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Level 1 Science, 2017

90944 Demonstrate understanding of aspects of acids and bases

9.30 a.m. Wednesday 15 November 2017
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 15

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QUESTION ONE

A sample of powdered sodium hydrogen carbonate ($NaHCO_3$) was added to sulfuric acid (H_2SO_4) in a flask, and fizzing was observed.

Two experiments were carried out with the acid at different temperatures, using the same amount of powdered sodium hydrogen carbonate and the same concentration and volume of sulfuric acid:

Experiment	Temperature of acid, °C
1	30
2	55

(a) What caused the fizzing?

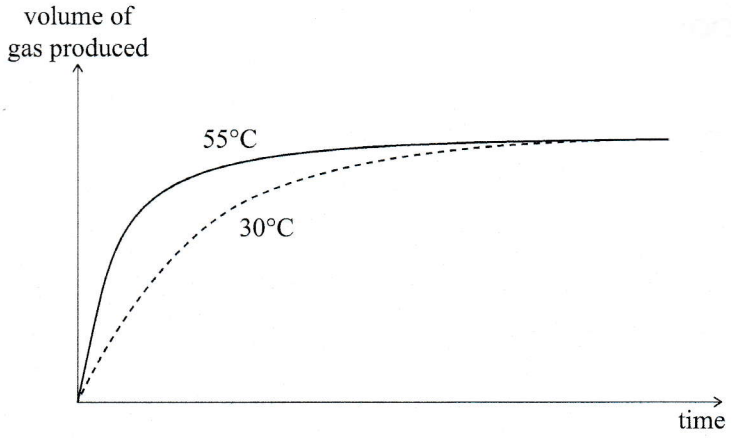
The fizzing was caused by the chemical reaction that occurred between sodium hydrogen carbonate and sulfuric acid.

(b) Why was the fizzing fastest immediately after the sodium hydrogen carbonate had been added?

Your answer should refer to particle collisions.

The fizzing was the fastest as soon as the $NaHCO_3$ was added because this was when the most particles were colliding, and causing the fizzing. This means that before the two reactants had dissolved, there was the most particles, which means that the frequency for effective particle collisions was higher because there were more particles.

(c) The rate of reaction for each experiment was found by measuring the volume of gas produced over time, as shown in the graph below.



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Refer to the graph on the previous page to answer the following question:

What is the effect of increasing temperature on the rate of reaction?

Your answer should refer to particle collisions and explain why both lines finish at the same point.

When the temperature of a substance is increased, the kinetic energy increases. The more kinetic energy means that the particles are colliding at a faster rate, which means the particles* have higher activation energy. ~~Has a higher chance of being met~~. So the particles are colliding with a sufficient amount of energy due to the increase in temperature, and the frequency for effective particle collisions is increased. The liner of the two different temperatures of acid finish at the same time because at this point all the reactants (H_2SO_4 and $NaHCO_3$) are used up and no more particles can collide.

* have higher energy than the

(d) Write a word equation AND a balanced symbol equation for the reaction between sodium hydrogen carbonate ($NaHCO_3$) and sulfuric acid (H_2SO_4).

Word equation:

Sodium hydrogen carbonate + sulfuric acid → carbon dioxide + water + sodium sulfate

Balanced symbol equation:

$NaHCO_3 + H_2SO_4 \rightarrow CO_2 + H_2O + Na_2SO_4$

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QUESTION TWO

Sodium and potassium are both highly reactive metals that react with oxygen gas. However, sodium and potassium do not react with each other.

(a) Why do sodium and potassium each react with oxygen, but not with each other?

In your answer you should:

- refer to the electron arrangements of each of the three atoms and three ions involved
- explain how the electron arrangement of each of the three atoms relates to its position in the periodic table
- explain how an ionic bond forms when sodium or potassium reacts with oxygen.

Sodium (Na) has an electron arrangement of 2, 8, 1. Which we can tell from the period + group number on the periodic table.* When Na turns into an ion, it must lose 1 electron to form a full valence shell. It now has an electron arrangement of 2, 8 and a charge of +1 as it has 11 positive protons and 10 negative electrons. Potassium (K) has an arrangement of 2, 8, 8, 1 as an atom, so when it forms an ion it loses 1 electron to have a full, stabe, non-reactive valence shell. It now has a charge of +1. Oxygen has an electron arrangement of 2, 8, 6, so it gains 2 electrons to have a full valence shell. It now has a charge of -2. An ionic bond is formed between a cation (positive ion) and an anion (negative ion). This is because they're opposite charges attract each other. This is why a oxygen ion can react with a potassium ion as O^{-2} is an anion and K^{+} is an cation. This is also why O^{-2} can react with Na^{+}. But, K^{+} and Na^{+} cannot react withe each other and form an ionic bond because they are both cations and have a positive charge.

* we can tell from the group no: its amount of electrons in its valence shell. We can also see from its period no: its number of shells.

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(b) Three unlabelled colourless solutions are known to be:

- nitric acid (HNO_3)
- sodium chloride (NaCl)
- sodium hydrogen carbonate ($NaHCO_3$).

