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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.

Excellence

TOTAL 22

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QUESTION ONE

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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?

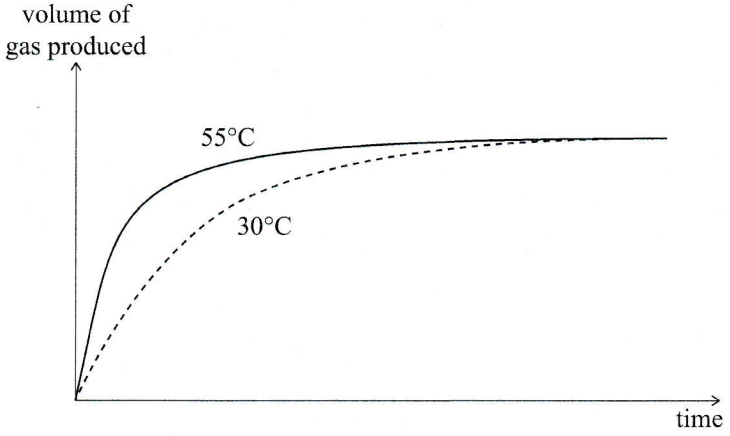
The release of carbon dioxide when the $NaHCO_3$ and H_2SO_4 react.

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

Your answer should refer to particle collisions.

As the $NaHCO_3$ and H_2SO_4 particles collide with enough energy and the correct orientation, a reaction takes place and forms sodium sulfate, water and carbon dioxide. The fizzing is the release of the carbondioxide. It is fastest immediately when there are the most reactant particles avaliable for ~~reactions~~ effective collisions to take place and form reactions. Immediately after the sodium hydrogen carbonate is added, the most reactions are taking place ^ at a given time therefore the most carbondioxide is released per second therefore the fizzing is the fastest at this time.

(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.



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

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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.

increasing the temprature increases the amount of kinetic energy the particles have. This means they move faster and are more likely to collide with other reactant particles with the correct orientation at any given time, to form reactions. This is why the volume of gas produced at 55°C is higher than that of 30°C at the beginning of the reaction. Both lines finish at the same point because after most of the reactant particles have collided and reacted already, there are just a few left, and in a large space, it can take a while for the particles to find each other and collide with enough energy to form reactions and release CO_2, ~~[illegible]~~ even if some were moving faster. And the temprature would likely have lowered, meaning that the particles are not moving as fast as they were at the start, therefore no longer making a difference.

(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 → Sodium sulfate + water + carbon dioxide

Balanced symbol equation:

$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$

M6

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.

An ionic bond forms when a positively charged ion reacts with a negatively charged ion. A positively charged ion is formed when an atom with 1-3 electrons in its valance shell has loses electrons to become stable and therefore the overall charge becomes positive as there are an excess of protons compared to electrons. A negatively charged ion is formed when an atom has 5-7 electrons in it's valance shell and it gains electrons, making the ~~rationar~~ charge negative. Both sodium and potassium are in group 1 on the periodic table, this means they have 1 electron in their valance shell. In order to become stable, K and Na need to lose this 1 electron to make the arrangement 2,8,8 for K & 2,8 for Na. When this happens, K and Na now have one more proton than electron, K has 19 P and 18 E and Na has 11 P and 10 E, therefore they make positively charged ions. Oxygen is in group 16 on the periodic table, this indicates that it has 6 electrons in its valance shell, electron arrangement 2,6 in order to become stable, it must gain 2 electrons to form a full outer shell, electon arrangement 2,8. it can do this by forming an ionic bond with Na and K. Na and K both lose one electron therefore they can provide 2 electrons for oxygen to gain to fill it's outershell. Since oxygen gains electrons, it becomes negatively charged (O^{2-}) and is attracted to positively charged ions (K^+ & Na^+) to form an ionic bond. K^+ & Na^+ don't attract each other since they are both positively charged & lose electrons, therefore they can't form an ionic bond. 2 Na^+ ions or 2 K^+ ions are needed to react and form an ionic bond with O^{2-}.

to form a full outer shell

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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)	litmus paper stays red	Bubbles produced and carbon dioxide is released.
Sodium chloride (NaCl)	NO observation - Litmus paper stays red.	NO observation
Sodium hydrogen carbonate ($NaHCO_3$)	litmus paper turns blue	NO observation

We can identify the Nitric acid because we know it is an acid and the litmus paper stays red indicating that it is not basic but acidic and bubbles were produced when the potassium carbonate was added, indicating the release of carbon dioxide (balanced symbol equation) which happens when a carbonate is added to an acid. We can identify the Sodium Hydrogen carbonate since we know it is a base and it turned the red litmus paper blue, indicating that the solution is basic. ~~Sodium chloride is a salt~~ There was no observation when K_2CO_3 was added as both are bases and don't react. Sodium Chloride is a salt therefore it had no observation as it did not react with the K_2CO_3. It did not change the colour of the litmus paper as it is not a base, therefore no change occoured.

