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1

90944



909440



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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Level 1 Science, 2015

90944 Demonstrate understanding of aspects of acids and bases

9.30 a.m. Tuesday 10 November 2015
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 2–11 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.

Achievement

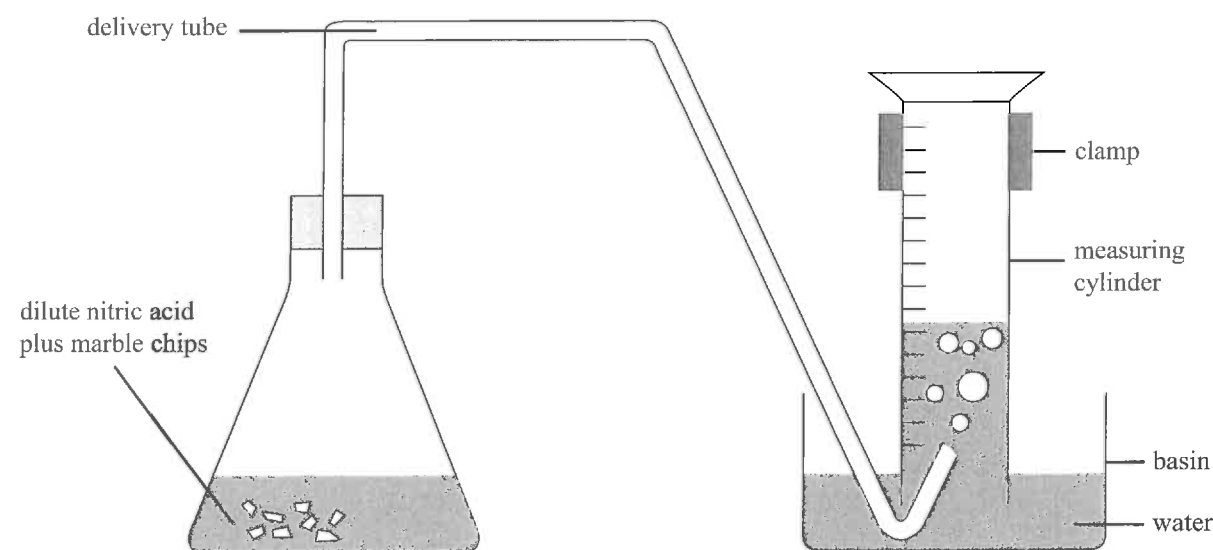
TOTAL

10

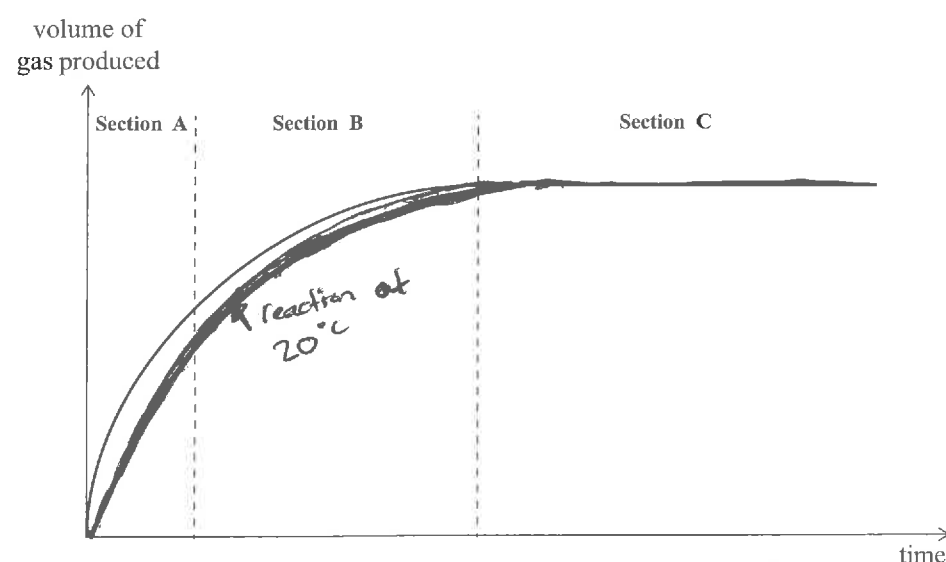
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QUESTION ONE

Marble chips (calcium carbonate) were added to ^{base}nitric acid in a conical flask. The temperature of the acid was 50°C . The flask was connected to an inverted measuring cylinder in a basin of water to measure the volume of gas produced, as shown in the diagram below.



