90934 Demonstrate understanding of aspects of chemical reactions

Activity series

Li	Na	Ca	Mg	Al	Zn	Fe	Pb	(H)	Cu	Ag	Au

Solubility rules

nitrates, NO_3^-	All **soluble**
chlorides, Cl^-	All **soluble** except AgCl, $PbCl_2$
sulfates, SO_4^{2-}	All **soluble** except $BaSO_4$, $PbSO_4$, $CaSO_4$
hydroxides, OH^-	All **insoluble** except KOH, NaOH
carbonates, CO_3^{2-}	All **insoluble** except K_2CO_3, Na_2CO_3

Table of ions

+1	+2	+3	–3	–2	–1
NH_4^+	Ca^{2+}	Al^{3+}		O^{2-}	OH^-
Na^+	Mg^{2+}	Fe^{3+}		S^{2-}	Cl^-
K^+	Cu^{2+}			CO_3^{2-}	NO_3^-
Ag^+	Pb^{2+}			SO_4^{2-}	HCO_3^-
H^+	Fe^{2+}				CH_3COO^-
Li^+	Ba^{2+}				
	Zn^{2+}				

The following questions (and answers) have been taken from past NCEA papers / sample papers. Their answers are at the bottom of each page.

QUESTION ONE: PRECIPITATION

A chemical reaction occurs when a solution of calcium nitrate is added to a solution of sodium hydroxide.

Analyse this reaction by:

- describing any observations that would be made
- identifying the products
- explaining what happens to EACH ion that is present in these two solutions
- writing a balanced symbol equation for this reaction. (Spectator ions may be omitted.)

Balanced symbol equation

A white precipitate forms in a colourless solution.
Calcium hydroxide $Ca(OH)_2$ precipitate would form.
The Ca^{2+} and OH^- ions would be attracted to each other to form the insoluble precipitate.
The Na^+ and NO_3^- ions are soluble and would be found on their own in the solution as spectator ions.
$Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$ OR $Ca(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Ca(OH)_2(s) + 2NaNO_3(aq)$

QUESTION TWO: DISPLACEMENT REACTION

A piece of copper wire placed in a solution of silver nitrate undergoes a displacement reaction.

Give a detailed account of this reaction. You may refer to the Activity series in the Resource Booklet.

In your answer you should:

- describe any observations that would be made
- link these observations to the chemical species involved
- explain why the displacement reaction occurs
- write a balanced ionic equation for this reaction.

Balanced ionic equation

A grey / black / silver deposit slowly forms on the copper wire. This is the formation of silver (Ag) as silver ions are displaced out of solution.

The colourless solution will slowly turn blue and copper wire dissolves / decreases in mass. This is because Cu^{2+} ions are moving into solution.

The displacement reaction occurs because copper is more reactive than silver. (Copper is higher than silver on the metals Activity Series.) The copper atoms will form copper ions in the solution, and the silver ions in the solution will form silver metal on the surface of the wire.

Equations: $2Ag^{+}(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

QUESTION THREE: DECOMPOSITION

Students in a laboratory are asked to identify three powders by using a thermal decomposition reaction.

The powders are copper hydroxide, $Cu(OH)_2$, sodium carbonate, Na_2CO_3, and sodium hydrogen carbonate, $NaHCO_3$.

Explain how you could identify each of these powders by heating them.

Your answer should include:

- any observations that would be made
- any tests that would be carried out on products formed to confirm their presence
- balanced symbol equations for any reactions occurring.

Balanced symbol equations

$Cu(OH)_2(s) \rightarrow CuO(s) + H_2O(g)$ This goes from blue to a black powder, and condensation (a colourless liquid) may form. The condensation can be tested with cobalt chloride paper which will turn from blue to pink.

Na_2CO_3 does not decompose so no colour change will be observed and no gases will be formed.

$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$ $NaHCO_3$ is a white powder that will decompose to form a white powder. Two gases will form. (Or condensation (a colourless liquid) may form.) One will turn <u>limewater</u> <u>milky</u> / extinguish burning splint, and the other would turn cobalt chloride paper from blue to pink.

QUESTION FOUR: COMBINATION REACTIONS

Different elements can be reacted together to form compounds with properties that are different to the original elements.

The reaction of iron and sulfur to form iron(II) sulfide is an example of a combination reaction where all species (reactants and products) have different properties.

Give a detailed account of this combination reaction.

In your answer you should:

- state the conditions required for this reaction to occur
- describe any observations that would be made
- outline the physical and chemical properties of EACH of the species
- explain why the properties of the reactants differ from those of the products
- write a balanced symbol equation for the reaction.

Balanced symbol equation

At room temperature, iron and sulfur can be mixed in a beaker as a mixture. Heat is required for the reaction to occur.

Iron: Physical: solid, black / grey, magnetic, metallic properties. Chemical: 2 electrons to lose so it is relatively reactive.

Sulfur: Physical: yellow solid, brittle, non-metallic properties. Chemical: reactive due to requiring 2 valence electrons for a stable octet.

Iron sulfide: Physical: black solid, no longer magnetic. Chemical: a stable ionic compound.

In the reaction, there is a glow as the sulfur melts and reacts with the iron. Each Fe atom loses 2 electrons forming Fe^{2+}, each sulfur atom gains 2 electrons, forming S^{2-}.

$Fe(s) + S(s) \rightarrow FeS(s)$