CBSE CLASS X

Science (086)

ANSWER KEY

AI-generated question paper

Code: MFWVEW	Questions: 33	Maximum Marks: 97	Generated: 2026-06-25 17:39

SELECTIONS USED

Subject	Science
Lessons	2 Acids, Bases and Salts
Level of understanding	Thorough understanding
Question selection	Curated chapter coverage (~5 questions per section + 8 synthesis)
Model	claude-sonnet-4-6

Composition — Difficulty: 2 straightforward · 22 medium · 9 deep | Types: 24 Short · 6 Long · 3 MCQ

Q1. medium | thorough-understanding | § Introduction **[3]**

A student spills some soap solution on a yellow curry stain on a white cloth. The stain turns reddish-brown. When the cloth is later rinsed thoroughly with plenty of water, the stain turns yellow again. What do these two colour changes tell you about the chemical nature of soap and water, and what property of the indicators involved explains why the colour reverses on rinsing?

◆ Acids, Bases and Salts

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Model Answer

Soap is basic in nature. When soap solution (a base) is applied to the curry stain, turmeric (a natural indicator present in curry) changes from yellow to **reddish-brown**, indicating a basic medium.

Water is neutral (or very slightly acidic due to dissolved CO_2). When the cloth is rinsed with plenty of water, the base is washed away and the medium returns to neutral/acidic, so turmeric changes back to **yellow**.

Turmeric is a **natural acid-base indicator** — it is yellow in acidic or neutral conditions and reddish-brown in basic conditions. Since this colour change is **reversible**, the indicator returns to its original colour once the base is removed by rinsing.

Source: Chapter 2, Introduction (Acids, Bases and Salts)

Explanation

- **Key point 1:** Soap is basic → turmeric turns reddish-brown (base indicator response).
- **Key point 2:** Water is neutral → rinsing removes the base, turmeric reverts to yellow.
- **Key point 3:** Examiners expect you to name turmeric as a *natural indicator* and state that its colour change is *reversible* — this directly answers "why the colour reverses."
- Avoid confusing turmeric with litmus; turmeric is yellow in neutral/acidic and reddish-brown in basic medium (opposite pattern from litmus in one direction).
- Do not write about micelles or soap chemistry — that is not what this question tests.

Q2. deep | thorough-understanding | § Introduction **[2]**

Both litmus and turmeric can distinguish between acidic and basic solutions, yet neither is used when the exact strength of acidity or basicity needs to be determined. Identify one key limitation shared by these natural indicators compared to a universal indicator, and explain how this limitation affects their practical usefulness in a chemistry laboratory.

◆ **Acids, Bases and Salts**

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Model Answer

Key limitation: Both litmus and turmeric can only tell whether a solution is acidic or basic (qualitative result); they cannot indicate the **strength** (degree) of acidity or basicity.

Effect on practical usefulness: In a laboratory, knowing merely that a solution is acidic is often insufficient. A universal indicator, by contrast, shows a range of colours corresponding to pH values (0–14), allowing the chemist to determine whether an acid is weak or strong and to compare the strengths of different solutions accurately.

Source: Chapter 2, Section 2.3 — How Strong Are Acid or Base Solutions?

Explanation

- Examiners expect you to name the limitation clearly: natural indicators give only a **yes/no (acid/base)** answer, not a pH value or strength.
- The contrast with the universal indicator (which shows **different colours at different H^+ concentrations** on the pH scale 0–14) is what earns the second mark.
- Activity 4.7 (Chapter 4) directly illustrates this: litmus cannot distinguish dilute acetic acid from dilute HCl, but the universal indicator can, because it shows their different pH values.
- Keep the answer focused — one limitation + one practical consequence = 2 marks.

Q3. straightforward | thorough-understanding | § 2.1 UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES **[2]**

When zinc granules are added to dilute sulphuric acid, a gas is evolved. What is this gas, and how would you confirm its identity?

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Model Answer

The gas evolved is **hydrogen (H_2)**.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Confirmation: When a burning candle/matchstick is brought near the mouth of the test tube collecting the gas, it burns with a **pop sound**, confirming it is hydrogen gas.

Source: Chapter 1, Section 1.1.2 (Balanced Chemical Equations)

Explanation

- 1 mark: Correctly naming the gas as hydrogen and writing the equation.
- 1 mark: Describing the test — "pop sound" with a burning splint/candle is the standard textbook test for hydrogen. Examiners expect both the *method* and the *observation* (pop sound) for full credit. Simply writing "it burns" is insufficient.

Q4. medium | thorough-understanding | § 2.1 UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES **[2]**

Curd and sour substances should not be stored in brass or copper vessels. Why?

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Model Answer

Curd and sour substances contain acids (such as lactic acid). These acids react with brass (copper-zinc alloy) or copper vessels to form harmful salts, which can cause food poisoning. Storing such foods in these vessels makes the food toxic and unsafe for consumption.

Source: Chapter 3, Section 3.5 (Corrosion)

Explanation

- The key point examiners expect: **acids in sour food react with the metal/alloy** to produce **poisonous/harmful compounds**, making food unsafe.
- Mention that curd/sour substances contain acid — just saying "acidic" is enough; naming lactic acid is a bonus.
- Do NOT just say "it causes corrosion" — you must link it to **harmful salts** or **food becoming poisonous**, as that is the reason for the practical concern.
- Two marks: one for the reason (acid reacts with metal) and one for the consequence (harmful/toxic compounds formed).

Q5. deep | thorough-understanding | § 2.1 UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES **[5]**

Zinc reacts with dilute sulphuric acid to produce hydrogen gas, and it also reacts with sodium hydroxide solution to produce hydrogen gas. Write the chemical equations for both reactions, identify the other product formed in each case, and use this information to explain what the nature of zinc oxide reveals about metallic oxides in general.

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Model Answer

Reaction 1 – Zinc with dilute sulphuric acid:

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2 \uparrow$$

The other product formed is **zinc sulphate ($ZnSO_4$)**, a salt.

Reaction 2 – Zinc with sodium hydroxide solution:

$$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2 \uparrow$$

The other product formed is **sodium zincate (Na_2ZnO_2)**.