The graph below shows the volume of gas produced against time.



- (a) Explain what is happening in terms of particle collisions and rate of reaction in **each** section of the graph.

Section A: In Section "a" there are more particle collisions because there is more particles. ~~There~~ Therefore the rate of reaction is higher because of more collisions.

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Section B: In Section "B" the rate of reaction starts to slow down because there are not as many particles, this makes more space for particles to move and less collisions.

Section C: Section "C" there are no collisions present because there is no gas produced over ~~quite~~ quite a long period of time

- (b) The reaction was carried out again but this time at 20°C . The mass and size of the marble chips, and the concentration and volume of nitric acid used were kept the same.

- (i) Draw a line on the graph that represents the reaction at 20°C . ✓
(ii) Explain why you drew this line where you did, and explain if this means that the rate of reaction is slower, the same, or faster. ✓

In your answer you should

- discuss why you drew your line with the slope that you did, and why you stopped the line at the point that you did
- explain the effect of temperature on reaction rate, in terms of particle collisions.

I drew the line where I did because the temperature is 30°C lower than before, the particles will be moving slower which will slow down the reaction rate. I drew the line with that slope because the reaction is slower. I stopped the line where I did because I thought that it would continue a little longer than the previous 50°C experiment. When temperature is increased,

There is more space for your answer to this question on the following page.

the reaction rate is faster because the particles speed up, meaning more collisions.

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- (c) Write a word equation AND a balanced symbol equation for the reaction between nitric acid and calcium carbonate.

Word equation:

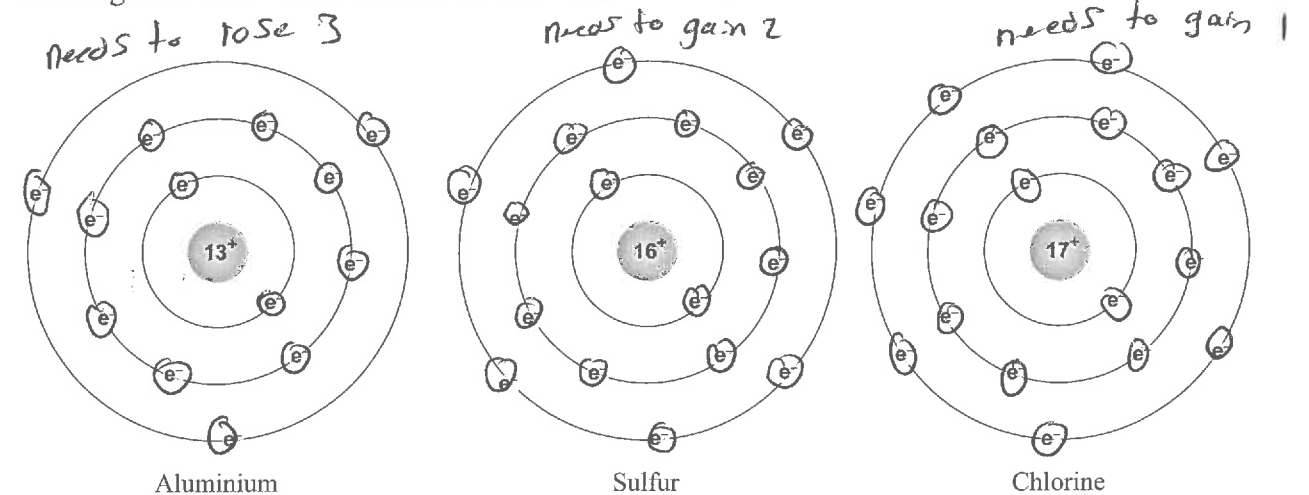
Nitric acid + calcium carbonate → Salt + water

Balanced symbol equation:



QUESTION TWO

The diagrams below show models of three different atoms.



- (a) Each of these atoms can form ions, as listed below.

- Explain why each of the **ions** has the charge it does, in terms of electron arrangement and number of protons.
- Ions are charged atoms. Explain how each of the ions below reached the charge shown. You should discuss particles gained or lost by the atoms involved, and the reasons for this.

Aluminium ion, Al^{3+} : Aluminium has a positive 3 charge, this is because to become stable it needs to lose 3 electrons from its outer (valence) shell.

