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Level 1 Science, 2016

90944 Demonstrate understanding of aspects of acids and bases

9.30 a.m. Monday 14 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of acids and bases.	Demonstrate in-depth understanding of aspects of acids and bases.	Demonstrate comprehensive understanding of aspects of acids and bases.

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.

Pull out Resource Booklet 90944R from the centre of this booklet.

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 2–8 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.

Merit

TOTAL 18

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Merit exemplar 2016

Subject: Science		**Standard: 90944**	**Total score: 18**
Q	**Grade score**	**Annotation**	
1	M6	Correctly balanced symbol equation. Explains that oxygen needs to gain two electrons and sodium needs to lose an electron to have full valence shells. Explains that oxygen is in Group 16, has 8 protons and electrons – with an electron arrangement of 2,6 – and that to form an oxygen ion it needs to gain 2 electrons to have a full valence shell.	
2	M6	Explains that the greater surface area of calcium carbonate in powder form leads to more successful collisions between the hydrochloric acid particies and the powdered calcium carbonate particles leading to a faster rate of reaction when compared to a slower rate with chips of calcium carbonate which have a smaller area. Explains that hydrochloric acid with a pH 1 has more hydrogen ions and is therefore able to have a faster reaction rate with the powdered calcium carbonate than an acid at pH 5 which has fewer hydrogen ions.	
3	M6	Correctly links potassium hydroxide (purple with universal indicator) with having a higher pH (14) than potassium carbonate (blue) which has a pH between 11-13. Correctly balanced symbol equation Explains that before any acid is added there is an excess of OH- ions which decreases as H+ ions are added until there is an excess of H+ ions.	

QUESTION ONE

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(a) Complete the table below.

Element	Atomic number	Electron arrangement of atom	Electron arrangement of ion
F	9	2,7	2,8
S	16	2,8,6	2,8,8
Ca	20	2,8,8,2	2,8,8

(b) Write the formulae for the following ionic compounds.

Use the table of ions in your resource booklet to help you.

(i) Silver fluoride AgF

(ii) Potassium sulfate K_2SO_4

(iii) Calcium nitrate $Ca(NO_3)_2$

(c) Sodium burns in oxygen gas, O_2, to form sodium oxide, Na_2O.

(i) Explain how the Na and O atoms form Na^+ and O^{2-} ions, in terms of their groups in the periodic table, electron arrangement, AND number of protons.

Oxygen is in group 16 in the periodic table. It has an electron arrangment of 2,6 So a total of 8 electrons & protons. To form an ion it needs to gain 2 electrons to make its full valence shell. So then it has a charge of 2^-. The number of protons remain at 8.

Sodium is in group 1 of the periodic table. It has an electron arrangment of 2,8,1. So a total of 11 electrons and protons. For sodium to make

its full valence shell it needs to lose 1 electron. It then gets a charge of + (1+). It still has 11 protons after it has become an ion. All Elements in group 1 have a charge of +. In group 16 2-.

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(ii) Justify the ratio of Na^+ and O^{2-} ions in the formula Na_2O, in terms of the **electrons** lost or gained, and the **charge** on each ion.

Include an explanation of the **type of bonding** between the Na^+ and O^{2-} ions.

This is an ionic-bond between sodium (Na^+) and oxygen (O^{2-}). Ionic-bond is the attraction between a cation and a anion. As the sodium ion has only lost 1 electron it has a charge of + and oxygen has gained 2 electrons so it has a charge of 2-. This means that there needs to be a ratio of 2:1 of the sodium & oxygen. For every 1 oxygen ion there is 2 Sodium ions. This is because they want a neutral charge of 0 so 2 sodiums cancel out 1 oxygen.

(d) Write a word equation AND a balanced symbol equation for the reaction between **sodium hydroxide** and **sulfuric acid**.

Word equation:

Sodium hydroxide + sulfuric acid → sodium sulfate + water

Balanced symbol equation:

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

M6

Na^+ OH^- H^+ SO_4^{2-}

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QUESTION TWO

A sample of calcium carbonate is added to dilute hydrochloric acid in an open conical flask. The total mass of the flask and contents is measured over time.

Three experiments are carried out at 25°C using the same mass of calcium carbonate, and the same volume of acid:

	Calcium carbonate pieces	pH of acid
Experiment 1	Chips	1
Experiment 2	Powdered	1
Experiment 3	Powdered	5

(a) For each of the experiments reacting calcium carbonate and dilute acid together, the mass of the flask and its contents decreases over time.

Describe why this happens.

This is because some of the content gets turned into carbon dioxide gas.

(b) (i) Identify the factor affecting the reaction rate being investigated in **Experiments 1 and 2**.

Surface area.

