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Level 1 Chemistry, 2015

90934 Demonstrate understanding of aspects of chemical reactions

9.30 a.m. Tuesday 24 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of chemical reactions.	Demonstrate in-depth understanding of aspects of chemical reactions.	Demonstrate comprehensive understanding of aspects of chemical reactions.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L1–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 22

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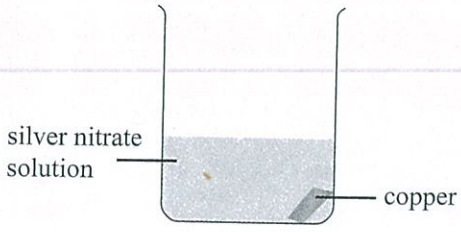
QUESTION ONE

ASSES USE C

(a) A piece of copper was added to a solution of silver nitrate in a beaker, and left for one day.



(i) Identify the type of reaction occurring in the beaker.

Displacement

(ii) Describe the observations occurring, and link them to the reactants and products involved.

Pink solid, copper, is added to colourless silver nitrate solution. Over night the colourless solution would be a light blue colour (indicating copper nitrate.) Also the copper metal would ~~Hee~~ be reduced visibly in mass and a grey deposit of silver metal would have formed on its surface.

(iii) Write a balanced ionic equation for the reaction occurring in the beaker.

$$Cu_{(s)} + 2AgNO_{3(aq)} \longrightarrow 2Ag_{(s)} + Cu(NO_3)_{2(aq)}$$

Question 1 achieved an E7. The minor error was due to reference of blue colour fading rather than linking $MgSO_4$ solution as being colourless.

(b) A strip of silver-grey metal is known to be either **silver** or **magnesium**.

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Explain how the identity of the metal could be determined by adding **copper sulfate** solution to the strip of metal, and leaving it for one day.

In your answer, you should:

- give any observations you would expect to see if the metal is:
  - silver, and
  - magnesium,

  and link them to the relevant species present
- explain why a chemical reaction may or may not occur, depending on whether the metal is silver or magnesium.

If an unknown strip of grey metal is added to blue solution copper sulfate and after a time the colour of the solution fades with the mass of the metal reducing and a deposit of pink solid copper is forming on its surface then the metal may be identified as magnesium. The faded solution is magnesium sulfate. If the strip of grey metal is added to the blue copper sulfate solution and the colour does not change and the strip of metal stays the same in mass and ~~colour~~ colour also then the unknown metal is silver. ~~It is~~ A displacement reaction did not occur as silver is less reactive than copper and unable to displace it in the sulfate solution. (as placed further right on activity series)

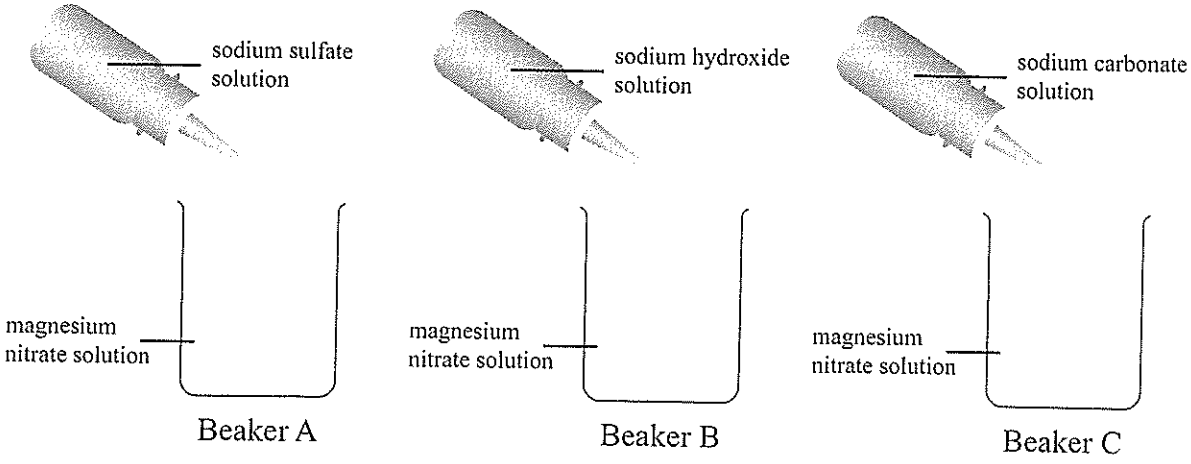
Magnesium is a more reactive metal than copper with it being placed further left afield on the activity series. Because of this magnesium is able to replace copper in the sulfate solution. Magnesium forms an ion by ~~losing~~ losing its 2 valence electron to gain stable valence shell of eight electrons. These electrons are gained by the less reactive copper ions, destabilising them and forcing them to ~~revert to~~ devolve into their elemental form. As the copper ions ~~turn~~ turn into copper metal they deposit on the surface of the magnesium strip of metal. Simultaneously the metal is being reduced in mass as more Mg atoms ionise to join sulfate ions in solution. ~~As they do not take part in reaction~~ Sulfate ~~are~~ spectator ions