Sulfide ion, S^{2-} : Sulfide has negative 2 charge because it needs to gain 2 electrons in its outer (valence) shell to become stable.

Chloride ion, Cl^- : Chloride has a negative charge because in order for it to become stable it needs to gain one electron in its outer shell.

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(b) Explain why an ionic bond would **not** form between a sulfide ion and a chloride ion.

In your answer you should:

- describe an ionic bond ✓
- refer to charges and electron arrangements of the ions involved.

An ionic bond is when two atoms exchange ions to become stable (with a full valance shell). An ionic bond would **not** form between a sulfide ion and a chloride ion because they are both negatively charged. In order for an ionic bond to happen, the atoms must be oppositely charged. For example, ~~chloride~~ Aluminium needs to gain 3 electrons ~~and~~ and chloride needs to lose one. If chloride gives Aluminium one electron, chloride will become stable. Then two more unstable chloride atoms give their one electron from each of their ~~shells~~ outer shells and Aluminium will be balanced.

(c) Determine the ionic formulae of the compound that forms when aluminium combines with chlorine, AND when aluminium combines with sulfur.

In your answer you should:

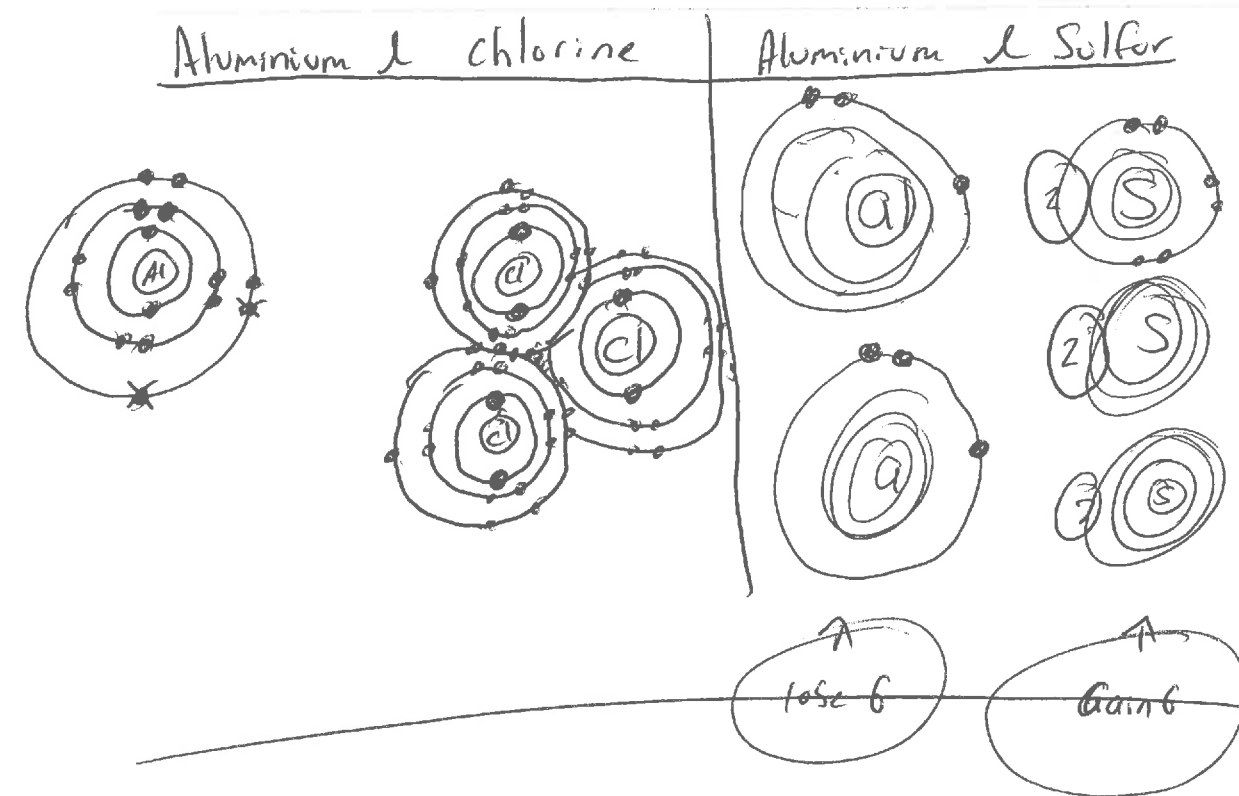
- consider the ratio of ions in each formula, and explain how the ratio is related to the charge on the ions
- relate the ratio of ions in each formula to the number of electrons lost or gained by each atom when forming ions.

