

FORM 2 CHEMISTRY

ACIDS

Complete Point-by-Point Notes + 30 ECZ-Style Scenario Questions



Haggai CN ZM

Chemistry Study Booklet • Form 2

CONTENTS

1. Meaning of an Acid
2. Sources of Acids
3. Common Acids and Their Formulae
4. Properties of Acids
5. Acids Conduct Electricity
6. Acids React with Metals
7. Factors Affecting Acid–Metal Reactions
8. Acids React with Metal Oxides
9. Acids React with Metal Hydroxides
10. Acids React with Carbonates
11. Test for Carbon Dioxide
12. Acids React with Hydrogencarbonates
13. Effervescence
14. Acids React with Ammonia
15. Strong and Weak Acids
16. Strong Acid vs Concentrated Acid
17. Dilute Acids
18. Concentrated Acids
19. Acids and the pH Scale
20. Hydrogen-Ion Concentration and Acidity
21. Acids and Indicators
22. Uses of Acids
23. Acids in the Human Body
24. Acids in Agriculture
25. Important Acid Reactions
26. Key Laboratory Gas Tests
27. Key Terms
28. 30 ECZ-Style Scenario Questions

1. Meaning of an Acid

An **acid** is a substance that produces **hydrogen ions (H⁺)** when dissolved in water.

According to the Brønsted–Lowry definition, an acid is a substance that **donates a proton (H⁺)**.

Examples include hydrochloric acid (HCl), sulfuric acid (H₂SO₄), nitric acid (HNO₃), ethanoic acid (CH₃COOH), and carbonic acid (H₂CO₃).



2. Sources of Acids

Natural sources

- Lemon — citric acid
- Orange — citric acid
- Vinegar — ethanoic acid
- Tamarind — tartaric acid
- Sour milk — lactic acid
- Fizzy drinks — carbonic acid

Laboratory/industrial acids

- Hydrochloric acid
- Sulfuric acid
- Nitric acid

3. Common Acids and Their Formulae

Acid	Formula	Some uses
Hydrochloric acid	HCl	Cleaning; laboratory reactions
Sulfuric acid	H ₂ SO ₄	Fertilisers; car batteries
Nitric acid	HNO ₃	Fertilisers; chemical production
Ethanoic acid	CH ₃ COOH	Vinegar; food preservation
Carbonic acid	H ₂ CO ₃	Soft drinks
Citric acid	C ₆ H ₈ O ₇	Foods and drinks

4. Properties of Acids

- Acids have a sour taste. Many food acids taste sour, but laboratory chemicals must never be tasted.
- Acids change indicator colours. Blue litmus turns red in an acid.
- Acidic solutions have pH values below 7.
- The lower the pH, generally, the greater the hydrogen-ion concentration.

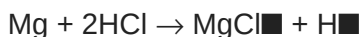
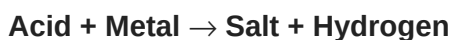
5. Acids Conduct Electricity

Aqueous acids contain mobile ions, so they can conduct electricity. For example:

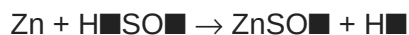


The ions move through the solution and allow electric current to flow.

6. Acids React with Metals



Magnesium + hydrochloric acid → magnesium chloride + hydrogen.



Metals such as magnesium, zinc and iron react with suitable dilute acids. Copper does not react readily with dilute hydrochloric acid.

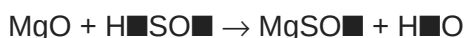
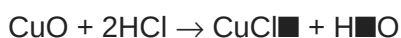
Test for hydrogen

A lighted splint gives a characteristic **squeaky pop** when hydrogen is present.

7. Factors Affecting the Reaction Between an Acid and a Metal

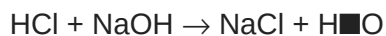
- Temperature — increasing temperature generally increases reaction rate.
- Acid concentration — a more concentrated acid generally reacts faster, all else equal.
- Surface area — powdered metal generally reacts faster than a large lump.
- Type of metal — different metals have different reactivities.

8. Acids React with Metal Oxides



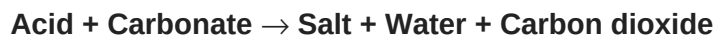
9. Acids React with Metal Hydroxides

Metal hydroxides are bases. Acids react with metal hydroxides to form salt and water.



This is a **neutralisation** reaction.

10. Acids React with Carbonates



Effervescence is normally observed because carbon dioxide gas is released.

11. Test for Carbon Dioxide

Bubble the gas through limewater. **Limewater turns milky/cloudy** if carbon dioxide is present.



12. Acids React with Hydrogencarbonates

Acid + Hydrogencarbonate → Salt + Water + Carbon dioxide



13. Effervescence

Effervescence is the rapid formation and escape of gas bubbles from a liquid. Acid–carbonate reactions show effervescence because carbon dioxide is produced.

