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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.

Excellence

TOTAL 22

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Annotated Exemplar Template

Excellence exemplar 2016

Subject:	Science	Standard:	90944	Total score:	22

Q	Grade score	Annotation
1	E7	Correctly balanced symbol equation. Clearly explains how atoms become ions for both sodium and oxygen (including the significance of the valence electrons) and is able to clearly explain the differences between the numbers of protons and electrons to the charge of the ion.
2	E7	Fully explains the relationship between a greater surface area, particle collision and frequency of successful collisions with a faster rate of reaction. Fully explains how an acid of pH 1 has more hydrogen ions present which leads to a higher frequency of successful collisions and therefore a faster rate of reaction, compared to an acid of pH 5.
3	E8	Correctly balanced symbol equation. Fully explains and links the changing colour of universal indicator as H+ ions are added in the form of hydrochloric acids. Fully explains the changing proportions of OH- and H+ ions at different points on the pH scale, including how at pH 7 the solution is green and neutral indicating an equal and balanced amount of OH- and H+ which together form water.

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.

The sodium atom is in the first group in the periodic table which means it has 1 electron in its valence shell. Oxygen is in the 16th group which means it has 6 electrons in its valence shell. The electron arrangement of sodium is 2,8,1 and it wants to have a full valence shell with the arrangement of 2,8, this is so it can become chemically stable. This means sodium loses 1 electron to form the ion Na^+. Sodium now has 11 protons, and 10 electrons (before it had 11) because protons are positively charged, and electrons negative, the atom now has an overall charge of +1 as it has one more proton than electrons. Oxygen has an electron

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arrangement of 2,6 and to gain a full valence shell and have the stable arrangement of 2,8, it needs to gain 2 electrons. When oxygen gains 2 electrons it now has 8 protons and 10 electrons (before it had 8) This means the atom has an overall charge of -2 as it has 2 more electrons than protons and electrons are negatively charged while protons are positively charged. N

(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.

N Ionic bonding occurs between the atoms sodium and oxygen when it forms the ionic compound Na_2O. This means the two atoms have either donated or accepted eletrons from each other to become a neutral compound. Na lost 1 electron and Oxygen gained 2, creating a ratio of 1:2 as for every 1 sodium lost, oxygen gained 2, so they become Na_2O so they are neutral as

$Na_2 = 1 \times 2 = +2$

$O_1 = 2 \times 1 = -2$

(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:

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

E7

QUESTION TWO

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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.

N This happens because the calcium carbonate and hydrochloric acid particles are reacting and as the reaction goes in the particles are being used up and the carbon dioxide being produced is escaping N

(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.

N increasing the surface area of the calcium carbonate pieces by changing it from chips to powder means their is more surface area for the particles to collide with which increases the rate of the reaction as because there is more availbale surface area to collide with, more successful collisions occur per second which speeds up the rate of the reaction. In

experiment 2, the mass of the contents of the flask should decrease quicker than the mass in experiment 1 as because the calcium carbonate was powder in experiment 2, more successful collisions per second occured as there was more surface are for the calcium carbonate particles and the hydrochoric acid particles to collide with, speeding up the reaction which should of occured quicker in experiment 2 as when they reacted and the gas carbon dioxide was produced, it escaped earlier in experiment 2, decreasing the mass faster. N

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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 experiments 2 & 3, the calcium carbonate pieces were both powder and were both carried out at the same temperature of 25°c. In experiment 2, the hydrochloric acid had a pH of 1 while in experiment 3, it had a pH of 5, making the hydrochloric acid in experiment 2 more concentrated as it contained a higher amount of hydrogen ions (compared to hydroxide ions) than experiment 3, which contained less hydrogen ions than experiment 2 but still more hydrogen ions than hydroxide ions. This means the particles in experiment 2 had a smaller volume of acid to react in, which made it more likely more successful collisions per second would occur, speeding up the rate of reaction. N

E7

QUESTION THREE

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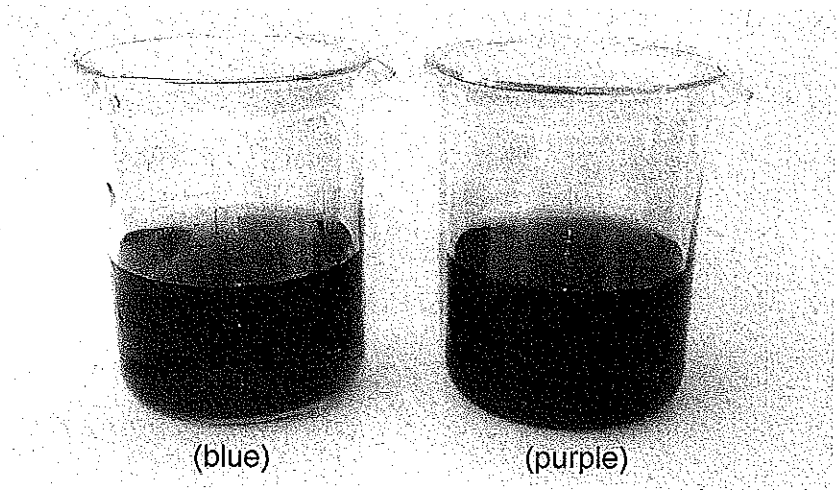
A student added universal indicator to the solutions in two beakers as shown below.



Beaker 1
Potassium carbonate

Beaker 2
Potassium hydroxide

(a) Explain why the solutions are different colours.

The two solutions are different colours as they have different concentration of hydrogen ions and hydroxide ions, ~~giving them~~ with the solution in Beaker 2 containing more hydroxide ions than the solution in Beaker 1 making solution 2 more basic and giving them different numbers on the pH scale than hydrogen ions

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 + water + carbon dioxide

Balanced symbol equation:

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

(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.

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As hydrochloric acid is added to the potassium hydroxide the solution will change colours going from purple to blue to green to yellow to red. The colour change occurs because of the different concentration of hydrogen ions to hydroxide ions. when the solution is a purple it has only hydroxide ions and a pH of 14 when more acid is added, changing it to blue there are still more hydroxide ions, but there are some hydrogen ions.* when more acid is added and the solution turns green, a neutralization reaction has occured meaning the concentration of hydrogen ions ~~and~~ (H^+) and hydroxide ions (OH^-) are equal, producing water (H_2O) creating a neutral pH of 7. If more acid was added, the solution will become more acidic than basic, having a higher concentration of hydrogen ions than hydroxide ions changing to an orange or yellow colour and having a pH of around 2-6. If even more acid was added, the solution would become fully acidic, containg only hydrogen ions and change to the colour red & have the lowest possible pH number of 1.

* creating a ph of between 8-12

E8