Aluminium and chlorine: Aluminium needs to ~~gain~~ ^{lose} 3 electrons. Chlorine needs to ~~lose~~ ^{gain} one. If one chloride atom ~~gives~~ ^{gets} Aluminium's ~~the~~ electron from its valance shell, Chlorine will become balanced. Aluminium still needs to ~~lose~~ ^{gain} 2 electrons. If we add 2 more chloride atoms, they ~~give~~ ^{gain} Aluminium ~~the~~ 2 electron in the outer shell, then they are all stable. Each chloride atom would have ~~lost~~ ^{gained} 1 electron giving ~~them~~ ^{them} a negative charge, the Aluminium would have ~~gained~~ ^{lost} 3, giving it a ~~negative~~ ^{positive} 3 charge.

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Aluminium and sulfur:

Aluminium needs 3, Sulfur needs to ^{7 to lose} gain ~~lose~~ 2. If we get 2 Aluminium Atoms and 3 Sulfur atoms, each Sulfur atom ~~loses~~ ^{gains} 2 electrons ~~each~~ ^{and} the 2 aluminium atoms lose ~~gain~~ 3 each. This gives aluminium atoms a ~~positive~~ ^{negative} 3 charge and the sulfur atoms ~~positive~~ ^{negative} 2 charge.

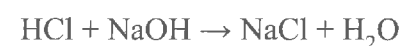


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A3

QUESTION THREE

The chemical equation below represents the reaction between hydrochloric acid and sodium hydroxide:



- (a) Complete the table below to show the approximate pH for each of the three solutions.

	Colour when UI is added	pH	
HCl	red	1	acidic
NaOH	purple	14	basic
H ₂ O	green	7	neutral

- (b) Water is formed in the reaction above.

Explain what ions form water in this reaction, and where they come from.

You may use an equation but this is not required.

Hydrogen ^{and} Oxygen. From Hydrochloric acid and Sodium hydroxide.

base

acid

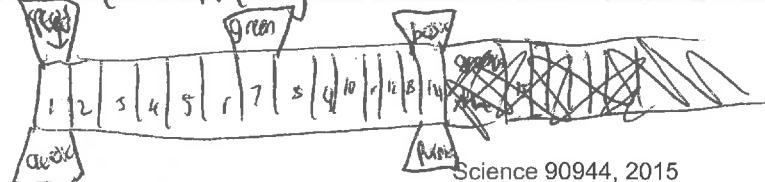
- (c) NaOH is gradually added to a solution of HCl with universal indicator present, until no further colour change occurs.

Discuss what is occurring in the beaker at each of the pH's shown, as the NaOH is added.

In your answer you should refer to:

- the colours that would occur at each pH
- the relative amounts of hydrogen and hydroxide present at each of the pH's shown.

pH = 1 (before any NaOH is added): The Solution will be red because at that present moment there is only acid therefore, acidic. This Solution has no hydroxide and mostly hydrogen.



pH = 4: The Solution will be yellow/orange (light orange) at this stage. It will be nearly neutral (green). This is because hydroxide (base) is added causing the solution to become less acidic.

pH = 7: The Solution is neutral. It is green. There is approximately an equal amount of acid and base (hydrogen and hydroxide) (hydrochloric acid and sodium hydroxide) in the solution.

pH = 10: The Solution will be blue, there is about 3/4 of the solution being a base (sodium hydroxide in the solution).

pH = 13: The Solution is a base. The colour is purple and none or very little acid (HCl) added. Strong base. ~~lots~~ lots of hydroxide.

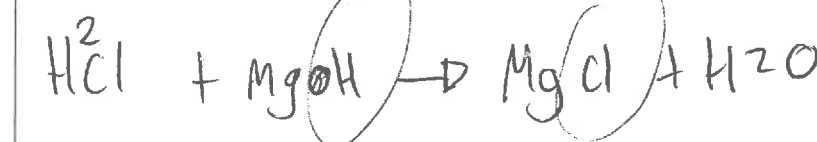
- (d) In a different chemical reaction, hydrochloric acid reacts with magnesium hydroxide.

