ (a) Electron transfer in MgO with ions named	1½ m
✓ (b) Any three properties of ionic compounds	1 m
✓ (b) Molten vs solid conduction explained	1 m

Ans. **Q20**

Top of series (K, Na, Ca, Mg, Al): too reactive for chemical reduction → obtained by **electrolytic reduction of molten salts**. Example — molten NaCl: at cathode $Na^+ + e^- \rightarrow Na$; at anode $2Cl^- \rightarrow Cl_2 + 2e^-$. **Middle (Zn, Fe, Pb, Cu):** ores (sulphides/carbonates) are first converted to oxides by roasting/calcination, then **reduced with carbon**: $ZnO + C \rightarrow Zn + CO$. Highly reactive metals can also act as reducing agents, e.g. the thermit reaction **$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ + Heat** (molten iron joins railway tracks). **Bottom (Hg, Cu from Cu_2S, Ag, Au):** obtained by **heating alone** or found free. Example: $2HgS + 3O_2 \xrightarrow{Heat} 2HgO + 2SO_2$; then $2HgO \xrightarrow{Heat} 2Hg + O_2$. Carbon cannot reduce oxides of Na or Al because these metals have **more affinity for oxygen than carbon does** — carbon cannot pull the oxygen away.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ Top of series: electrolysis with example	1½ m
✓ Middle: roasting/calcination → carbon reduction + thermit	2 m
✓ Bottom: heating alone with HgS example	1 m
✓ Why carbon cannot reduce Na/Al oxides	½ m

Ans. **Q21**

(a) Corrosion is the eating away of a metal surface attacked by moisture, air, acids, etc. Activity: three test tubes with clean iron nails — **A:** ordinary water + air; **B:** boiled distilled water covered with an oil layer (no dissolved air); **C:** anhydrous calcium chloride to keep the air dry, tube corked. After a few days, nails rust **only in A**, where both air and water are present — proving both are essential. (b) Prevention (any four): painting, oiling, greasing, **galvanising**, chrome plating, anodising, alloying (e.g. stainless steel). A galvanised article stays protected even with a broken coating because **zinc is more reactive than iron** — zinc is attacked (oxidised) in preference to the iron beneath, so the iron still does not rust.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Definition of corrosion	1 m
✓ (a) Three-test-tube activity described correctly	2 m
✓ (b) Any four prevention methods	1 m
✓ (b) Galvanisation works even when broken — reason	1 m

Ans. **Q22**

(a) **$S(s) + O_2(g) \rightarrow SO_2(g)$** (1) (b) (i) On **dry** litmus: no effect. (ii) On **moist blue** litmus: turns **red**. Reason: SO_2 shows acidic behaviour only after dissolving in the water on the moist paper (forming an acidic solution); with no water there are no ions, so dry litmus is unaffected. (2) (c) Non-metals form **acidic (or neutral)** oxides; metal oxides are **basic** in nature (a few like Al_2O_3/ZnO are amphoteric). (1) (d) Chemical difference: metal oxides are basic while non-metal oxides are acidic/neutral. (Also acceptable: metals displace hydrogen from dilute acids, non-metals do not; metals form positive ions, non-metals negative.) (1)

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) S + O2 → SO2	1 m
✓ (b) Effect on dry vs moist litmus with reason	2 m
✓ (c) Acidic non-metal oxides vs basic metal oxides	1 m
✓ (d) One chemical difference stated	1 m

EXAM RADAR — TOP 8 HIGH-PROBABILITY QUESTIONS

#	Question	Why examiners love it
1	Four unknown metals A–D + salt-solution table → deduce reactivity order	The classic competency question of this chapter — pure activity-series reasoning with no memorised answer possible.
2	Reasons cluster: Na/K in kerosene, Al utensils despite reactivity, jewellery metals, Ca floating	"Give reasons" questions test understanding over recall and appear in nearly every paper.
3	Roasting vs calcination — definitions, conditions, one equation each	A precise contrast pair (excess vs limited air) that instantly separates prepared students.
4	Thermit reaction with equation and use	An equation + application combo (railway tracks) — compact and repeatedly asked.
5	Electrolytic refining of copper: label anode, cathode, electrolyte, anode mud	Diagram-based questions on this figure recur; naming all four parts is a full-marks formula.
6	Formation of NaCl/MgO by electron transfer + two properties of ionic compounds	Bridges this chapter to bonding concepts; a staple 5-mark structure.
7	Rusting conditions activity (three test tubes) and prevention methods	Experiment-design questions fit the CBSE competency focus; galvanisation's "broken coating" twist is a favourite HOTS add-on.
8	Why no H_2 with HNO_3 / the aqua regia gold-theft story	Exception-based and story-based questions check deeper reading of the chapter — both are directly from NCERT text.

COMMON MISTAKES & EXAMINER TIPS

Common mistakes students make: 1. **Jumbling the activity series.** One slip (e.g. placing Zn below Fe) wrecks every displacement prediction. Learn the full order with hydrogen's position marked. 2. **Roasting/calcination swap.** Roasting = **s**ulphide + exce**ss** air; calcination = **c**arbonate + limited air. The S–S and C–C pairing is the easiest memory hook. 3. **Saying ionic compounds conduct in all states.** They conduct **only** in molten state or aqueous solution — never as solids. State the reason (ion mobility) for full marks. 4. **Writing "iron reacts with cold water."** Fe, Al and Zn react **only with steam**; K and Na react with cold water; Mg needs hot water. 5. **Wrong products with steam.** Steam gives the metal **oxide** (Fe_3O_4, Al_2O_3), not the hydroxide — hydroxides come from reactions with liquid water. 6. **Claiming carbon can reduce any metal oxide.** Carbon fails for Na, Mg, Ca, Al — these need electrolysis. Mentioning "greater affinity for oxygen" earns the reasoning mark. 7. **Anode/cathode mix-up in refining.** Impure = **a**node ("impure Anode"), pure = cathode. Anode mud sits **below the anode**. 8. **Forgetting HNO_3 is the exception acid.** Writing "metal + HNO_3 → salt + H_2" is a standard trap; H_2 is oxidised to water (exceptions: Mg, Mn with very dilute HNO_3).

