

## Demonstrate understanding of aspects of chemical reactions Last minute Reminders – Part I of 2.

A lot of information is provided in the resource booklet; you no longer need to memorise colours.

Colours of selected ions and solids		Solubility rules	
Colourless ions	chloride, iodide, sulfate, hydroxide, carbonate, calcium, magnesium, zinc, lead, barium, silver	nitrates	All <b>soluble</b>
Blue ions	copper	chlorides	All <b>soluble</b> except silver chloride, lead chloride
Pale green ions	iron(II)	iodides	All <b>soluble</b> except silver iodide, lead iodide
White solids	calcium sulfate, calcium hydroxide, calcium carbonate, magnesium hydroxide, magnesium carbonate, zinc carbonate, lead chloride, lead sulfate, lead carbonate, barium sulfate, barium hydroxide, barium carbonate, silver chloride	sulfates	All <b>soluble</b> except barium sulfate, lead sulfate, calcium sulfate
		hydroxides	All <b>insoluble</b> except potassium hydroxide, sodium hydroxide
Green solid	iron(II) hydroxide, iron(II) carbonate	carbonates	All <b>insoluble</b> except potassium carbonate, sodium carbonate
Blue solid	copper hydroxide	<b>Activity series</b> <div style="border: 1px solid black; padding: 5px; display: inline-block;">Ca Mg Al Zn Fe Pb (H) Cu Ag</div>	
Yellow solid	lead iodide		
Cream solid	silver iodide		

All the 'solids' listed here are insoluble solids.

Concentrate on linking the observations to the "species" involved in the reaction.

Assume solids are white and solutions are colourless unless listed above. Remember copper sulfate solid and its solution are blue. Describe all metals as grey or silvery grey except for copper which is a pinky orange or orange-brown (and never "copper coloured!")

1. Precipitation reactions. Recognized by  $\text{---(aq)} + \text{---(aq)} \rightarrow \text{---(aq)} + \text{---(s)}$ , where (s), the solid is the precipitate. E.g. mix solutions of copper sulfate + sodium hydroxide; copper ions are blue. Use solubility rules to work out that copper hydroxide is insoluble. When blue copper sulfate is mixed with colourless sodium hydroxide solution a blue precipitate of copper hydroxide is made and a colourless solution of sodium sulfate. This is a precipitation reaction because when the two solutions (copper sulfate and sodium hydroxide) are added together, an insoluble substance forms.

- Copper sulfate + sodium hydroxide  $\rightarrow$  copper hydroxide + sodium sulfate
- This is a precipitation reaction because when the two solutions are added together, an insoluble precipitate forms, OR because when the two solutions are added together, ions from each substance are swapped or exchanged, and an insoluble substance (precipitate) forms.

PRECIPITATION REACTIONS DO NOT INVOLVE ELECTRON TRANSFER.

2. Decomposition

Thermal decomposition: reaction ALWAYS needs heat  $\text{---(s)} \rightarrow 2 \text{ or } 3 \text{ simpler compounds}$

E.g. Heat magnesium carbonate; White magnesium carbonate will breakdown into white magnesium oxide and colourless carbon dioxide gas. Magnesium carbonate  $\rightarrow$  magnesium oxide + carbon dioxide..

- metal carbonate  $\rightarrow$  metal oxide + carbon dioxide (Remember: white  $\text{Na}_2\text{CO}_3$  does not decompose so no colour change will be observed and no gases will be formed.)
- sodium hydrogen carbonate  $\rightarrow$  sodium carbonate + water + carbon dioxide
- metal hydroxide  $\rightarrow$  metal oxide + water

Heat a small amount of the solid in a boiling-tube. The boiling tube should have a bung in it, with a delivery tube going into a test-tube of limewater. If the limewater turns from colourless to cloudy during heating, this indicates that carbon dioxide gas has been produced.

Heat a small amount of the solid in a boiling-tube. Hydrogen carbonates and metal hydroxides will also release steam. A piece of cobalt chloride paper held in this gas will turn from blue to pink

THERMAL DECOMPOSITION REACTIONS DO NOT INVOLVE ELECTRON TRANSFER.

Decomposition (catalytic): hydrogen peroxide  $\rightarrow$  water + oxygen

E.g. A black solid catalyst ( $\text{MnO}_2$ ) (catalyses) a colourless liquid / solution ( $\text{H}_2\text{O}_2$ ) to form bubbles of colourless gas ( $\text{O}_2$ ) and a colourless liquid ( $\text{H}_2\text{O}$ ) (glowing splint relights –  $\text{O}_2$ , test tube gets warm). The black / dark brown solid remains.