What this reveals about zinc oxide:

In Reaction 1, zinc behaves like a typical metal (reacting with acid to give a salt and hydrogen). In Reaction 2, zinc also reacts with a base (NaOH) to produce hydrogen, which means it shows acidic character as well.

This tells us that **zinc oxide (ZnO) is an amphoteric oxide** — it reacts with both acids and bases to form salt and water. Zinc oxide is therefore an exception to the general rule that metallic oxides are basic. Most metal oxides are basic, but some (like ZnO and Al_2O_3) show both acidic and basic properties and are known as **amphoteric oxides**.

Source: Metals and Non-metals, Section 3.2.1 and 3.2.3; Chemical Equations, Section 1.1.2

Explanation

- The examiner expects **both balanced equations** written correctly — these fetch 1 mark each.
- Naming the other product in each reaction is explicitly asked — 1 mark each.
- The final point on amphoteric oxides ties everything together for the 5th mark. Use the word "amphoteric" — it is the textbook term.
- The equation for zinc + NaOH is less commonly drilled than zinc + acid, so practise writing sodium zincate (Na_2ZnO_2) correctly.
- Do not confuse the question: it asks what zinc's dual behaviour *reveals about metallic oxides in general* — the answer is that not all metallic oxides are purely basic; some are amphoteric.

Q6. medium thorough-understanding § 2.1 UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES **[2]**

When carbon dioxide gas is bubbled through lime water, a white precipitate forms. However, if excess carbon dioxide continues to be passed, the precipitate disappears. What chemical change causes the precipitate to dissolve?

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Model Answer

When CO_2 is passed through lime water, it reacts with calcium hydroxide $Ca(OH)_2$ to form a white precipitate of calcium carbonate ($CaCO_3$):

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3(s) + H_2O$$

When **excess** CO_2 is passed, the insoluble $CaCO_3$ reacts with CO_2 and water to form calcium bicarbonate $Ca(HCO_3)_2$, which is soluble in water, causing the precipitate to dissolve:

$$CaCO_3(s) + CO_2 + H_2O \rightarrow Ca(HCO_3)_2(aq)$$

Source: Chapter 1, Section 1.2.1 (Combination Reaction)

Explanation

- Examiners expect **both** equations — formation of $CaCO_3$ and its conversion to soluble $Ca(HCO_3)_2$.
- Key term: **calcium bicarbonate** (soluble) — this is why the precipitate disappears.
- The second equation is the key chemical change being asked about; don't omit it.
- State symbols (s) and (aq) add value but are not strictly penalised if missing in short answers.

Q7. medium | thorough-understanding | § 2.1 UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES **[3]**

Copper oxide is a black solid. When it is added to dilute hydrochloric acid with stirring, the black solid dissolves and the solution turns blue-green. Write the chemical equation for this reaction and use the nature of the products to explain how metallic oxides should be classified chemically.

◆ **Acids, Bases and Salts**

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Model Answer

Chemical equation:

$$CuO\ (s) + 2HCl\ (aq) \rightarrow CuCl_2(aq) + H_2O\ (l)$$

The black copper oxide dissolves to form copper chloride (which gives the blue-green colour) and water. Copper chloride is a salt, and water is formed — these are the products of a reaction between a base and an acid.

Since copper oxide reacts with hydrochloric acid to form salt and water, it behaves as a base. Therefore, **metallic oxides should be classified as basic oxides** (also called basic in nature). Some metallic oxides, such as aluminium oxide and zinc oxide, react with both acids and bases and are called **amphoteric oxides**.

Source: Chapter 3, Section 3.2.1

Explanation

- Examiners award 1 mark for the correct balanced equation, 1 mark for identifying the products as salt + water (indicating a base–acid reaction), and 1 mark for the correct classification: metallic oxides are **basic oxides** (with the amphoteric example as a bonus/completing point).
- Write the equation with state symbols for full credit.
- The key phrase the examiner looks for is "metal oxides are basic in nature" — this must appear explicitly.
- Mentioning amphoteric oxides (Al_2O_3, ZnO) shows a more complete answer and is mentioned directly in the textbook in this context.

Q8. medium | thorough-understanding | § 2.2 WHAT DO ALL ACIDS AND ALL BASES HAVE IN COMMON? **[3]**

Glucose and hydrochloric acid both contain hydrogen, yet only HCl is classified as an acid. When solutions of both are tested for electrical conductivity, what difference in observation would you expect, and what does this reveal about what makes a substance acidic?

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Model Answer

Observation: When dilute HCl solution is tested, the bulb glows, indicating it conducts electricity. When glucose solution is tested, the bulb does **not** glow, showing glucose solution does not conduct electricity.

Reason: HCl ionises in water to produce H^+(aq) and Cl^- ions. These ions carry electric current through the solution. Glucose, despite containing hydrogen, does not ionise in water and produces no ions.

Conclusion: The presence of hydrogen alone does not make a substance acidic. A substance is acidic only if it produces H^+(aq) ions (hydronium ions, H_3O^+) in aqueous solution. This is what makes HCl an acid while glucose is not.

Source: Chapter 2, Section 2.2 (Activity 2.8)

Explanation

- Examiners expect: the specific observation (bulb glows / does not glow), the reason (ions / no ions), and the conclusion about what makes a substance acidic.
- Key phrase to use: "ionisation" and "H^+(aq) ions in solution."
- Don't just say "HCl is an acid" — explain *why* in terms of ion production.
- This question tests Activity 2.8 directly; the three-part structure (observation → reason → conclusion) is the ideal format for 3 marks.

Q9. medium | thorough-understanding | § 2.2 WHAT DO ALL ACIDS AND ALL BASES HAVE IN COMMON? **[2]**

Why does dry HCl gas not exhibit acidic properties, even though HCl is a well-known acid?

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Model Answer

Acidic properties of HCl are due to the production of H^+(aq) or hydronium ions (H_3O^+) in solution. In dry HCl gas, water is absent, so ionisation cannot occur:

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Since H^+ ions are not produced without water, dry HCl shows no acidic properties.

