Qualitative analysis of ions

OCR A Chemistry (H032 / H432) · AS and A level

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. Test an evolved gas

A solid contains carbonate, sulfate or chloride ions. Adding dilute acid gives effervescence. The gas turns limewater cloudy. Identify the gas and the anion in the solid.

2. A white precipitate

An unknown solution is acidified and then treated with aqueous barium ions. A white precipitate forms. Identify the anion and write the ionic equation including state symbols.

3. A halide test

A sample gives a yellow precipitate with acidified silver nitrate. It stays solid even in concentrated ammonia. Identify the ion and write its precipitation equation.

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4. Warm sodium hydroxide

A sample is warmed with aqueous sodium hydroxide. A gas turns damp red litmus paper blue. Identify the gas and cation and write an ionic equation for the test.

5. An unreliable precipitate

A student acidifies a sample with hydrochloric acid before testing it with silver nitrate. Explain why a white precipitate is unreliable evidence for the original sample. Name a suitable acid.

6. Put the anion tests in order

A single sample may contain carbonate, sulfate and a halide. Put these additions in a suitable order: barium nitrate solution, dilute nitric acid, silver nitrate solution. Explain which two false positives the sequence prevents.

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7. Select a barium reagent

A student uses one portion for sequential tests and has aqueous barium chloride or barium nitrate available. Which reagent should they choose? Name the separation step before the halide test.

8. Identify the salt

An unknown is one of potassium sulfate, ammonium sulfate, ammonium bromide and sodium carbonate. There is no fizzing with dilute acid, and barium ions form a white precipitate in the acidified sample. A fresh portion releases ammonia with warm NaOH. Identify the salt.

9. Extra challenge · Quantify a mixture from two tests

A 0.424 g mixture contains only Na_2CO_3, Na_2SO_4 and NaBr. Acid gives 24.0 cm^3 CO_2. Sulfate later gives 0.350 g $BaSO_4$. Use 24.0 dm^3 mol^{-1} for CO_2 and M_r values of 106, 142 and 233.4 for Na_2CO_3, Na_2SO_4 and $BaSO_4$.

Find the mass of NaBr. Explain why neither reagent can contain a halide if the same solution is used to confirm bromide.

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Worked answers

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1. Test an evolved gas

The gas is carbon dioxide. The anion is carbonate.

$CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$.

2. A white precipitate

The anion is sulfate. $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$.

3. A halide test

The ion is iodide. The yellow solid is silver iodide.

$Ag^+ + I^- \rightarrow AgI(s)$.

4. Warm sodium hydroxide

Ammonia is the gas. The cation is ammonium, NH_4^+.

$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$.

5. An unreliable precipitate

Hydrochloric acid adds chloride ions, which can form AgCl even if the original sample contained none.

Dilute nitric acid acidifies the sample without adding halide ions.

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Worked answers

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6. Put the anion tests in order

Add dilute nitric acid first. Carbonate gives CO_2, so carbonate cannot form a white precipitate with barium. Add barium nitrate second to precipitate sulfate. Remove that solid and add silver nitrate to the filtrate. This avoids white silver sulfate obscuring the halide test.

7. Select a barium reagent

Choose barium nitrate. Barium chloride would add chloride ions and could give a white silver chloride precipitate in the halide test. Filter off barium sulfate and test the filtrate.

8. Identify the salt

The white barium precipitate in the acidified sample shows sulfate. The ammonia result shows ammonium.

The salt is ammonium sulfate, $(NH_4)_2SO_4$.

9. Extra challenge · Quantify a mixture from two tests

24.0 ÷ 24 000 = 0.00100 mol CO_2, from 0.00100 mol Na_2CO_3 or 0.106 g.

0.350 ÷ 233.4 = 0.001500… mol $BaSO_4$, matching 0.001500… mol Na_2SO_4 or 0.213 g. NaBr mass = 0.424 − 0.106 − 0.213 = 0.105 g.

An added halide can produce its own silver halide precipitate. Use dilute nitric acid and barium nitrate, then filter out the barium sulfate before testing the filtrate.

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