3. Displacement: a more reactive metal displaces another less reactive metal from a solution of its salt; refer to activity series given in the Resource booklet e.g.  $\text{A} + \text{B sulfate} \rightarrow \text{B} + \text{A sulfate}$  (as long as metal A is more reactive than B)

E.g. The reaction between zinc metal and lead nitrate is a displacement reaction because when zinc metal is placed into a solution of lead nitrate, the zinc metal displaces lead ions in solution to form zinc nitrate – since zinc is higher on the activity series. Zinc metal loses two electrons to form  $\text{Zn}^{2+}$  and the electrons are gained by  $\text{Pb}^{2+}$  to form Pb. Use the Table of ions to work out electrons lost / gained

+1	+2	+3	-3	-2	-1
$\text{NH}_4^+$	$\text{Ca}^{2+}$	$\text{Al}^{3+}$		$\text{O}^{2-}$	$\text{OH}^-$
$\text{Na}^+$	$\text{Mg}^{2+}$	$\text{Fe}^{3+}$		$\text{S}^{2-}$	$\text{Cl}^-$
$\text{K}^+$	$\text{Cu}^{2+}$			$\text{CO}_3^{2-}$	$\text{I}^-$
$\text{Ag}^+$	$\text{Pb}^{2+}$			$\text{SO}_4^{2-}$	$\text{NO}_3^-$
$\text{H}^+$	$\text{Fe}^{2+}$				$\text{HCO}_3^-$
$\text{Li}^+$	$\text{Ba}^{2+}$				$\text{F}^-$
	$\text{Zn}^{2+}$				

When the orange / pink / brown solid (copper) is added to the colourless solution (silver nitrate), a grey solid (silver) forms, and the solution turns blue as copper nitrate solution is formed. Cu metal loses 2 electrons to form  $\text{Cu}^{2+}$ . And the electrons are gained by  $\text{Ag}^+$  to form Ag.  $\text{Cu(s)} + 2\text{Ag}^+(\text{aq}) \rightarrow 2\text{Ag(s)} + \text{Cu}^{2+}(\text{aq})$

**DISPLACEMENT REACTIONS INVOLVE ELECTRON TRANSFER.**

4. Combination:  $\text{A} + \text{B} \rightarrow \text{AB}$  2 reactants combine to form one single product OR two elements react together to form one new compound. e.g. metal + oxygen  $\rightarrow$  metal oxide

Particular combinations are not specified in the Achievement standard so here are some common ones:

- Grey/black iron powder (magnetic) and yellow sulfur powder reacts with a bright glow to form a black/grey solid (now non-magnetic), iron sulfide.  $\text{Fe} + \text{S} \rightarrow \text{FeS}$  Each Fe loses 2 electrons to form  $\text{Fe}^{2+}$ . Each S gains 2 electrons to form  $\text{S}^{2-}$ .
- Magnesium and oxygen Magnesium + oxygen  $\rightarrow$  magnesium oxide.  $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ . Each Mg loses two electrons to form  $\text{Mg}^{2+}$ . Each O atom gains two electrons to form  $\text{O}^{2-}$ .
- When heated, the orange / pink / brown copper would become coated with a black layer of black copper oxide. Copper + oxygen  $\rightarrow$  copper oxide.  $2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$ . Each Cu loses 2 electrons to form  $\text{Cu}^{2+}$  and each O atom gains two electrons to form  $\text{O}^{2-}$ .
- Shiny grey metal sodium reacts with yellow / green chlorine gas to form white crystals of sodium chloride.  $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$ . Each Na atom loses 1 electron to each Cl atom / each Cl atom gains 1 electron.
- Ignite hydrogen gas in oxygen / air. The hydrogen and oxygen would explode with a small flame and a loud squeaky pop. Condensation / colourless liquid would form on the tube and could be tested with  $\text{CoCl}_2$  paper, which will turn from blue to pink.  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- Heat some sulfur in air (or oxygen gas) until it burns. The yellow solid melts, and then catches fire light in the colourless gas (or air), burning with a blue flame forming a colourless gas.  $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$

**COMBINATION REACTIONS BETWEEN METALS AND NONMETALS INVOLVE ELECTRON TRANSFER.** – form ionic compounds.

**COMBINATION REACTIONS NONMETALS INVOLVE ELECTRONS BEING SHARED.** – form covalent compounds.