Source: Chapter 2, Section 2.2.1

Explanation

- The key concept is that **acids produce H^+(aq) ions only in the presence of water** — this is what the examiner is looking for.
- State clearly that H^+ cannot separate from HCl in the absence of water.
- Writing the equation earns a mark; don't skip it.
- The Activity 2.9 observation (dry litmus doesn't change colour, wet litmus does) is the experimental basis — mention it if the question asks for an activity, but here the conceptual explanation + equation is sufficient for 2 marks.

Q10. straightforward | thorough-understanding | § 2.2 WHAT DO ALL ACIDS AND ALL BASES HAVE IN COMMON? **[1]**

Which of the following best explains why an aqueous solution of sodium hydroxide conducts electricity?
(A) NaOH molecules carry charge through the solution as intact units.
(B) NaOH dissolves in water to produce Na^+ and OH^- ions, which act as charge carriers.
(C) Water molecules break down into H^+ and OH^- ions when NaOH is added, and it is these water-derived ions alone that conduct electricity.
(D) The high solubility of NaOH increases the density of the solution, enabling charge flow.

A NaOH molecules carry charge through the solution directly.
B NaOH dissolves in water to produce Na^+ and OH^- ions, which carry the electric current.
C NaOH reacts with water to produce H_2 gas, which aids conduction.
D Water itself becomes a good conductor when NaOH is added due to the rise in temperature.

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Model Answer

(B) NaOH dissolves in water to produce Na^+ and OH^- ions, which carry the electric current.

Source: Acids, Bases and Salts (Chapter 2), Section 2.2.1

Explanation

The textbook explicitly shows: **$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$**. These free ions act as charge carriers, enabling conduction. Option A is wrong because intact molecules cannot carry charge. Option C is fabricated. Option D is incorrect — density has no role in ionic conduction. Examiners look for the key idea: **ionic dissociation produces free ions → conduction**.

Q11. deep | thorough-understanding | § 2.2 WHAT DO ALL ACIDS AND ALL BASES HAVE IN COMMON? **[5]**

A student adds excess sodium hydroxide solution to a fixed volume of hydrochloric acid. (a) Write the ionic equation for the neutralisation reaction that occurs. (b) Explain, using the concept of ions, why the resulting solution is basic rather than neutral. (c) Predict the colour of universal indicator in the original HCl solution and in the final solution after excess NaOH has been added, giving reasons for each.

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Model Answer

(a) Ionic equation for neutralisation:

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

(b) Why the resulting solution is basic:

HCl provides $H^+(aq)$ ions and NaOH provides $OH^-(aq)$ ions. During neutralisation, H^+ and OH^- combine to form water. Since NaOH is added in **excess**, all the H^+ ions are used up, but surplus OH^- ions remain in solution. These extra OH^- ions make the solution basic (pH > 7).

(c) Universal indicator colours:

- **Original HCl solution:** The colour will be **red**, because HCl is a strong acid producing a high concentration of $H^+(aq)$ ions, giving a very low pH (around 1–2).
- **Final solution after excess NaOH:** The colour will be **violet/purple**, because excess OH^- ions remain, making the solution strongly alkaline with a high pH (above 10).

Source: Chapter 2, Section 2.2 and 2.2.1

Explanation

- Examiners expect the **net ionic equation** in (a) — not the full molecular equation. Na^+ and Cl^- are spectator ions and must be omitted.
- In (b), the key phrase is **"excess OH^- ions remain"** — link the ionic concept directly to basicity. Simply saying "more NaOH was added" without mentioning ions will lose marks.
- In (c), remember the universal indicator colour scale: red/orange = strongly/weakly acidic; green = neutral; blue/violet = alkaline. HCl (strong acid) → red; strongly alkaline solution → violet. Always give a reason linked to ions or pH.

Q12. medium | thorough-understanding | § 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS? **[3]**

Two solutions have pH values of 3 and 11 respectively. Compare their H^+(aq) ion concentrations and explain what each pH value indicates about the chemical nature of the solutions.

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Model Answer

Comparison of H^+(aq) ion concentrations:

On the pH scale, higher H^+ ion concentration means lower pH. Since pH 3 < pH 11, the solution with pH 3 has a much higher concentration of H^+(aq) ions than the solution with pH 11. In fact, the difference of 8 pH units means the H^+ concentration of the pH 3 solution is 10^8 times greater.

Nature of solutions:

- pH 3 → less than 7 → **acidic solution** (higher H^+ ion concentration)
- pH 11 → greater than 7 → **basic (alkaline) solution** (lower H^+ ion concentration, higher OH^- ion concentration)

A neutral solution has pH = 7.

Source: Chapter 2, Section 2.3 — How Strong Are Acid or Base Solutions?

Explanation

- The key relationship to state: **higher H^+ concentration = lower pH value** (directly from the passage: "Higher the hydronium ion concentration, lower is the pH value").
- Examiners expect you to explicitly compare the two concentrations AND identify each solution's nature (acidic/basic).
- For 3 marks: 1 mark for comparison, 1 mark for identifying pH 3 as acidic, 1 mark for identifying pH 11 as basic. Don't skip any part.
- Mentioning the neutral pH (7) as a reference point shows understanding of the scale and is good practice.

Q13. medium | thorough-understanding | § 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS? **[3]**

Equal concentrations of hydrochloric acid and acetic acid are tested with a universal indicator. Hydrochloric acid shows a lower pH than acetic acid. What does this difference tell you about the two acids, and what is the underlying reason for it?

◆ Acids, Bases and Salts

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Model Answer

When equal concentrations of HCl and acetic acid are tested, HCl shows a lower pH, meaning it has a higher concentration of H^+(aq) ions in solution.

This tells us that **HCl is a strong acid** and **acetic acid (ethanoic acid) is a weak acid**.

The reason is that HCl is a mineral acid and **completely ionises** in water, producing a large number of H^+ ions. Acetic acid, being a carboxylic acid, is **only partially ionised**, producing fewer H^+ ions at the same concentration. Since lower pH means higher H^+ ion concentration, HCl registers a lower pH value.

Source: Chapter 2, Section 2.3; Chapter 4, Section 4.4.2

Explanation

- Examiners expect three clear points: (1) HCl has lower pH → more H^+ ions, (2) HCl = strong acid / acetic acid = weak acid, (3) reason = complete vs. partial ionisation.
- The textbook explicitly states: *"unlike mineral acids like HCl, which are completely ionised, carboxylic acids are weak acids"* — use this reasoning directly.
- Avoid vague language like "HCl is stronger" without linking it to ionisation and H^+ ion concentration.