Examiner tips for full marks: - In reactivity-table questions, **write the reasoning chain** ("B displaces Fe, so B > Fe...") — the logic carries the marks, not just the final order. - For "give reasons," answer in the pattern **property → consequence** ("Zinc is more reactive than iron, therefore zinc is oxidised first..."). - Always attach the **use** to a process equation (thermit → railway tracks; galvanising → iron sheets) — application lines are mark-fetchers. - When drawing/describing electrolytic refining, label all **four** items: anode, cathode, electrolyte, anode mud. - In electron-transfer answers, show configurations (2,8,1 → 2,8) — configurations are part of the marking scheme.

ONE-PAGE QUICK REVISION

THE CHAPTER IN 60 SECONDS

Physical split: Metals — lustrous, malleable, ductile, conducting, sonorous solids. Non-metals — opposite. Exceptions: Hg (liquid metal), graphite (conducting non-metal), iodine (lustrous non-metal), Na/K (soft, knife-cuttable).

THE ACTIVITY SERIES (the chapter's spine): K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag > Au - Above H → displaces H_2 from dilute acids • Higher metal displaces lower from salt solution.

Water reactivity ladder: K, Na (cold, violent, H_2 ignites) → Ca (cold, floats) → Mg (hot) → Al, Zn, Fe (steam only) → Pb, Cu, Ag, Au (never).

Acid facts: Metal + dilute acid → salt + H_2 (vigour Mg > Al > Zn > Fe; Cu none) • HNO_3 exception — H_2 oxidised to H_2O (except Mg, Mn in very dilute) • Aqua regia = conc. HCl : conc. HNO_3 = 3:1, dissolves gold and platinum.

Oxide chemistry: Metal oxides basic (Na_2O, K_2O → alkalis in water) • Al_2O_3, ZnO amphoteric • Non-metal oxides acidic/neutral (SO_2 reddens moist litmus).

Ionic compounds: metal loses e^- → cation; non-metal gains → anion (Na^+Cl^-, $Mg^{2+}(Cl^-)_2$). Hard brittle solids • high m.p./b.p. • water-soluble • conduct molten/solution only.

Metallurgy map: | Series position | Ore form | Extraction | |---|---|---| | Top (K–Al) | never free | electrolysis of molten salt (metal at cathode) | | Middle (Zn–Pb) | sulphides/carbonates | roast (excess air) / calcine (limited air) → oxide → reduce with C | | Bottom (Cu–Au) | often free | heating alone (HgS → HgO → Hg) |

Star equations: Thermit: $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ + Heat (railway tracks) • $ZnO + C \rightarrow Zn + CO$ • Refining: impure anode → pure cathode, anode mud below.

Corrosion: needs air + moisture (3-nail activity proves it). Prevention: paint, oil, grease, galvanise, chrome-plate, anodise, alloy. Galvanised iron survives a scratched coat — zinc corrodes first.

Alloys: homogeneous metal mixtures; lower conductivity and m.p. than pure metal. Steel (Fe+C), stainless (Fe+Ni+Cr), brass (Cu+Zn), bronze (Cu+Sn), solder (Pb+Sn), amalgam (+Hg), 22-carat gold = 22 Au : 2 Cu/Ag.

AlphaLearn Studylab • Class 10 CBSE Chemistry • Chapter 3 Guide • Board Exam 2027 pattern