14. Acids React with Ammonia

Acids can react with ammonia to form ammonium salts.



15. Strong and Weak Acids

A **strong acid** ionises almost completely in water. Examples include HCl, HNO₃ and H₂SO₄.



A **weak acid** only partially ionises in water. Examples include ethanoic acid and carbonic acid.



16. Strong Acid vs Concentrated Acid

Strong refers to the extent of ionisation. **Concentrated** refers to the amount of acid per unit volume of solution.

- A strong acid can be dilute.
- A weak acid can be concentrated.
- Strength and concentration are different concepts.

17. Dilute Acids

A dilute acid contains a relatively small amount of acid dissolved in a relatively large amount of water.

Safety: when diluting concentrated acid, add acid slowly to water while stirring carefully. This helps reduce dangerous splashing caused by heat release.

18. Concentrated Acids

A concentrated acid contains a relatively large amount of acid compared with the amount of water present. Concentrated acids can be highly corrosive and must be handled carefully.

19. Acids and the pH Scale

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

- pH below 7 — acidic
- pH 7 — neutral
- pH above 7 — alkaline

Generally, the lower the pH, the more acidic the solution.

20. Hydrogen-Ion Concentration and Acidity

Acidity is related to the concentration of H^+ ions. A solution with a higher H^+ concentration has a lower pH.

$$\text{pH} = -\log_{10}[\text{H}^+]$$

$[\text{H}^+]$ represents hydrogen-ion concentration in mol dm^{-3} .

21. Acids and Indicators

An **indicator** is a substance that changes colour depending on whether a solution is acidic or alkaline.

Indicator	Acidic solution	Alkaline solution
Litmus	Blue litmus → red	Red litmus → blue
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink
Universal indicator	Red/orange/yellow depending on pH	Blue/purple depending on pH

22. Uses of Acids

- **Hydrochloric acid:** chemical manufacture, laboratory reactions, and cleaning certain metal surfaces.
- **Sulfuric acid:** manufacture of fertilisers, car batteries, and chemicals.
- **Nitric acid:** manufacture of fertilisers and chemicals.
- **Ethanoic acid:** vinegar and food preservation.
- **Citric acid:** foods and drinks, preservation and flavouring.

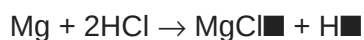
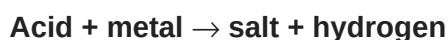
23. Acids in the Human Body

The stomach contains hydrochloric acid, which helps create an acidic environment needed for digestion. Antacids are medicines used to neutralise excess stomach acid.

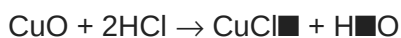
24. Acids in Agriculture

Some soils are too acidic for particular crops. Materials such as lime can be used to help reduce soil acidity. The appropriate treatment depends on the soil and crop.

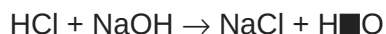
25. Important Acid Reactions



Acid + metal oxide → salt + water



Acid + metal hydroxide → salt + water



Acid + carbonate → salt + water + carbon dioxide



Acid + hydrogencarbonate → salt + water + carbon dioxide



26. Key Laboratory Gas Tests

Gas	Test	Positive result
Hydrogen	Lighted splint	Squeaky pop
Carbon dioxide	Limewater	Turns milky/cloudy
Oxygen	Glowing splint	Relights

27. Key Terms

Acid: A substance that produces H^+ ions in aqueous solution.

Acidic: Having properties associated with acids; aqueous solutions have pH below 7.

Strong acid: An acid that ionises extensively in water.

Weak acid: An acid that only partially ionises in water.

Concentrated acid: An acid solution containing a relatively large amount of acid per unit volume.

Dilute acid: An acid solution containing a relatively small amount of acid per unit volume.

Indicator: A substance that changes colour according to the acidity or alkalinity of a solution.

Neutralisation: A reaction in which an acid reacts with a base to form salt and water.

Effervescence: Rapid formation and escape of gas bubbles.

pH: A measure related to hydrogen-ion concentration.

28. 30 ECZ-STYLE SCENARIO QUESTIONS

Instructions: Answer all questions. Show balanced chemical equations where required. These questions are designed for practice and include application of the notes above.