Q14. medium | thorough-understanding | § 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS? **[2]**

Acid rain flows into a freshwater river. Describe the chemical change it causes in the river water and explain, with reference to pH, why a sustained change of this kind poses a threat to aquatic life.

◆ Acids, Bases and Salts

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Model Answer

Acid rain increases the concentration of H^+(aq) ions in the river water, lowering its pH to below 7, making it acidic. Living organisms carry out their metabolic activities within an optimal pH range. A sustained drop in pH disrupts these processes, making survival impossible for most aquatic life.

Source: Chapter 2, Acids, Bases and Salts

Explanation

- The key chemical change to mention is the **increase in H^+(aq) ions** and the resulting **fall in pH below 7**.
- Link the threat directly to the textbook point: *"Living beings carry out their metabolic activities within an optimal pH range."*
- Don't just say "water becomes acidic" — always connect it to pH scale and biological consequence for full marks.
- For 2 marks: 1 mark for the chemical change (pH drops/acidic), 1 mark for the biological threat (optimal pH disrupted → aquatic life harmed).

Q15. medium | thorough-understanding | § 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS? **[3]**

A patient suffering from excess acid production in the stomach is given milk of magnesia. Explain why this treatment works, using your understanding of pH and neutralisation.

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Model Answer

The stomach produces hydrochloric acid (HCl) for digestion. During excess acid production, the pH of the stomach falls too low, causing pain and irritation.

Milk of magnesia is magnesium hydroxide — $Mg(OH)_2$ — a mild base. When taken, it neutralises the excess hydrochloric acid in the stomach:

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

This neutralisation reaction raises the stomach's pH back to a comfortable level, relieving pain. Since $Mg(OH)_2$ is a mild base, it does not make the stomach too alkaline, making it a safe antacid.

Source: Acids, Bases and Salts (Chapter 2), Section 2.3.1 — pH in our digestive system

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Explanation

- **3 marks = 3 key points**: (1) stomach produces excess HCl → low pH, (2) $Mg(OH)_2$ is a mild base/antacid, (3) neutralisation reaction raises pH and relieves pain.
- Always write the balanced equation — examiners expect it and it can fetch a dedicated mark.
- The word "mild base" is important; it shows you understand why $Mg(OH)_2$ is safe to use (won't over-alkalise the stomach).
- Directly grounded in the textbook passage: *"Magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose. These antacids neutralise the excess acid."*

Q16. deep | thorough-understanding | § 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS? **[5]**

Tooth enamel is the hardest substance in the human body, yet it gets corroded after eating sugary food. Explain the sequence of events responsible for this, and suggest one way to prevent it.

◆ Acids, Bases and Salts

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Model Answer

Sequence of events leading to tooth enamel corrosion:

1. When we eat sugary food, bacteria present in the mouth act on the sugars (simple carbohydrates) and produce **acids**.
2. These acids attack and **demineralise** the tooth enamel, causing gradual softening — this is called **dental caries** (tooth decay).
3. Bacterial cells, along with food particles, stick to the teeth forming **dental plaque**, which covers the tooth surface.
4. The plaque prevents **saliva** from reaching the tooth surface. Normally, saliva would neutralise the acid, but plaque blocks this protective action.
5. If untreated, the microorganisms penetrate deeper, invading the **pulp**, causing inflammation and infection.

Prevention:
Brush teeth immediately after eating to remove plaque before the bacteria can produce acids, allowing saliva to neutralise any remaining acid and protect the enamel.

Source: Chapter 5, Section 5.2.4 — "More to Know: Dental Caries"

Explanation

- The examiner expects the full chain: sugar → bacteria → acid → demineralisation → plaque formation → saliva blocked → pulp infection.
- All key terms (**dental caries, demineralise, plaque, saliva**) should appear — they are directly from the "More to Know" box and fetch marks.
- One clear prevention point (brushing after eating) is sufficient; don't list multiple vague ones.
- The word "corrosion" in the question is a hook to the chemistry chapter, but the actual answer is entirely from Chapter 5's dental caries box — stay grounded there.

Q17. medium | thorough-understanding | § 2.4 MORE ABOUT SALTS **[3]**

Sodium chloride, potassium nitrate, copper sulphate and sodium acetate are all salts. What determines whether a salt solution is acidic, basic or neutral?

◆ **Acids, Bases and Salts**

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Model Answer

The nature of a salt solution (acidic, basic, or neutral) is determined by the **relative strengths of the acid and base** used to form it.

- **Salts of a strong acid and strong base** are **neutral** (pH = 7). Example: NaCl (HCl + NaOH).
- **Salts of a strong acid and weak base** are **acidic** (pH < 7). Example: copper sulphate (H_2SO_4 + $Cu(OH)_2$).
- **Salts of a strong base and weak acid** are **basic** (pH > 7). Example: sodium acetate (NaOH + CH_3COOH).

Potassium nitrate (strong acid + strong base) is neutral; sodium acetate (weak acid + strong base) is basic.

Source: Chapter 2, Section 2.4.2

Explanation

- The **key principle** examiners expect: strength of parent acid and base determines the pH of the salt solution.
- Mention all three cases (neutral, acidic, basic) with the rule and at least one example each — this covers all 3 marks.
- Using examples from the question itself (copper sulphate, sodium acetate) shows application and earns full marks.
- Do not confuse "strong/weak" acid-base with "concentrated/dilute" — these are different concepts.

Q18. medium thorough-understanding § 2.4 MORE ABOUT SALTS **[3]**

In the chlor-alkali process, electrolysis of brine produces products at both electrodes. Name the products released at each electrode, give their uses, and explain why the process is called 'chlor-alkali'.

◆ Acids, Bases and Salts

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Model Answer

Chlor-alkali process involves electrolysis of brine (NaCl solution):

- **At cathode:** Hydrogen gas (H_2) is released. Used as fuel and in margarine production.
- **At anode:** Chlorine gas (Cl_2) is released. Used in water treatment (disinfection) and PVC manufacturing.
- **In solution:** Sodium hydroxide (NaOH) is formed. Used in degreasing, soap making, and paper industry.