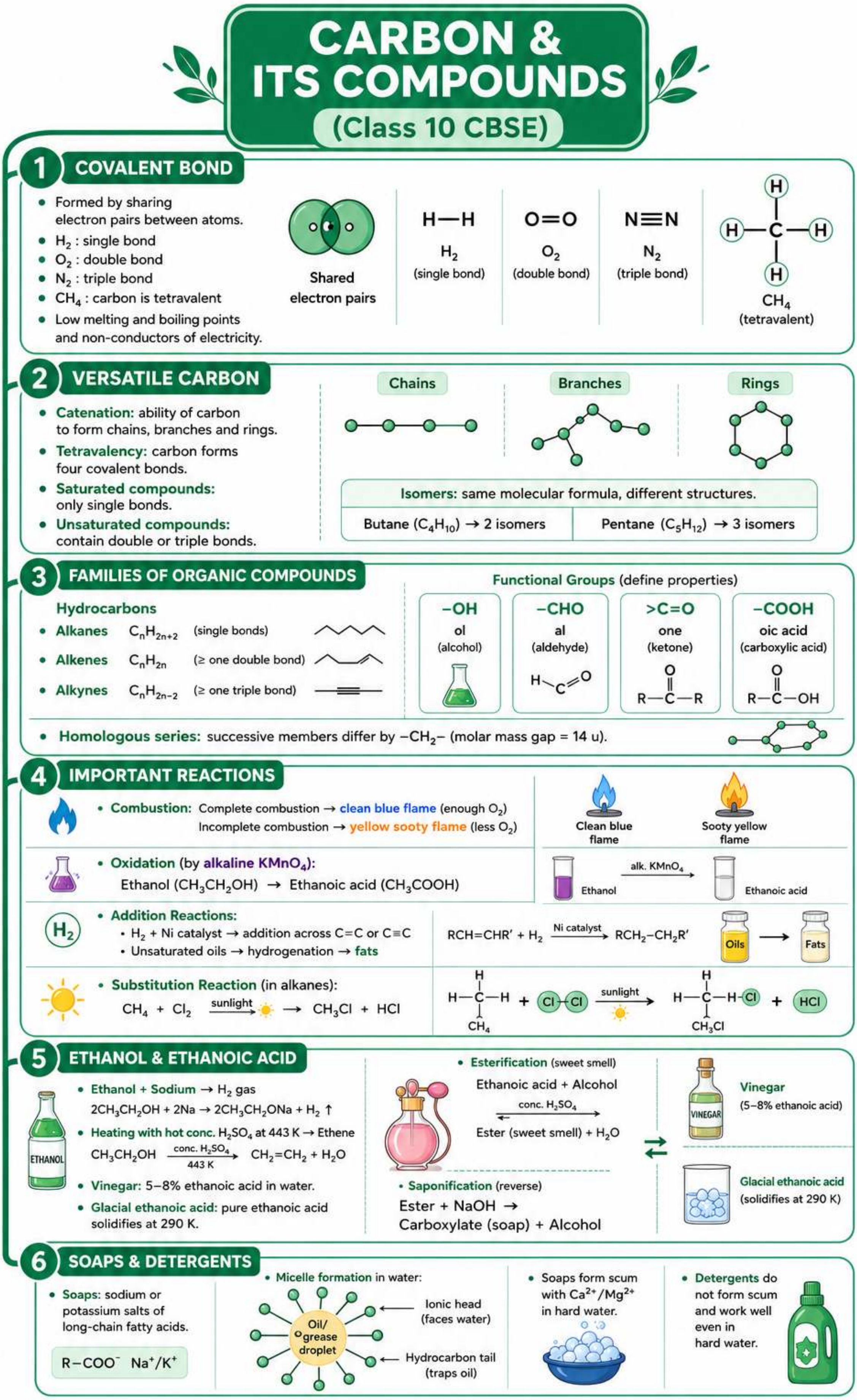
CHAPTER 4

Carbon and its Compounds

Covalent bonds, hydrocarbons, ethanol, ethanoic acid and soaps

Mind Map | Master Equations | Solved Examples | Labelled Diagrams | 22-Q Practice + Key | Exam Radar | 1-Page Revision

CHAPTER 4 • MIND MAP — THE CHAPTER AT A GLANCE



KEY DEFINITIONS & MASTER EQUATIONS

2.1 Key Definitions

1. **Covalent bond:** A bond formed by the sharing of an electron pair between two atoms so that both complete their outermost shells.

2. **Catenation:** Carbon's unique ability to form bonds with other carbon atoms, giving long chains, branched chains and rings.

3. **Tetravalency:** Carbon has four valence electrons, so it forms four covalent bonds.

4. **Saturated compound:** A carbon compound with only single bonds between carbon atoms (alkanes) — generally not very reactive.

5. **Unsaturated compound:** A carbon compound with at least one double bond (alkenes) or triple bond (alkynes) between carbon atoms — more reactive than saturated ones.

6. **Hydrocarbon:** A compound of carbon and hydrogen only.

7. **Structural isomers:** Compounds with the same molecular formula but different structures (e.g. the two forms of C_4H_{10}).

8. **Heteroatom:** An atom (Cl, Br, O, N, S) that replaces hydrogen in a hydrocarbon chain.

9. **Functional group:** The heteroatom or group that gives a compound its characteristic properties, regardless of chain length.

10. **Homologous series:** A family of compounds with the same functional group, in which successive members differ by a $-CH_2-$ unit (molecular mass difference 14 u).

11. **Oxidising agent:** A substance capable of adding oxygen to another substance (e.g. alkaline $KMnO_4$, acidified $K_2Cr_2O_7$).

12. **Catalyst:** A substance that changes the rate of a reaction without itself being consumed or changed.

13. **Hydrogenation:** Adding hydrogen to an unsaturated compound using a nickel or palladium catalyst; used industrially to convert vegetable oils to solid fats.

14. **Substitution reaction:** A reaction in which one atom or group replaces another (e.g. Cl replacing H in methane in sunlight).

15. **Esterification:** Reaction of a carboxylic acid with an alcohol (acid catalyst) to form a sweet-smelling ester.

16. **Saponification:** Treating an ester with sodium hydroxide to give back the alcohol and the sodium salt of the acid; used for making soap.

17. **Soap:** The sodium or potassium salt of a long-chain carboxylic acid.

18. **Micelle:** A spherical cluster of soap molecules in water with hydrophobic tails pointing inward (holding oily dirt) and hydrophilic ionic heads facing the water.

19. **Denatured alcohol:** Industrial ethanol made unfit for drinking by adding poisonous methanol and a blue dye.

2.2 General Formulae and Family Facts

- **Alkanes: C_nH_{2n+2}** (methane CH_4, ethane C_2H_6, propane C_3H_8, butane C_4H_{10}, pentane C_5H_{12}, hexane C_6H_{14})
- **Alkenes: C_nH_{2n}** (first member: ethene C_2H_4)
- **Alkynes: C_nH_{2n-2}** (first member: ethyne C_2H_2)
- Successive homologues differ by **$-CH_2-$ = 14 u**.

2.3 Functional Group and Naming Table (memorise)

Class	Functional group	Prefix/Suffix	3-carbon example
Haloalkane	–Cl / –Br	prefix chloro-/bromo-	Chloropropane
Alcohol	–OH	suffix -ol	Propanol
Aldehyde	–CHO	suffix -al	Propanal
Ketone	>C=O	suffix -one	Propanone
Carboxylic acid	–COOH	suffix -oic acid	Propanoic acid
Alkene	C=C	suffix -ene	Propene
Alkyne	C≡C	suffix -yne	Propyne

Naming rule: count carbons → base name; if the suffix begins with a vowel, drop the final 'e' (propane – e + one = propanone).

2.4 Master List of Balanced Equations

Combustion (oxidation with heat and light) 1. $C + O_2 \rightarrow CO_2$ + heat and light 2. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat and light 3. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ + heat and light

Controlled oxidation (alcohol → acid) 4. $CH_3CH_2OH \xrightarrow{\text{Alkaline } KMnO_4 \text{ + Heat (or acidified } K_2Cr_2O_7 \text{ + Heat)}} CH_3COOH$

Addition (hydrogenation) 5. Unsaturated hydrocarbon + H_2 $\xrightarrow{\text{Ni or Pd catalyst}}$ Saturated hydrocarbon (vegetable oil → vanaspati/fat)

Substitution (in sunlight) 6. $CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$

Reactions of ethanol 7. $2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+$ (sodium ethoxide) + H_2 (pop-sound test for H_2) 8. $CH_3CH_2OH \xrightarrow{\text{Hot conc. } H_2SO_4\text{, 443 K}} CH_2{=}CH_2 + H_2O$ (dehydration; H_2SO_4 = dehydrating agent)