Write a word equation and a balanced chemical equation for this reaction in the boxes below.

Word equation:

hydrochloric acid + magnesium hydroxide → Salt + water

Balanced symbol equation:



Achieved exemplar for 90944 2015			Total score	10
Q	Grade score	Annotation		
1	A4	<p>Candidate appreciated that the reaction occurred slower and finished at some point. These two points were indicated on the graph.</p> <p>Candidate also indicated that no gas was produced in section C as well as at lower temperatures particles will slow.</p> <p>To get to higher grades a correct symbol equation was required as well as an explanation as to why slower particle motion will cause a slower reaction.</p>		
2	A3	<p>This candidate only talked about electrons in an atom and did not mention protons in this atom or the ratio of protons to electrons.</p> <p>The candidate mentioned that the sulfide ion and chloride ion would not bond as they are both negative but said that opposite charged ions would form to become stable rather than neutral. An individual ion will form a stable ion but two ions will form neutral compounds.</p> <p>The drawing of the two compounds gave the marker some idea of ratios however there was no mention as to why and the lose 6 and gain 6 was not specific enough.</p>		
3	A3	<p>This candidate mentioned the correct pH of the correct colours in the table as well as the correct colours at pH= 4 and pH = 10.</p> <p>The candidate also mentioned pH= 7 being neutral.</p> <p>To get to a higher grade this candidate needed to appreciate that it is H⁺ ions and OH⁻ ions that form water and it is the ratio of these two ions that change the colour of UI.</p>		