Why called 'chlor-alkali': The process produces **chlorine** (chlor) and **sodium hydroxide** — an alkali (alkali) — hence the name *chlor-alkali* process.

Explanation

- Examiners expect you to name all three products (Cl_2, H_2, NaOH), locate them correctly (anode/cathode/solution), give at least one use each, and explain the name derivation.
- "Chlor" = chlorine; "alkali" = NaOH. That two-part etymology directly explains the name — don't skip it.
- This topic is from Chapter 2 (Acids, Bases and Salts), specifically the section on salts and their uses. It is a frequent 3-mark question.

Q19. medium | thorough-understanding | § 2.4 MORE ABOUT SALTS **[3]**

Bleaching powder is produced by passing chlorine gas over dry slaked lime. Would the same reaction work with wet slaked lime or with calcium oxide? Justify your answer and write the balanced chemical equation for the preparation of bleaching powder.

◆ **Acids, Bases and Salts**

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Model Answer

No, the reaction does not work with wet slaked lime or with calcium oxide.

- **Wet slaked lime** contains moisture, and chlorine reacts with water to form hypochlorous acid and hydrochloric acid instead of forming bleaching powder. The product obtained is not bleaching powder.
- **Calcium oxide (quicklime)** reacts vigorously with water and heat; it does not react with chlorine in the same way to produce bleaching powder.

Only **dry slaked lime** [$Ca(OH)_2$] reacts with chlorine gas to give bleaching powder (calcium oxychloride):

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

Source: Chapter 2, Acids, Bases and Salts

Explanation

- Examiners expect: (1) clear rejection of both alternatives with reasons, (2) the correct balanced equation.
- The key point is that **dry** $Ca(OH)_2$ is required — moisture causes side reactions; CaO reacts with water first before it can react with Cl_2 meaningfully to form bleaching powder.
- Write the chemical name of bleaching powder (calcium oxychloride) or its formula ($CaOCl_2$) for full marks.
- The balanced equation shown is the standard one expected in board exams.

Q20. deep | thorough-understanding | § 2.4 MORE ABOUT SALTS **[3]**

A baker accidentally uses washing soda instead of baking soda while making a cake. The cake turns out flat and dense. Explain, in terms of the chemistry of both compounds, why this happened.

◆ Acids, Bases and Salts

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Model Answer

Baking soda ($NaHCO_3$) decomposes on heating to release CO_2 gas:

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2 \uparrow$$

This CO_2 makes the cake rise, giving it a light, fluffy texture.

Washing soda ($Na_2CO_3 \cdot 10H_2O$) is sodium carbonate, a strongly alkaline salt. It does **not** decompose on baking to release CO_2. Without CO_2 gas being produced, no air bubbles are formed in the batter, so the cake does not rise and remains flat and dense.

Source: Chapter 2, Uses of Salts / Baking Soda and Washing Soda

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Explanation

- Examiners want you to name both compounds correctly ($NaHCO_3$ and Na_2CO_3), state the decomposition equation for baking soda, and clearly link CO_2 production to the cake rising.
- The key contrast: baking soda → releases CO_2 on heating; washing soda → no such decomposition, so no leavening action.
- Writing the chemical equation earns a dedicated mark; don't skip it.

Q21. medium | thorough-understanding | § 2.4 MORE ABOUT SALTS **[1]**

Which of the following best explains why Plaster of Paris must be stored in a moisture-proof container?
(A) Moisture causes Plaster of Paris to decompose into calcium oxide and water.
(B) Moisture reacts with Plaster of Paris to convert it back to gypsum, making it hard and unusable.
(C) Moisture dissolves Plaster of Paris, washing it away.
(D) Moisture causes Plaster of Paris to lose its water of crystallisation.

A Moisture causes Plaster of Paris to decompose into calcium oxide and water.
B Moisture reacts with Plaster of Paris to convert it back to gypsum, making it hard and unusable.
C Moisture dissolves Plaster of Paris, washing it away.
D Moisture causes Plaster of Paris to lose its water of crystallisation.

◆ Acids, Bases and Salts

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Model Answer

(B) Moisture reacts with Plaster of Paris to convert it back to gypsum, making it hard and unusable.

Explanation

Plaster of Paris is calcium sulphate hemihydrate ($CaSO_4 \cdot \frac{1}{2}H_2O$). When it absorbs moisture, it rehydrates to form gypsum ($CaSO_4 \cdot 2H_2O$), setting hard — making it useless for further application. Options A, C, and D describe incorrect reactions. Examiners expect students to recall the reversible relationship between gypsum and Plaster of Paris.

Q22. medium | thorough-understanding | § 2.4 MORE ABOUT SALTS **[2]**

Blue copper sulphate crystals turn white when heated strongly, but regain their blue colour when a few drops of water are added to the white powder. What does this experiment reveal about water of crystallisation? Write the chemical equations for both the forward and reverse changes observed.

◆ Acids, Bases and Salts

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Model Answer

Water of crystallisation is the fixed number of water molecules chemically bonded within a crystal. This experiment shows that water of crystallisation is essential for the blue colour of copper sulphate crystals, and its removal/addition causes a reversible change.

Forward change (heating):

$$\mathrm{CuSO_4 \cdot 5H_2O}(s) \xrightarrow{\Delta} \mathrm{CuSO_4}(s) + 5\mathrm{H_2O}(g)$$

(Blue) (White)

Reverse change (adding water):

$$\mathrm{CuSO_4}(s) + 5\mathrm{H_2O}(l) \rightarrow \mathrm{CuSO_4 \cdot 5H_2O}(s)$$

(White) (Blue)

Explanation

- The key concept tested is **water of crystallisation** — examiners expect you to define it and link it to the colour change.
- Write **both** balanced equations; each is worth a mark in a 2-mark question.
- Note the state symbols and the $\cdot 5\mathrm{H_2O}$ notation — these show the examiner you understand the chemical formula of hydrated copper sulphate (blue vitriol).
- The reaction is reversible, which is also a good point to mention briefly.