(ii) Explain how this factor affects the rate of reaction in the two flasks, with reference to particle collisions.

Explain any observations, including changes in mass, over the course of **Experiments 1 and 2** until the reactions are finished.

Surface area affects the rate of reaction because it means that more particles of the calcium carbonate are exposed the hydrochloric acid. This means that there can be more successful collisions as there is more of a chance they collide. The particle collision theory states that in order for a chemical

reaction to occur the particles must collide with sufficent force and at the correct orientation, This means the reaction will take place much quicker than when the calcium was in chips. The mass will stay the same as its still the same amounts but the experiment 2 will use up the calcium powder much quicker than if it was chips. So the rate of reaction is quicker.

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(c) Compare and contrast the rate of reaction of **Experiments 2 and 3**, with reference to particle collisions and the concentration of hydrogen ions in the solution.

In experiment 2 there is a ph of 1 so there is a much higher concentration of the acid. This means that there are much more H^+ ions (hydrogen) in the acid ~~than~~ there is of the OH^- ions (hydroxide). In experiment 2 there is a ph of 5 so close to neutral, this means there is a low concentration of acid. There are alot more OH^- ions present in there than experiment 1. The rate is nearing 50% as its close to neutral. This means that it would take much longer to fully react as there are less collisions happening. There arent as much H^+ ions colliding with the $CaCO_3$ ions. So the reaction would take longer.

M6

QUESTION THREE

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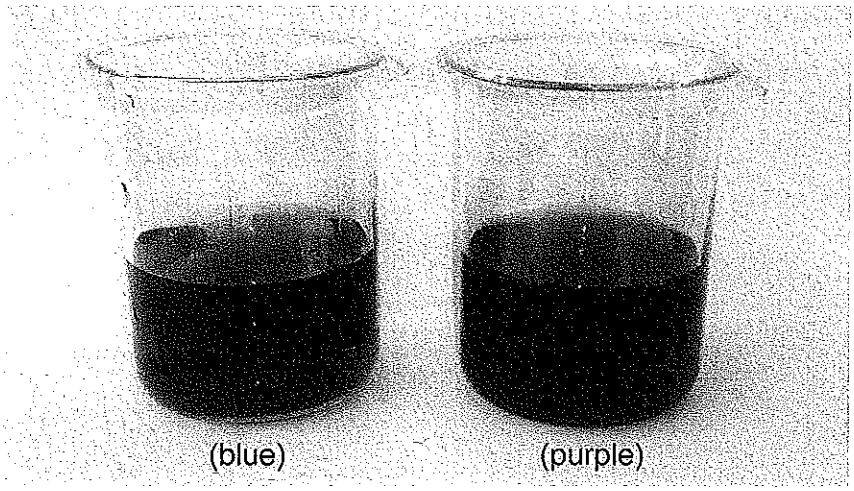
A student added universal indicator to the solutions in two beakers as shown below.



Beaker 1	Beaker 2
Potassium carbonate	Potassium hydroxide

(a) Explain why the solutions are different colours.

They are different colour as they have a different amount of hydroxide and Hydrogen ions in them. They have different ph levels (blue 11-13 Ph) (Purple 14 Ph). They are both basic but beaker 2 is more basic.

The student then adds hydrochloric acid to each of the beakers until there are no more changes in colour.

(b) Write a word equation AND a balanced symbol equation for the reaction between **hydrochloric acid** and **potassium carbonate** in Beaker 1.

Word equation:

Hydrochloric acid + Potassium carbonate → Potassium chloride + Carbon dioxide + water

Balanced symbol equation:

$2HCl + K_2CO_3 \rightarrow 2KCl + CO_2 + H_2O$

$H^+ \; Cl^- \quad K^+ \; (CO_3)^{2-}$

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(c) Explain what will happen to the indicator colour in **Beaker 2 (potassium hydroxide)** as the hydrochloric acid is added.

Relate this to the changing pH, the ions present in the beaker, and the type of reaction occurring.

As the Hydrochloric acid is put into the potassium hydroxide beaker the ph level will start to lower. The Universal indicator colour will go from the purple down to blue to a green then orange and then Finally red. At the moment the is a excess / alot more OH^- ion (hydroxide) present in the solution. When you start putting the hydrochloric acid in there are more H^+ (hydrogen ions) going into the solution. When it goes neutral (green) there are 50% H^+ and 50% OH^- ions in the beaker. After that there will be more H^+ ions in the solution as it's going to the acidic side of the ph. ~~If~~ When the U.I is red then there are much more H^+ ions present and not much OH^- ions in the solution. This type of reaction is producing carbon dioxide gas, water, and Potassium chloride. A neutralising experiment.

Acid + metal carbonate → metal salt + carbon dioxide + water

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