E7

QUESTION TWO

ASSE USE

(a) Three different solutions were added to separate beakers containing a solution of magnesium nitrate. Only two of the mixtures produced precipitates.



Complete the table below by identifying:

- whether a precipitate forms
- the name of any precipitate that may have formed in the beakers.

You may use the solubility rules provided in the resource booklet.

	Precipitate forms? Yes / No	**Name of precipitate**
Beaker A	No	—
Beaker B	Yes	Magnesium hydroxide
Beaker C	Yes	Magnesium carbonate

(b) (i) Iron(II) sulfate solution and sodium hydroxide solution react to form a precipitate.

Complete the following ionic equation to show the formation of the precipitate.

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_{2(s)}$

(ii) Elaborate on the reaction occurring in (b)(i).

In your answer, you should:

- explain why the reaction is classified as a precipitation reaction by referring to the ions in both solutions and the precipitate formed
- describe any observations that would be seen, and link them to the reactants and products involved.

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The solutions pale green iron(II) sulfate and colourless sodium hydroxide seperately may not form precipitates as they are soluble (according to solubility table) but combined the pale green precipitate iron(II) hydroxide is produced. This precipitate reaction is defined as such due to the combination of two soluble solutions resulting in a solid ~~and~~ in solution. The ions (SO_4^{2-} and Na^+) of the resulting solution are spectator ions as they do not take place in precipitate formation and remain unchanged in solution.

The green solid iron(II) hydroxide will settle to bottom of the colourless Na_2SO_4 solution.

This question earned an E7 because in part b(i) there was no links made of $Fe(II)$ & OH^- ions forming the $Fe(OH)_2$ precipitate

(c) A sample of water is required to be tested for the presence of calcium ions and silver ions. It is known that the sample of water does not contain any other positive ions/cations.

ASSE USE

Explain how the sample of water could be tested to show whether or not it contains calcium ions, or silver ions, or both.

In your answer, you should:

- write a method that could be carried out in a school laboratory
- name any chemicals you would use
- identify any precipitates formed and link these to any observations that would be made
- explain how the results are used to determine which ions are present or absent.

You should use the solubility rules provided in the resource booklet.

In one sample of water, add colourless magnesium sulfate. If calcium is present a white calcium sulfate precipitate will form and settle at bottom of resulting colourless solution with magnesium ions. In another test tube of ~~the~~ with a new sample of the water you are testing add colourless sodium chloride solution. If silver is present a white silver chloride precipitate should form, ~~suspended~~ suspended in a solution of sodium ions. Because only either calcium or silver ~~ion~~ ions are present in the water, when ~~chloride~~ sodium chloride is introduced, according to solubility rules, only silver would form ~~a precip~~ ionic compound ~~of~~ with the chloride ions between which their electrostatic bonds are not overcome by attraction of water molecules, thus a solid white silver chloride precipitate forms. Similarly, when magnesium is added to sample only containing either Ag^+ or Ca^{2+} ions, if Ca^{2+} is present then precipitate calcium sulfate must form. Calcium sulfates electrostatic bonds are not overcome by polar attraction of water thus are not dissociated into seperate ions in solution like spectator ions magnesium.