How could each of these unlabelled solutions be identified using only **potassium carbonate (K_2CO_3)** solution, and **red litmus paper**?

In your answer you should:

- complete the table
- explain how the observations allow you to identify each solution
- include balanced symbol equation(s) for any reactions.

Unlabelled solution	**Observation (if any) with red litmus paper**	**Observation (if any) with potassium carbonate (K_2CO_3)**
Nitric acid (HNO_3)	stays red	~~effervescence turns green~~ nothing
Sodium chloride (NaCl)	stays red	nothing
Sodium hydrogen carbonate ($NaHCO_3$)	turns blue	~~bubbles~~ nothing

Nitric acid (HNO_3) is acidic which means if you dip red litmus paper into it and it stays red, it is an acid. This is how it could be identified using litmus paper.* When red litmus paper is added to NaCl, nothing occurs because it is neutral, but when K_2CO_3 is added, which is a base, it will change into a base and OH^- particles will dissociate. When $NaHCO_3$ has red litmus dipped in it will turn blue as it is a base, nothing will occur when K_2CO_3 is added because that is also a base.

* HNO_3 and K_2CO_3 will react and neutralise as it is an acid and base reacting.

Balanced symbol equation(s):

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QUESTION THREE

(a) (i) Explain why silver oxide, Ag_2O, has a 2:1 ratio of ions.

In your answer you should:

- relate the ratio of ions to the number of electrons lost or gained by each atom when forming ions
- explain how the ratio of the ions in the compound is related to the charge on the ions.

Silver (Ag) as an atom loses 1 electron to gain a full valence shell, so it has a charge of Ag^{+1}. Oxygen gains 2 electrons, so it has a charge of -2. When Ag and O react and form an ionic bond, there must be 2 Ag ions as it has a charge of +1 compared to Oxygens charge of -2. So there must be two Ag ions so it has a charge of +2 to cancel out oxygen charge of -2 and they can form the compound Ag_2O.

(ii) Silver oxide is a base and will react with hydrochloric acid.

Write a word equation AND a balanced symbol equation for the reaction between silver oxide and hydrochloric acid.

Word equation:

Silver oxide + hydrochloric acid → water + Silver chloride

Balanced symbol equation:

$Ag_2O + 2HCl \rightarrow H_2O + 2AgCl$

(b) A solution of sodium hydroxide (NaOH) is slowly stirred into a beaker of hydrochloric acid (HCl) with universal indicator added. The HCl and universal indicator solution **starts out red**.

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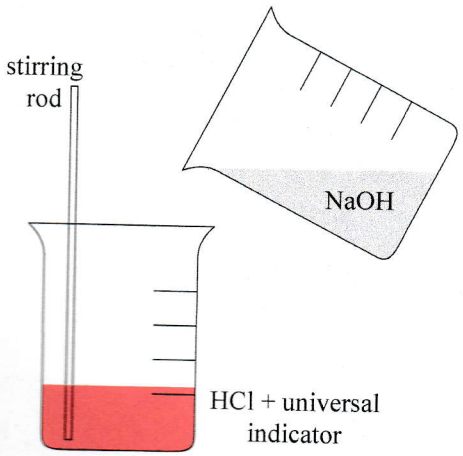

Explain the changes in the colour of the universal indicator as the sodium hydroxide solution is slowly added until no further colour changes occur.

In your answer, you should:

- relate the changes in the colour of the universal indicator to the approximate pH of the solution
- link the pH to the relative concentrations of hydrogen ions and hydroxide ions in solution
- explain the neutralisation reaction occurring.

When the sodium hydroxide is added to hydrochloric acid, there will be colour changes of the solution as there is universal indicator added. Since NaOH is a base, and HCl is an acid, they will react with eachother and neutralise and turn green. At the beginning before the base is added, the solution has a pH of around 1, but as the base is added it will turn to 7. Acids contain H^+ ions and bases have OH^- ions, so when mixed together, these ions will dissociate from the reactants and make the colour change occur.

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Subject:	Science	Standard:	90944	Total score:	15

Q	Grade score	Annotation
1	M5	For merit, the candidate explains effect of reactant concentration on collision frequency. However, there is no explanation of why the reaction slows. For merit, candidate explains effect of higher energy of hotter particles on collision rate, but omits higher speed of particles, or that both reactions have the same reactant mass and product (gas) volume for excellence. The equation is incorrect with carbonate rather than carbon dioxide included.
2	M5	There are several errors in this answer, but the candidate has explained how ions form for all 3 elements for merit and the need for attraction of opposing charges for ionic bond formation is also there. Part b has some good
		information but can't distinguish between the acid and salt as does not recognise there would be an observation when acid reacts with a base.
3	M5	Explains the requirement for two Ag^+ ions to achieve a neutral overall charge for merit, but omits any electron transfer. Symbol equation has correct formulae but is unbalanced. Part b has insufficient detail on colours, pH or ions present.