Compounds, formulae and equations

OCR A H032 and H432 · AS and A level

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

Name _____ Date _____

1. Use the periodic table

Predict the charges on the ions formed from barium, bromine and oxygen. Write the formulae of the ionic compounds barium bromide and barium oxide.

2. Write three formulae

Write the formulae of ammonium sulfate, zinc hydroxide and silver carbonate. Show the ions you used for each compound.

3. Check a label

A metal ion M forms a salt containing two nitrate ions for each metal ion. A label gives the formula MNO_{32}. State the charge on M and write the correct formula of the salt.

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4. Represent a decomposition

On heating, solid silver nitrate decomposes to solid silver, nitrogen dioxide gas and oxygen gas. Write a balanced equation with state symbols, using the smallest whole-number coefficients.

5. Mix two solutions

Calcium nitrate solution and sodium fluoride solution form a precipitate of calcium fluoride. Write the ionic equation with state symbols and name the spectator ions.

6. Compare two equations

Sodium carbonate solution reacts with dilute hydrochloric acid. The products are sodium chloride solution, water and carbon dioxide. Write both the full equation and the ionic equation, including state symbols.

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7. A precipitate and water

Barium hydroxide solution reacts with dilute sulfuric acid. The only products are solid barium sulfate and water. Write a single ionic equation with state symbols that accounts for both products.

8. Correct an ionic equation

Limited aqueous sodium hydroxide is added to aluminium sulfate solution. Solid aluminium hydroxide forms. A student writes $Al^{3+}(aq) + OH^{-}(aq) \rightarrow Al(OH)_3(s)$. Correct their equation and show that atoms and charge balance.

9. Extra challenge · Resolve a misleading precipitate

An aqueous sample contains sodium carbonate and may contain sodium chloride. Adding aqueous silver nitrate to one portion gives a precipitate. Both silver carbonate and silver chloride are insoluble.

Explain why this observation does not identify chloride. Design a test using a fresh portion and dilute nitric acid to check for chloride. Write ionic equations with state symbols for the reactions used to justify your method.

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Worked answers

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1. Use the periodic table

Barium is in Group 2 and forms Ba^{2+}. Bromine is a halogen and forms Br^{-}. Oxygen is in Group 16 (Group 6) and forms O^{2-}.

$BaBr_2$ needs two Br^{-} ions per Ba^{2+} ion. BaO needs one O^{2-} ion per Ba^{2+} ion.

2. Write three formulae

$(NH_4)_2SO_4$ contains two NH_4^{+} ions per SO_4^{2-} ion. $Zn(OH)_2$ contains two OH^{-} ions per Zn^{2+} ion. Ag_2CO_3 contains two Ag^{+} ions per CO_3^{2-} ion.

Brackets keep a repeated group together. In $(NH_4)_2SO_4$, the subscript outside the brackets counts entire ammonium ions.

3. Check a label

Each nitrate ion has charge −1, so M has charge +2. Write $M(NO_3)_2$ to count two whole nitrate ions.

The formula contains one M, two N and six O atoms per formula unit.

4. Represent a decomposition

$2AgNO_3(s) \rightarrow 2Ag(s) + 2NO_2(g) + O_2(g)$.

The two nitrate units contain two nitrogen and six oxygen atoms. The two NO_2 molecules account for four oxygen atoms, leaving two for one O_2 molecule.

5. Mix two solutions

$Ca^{2+}(aq) + 2F^{-}(aq) \rightarrow CaF_2(s)$. Two fluoride ions balance the charge on one calcium ion.

Sodium and nitrate ions remain in solution and are omitted from the ionic equation.

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Worked answers

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6. Compare two equations

$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$.

$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$. Sodium and chloride ions cancel.

7. A precipitate and water

$Ba^{2+}(aq) + SO_4^{2-}(aq) + 2H^+(aq) + 2OH^-(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$.

Barium and sulfate form the precipitate. The two hydroxide ions from each barium hydroxide formula unit combine with two hydrogen ions. Total charge is zero on each side.

8. Correct an ionic equation

$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$. Each side has one Al, three O and three H atoms. The total charge on the left is +3 − 3 = 0, matching the neutral product.

Sodium and sulfate ions remain in solution. Keep the precipitate formula fixed and balance the equation by changing the coefficients.

9. Extra challenge · Resolve a misleading precipitate

The known carbonate can precipitate silver carbonate. $2Ag^+(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)$. That precipitate alone does not establish the presence of chloride.

Acidify a fresh portion with dilute nitric acid to remove carbonate: $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$. Nitric acid does not add chloride.

After reaction with the acid, add aqueous silver nitrate. A white precipitate indicates chloride under the stated sample conditions: $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$.

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