Worksheet: Gas Tests & Ion Identification Tests

ChemistrySheets

Specification: AQA 5.8.2 / Edexcel SC24 / OCR Gateway C6.2

Core Concepts: Qualitative tests for common gases (hydrogen, oxygen, carbon dioxide, chlorine) and ions (cations: Li^+, Na^+, K^+, Ca^{2+}, Cu^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}; anions: CO_3^{2-}, Cl^-, Br^-, I^-, SO_4^{2-}). Understanding reagents, observations, and chemical principles.

Section A: Key Terms & Concepts

1. Complete the table below by identifying the correct test and observation for each gas.

Gas	Test	Observation
Hydrogen	**Lit splint**	**Squeaky pop**
Oxygen	**Glowing splint**	**Relights**
Carbon dioxide	**Limewater**	**Turns cloudy**
Chlorine	**Damp litmus paper**	**Bleached white**

2. Fill in the blanks to complete the sentences about ion identification tests.

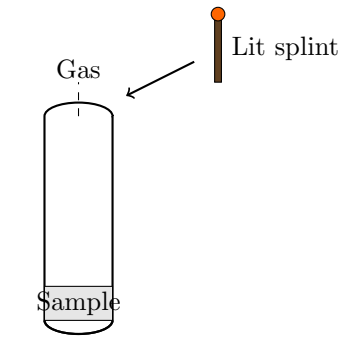
   (a) Flame tests are used to identify **metal** **ions** based on the characteristic **colour** they emit when heated in a flame.

   (b) When testing for halide ions, **dilute nitric acid** is added first to remove any **carbonate** ions, followed by **silver nitrate** solution.

   (c) The test for carbon dioxide involves bubbling the gas through **limewater**, which is a solution of **calcium hydroxide**.

Section B: Core Concepts & Explanations

1. Describe the test for hydrogen gas, including the expected observation.



Squeaky pop

Figure 1: Test for Hydrogen Gas

Model Answer:
To test for hydrogen, a lit splint is brought to the mouth of a test tube containing the gas. A 'squeaky pop' sound indicates the presence of hydrogen.

2. Explain the observations when testing for copper(II) ions using sodium hydroxide solution. Include a relevant ionic equation.

Model Answer:
When sodium hydroxide solution is added to a solution containing copper(II) ions, a blue precipitate is formed. This precipitate is copper(II) hydroxide, $Cu(OH)_2$. The ionic equation is $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$.

3. Outline the procedure and expected observations for distinguishing between chloride, bromide, and iodide ions.

Model Answer:
To distinguish between chloride, bromide, and iodide ions, first add dilute nitric acid, then silver nitrate solution. Chloride ions give a white precipitate of AgCl. Bromide ions give a cream precipitate of AgBr. Iodide ions give a yellow precipitate of AgI.

4. Describe the steps and observations for testing for sulfate ions. Include a relevant ionic equation.

Model Answer:
To test for sulfate ions, first add dilute hydrochloric acid to remove any carbonate ions that would interfere. Then, add barium chloride solution. If sulfate ions are present, a white precipitate of barium sulfate ($BaSO_4$) will form. This precipitate is insoluble in excess dilute acid. The ionic equation is $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$.

Section C: Exam Application & Extended Writing

1. A student tested three unknown solutions (A, B, and C) using various reagents. The results are shown in the table below.

Solution	Flame Test	NaOH Test	$AgNO_3$ Test (after HNO_3)
A	Lilac	No precipitate	White precipitate
B	Blue-green	Blue precipitate	No precipitate
C	Red	White precipitate	Cream precipitate

Identify the ions present in each solution (A, B, and C), providing reasoning for your answers.

Model Answer:
Solution A contains Potassium ions (K^+) due to the lilac flame and Chloride ions (Cl^-) due to the white precipitate with silver nitrate. Solution B contains Copper(II) ions (Cu^{2+}) indicated by the blue-green flame and blue precipitate with NaOH. Solution C contains Calcium ions (Ca^{2+}) from the red flame and white precipitate with NaOH, and Bromide ions (Br^-) from the cream precipitate with silver nitrate.

2. Explain, in detail, how to test for carbonate ions and sulfate ions. For each test, describe the reagents used, the expected observations, and include any relevant balanced ionic equations. (6 marks)

Model Answer:
Both carbonate and sulfate ions are tested for using precipitation reactions, but with different reagents and observations.
Carbonate Test: To test for carbonate ions (CO_3^{2-}), dilute acid (e.g., hydrochloric acid) is added to the sample. If carbonates are present, effervescence (fizzing) will be observed as carbon dioxide gas is produced. This gas can then be tested by bubbling it through limewater, which will turn cloudy. The ionic equation for the reaction is $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$.
Sulfate Test: To test for sulfate ions (SO_4^{2-}), dilute hydrochloric acid is added first to remove any interfering carbonate ions. Then, barium chloride solution is added. If sulfate ions are present, a white precipitate of barium sulfate ($BaSO_4$) will form. This precipitate is insoluble in excess dilute acid. The ionic equation is $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$.
In summary, the carbonate test produces a gas that turns limewater cloudy, while the sulfate test produces a white precipitate with barium chloride after acidification.