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Achievement

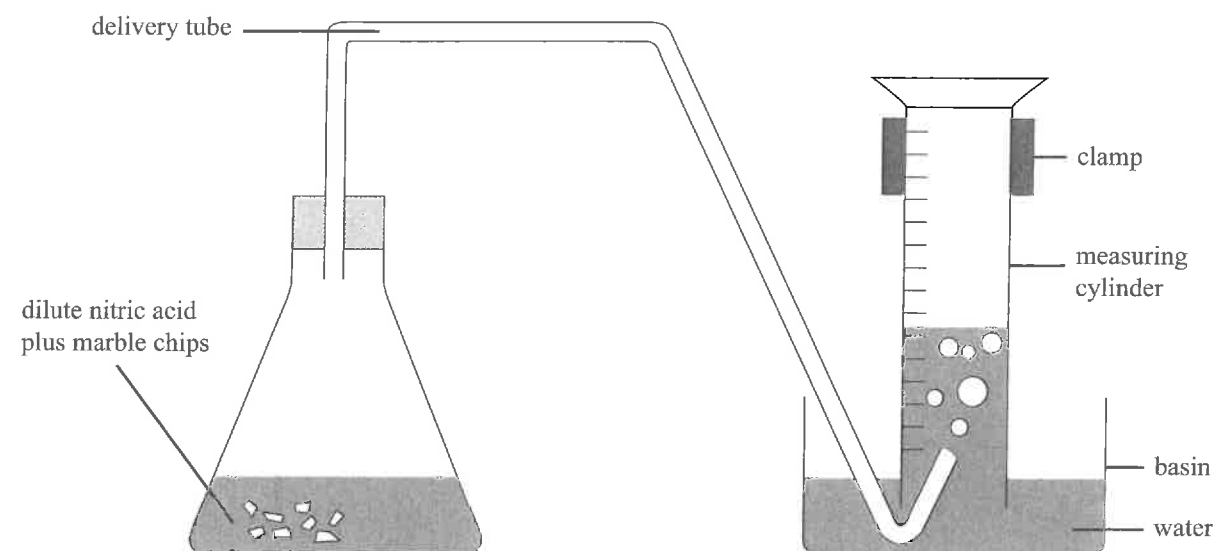
TOTAL

11

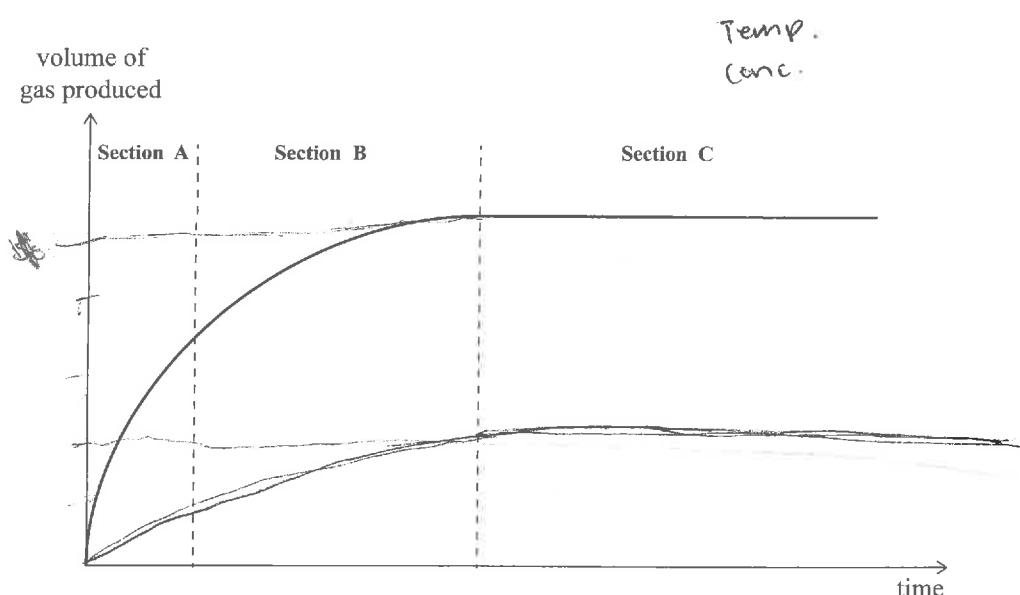
ASSESSOR'S USE ONLY

QUESTION ONE

Marble chips (calcium carbonate) were added to nitric acid in a conical flask. The temperature of the acid was 50°C . The flask was connected to an inverted measuring cylinder in a basin of water to measure the volume of gas produced, as shown in the diagram below.



The graph below shows the volume of gas produced against time.



- (a) Explain what is happening in terms of particle collisions and rate of reaction in **each** section of the graph.

Section A: In this section the heat is just starting up therefore there are not many particle collisions in the beginning but as the heat increases so does the collisions. Therefore the rate of reactions would be building up to fast.

Section B: In this section there are many particle collisions as the temperature is increasing. This means that the rate of reaction will be faster.

Section C: In this section not much is done. For a long period of time there is the same amount of gas produced. There wouldn't be an increase in particle collisions as the temperature is not rising and the concentration is the same throughout this section therefore the rate of reaction would be faster.

- (b) The reaction was carried out again but this time at 20°C . The mass and size of the marble chips, and the concentration and volume of nitric acid used were kept the same.
- Draw a line on the graph that represents the reaction at 20°C .
 - Explain why you drew this line where you did, and explain if this means that the rate of reaction is slower, the same, or faster.
- In your answer you should
- discuss why you drew your line with the slope that you did, and why you stopped the line at the point that you did
 - explain the effect of temperature on reaction rate, in terms of particle collisions.

Because the heat is not as high as the 50°C one I think the reaction rate would be slower but still fast. Like not really slow but enough so that there are a lot of particle collisions.

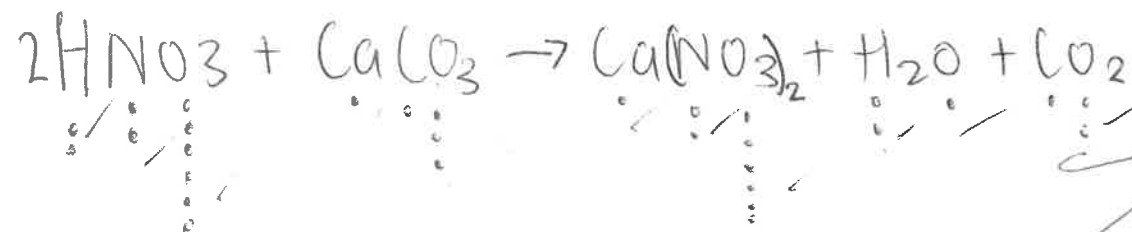
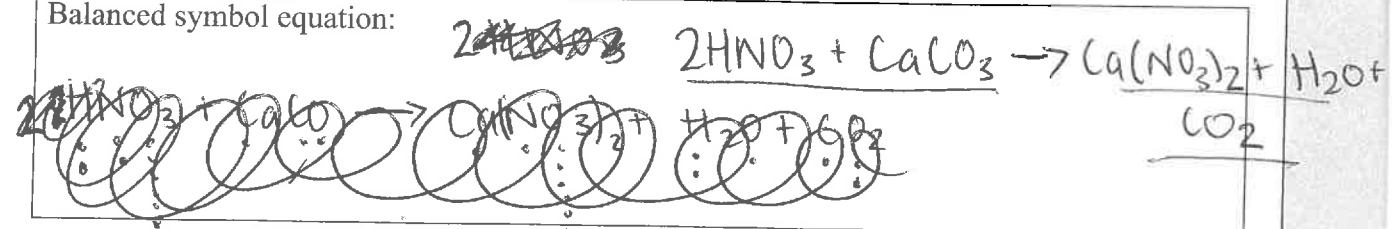
There is more space for your answer to this question on the following page.