Reactions of ethanoic acid 9. $CH_3COOH + NaOH \rightarrow CH_3COONa$ (sodium ethanoate/acetate) + H_2O 10. $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$ 11. $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$ (brisk effervescence; CO_2 turns lime water milky)

Esterification and saponification (a reversible pair) 12. $CH_3COOH + CH_3CH_2OH$ —Acid catalyst→ $CH_3COOC_2H_5$ (ester) + H_2O (sweet smell — perfumes, flavours) 13. $CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$ (saponification — soap making principle)

SOLVED EXAMPLES — BOARD STYLE

Solved Example 1 (3 marks) — Counting covalent bonds

Q. How many covalent bonds are present in ethane (C_2H_6)? Show the working.

Answer: - Structure: each carbon is joined to the other carbon by one C–C bond, and each carbon carries three hydrogens. - Count: **1 (C–C) + 6 (C–H) = 7 covalent bonds.** - Working check with valency: total bonding capacity = 2 carbons × 4 + 6 hydrogens × 1 = 14 half-bonds → 14 ÷ 2 = 7 bonds. ✓

Solved Example 2 (3 marks) — Homologous series

Q. What is a homologous series? Show that CH_3OH and C_2H_5OH belong to one, using formula and mass differences.

Answer: - A homologous series is a family of compounds carrying the **same functional group** on carbon chains of different lengths, so their chemical properties are similar while physical properties change gradually. - Formula difference: $C_2H_5OH - CH_3OH$ = **–CH_2–** unit. - Mass difference: (2×12 + 6×1 + 16) − (12 + 4×1 + 16) = 46 − 32 = **14 u** — exactly one CH_2 (12 + 2). - Same –OH group + constant CH_2 gap → they are consecutive members of the **alcohol homologous series**.

Solved Example 3 (3 marks) — Flame test for saturation

Q. Two unlabeled gas jars contain a saturated and an unsaturated hydrocarbon. Give a simple test to identify them, with reason. Why does even a saturated fuel sometimes burn with a sooty flame at home?

Answer: - Burn small samples: the **saturated** hydrocarbon burns with a **clean blue flame**, while the **unsaturated** one burns with a **yellow, sooty flame** (its higher carbon fraction burns incompletely, releasing carbon particles). - At home, a sooty flame from a gas stove means the **air holes are blocked** — the limited oxygen supply causes incomplete combustion even of saturated fuel (this is why vessel bottoms blacken and fuel is wasted).

Solved Example 4 (3 marks) — Ethanol vs ethanoic acid

Q. Give two tests to distinguish ethanol from ethanoic acid.

Answer: - **Litmus test:** ethanoic acid turns blue litmus red (it is an acid); ethanol has no effect on litmus. - **Sodium carbonate/hydrogencarbonate test:** ethanoic acid gives **brisk effervescence of CO_2** (which turns lime water milky): $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$. Ethanol gives no reaction with carbonates. - (Physical difference also acceptable: pure ethanoic acid freezes at 290 K in cold weather — glacial acetic acid — while ethanol stays liquid.)

Solved Example 5 (5 marks) — Cleaning action of soap

Q. What is a micelle? Explain the mechanism by which soap removes oily dirt from clothes. Why does soap not work well in hard water, and how do detergents solve this?

Answer: - A soap molecule has two ends: a **hydrophilic ionic head** (loves water) and a **hydrophobic hydrocarbon tail** (loves oil). - In water, soap molecules cluster into spheres called **micelles** — tails pointing inward, ionic heads outward on the surface. - Mechanism: the tails dissolve into the **oily dirt** on cloth, trapping the oil droplet at the centre of the micelle; the ionic heads keep the whole cluster suspended in water as an **emulsion**. Micelles repel one another (ion–ion repulsion), so they stay dispersed as a colloid and the dirt **rinses away** with the water. (The colloid also scatters light — that's why soap solution looks cloudy.) - In **hard water**, soap reacts with the calcium and magnesium salts to form an insoluble **scum**, wasting soap and leaving deposits. - **Detergents** (long-chain compounds such as sodium salts of sulphonic acids) have charged ends that do **not** form insoluble precipitates with Ca^{2+}/Mg^{2+} ions, so they lather and clean effectively even in hard water.

REAL-LIFE APPLICATION

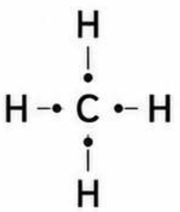
How soap actually pulls grease off your clothes

Oily dirt will not dissolve in water — but a soap molecule has a tail that loves oil and a head that loves water. Millions of soap molecules surround each grease droplet, tails buried in the oil, heads facing the water, forming a micelle. Rinse, and the whole package washes away. In hard water this fails (scum forms), which is exactly why detergents were invented.

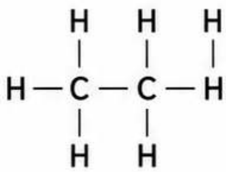
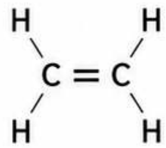
CHAPTER 4 • KEY DIAGRAMS — SHEET 1

Chapter 4: Covalent Bonding & Structures (1 of 2)

1 Electron dot structures

H_2	H :: H	Single bond
O_2	:Ö :: Ö:	Double bond
N_2	:N ⁝⁝ N:	Triple bond
CH_4		Methane — carbon is tetravalent

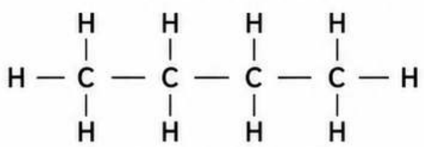
2 Hydrocarbon trio

Ethane — saturated		$CH_3{-}CH_3$
Ethene — double bond		$CH_2{=}CH_2$
Ethyne — triple bond	H—C≡C—H	CH≡CH