Q23. deep | thorough-understanding | § 2.4 MORE ABOUT SALTS **[5]**

Sodium hydrogencarbonate (baking soda) is used both in fire extinguishers and as an antacid. Explain, with relevant equations, how the same compound serves two such different purposes.

◆ Acids, Bases and Salts

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Model Answer

$NaHCO_3$ in Fire Extinguishers:

When $NaHCO_3$ is heated (or reacts with acid in the extinguisher), it decomposes to release CO_2 gas. CO_2 being heavier than air cuts off the oxygen supply to the fire, extinguishing it.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2 \uparrow$$

In soda-acid extinguishers, $NaHCO_3$ reacts with H_2SO_4:

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2 \uparrow$$

$NaHCO_3$ as Antacid:

When excess acid (HCl) is produced in the stomach, $NaHCO_3$ neutralises it, relieving indigestion. It is a mild, non-corrosive base, safe for consumption.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2 \uparrow$$

Thus, the same compound acts as a CO_2 source in fire-fighting and as a mild base (antacid) in medicine.

Source: Acids, Bases and Salts, Chapter 2; uses of baking soda

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Explanation

- **5 marks → ~5 key points:** name the two uses, give the mechanism for each, write correct balanced equations (2 equations minimum), and conclude.
- Examiners look for **both equations** and the **reason** (CO_2 smothers fire; base neutralises stomach acid).
- Note: in soda-acid extinguishers the acid triggers the reaction; thermal decomposition is the other route — mentioning either is fine, but both scores higher.
- The word "mild/non-corrosive base" is important for the antacid explanation — it distinguishes $NaHCO_3$ from stronger, harmful bases.
- "What you have learnt" (Ch. 2) confirms: acid + hydrogencarbonate → salt + CO_2 + water. Use that reaction pattern for the antacid equation.

Q24. medium | thorough-understanding | § 2.4 MORE ABOUT SALTS **[3]**

Starting from common salt (NaCl), outline the sequence of steps by which washing soda ($Na_2CO_3 \cdot 10H_2O$) is obtained industrially. Why is the recrystallisation step essential, and what role does the water of crystallisation play in the properties of washing soda?

◆ **Acids, Bases and Salts**

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Model Answer

Steps to obtain washing soda from NaCl:

1. Electrolyse brine (NaCl solution) → NaOH (chlor-alkali process).
2. React $NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3$ (baking soda).
3. Heat $NaHCO_3$: $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$
4. Recrystallise Na_2CO_3: $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$ (washing soda).

Recrystallisation is essential to incorporate the water of crystallisation and obtain the pure crystalline form of washing soda.

Water of crystallisation is the fixed number (10) of water molecules present per formula unit. It gives washing soda its crystalline structure; the compound is not wet, but the water is chemically bound within the crystal lattice.

Source: Chapter 2, Section 2.4.3 & 2.4.4

Explanation

- Examiners expect the **sequence** to be clear: NaCl → baking soda → Na_2CO_3 (by heating) → washing soda (by recrystallisation). Missing any step loses marks.
- The equation for recrystallisation and for heating $NaHCO_3$ are commonly asked — write them.
- For water of crystallisation, the key point is that it is *chemically fixed*, not free water, so the salt is not "wet" — this directly addresses the textbook question "Does $10H_2O$ make Na_2CO_3 wet?"
- Avoid padding; three tight points covering steps, recrystallisation purpose, and water of crystallisation role are sufficient for 3 marks.

Q25. medium | thorough-understanding | § Group Activity **[3]**

[short_answer] In a soda-acid fire extinguisher, dilute sulphuric acid reacts with sodium hydrogencarbonate solution. (a) Write the balanced chemical equation for this reaction. (b) Name the gas produced and explain two properties of this gas that make it effective at extinguishing a fire.

◆ **Acids, Bases and Salts**

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Model Answer

(a) The balanced chemical equation is:

$$H_2SO_4(\text{dil.}) + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2 \uparrow$$

(b) The gas produced is **carbon dioxide (CO_2)**.

Two properties that make it effective:

1. **CO_2 does not support combustion** — it neither burns nor allows other substances to burn, so it cuts off the fuel's oxygen supply.
2. **CO_2 is heavier than air** — it forms a blanket over the burning material, cutting off the supply of oxygen and smothering the fire.

Source: Chapter 2, Acids Bases and Salts; Chapter 1, Chemical Reactions and Equations

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Explanation

- The equation is the most commonly asked part — ensure it is balanced (coefficient 2 before $NaHCO_3$, H_2O, and CO_2).
- For part (b), examiners expect two **distinct** properties — non-supporter of combustion AND heavier than air (blanket effect). Mentioning only one will cost a mark.
- Avoid vague answers like "it puts out fire" — name the specific property (non-supportive of combustion, density higher than air).

Q26. deep | thorough-understanding | § (whole-chapter synthesis) **[3]**

Zinc reacts with both dilute sulphuric acid and sodium hydroxide solution to produce hydrogen gas, yet these two reactions differ in the type of salt formed. Compare the two reactions — what does this tell you about the nature of zinc, and why does the salt formed with NaOH contain an oxyanion while the one formed with H_2SO_4 does not?

◆ **Acids, Bases and Salts**

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Model Answer

Zinc reacts with dilute H_2SO_4 as well as NaOH solution to produce hydrogen gas, which shows that zinc is **amphoteric** in nature — it behaves as a metal (reacting with acid) and also as a non-metal (reacting with base).

With dilute H_2SO_4:

$$\mathrm{Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2 \uparrow}$$

The salt formed is zinc sulphate, containing the simple $\mathrm{SO_4^{2-}}$ anion from the acid.

With NaOH:

$$\mathrm{Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2 \uparrow}$$

The salt formed is sodium zincate, which contains the oxyanion $\mathrm{ZnO_2^{2-}}$ — a negative ion **composed of the metal and oxygen**.

This difference arises because when a base reacts with a metal, the salt formed has a negative ion composed of the metal and oxygen (an oxyanion), whereas an acid simply donates its own anion ($\mathrm{SO_4^{2-}}$) to the salt.