E7

QUESTION THREE

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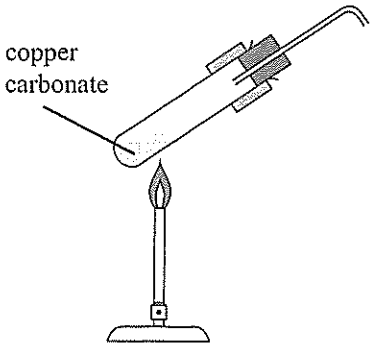
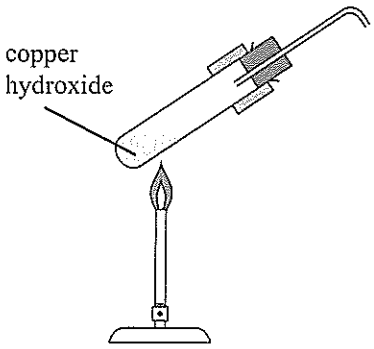
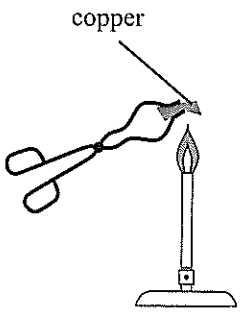
A student made samples of copper oxide using three different methods in a school laboratory.



Reaction 1



Reaction 2



Reaction 3

(a) (i) Identify the type of reaction occurring in each experiment.

Reaction 1: Thermal Decomposition

Reaction 2: Thermal Decomposition

Reaction 3: Combination.

(ii) Describe any observations that would be made during each experiment, and link them to the reactants and products involved.

Reaction 1: Green solid copper carbonate is heated to produce colourless odourless carbon dioxide that rises through the copper carbonate to cause it to jump about. As gas emitted the mass of remaining black solid copper oxide is reduced.

Reaction 2: Blue-green solid copper hydroxide is heated. Colourless odourless water vapour rises ~~Hsent~~ causing the initial copper hydroxide to jump about. The mass of copper hydroxide reduces until reaction is completed and only black solid copper oxide remains. Water vapour condenses on test tube sides

Reaction 3: Pink solid copper oxide is heated in colourless oxygen gas to produce a black solid copper oxide that forms on the outside of the initially pink metal.

(b) Explain how the student could identify ONE of the products for each of reactions 1 and 2.

Reaction 1: Bubble carbon dioxide into lime water. A white precipitate of calcium carbonate will form if CO_2 present. If no change then CO_2 not present.

Reaction 2: ~~Water Vapour~~ Apply blue cobalt chloride paper to condensed water vapour on test tube. Cobalt chloride paper changes from blue to a pale white colour. if water present. If no water present no change occurs. to colour.

(c) Compare and contrast the three reactions in part (a) on the previous page.

In your answer, you should:

- write word and balanced symbol equations for all three reactions in the boxes provided below
- explain what is occurring during each of the different reactions
- where relevant, explain the reaction(s) in terms of electron transfer.

Reaction 1

Word equation:

Copper carbonate $\xrightarrow{heat}$ Copper oxide + carbondioxide

Balanced symbol equation:

$CuCO_3 \xrightarrow{heat} CuO + CO_2$

Reaction 2

Word equation:

Copper hydroxide $\xrightarrow{heat}$ Copper oxide + water

Balanced symbol equation:

$Cu(OH)_2 \xrightarrow{heat} CuO + H_2O$

Reaction 3

Word equation:

$2Cu + O_2 \longrightarrow 2CuO$

Balanced symbol equation:

Copper + oxygen $\longrightarrow$ copper oxide

In reactions one and two an ionic compound (firstly a ~~base~~ metal carbonate ($CuCO_3$) and then a metal hydroxide ($Cu(OH)_2$)) is being thermally decomposed ~~is~~ to smaller compounds. By forcing heat upon the initial compound, energy is absorbed into the system and bond are broken. The resulting products of this process are less stable than the reactant and more reactive. The ~~first~~ re 1st and 2nd reactions both produce black copper oxide, however, the first also produces CO_2 and the 2nd H_2O in addition. During the ~~third reaction th~~ a combination reaction occurs. Copper and oxygen, two single elements, combine to form a compound CuO. By combining these two bonds are formed and thus the product is more energetically stable. Also, instead of heat being absorbed like in decomposition, heat is instead emitted as bonds between Cu and O_2 are forged. Copper will lose its ~~one~~ two valence electron to have the ~~8~~ stable octet while ~~2~~ oxygen will gain those same two to also achieve the octet. Thus electrostatic bonds are formed between cation copper of charge 2+ and anion oxygen of charge 2-. One copper ion will bond with one oxygen ion due to their equating charges.

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~~So~~ Evidence ~~was~~ demonstrated comprehensive understanding. Some inaccurate statements regarding energy were ignored as the concepts were beyond Level 1.

E8