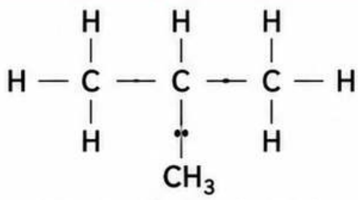
Unsaturated = more reactive

3 Isomers of butane

Same formula C_4H_{10}



Straight chain (n-butane)
C_4H_{10}



Branched chain (isobutane)
C_4H_{10}

Different structures
Structural isomers

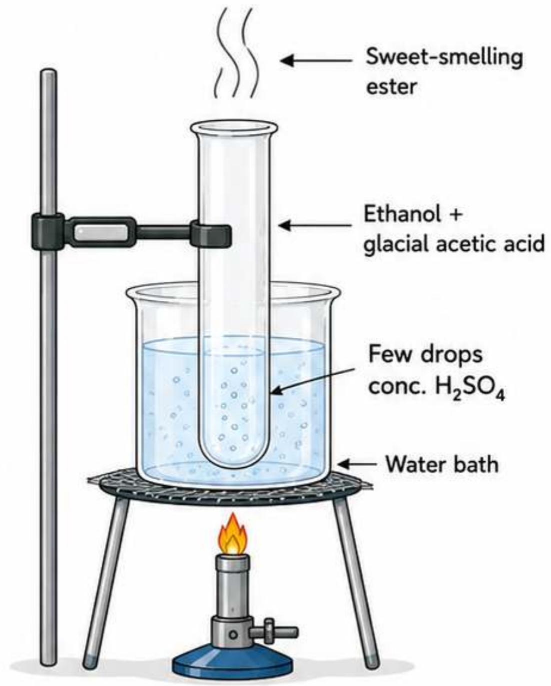
4 Functional group chart

—O—H	—OH alcohol (-ol)
$-\underset{\underset{O}{\Vert}}{C}-H$	—CHO aldehyde (-al)
$-\underset{\underset{O}{\Vert}}{C}-R$	>C=O ketone (-one)
$-\underset{\underset{O}{\Vert}}{C}-O-H$	—COOH carboxylic acid (-oic acid)
—Cl / —Br	—Cl/—Br halo (prefix)

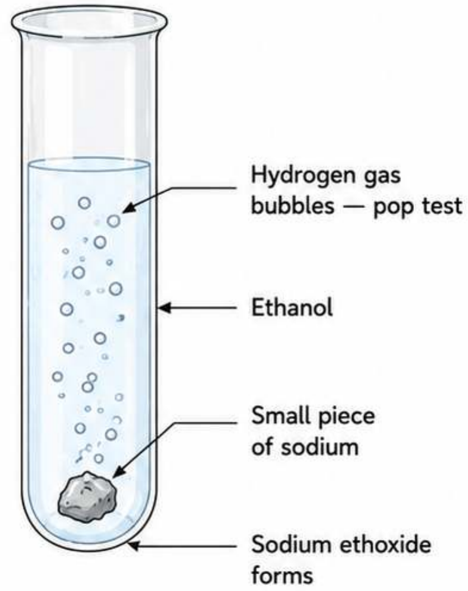
CHAPTER 4 • KEY DIAGRAMS — SHEET 2

Chapter 4: Reactions of Ethanol, Ethanoic Acid & Soap (2 of 2)

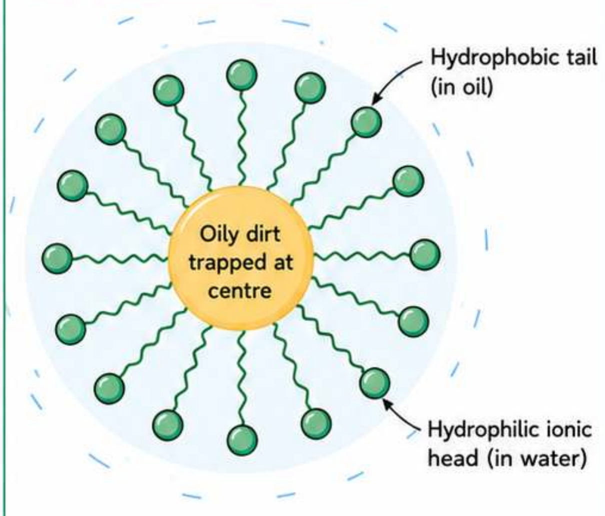
1 Ester formation apparatus



2 Sodium + ethanol



3 Micelle structure

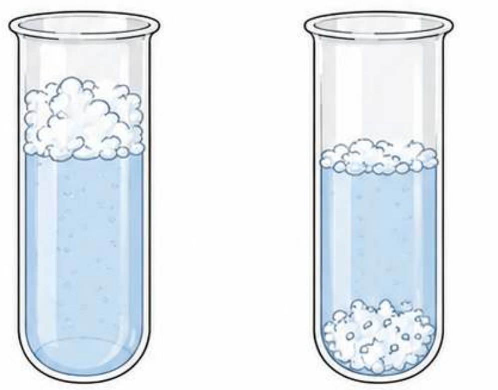


Micelle — emulsifies dirt

4 Soap vs hard water

Soft water — good lather

Hard water — scum (Ca/Mg salts)



Detergents lather even in hard water

PRACTICE SET — CBSE 2027 PATTERN

CHAPTER-WISE PRACTICE • 10 MCQ • 8 SHORT • 4 LONG (incl. CASE STUDY)

Part A — Multiple Choice Questions (1 mark each) — Q1 to Q10

Q1 1 MARK Apply (Numerical)

Ethane (C_2H_6) has:

(a) 6 covalent bonds

(b) 7 covalent bonds

(c) 8 covalent bonds

(d) 9 covalent bonds

Q2 1 MARK Understand

Butanone is a four-carbon compound with the functional group:

(a) carboxylic acid

(b) aldehyde

(c) ketone

(d) alcohol

Q3 1 MARK Analyse

While cooking, if the bottom of the vessel is getting blackened on the outside, it means that:

(a) the food is not cooked completely

(b) the fuel is not burning completely

(c) the fuel is wet

(d) the fuel is burning completely

Q4 1 MARK Remember

The general formula of alkynes is:

(a) C_nH_{2n+2}

(b) C_nH_{2n}

(c) C_nH_{2n-2}

(d) C_nH_n

Q5 **1 MARK** **Apply**

Which of the following will undergo an addition reaction?