Source: Chapter 2 (Acids, Bases and Salts), What you have learnt; Chapter 3 (Metals and Non-metals), What you have learnt

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Explanation

- **Key concept tested:** Amphoteric nature of zinc — it reacts with both acids and bases. The textbook explicitly states that zinc oxide is an amphoteric oxide, implying zinc itself is amphoteric.
- **Oxyanion point:** The "What you have learnt" summary in Chapter 2 directly states: *"When a base reacts with a metal, along with the evolution of hydrogen gas a salt is formed which has a negative ion composed of the metal and oxygen."* Quote or paraphrase this for full marks.
- **Do not confuse** $ZnSO_4$ (sulphate anion comes from the acid, not from zinc) with Na_2ZnO_2 (zincate anion is built from zinc + oxygen — hence the oxyanion).
- Write both equations; one equation alone will lose a mark.

Q27. medium | thorough-understanding | § (whole-chapter synthesis) **[3]**

Dry HCl gas does not change the colour of dry litmus paper, but when HCl dissolves in water it turns blue litmus red. Using the ionic picture of acids, explain why water is essential for HCl to exhibit acidic behaviour. In light of this, why is it incorrect to say that HCl itself is an acid, rather than its aqueous solution?

◆ **Acids, Bases and Salts**

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Model Answer

Acidic behaviour is due to the formation of $H^+(aq)$ ions in solution. Dry HCl gas has no water, so it cannot ionise — the separation of H^+ from HCl **cannot occur in the absence of water**. Therefore, dry HCl produces no H^+ ions and does not affect dry litmus paper.

When HCl dissolves in water, the reaction occurs:

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

H^+ ions (as hydronium ions, H_3O^+) are produced, which turn blue litmus red.

Since HCl shows acidic properties **only in the presence of water**, it is incorrect to call HCl itself an acid. It is the **aqueous solution of HCl** that is the acid.

Source: Chapter 2, Section 2.2.1

Explanation

- The key concept examiners look for: **ionisation requires water**; without it, no $H^+(aq)$ forms.
- Always include the equation $HCl + H_2O \rightarrow H_3O^+ + Cl^-$ for full marks.
- Conclude clearly that acidic behaviour belongs to the **solution**, not the pure compound — this directly answers the "why incorrect" part.
- The term **hydronium ion (H_3O^+)** should be used; writing only H^+ is acceptable but mentioning both is better.

Q28. deep thorough-understanding § (whole-chapter synthesis) **[5]**

A farmer notices that his crops are growing poorly. He tests the soil and finds its pH is around 4. He treats the field with slaked lime.

(i) Why does a low soil pH harm crops?

(ii) What chemical reaction takes place when slaked lime is added to the acidic soil?

(iii) After treatment, the soil pH rises to 7. Has a salt been formed? Justify.

◆ **Acids, Bases and Salts**

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Model Answer

(i) A low pH (around 4) means the soil is highly acidic. Most crops grow best in a neutral to slightly acidic pH (near 7). Highly acidic soil reduces the availability of essential nutrients and is harmful to beneficial soil organisms, causing poor crop growth.

(ii) Slaked lime is calcium hydroxide, $Ca(OH)_2$, which is a base. When added to acidic soil, it undergoes a **neutralisation reaction** with the acids present:

$$\mathrm{Ca(OH)_2} + 2\mathrm{H}^+ \rightarrow \mathrm{Ca}^{2+} + 2\mathrm{H_2O}$$

The base (slaked lime) neutralises the excess acid in the soil, raising the pH.

(iii) Yes, a salt has been formed. Neutralisation is the reaction between an acid and a base to produce a **salt and water**. When $Ca(OH)_2$ reacts with the acids in the soil, the calcium ions (Ca^{2+}) combine with the negative ions of the acid to form a salt (e.g., calcium sulphate or calcium chloride, depending on the acid present). A pH of 7 confirms that the reaction has reached neutrality, which is characteristic of a neutral salt formed from a strong acid and a strong base.

Source: Chapter 2, Acids, Bases and Salts — Introduction; Section 2.4.2 pH of Salts

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Explanation

- **(i)** Living beings carry out metabolic activities within an optimal pH range — this is the key idea. Low pH disrupts nutrient availability and soil biology.
- **(ii)** Examiners expect you to name the reaction as **neutralisation**, write the ionic equation (or word equation), and identify $Ca(OH)_2$ as the base. Even a word equation with a balanced formula earns marks.
- **(iii)** This is a **justify** question — stating "yes" alone is insufficient. You must link it to the definition: *acid + base → salt + water*. The textbook states: "Salts of a strong acid and strong base are neutral with pH = 7," which supports the justification. Always connect the pH observation back to the chemistry.

Q29. medium | thorough-understanding | § (whole-chapter synthesis) **[1]**

Assertion (A): When excess carbon dioxide is bubbled through lime water that has already turned milky, the white precipitate dissolves and the solution becomes clear again.
Reason (R): Calcium carbonate reacts with water and carbon dioxide to form calcium hydrogencarbonate, which is soluble in water.

Choose the correct option:
(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

A Both A and R are true, and R is the correct explanation of A.
B Both A and R are true, but R is NOT the correct explanation of A.
C A is true but R is false.
D A is false but R is true.

◆ Acids, Bases and Salts

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Model Answer

(A) Both A and R are true, and R is the correct explanation of A.

When excess CO_2 is passed through milky lime water, $CaCO_3$ reacts with H_2O and CO_2 to form $Ca(HCO_3)_2$ (calcium hydrogencarbonate), which is soluble, making the solution clear again. R correctly explains A.

Explanation

The key chemistry here: $CO_2 + H_2O + CaCO_3 \rightarrow Ca(HCO_3)_2$. Both statements are factually correct, and R directly explains the mechanism behind A — the dissolving of the white precipitate is *caused by* formation of soluble calcium hydrogencarbonate. This is a standard "excess CO_2 with lime water" observation tested in CBSE boards. Option A is correct.

Q30. medium thorough-understanding § (whole-chapter synthesis) **[5]**

Baking soda and washing soda are both manufactured starting from sodium chloride, yet they serve very different purposes. (i) Trace the sequence of industrial/chemical steps (Solvay process and beyond) that connect NaCl to each of these two products. (ii) For each product, explain one specific use that depends directly on its chemical nature — acidic, basic, or otherwise. (iii) How are baking soda and washing soda chemically related to each other?