Balanced symbol equation(s):

$2HNO_3 + K_2CO_3 \rightarrow 2KNO_3 + H_2O + CO_2$

E8

QUESTION THREE

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(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.

The silver ion looses one electron to form a full outer shell, making it one positively charged. (Ag^+) Oxygen gains 2 electrons to form a full outer shell, making it negatively charged (O^{2-}). This means that for both O and Ag to become stable, 2 silver ions are needed for every O^{2-} ion, each one provides one electron to total two for the oxygen ion to gain. We need 2 Ag^+ ions to provide 2 electrons to balance out the O^{2-} ion, this makes an ionic compound (Ag_2O) with no overall charge since ionic compounds ~~don't have~~ are neutral.

(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 → Silver chloride + water

Balanced symbol equation:

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

(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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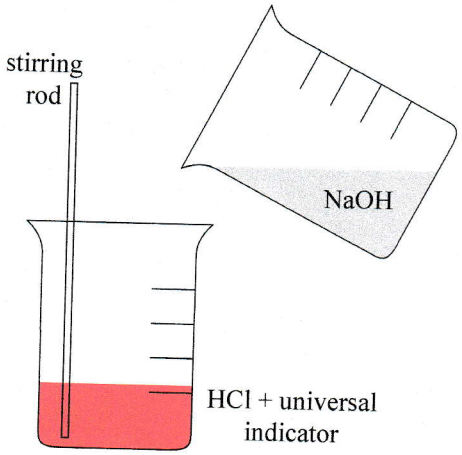

Explain the changes in the colour of the universal indicator as the sodium hydroxide solution is slowly added until no further colour changes occur.

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.

HCl is a very strong acid, it starts out red with a pH of 1-2 as it releases an large excess of Hydrogen (H^+) ions when in contact with water. as sodium hydroxide (NaOH) is added, the hydroxide (OH^-) ions balance with and cancel out some of the excess H^+ ions, making it a weaker base with a pH of 3-4, a orangey colour in UI (universal indicator). As more NaOH is added, more OH^- ions are released to cancel out more H^+ ions and it becomes a weak acid pH 5-6, still with excess H^+ ions and a yellow colour. It becomes neutral when it turns green with a pH of 7. Neutralisation has occoured and it is neither acidic or basic as all the H^+ and OH^- ions cancel eachother out. As more NaOH is added, there becomes an excess of OH^- ions, making it a weak base at a pH of 8-10 and it is a dark green/blue colour. As more NaOH is added, there becomes an large excessive amount of OH^- ions and it becomes a strong base pH of 13-14 and a dark purple colour. As more NaOH is added, no more changes will occour as it is already a strong base and a dark purple colour with a pH of 14. and adding more OH^- ions doesn't change it.

E8

Subject:	Science	Standard:	90944	Total score:	22

Q	Grade score	Annotation
1	M6	This provides evidence towards merit as the candidate explains the effect of higher concentration of reactant particles early in a reaction and further merit, the effect of higher temperature on collision rate. They have not explained why reaction rate decreases for excellence or that increased temperature affects collision force/energy or that both reactions have the same reactant mass and product (gas) volume for excellence. The equation is correct for excellence.
2	E8	A comprehensive answer explaining both parts of the question. Excellence is shown in why Na and K can react with O but not each other, including ion and ionic compound formation and group relevance. Excellence is also shown in how the 3 solutions can be identified and the equation is correct for excellence.
3	E8	A comprehensive answer covering all excellence points. The candidate explains that an ionic compound requires both electron transfer and a neutral charge for excellence and correctly balances the equation for excellence. Also for excellence, the candidate outlines the changing pH, colours and relative hydrogen and hydroxide ion concentrations. The explanation of neutralisation is missing the production of water/salt/neutral substances but shows a high level of understanding overall for this question.