2.3 Acids salts and chemical tests

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **acids, alkalis, salts and chemical tests** : indicators and pH, neutralisation, titration, making soluble and insoluble salts, and tests for gases and ions.

You must be able to:

- write equations for the reactions of acids
- calculate concentrations from titration results
- describe how to make a pure, dry soluble salt
- describe tests for gases and ions

1 Key knowledge and worked examples

Acid reactions and tests

idea	rule or formula
acid + metal	salt + hydrogen
acid + base (metal oxide or hydroxide)	salt + water
acid + carbonate	salt + water + carbon dioxide
moles in a solution	concentration × volume in $cm^3 \div 1000$
gas tests	hydrogen: lit splint, squeaky pop; oxygen: glowing splint relights; carbon dioxide: limewater turns milky; ammonia: damp red litmus turns blue

Worked example 1: an acid reaction. Write the equation for hydrochloric acid and calcium carbonate.

1. Known: acid + carbonate.
2. Rule: salt + water + carbon dioxide.
3. Numbers: $CaCO_3 + 2HCl$.
4. Result: $\mathbf{CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2}$.

Worked example 2: titration. 25.0 cm^3 of NaOH is neutralised by 20.0 cm^3 of 0.10 mol/dm^3 HCl. Find the NaOH concentration.

1. Known: HCl $0.10 \times 20.0 \div 1000 = 0.0020$ mol; ratio 1 : 1.
2. Rule: concentration = moles ÷ volume in dm^3.
3. Numbers: $0.0020 \div 0.0250$.
4. Result: 0.080 $\mathbf{mol/dm^3}$.

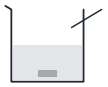
Answer shapes: use the mole ratio from the equation; sulfuric acid, H_2SO_4, reacts 1 : 2 with NaOH.

2 Practice

2.1 State the pH of a strong acid and of a neutral solution, and the colour of universal indicator in each. [2]



2.2 Name the salt made when zinc oxide reacts with sulfuric acid, and the other product. [2]



2.3 Describe the test for carbon dioxide and give the result. [2]



2.4 Write the ionic equation for neutralisation. [2]

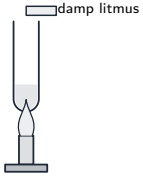
H^+ OH^- → ?

3 Exam-style questions

3.1 20.0 cm^3 of 0.050 mol/dm^3 sulfuric acid neutralises 25.0 cm^3 of sodium hydroxide solution. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$. Calculate the concentration of the sodium hydroxide. [3]

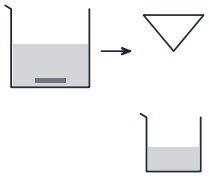


3.2 Describe a test to show that a solid contains ammonium ions. [3]



3.3 A student makes copper(II) sulfate crystals by adding copper(II) oxide to warm dilute sulfuric acid until no more dissolves. (M_r: CuO 80, $CuSO_4$ 160)

(a) Write the balanced equation, with state symbols. [3]



(b) Explain why copper(II) oxide is added until it is in excess, and how the excess is removed. [4]

(c) Calculate the maximum mass of anhydrous copper(II) sulfate that could be made from 4.0 g of copper(II) oxide. [3]

(d) Describe how the student should get pure, dry crystals from the solution. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- strong acid: pH 1 (or 0–2), red
- neutral: pH 7, green

2.2

- zinc sulfate
- water

2.3

- bubble the gas through limewater
- it turns milky (cloudy)

2.4

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

3.1

- moles $H_2SO_4 = 0.050 \times 20.0 \div 1000 = 0.0010$
- moles NaOH $= 0.0020$
- $0.0020 \div 0.0250 =$ **0.080** mol/dm^3

3.2

- add sodium hydroxide solution and warm
- test the gas with damp red litmus paper
- it turns blue (ammonia is given off)

3.3

(a) $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

(b) excess makes sure all the acid has reacted, so the solution contains only the salt and water, with no acid left; the excess solid is removed by filtration, leaving the solution as the filtrate

(c) moles CuO $4.0 \div 80 = 0.050$; moles $CuSO_4 = 0.050$; $0.050 \times 160 =$ **8.0** g

(d) points to include:

- pour the filtrate into an evaporating basin (K)
- heat gently to evaporate some water until the solution is saturated (crystals form on a cold glass rod) (K)
- leave the solution to cool slowly, so crystals form (K)
- filter off the crystals (K)
- wash them with a small amount of cold distilled water (App)
- dry them between filter papers or in a warm place; do not heat strongly, as the water of crystallisation would be lost (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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