◆ **Acids, Bases and Salts**

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Model Answer

(i) Steps from NaCl to each product:

Baking soda ($NaHCO_3$): NaCl is treated with water, CO_2, and NH_3 (Solvay-type reaction):

$$\mathrm{NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3}$$

Washing soda ($Na_2CO_3 \cdot 10H_2O$): Baking soda is heated to give Na_2CO_3, which is then recrystallised with water:

$$\mathrm{2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2}$$

$$\mathrm{Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O}$$

(ii) Uses linked to chemical nature:

- **Baking soda** is a mild non-corrosive base ($NaHCO_3$). Being alkaline, it neutralises excess acid in the stomach, making it effective as an antacid.
- **Washing soda** is a basic salt. It removes permanent hardness of water by reacting with dissolved calcium/magnesium salts.

(iii) Chemical relationship:

Baking soda ($NaHCO_3$) and washing soda ($Na_2CO_3 \cdot 10H_2O$) are chemically related — washing soda is produced from baking soda itself. Heating $NaHCO_3$ gives Na_2CO_3, which on recrystallisation becomes washing soda. Both are sodium salts of carbonic acid; baking soda has one Na^+ (acid salt) while washing soda has two Na^+ (normal salt).

Source: Chapter 2, Section 2.4.3

Explanation

- Examiners expect the **equations** for both products — write them clearly for full marks.
- For part (ii), always **link the use to the chemical property** (basic nature → neutralises acid; basic salt → softens water). Don't just list uses.
- For part (iii), the key point is that washing soda is *made from* baking soda, and both are sodium carbonate salts differing in the number of Na^+ ions and water of crystallisation. This shows their direct chemical relationship.
- Keep equations balanced; the heating arrow (Δ) over the arrow is expected.

Q31. medium | thorough-understanding | § (whole-chapter synthesis) **[3]**

Two students dissolve equal moles of HCl and CH_3COOH separately in water and measure the pH. Student A finds that the HCl solution has a lower pH than the CH_3COOH solution of equal concentration. Student B argues both should have the same pH since equal moles of acid were used. Who is correct, and what concept explains the difference?

◆ **Acids, Bases and Salts**

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Model Answer

Student A is correct.

HCl is a **strong acid** — it ionises completely in water, producing a high concentration of H^+ ions. CH_3COOH (acetic/ethanoic acid) is a **weak acid** — it ionises only partially, producing fewer H^+ ions.

Since pH depends on H^+ ion concentration (higher H^+ → lower pH), equal moles of HCl give a lower pH than equal moles of CH_3COOH at the same concentration.

The concept is **degree of ionisation (strong vs. weak acids)**. Equal moles do not mean equal H^+ ions — it depends on how completely the acid ionises.

Source: Chapter 2, Section 2.3; Chapter 4, Section 4.4.2

Explanation

- Examiners want three things: (1) identify the correct student, (2) define strong vs. weak acid using ionisation, (3) link it to pH/H^+ concentration. Each point is roughly 1 mark.
- Key phrase to use: "completely ionised" for HCl vs. "partially ionised / weak acid" for CH_3COOH — the textbook uses exactly this language in Section 4.4.2.
- Do not say Student B is "completely wrong" without explaining *why* equal moles ≠ equal H^+; that explanation is the core of the answer.

Q32. deep | thorough-understanding | § (whole-chapter synthesis) **[3]**

Tooth enamel begins to corrode when the pH of the mouth falls below 5.5 after a meal. (i) Identify the substance responsible for this drop in pH and explain its origin. (ii) How does the chemical nature of toothpaste counteract this effect? (iii) Why is it advisable to rinse your mouth with water immediately after consuming acidic foods or drinks, even before brushing?

◆ **Acids, Bases and Salts**

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Model Answer

(i) Bacteria in the mouth act on sugars (from food) and produce acids. These acids lower the pH of the mouth below 5.5, causing corrosion of tooth enamel.

(ii) Toothpaste is basic (alkaline) in nature. It neutralises the acid produced in the mouth, raising the pH above 5.5 and preventing damage to the enamel.

(iii) Rinsing with water immediately dilutes and washes away the acids before they can act on the enamel. This provides quick, temporary relief even before brushing can remove the bacterial plaque.

Source: Chapter 2 (Acids, Bases and Salts); Chapter 5, Section 5.2.4 (Dental caries — More to Know!)

Explanation

- **(i)** The key point is **bacteria** + **sugars** → **acid**. The source passage (Dental caries box) states bacteria acting on sugars produce acids.
- **(ii)** The examiner wants the word **basic/alkaline** and the concept of **neutralisation**.
- **(iii)** This part tests application: water **dilutes** acid quickly. Plaque prevents saliva from neutralising acid (per the passage), so rinsing physically removes it.
- Do not write more than what is shown above — three focused points is exactly what a 3-mark answer needs (1 mark each).

Q33. medium | thorough-understanding | § (whole-chapter synthesis) **[2]**

Copper sulphate crystals are blue but turn white on strong heating, and white Plaster of Paris sets hard when mixed with water. What common chemical principle underlies both these changes, and in which direction does each process go with respect to water of crystallisation?

◆ **Acids, Bases and Salts**

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Model Answer

Both changes involve **water of crystallisation**.

- **Copper sulphate** ($CuSO_4 \cdot 5H_2O$) is blue. On strong heating, it **loses** water of crystallisation and becomes anhydrous $CuSO_4$, which is white — water is **removed**.
- **Plaster of Paris** ($CaSO_4 \cdot \frac{1}{2}H_2O$) **gains** water when mixed with water, forming gypsum ($CaSO_4 \cdot 2H_2O$), which sets hard — water is **absorbed**.

Thus, both processes involve loss or gain of water of crystallisation; they proceed in **opposite directions**.

Explanation

The examiner expects students to name "water of crystallisation" as the common principle and clearly state the direction for each case — loss of water on heating ($CuSO_4$) and gain of water on setting (Plaster of Paris). Mixing them up is a common error. Note: the source passages confirm the concept of water of crystallisation in hydrated salts (e.g., $FeSO_4 \cdot 7H_2O$ losing water on heating), which underpins both examples here.

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