(a) C_2H_6

(b) C_3H_8

(c) C_3H_6

(d) CH_4

Q6 **1 MARK** **Remember**

Vinegar is a solution of about:

(a) 5–8% ethanoic acid in water

(b) 5–8% ethanol in water

(c) 50% ethanoic acid in water

(d) 100% ethanoic acid

Q7 **1 MARK** **Remember**

The catalyst used in the hydrogenation of vegetable oils is:

(a) iron

(b) nickel

(c) manganese dioxide

(d) copper

Q8 **1 MARK** **Remember**

The difference in molecular mass between any two successive members of a homologous series is:

(a) 12 u

(b) 14 u

(c) 16 u

(d) 18 u

Q9 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): Covalent compounds are generally poor conductors of electricity. **Reason (R):** Covalent compounds do not contain ions or free charged particles.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Q10 **1 MARK** Analyse (A-R) Assertion–Reason

Assertion (A): A mixture of ethyne and pure oxygen — not ethyne and air — is burnt for welding. **Reason (R):** Air produces incomplete combustion of ethyne, giving a sooty flame with a lower temperature that cannot melt metals well.

(a) Both A and R are true and R explains A

(b) Both A and R are true but R does not explain A

(c) A is true, R is false

(d) A is false, R is true

Part B — Short Answer Questions (2–3 marks) — Q11 to Q18

Q11 **3 MARKS** Understand

Which two properties of carbon lead to the enormous number of carbon compounds around us? Explain each briefly.

Q12 **2 MARKS** Understand

What is the formula of cyclopentane? Draw/describe its structure. How does it differ from pentane?

Q13 **3 MARKS** Apply

Name the following: (i) CH_3—CH_2—Br, (ii) a 3-carbon compound ending in -one, (iii) a 6-carbon aldehyde. State the rule used for (ii).

Q14 **2 MARKS** Analyse

Why does the colour of alkaline potassium permanganate not disappear when it is added in excess to warm ethanol? What are such substances called?

Q15 2 MARKS Remember

What is denatured alcohol? Why is it made this way?

Q16 2 MARKS Understand

Why is the conversion of ethanol to ethanoic acid called an oxidation reaction? Write the equation.

Q17 2 MARKS Apply

What change will you observe when soap is tested with red and blue litmus papers? What does this tell you about soap?

Q18 3 MARKS Understand

Explain the formation of scum when hard water is treated with soap. Why do detergents not form scum?

Part C — Long Answer Questions (5 marks) — Q19 to Q22

Q19 5 MARKS Understand

(a) Explain the nature of the covalent bond using the bond formation in CH_3Cl. (b) Why do covalent compounds generally have low melting and boiling points?

Q20 5 MARKS Understand

(a) Define structural isomers. Draw/describe the possible structural isomers of pentane (C_5H_{12}). (b) What are the differences between the three classes of hydrocarbons — alkanes, alkenes and alkynes — in terms of bonds and general formulae, with the first member of each?

Q21 2 MARKS Analyse

An organic compound 'A' is widely used as a preservative in pickles and has the molecular formula $C_2H_4O_2$. This compound reacts with ethanol (in the presence of an acid catalyst) to form a sweet-smelling compound 'B'. (a) Identify A and write its common name. (1) (b) Write the equation for the formation of B and name the reaction. (2) (c) How can B be converted back to ethanol? Write the equation and name this reaction.

Q22 5 MARKS Competency (Case)

Meera's teacher demonstrated Activity 4.6: she dropped a rice-grain-sized piece of sodium into absolute ethanol, and brisk bubbles of a gas were released. The gas gave a pop sound with a burning splinter. Next, the teacher heated ethanol with excess concentrated sulphuric acid at 443 K, and a different gas was collected that burnt with a sooty flame. (a) Write the equation for the reaction of sodium with ethanol and name the products. (2) (b) Identify the gas formed in the second experiment and write the equation. (1) (c) What role does concentrated sulphuric acid play in the second reaction? (1) (d) Why does the second gas burn with a sooty flame while ethanol itself burns cleanly? (1)

EASY STEP-WISE ANSWER KEY

EASY STEP-WISE ANSWERS — WITH CBSE MARKING SCHEME FOR 5-MARKERS

Part A — MCQs

Ans. **Q1**

(b) 7 covalent bonds — 1 C–C bond + 6 C–H bonds = 7. Check: (2×4 + 6×1) ÷ 2 = 7.

Ans. **Q2**

(c) Ketone — the suffix "-one" signals the ketone group (>C=O); butan + one = 4-carbon ketone.

Ans. **Q3**

(b) The fuel is not burning completely — blocked air inlets limit oxygen → incomplete combustion → soot (carbon) deposits on the vessel.

Ans. **Q4**

(c) C_nH_{2n-2} — alkynes carry a triple bond; alkanes are C_nH_{2n+2} and alkenes C_nH_{2n}.

Ans. **Q5**

(c) C_3H_6 — it fits C_nH_{2n} (propene, an alkene with a double bond), so it can add hydrogen. C_2H_6, C_3H_8 and CH_4 are saturated alkanes — no addition. (C_2H_2, ethyne, would also qualify.)

Ans. **Q6**

(a) 5–8% ethanoic acid in water — this dilute solution is vinegar, the pickle preservative.

Ans. **Q7**

(b) Nickel — Ni (or palladium) catalyses hydrogenation of oils into fats.

Ans. **Q8**

(b) 14 u — successive homologues differ by one $-CH_2-$ unit = 12 + 2 = 14 u.

Ans. **Q9**

(a) — Conduction needs charged particles free to move; covalent molecules share electrons and form no ions, so they don't conduct. R explains A.

Ans. **Q10**

(a) — Welding needs a very hot flame to melt metal. In air (limited oxygen), ethyne burns incompletely — sooty, cooler flame. Pure oxygen gives complete combustion and an extremely hot flame. R explains A.

Part B — Short Answers

Ans. **Q11**

(i) **Catenation** — carbon atoms bond with one another to build long chains, branched chains and rings; the C–C bond is unusually strong and stable, so huge molecules survive. (ii) **Tetravalency** — with four valence electrons, each carbon bonds to four other atoms (C, H, O, N, S, Cl...), multiplying the possible combinations. Carbon's small size lets its nucleus hold shared electron pairs tightly, making all these bonds strong.