1. A learner adds dilute hydrochloric acid to magnesium ribbon. (a) State two observations. (b) Name the gas produced. (c) Write a balanced equation.
2. A student adds dilute hydrochloric acid to calcium carbonate chips. (a) State the observation. (b) Identify the gas. (c) Describe a test for the gas.
3. A solution has a pH of 2. Is it acidic, neutral or alkaline? Explain what the pH indicates about H^+ concentration.
4. A laboratory technician has blue litmus paper and an unknown solution. State the result expected if the solution is acidic.
5. Distinguish between a strong acid and a concentrated acid.
6. Ethanoic acid and hydrochloric acid are both acids. Explain why they are not necessarily equally strong.
7. Write a balanced equation for the reaction between copper(II) oxide and hydrochloric acid.
8. A farmer discovers that a field is too acidic for a particular crop. Name one material that may be used to help reduce soil acidity and explain the purpose.
9. A student reacts zinc with dilute sulfuric acid. Name the salt formed and write the balanced equation.
10. Explain why aqueous hydrochloric acid conducts electricity.
11. A learner is given HCl, NaOH and an indicator. Explain how the indicator can help distinguish the acidic solution from the alkaline solution.
12. Write the general word equation for an acid reacting with a metal carbonate.
13. Explain what is meant by effervescence and identify a common acid reaction in which it occurs.
14. During an experiment, a gas turns limewater milky. Identify the gas and give one acid reaction that could have produced it.
15. Write the equation for hydrochloric acid reacting with sodium hydrogencarbonate.
16. State the pH range that represents acidic solutions on the usual 0–14 pH scale.
17. Name the acid commonly associated with vinegar and give its formula.
18. Give two laboratory safety precautions that should be followed when handling concentrated acids.

19. A student uses phenolphthalein in an acidic solution. What colour should be observed?
20. A student uses methyl orange in an acidic solution. What colour should be observed?
21. Explain why powdered magnesium can react faster with an acid than a large piece of magnesium of the same mass.
22. State four factors that can affect the rate of reaction between an acid and a metal.
23. Write the balanced equation for hydrochloric acid reacting with sodium hydroxide and name the reaction type.
24. Hydrogen is produced when some acids react with metals. Describe a test for hydrogen.
25. Give two differences between dilute and concentrated acids.
26. A solution contains many mobile ions. Explain how this can affect its electrical conductivity.
27. State two natural sources of acids and name the acid found in each.
28. Explain why a weak acid can still be concentrated.
29. A learner obtains a solution with pH 7. What does this indicate about the solution?
30. Give three everyday or industrial uses of acids and name a suitable acid for each use.

ANSWER KEY / MARKING GUIDE

1. (a) Magnesium dissolves; fizzing/bubbles occur; solution warms. (b) Hydrogen. (c) $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$.
2. (a) Effervescence/fizzing and calcium carbonate gradually dissolves. (b) Carbon dioxide. (c) Bubble it through limewater; limewater turns milky/cloudy.
3. Acidic. A pH of 2 indicates a relatively high H^+ concentration compared with neutral water.
4. Blue litmus turns red.
5. Strong acid ionises extensively/almost completely; concentrated acid contains a relatively large amount of acid per unit volume.
6. HCl is strong because it ionises extensively; ethanoic acid is weak because it only partially ionises.
7. $\text{CuO} + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{H}_2\text{O}$.
8. Lime; it helps neutralise/reduce excess acidity in soil.
9. Zinc sulfate; $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$.
10. It ionises in water to form mobile ions such as H^+ and Cl^- , which carry charge.
11. Litmus, methyl orange, phenolphthalein or universal indicator can show different characteristic colours in acidic and alkaline solutions.
12. Acid + metal carbonate $\rightarrow$ salt + water + carbon dioxide.
13. Rapid formation and escape of gas bubbles; for example, acid + carbonate.
14. Carbon dioxide; it can be produced when hydrochloric acid reacts with calcium carbonate.
15. $\text{HCl} + \text{NaHCO}_3 \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$.
16. pH below 7.
17. Ethanoic acid; CH_3COOH .
18. Wear appropriate protective equipment; handle carefully; add acid to water when diluting; follow laboratory instructions.
19. Colourless.
20. Red.
21. Powdered magnesium has a greater surface area exposed to the acid, increasing the frequency of effective collisions.
22. Temperature, concentration, surface area and type/reactivity of metal.
23. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$; neutralisation.
24. Use a lighted splint; hydrogen gives a characteristic squeaky pop.
25. Dilute acid has relatively little acid per unit volume; concentrated acid has relatively much acid per unit volume.
26. Mobile ions allow charge to move through the solution, so the solution can conduct electricity.
27. Examples: lemon—citric acid; vinegar—ethanoic acid; sour milk—lactic acid; tamarind—tartaric acid.

28. Strength describes ionisation; concentration describes amount of acid per unit volume. A weak acid may therefore be present at high concentration.

29. It is neutral on the usual pH scale.

30. Examples: sulfuric acid—fertiliser manufacture/car batteries; ethanoic acid—vinegar/food preservation; nitric acid—fertiliser manufacture; hydrochloric acid—chemical manufacture/cleaning.