Ans. **Q12**

Cyclopentane: **C_5H_{10}** — five carbon atoms joined in a **ring**, each carrying two hydrogens. Pentane (C_5H_{12}) is an **open chain**; the ring closure in cyclopentane uses up one C–C bond position, so it has two hydrogens fewer.

Ans. **Q13**

(i) **Bromoethane** (2 carbons + Br prefix). (ii) **Propanone** — rule: when the suffix starts with a vowel, the final 'e' of the chain name is dropped: propane – e + one. (iii) **Hexanal** (6 carbons + -al for aldehyde).

Ans. **Q14**

Alkaline $KMnO_4$ acts as an **oxidising agent** — it gives up its oxygen to ethanol, converting it to ethanoic acid, and its purple colour disappears as it is used up. Once ALL the ethanol has been oxidised, added $KMnO_4$ has nothing left to react with, so **its colour persists**. Substances that supply oxygen to others are called **oxidising agents**.

Ans. **Q15**

Denatured alcohol is industrial ethanol deliberately made **unfit for drinking** by adding poisonous **methanol**, with a **blue dye** for easy identification. This prevents the misuse of cheap industrial ethanol as a beverage.

Ans. **Q16**

In the conversion, ethanol **gains oxygen** — CH_3CH_2OH becomes CH_3COOH. Gain of oxygen is oxidation (Chapter 1 definition), so this is an oxidation reaction. **$CH_3CH_2OH \xrightarrow{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$**

Ans. **Q17**

Soap turns **red litmus blue**; blue litmus stays blue. This shows that soap solution is **basic in nature** (soaps are salts of a strong base, NaOH/KOH, with weak long-chain carboxylic acids).

Ans. **Q18**

Hard water contains dissolved **calcium and magnesium salts**. Soap reacts with these Ca^{2+}/Mg^{2+} ions to form an **insoluble curdy precipitate — scum** — so soap is wasted and lather forms with difficulty. Detergents (e.g. sodium salts of sulphonic acids) have charged ends that **do not form insoluble salts** with calcium and magnesium ions, so they stay dissolved and keep cleaning even in hard water.

Part C — Long Answers

Ans. **Q19**

(a) A covalent bond forms when two atoms **share a pair of electrons** so each attains a filled outer shell. In CH_3Cl: carbon (4 valence electrons) shares one electron pair with each of the **three hydrogens** (three C–H single bonds) and one pair with **chlorine** (one C–Cl single bond). Hydrogen reaches the helium configuration (2), while carbon and chlorine complete their octets — four shared pairs in total, all covalent. (b) Within a covalent molecule the bonds are strong, but the forces **between separate molecules are weak**. Melting/boiling only has to overcome these weak intermolecular forces, not the bonds themselves — so covalent compounds have **low melting and boiling points** (and, having no ions, they are also poor conductors).

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Sharing of pairs explained for CH3Cl	2 m
✓ (a) All four bonds identified (3 C–H + 1 C–Cl)	1 m
✓ (b) Weak intermolecular forces argument	2 m

Ans. **Q20**

(a) Structural isomers have the **same molecular formula but different arrangements of atoms**. Pentane, C_5H_{12}, has **three** isomers: (1) a straight chain of five carbons; (2) a four-carbon chain with one CH_3 branch on the second carbon; (3) a three-carbon chain with two CH_3 branches on the middle carbon. (b) **Alkanes** — only C–C single bonds, saturated, general formula C_nH_{2n+2}, first member methane (CH_4). **Alkenes** — at least one C=C double bond, unsaturated, C_nH_{2n}, first member ethene (C_2H_4). **Alkynes** — at least one C≡C triple bond, unsaturated, C_nH_{2n-2}, first member ethyne (C_2H_2). Unsaturated hydrocarbons are more reactive than saturated ones and undergo addition reactions.

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Definition of structural isomers	1 m
✓ (a) Three isomers of pentane described	2 m
✓ (b) Alkane/alkene/alkyne bonds + formulae + first members	2 m

Ans. **Q21**

(a) **A = Ethanoic acid (CH_3COOH)** — molecular formula $C_2H_4O_2$; common name **acetic acid** (5–8% solution = vinegar, the pickle preservative). (1) (b) **$CH_3COOH + CH_3CH_2OH \xrightarrow{\text{Acid catalyst}} CH_3COOC_2H_5 + H_2O$** — this is **esterification**; B is the sweet-smelling ester ethyl ethanoate, used in perfumes and flavourings. (2) (c) Treat B with sodium hydroxide: **$CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$** — the ester splits back into ethanol and sodium ethanoate. This is **saponification**, the reaction used in soap making. (2)

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Identifying A as ethanoic acid + common name	1 m
✓ (b) Esterification equation with acid catalyst	2 m
✓ (c) Saponification equation and name	2 m

Ans. **Q22**

(a) **$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+ + H_2$** — products: **sodium ethoxide** and **hydrogen gas** (confirmed by the pop sound). (2) (b) The gas is **ethene**: **$CH_3CH_2OH \xrightarrow{\text{Hot conc. } H_2SO_4,\ 443\ K} CH_2{=}CH_2 + H_2O$** (1) (c) Concentrated sulphuric acid acts as a **dehydrating agent** — it removes a water molecule from ethanol. (1) (d) Ethene is an **unsaturated** hydrocarbon; its combustion in air is incomplete, releasing carbon particles that make the flame yellow and sooty. Ethanol, with sufficient oxygen, burns completely with a clean flame. (1)

Breakdown — as per CBSE Marking Scheme (Total: 5 marks)	
✓ (a) Balanced Na + ethanol equation + products	2 m
✓ (b) Ethene identified with dehydration equation	1 m
✓ (c) Conc. H2SO4 as dehydrating agent	1 m
✓ (d) Sooty flame of unsaturated ethene explained	1 m

EXAM RADAR — TOP 8 HIGH-PROBABILITY QUESTIONS

#	Question	Why examiners love it
1	Electron-dot structures (H_2O, NH_3, CH_4, CO_2, ethane, ethanoic acid)	Drawing questions test genuine understanding of sharing; at least one appears nearly every year.
2	Catenation + tetravalency — "why does carbon form so many compounds?"	The chapter's central concept, perfectly sized for a 2–3 mark answer.
3	Homologous series: definition + CH_2/14 u working	Combines definition with a small calculation — CBSE's favourite blend of recall and application.
4	Isomers of butane/pentane	Structure-drawing discriminates strong students; pentane's three isomers are a classic.
5	Ethanol + Na, and ethanol → ethene with conc. H_2SO_4	Two named reactions with conditions (443 K) — condition-on-arrow marks are guaranteed here.
6	Distinguish ethanol vs ethanoic acid (litmus + carbonate test)	Practical-based distinguishing tests are core to the competency pattern.
7	Esterification ↔ saponification pair with equations	A reversible pair linking to daily life (perfume, soap) — ideal for the 5-mark chain question.
8	Micelle diagram + cleaning action + hard-water scum vs detergents	The soap section supplies the chapter's most reliable 5-marker; the hard-water twist adds the HOTS element.

COMMON MISTAKES & EXAMINER TIPS

Common mistakes students make: 1. **Confusing ionic and covalent behaviour.** Carbon compounds share electrons — they do NOT form ions, do not conduct, and have LOW melting points. Don't recycle Chapter 3's ionic properties here. 2. **Wrong general formula.** Alkane C_nH_{2n+2}, alkene C_nH_{2n}, alkyne C_nH_{2n-2} — students often swap alkene and alkyne. Anchor them to ethene (C_2H_4) and ethyne (C_2H_2). 3. **Counting bonds, not atoms.** In "how many covalent bonds" questions, count every C–H bond too (ethane = 7, not 1). 4. **Naming slips.** Forgetting to drop the final 'e' before a vowel suffix (propanone, not propaneone), or using "-ol" for acids. 5. **Calling hydrogenation a substitution.** Adding H_2 across a double bond is an **addition** reaction; substitution is Cl replacing H in sunlight. Addition needs unsaturation; substitution is the saturated compound's reaction. 6. **Writing "$KMnO_4$ is a catalyst."** It is an **oxidising agent** — it is consumed (its colour disappears). The catalysts in this chapter are Ni/Pd (hydrogenation) and conc. H_2SO_4 (esterification only; in dehydration it is a dehydrating agent). 7. **Ester equation without the acid catalyst on the arrow** — the condition carries a mark. 8. **Micelle drawn inside-out.** Tails (hydrophobic) point IN toward the oil; ionic heads (hydrophilic) point OUT toward water. In a hydrocarbon solvent the orientation reverses — and in ethanol no micelle forms at all (ethanol dissolves both ends).

Examiner tips for full marks: - For electron-dot structures, show **only valence electrons** and mark every shared pair clearly. - Write reaction **conditions on the arrow**: sunlight (substitution), 443 K + hot conc. H_2SO_4 (dehydration), Ni catalyst (hydrogenation), acid (esterification). - In distinguishing tests, give the **observation for BOTH substances**, not just one. - Memorise the six alkanes methane → hexane with formulae; nomenclature questions build directly on them. - The phrase "sweet-smelling compound" in any question = **ester**, "pop sound" = H_2; "lime water milky" = CO_2 — decode the clue words first.

ONE-PAGE QUICK REVISION

THE CHAPTER IN 60 SECONDS

Covalent bond = shared electron pair. H_2 single, O_2 double, N_2 triple. CH_4 = carbon's 4 valence electrons shared with 4 H. Strong bonds within molecules, weak forces between → low m.p./b.p., non-conductors.

Carbon's two superpowers: Catenation (C–C chains, branches, rings — strongest self-linking of any element) + **Tetravalency** (4 bonds; small atom grips shared pairs). Result: millions of compounds.

Hydrocarbon families: | Family | Bond | Formula | First member | |--------|------|---------|--------------| | Alkane | C–C only | C_nH_{2n+2} | Methane CH_4 | | Alkene | C=C | C_nH_{2n} | Ethene C_2H_4 | | Alkyne | C≡C | C_nH_{2n-2} | Ethyne C_2H_2 |

Saturated → clean blue flame • Unsaturated → sooty yellow flame (also = the identification test) • Blackened vessel = blocked air holes = incomplete combustion.

Isomers: same formula, different skeleton (butane 2, pentane 3). Rings: cyclohexane C_6H_{12}, benzene C_6H_6.

Homologous series: same functional group, gap of $–CH_2–$ (14 u); chemistry similar, physical properties graded. **Suffix decoder:** -ol alcohol • -al aldehyde • -one ketone • -oic acid • -ene double • -yne triple • chloro-/bromo- prefix.

Four reaction types: Combustion (CO_2 + H_2O + heat/light) • Oxidation (ethanol $\xrightarrow{\text{alk. } KMnO_4}$ ethanoic acid; oxidising agents ADD oxygen) • Addition (unsaturated + H_2, Ni catalyst — oils → fats) • Substitution (CH_4 + Cl_2 $\xrightarrow{\text{sunlight}}$ CH_3Cl + HCl).

Ethanol: liquid, fully miscible, solvent for medicines • + Na → sodium ethoxide + H_2 (pop) • hot conc. H_2SO_4/443 K → ethene + H_2O • denatured = + methanol + blue dye • methanol intake → blindness/death.

Ethanoic acid: weak acid (vs fully ionised HCl) • vinegar = 5–8% solution • glacial: freezes at 290 K • + NaOH → sodium ethanoate • + carbonates → CO_2 (lime-water test) • + ethanol/acid → ester (sweet smell) • ester + NaOH → back to alcohol + salt (saponification).

Soap: Na/K salt of long-chain carboxylic acid • hydrophilic head + hydrophobic tail → **micelle** traps oily dirt inside, emulsifies, rinses off • ion–ion repulsion keeps micelles apart; solution cloudy (scatters light) • hard water → scum (Ca/Mg salts) • detergents (sulphonic acid salts) beat hard water • soap is basic (red litmus → blue) • no micelles in ethanol.

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