- (c) Write a word equation AND a balanced symbol equation for the reaction between nitric acid and calcium carbonate.

Word equation:

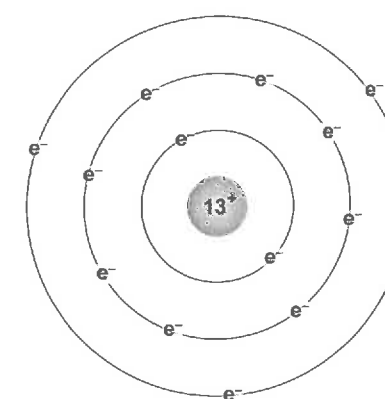
nitric acid + calcium carbonate \rightarrow calcium nitrate + water + carbon dioxide.

Balanced symbol equation:

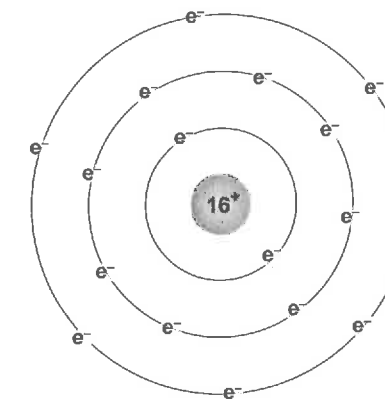


QUESTION TWO

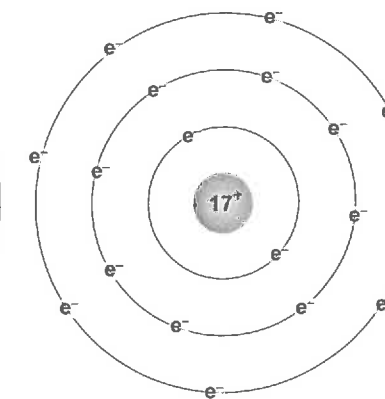
The diagrams below show models of three different atoms.



Aluminium



Sulfur



Chlorine

- (a) Each of these atoms can form ions, as listed below.

- Explain why each of the **ions** has the charge it does, in terms of electron arrangement and number of protons.
- Ions are charged atoms. Explain how each of the ions below reached the charge shown. You should discuss particles gained or lost by the atoms involved, and the reasons for this.

Aluminium ion, Al^{3+} : This ion has a charge of $3+$ because in order to have a full valence shell Aluminium has to lose 3 electrons making it a ion. Aluminium electron arrangement = 2, 8, 3. for Aluminium it is more energy efficient to lose 3 ions than to gain 5 more.

Sulfide ion, S^{2-} : Electron Arrangement = 2, 8, 6. It is more energy efficient for this atom to gain 2 electron rather than losing 6. This ion has a negative charge of $2-$, this is because it has gained 2 electrons making it an ion.

Chloride ion, Cl^- : Electron arrangement = 2, 8, 7. It is more energy efficient for chlorine to gain one electron than to lose 7 electrons. This ion has a negative charge of one as it has gained one electron in order for a full valence shell, making it an ion.

- (b) Explain why an ionic bond would **not** form between a sulfide ion and a chloride ion.

In your answer you should:

- describe an ionic bond
- refer to charges and electron arrangements of the ions involved.

An ionic bond is when 2 atoms can cancel each of its charges out. ~~is~~ for an ionic bond to happen out of the pair of atoms one has to be positively charged and one negatively charged. This is why the sulfide ion & chloride ion can not form an ionic bond as both ions are negatively charged. Both ions want to gain ions not lose them.

- (c) Determine the ionic formulae of the compound that forms when aluminium combines with chlorine, AND when aluminium combines with sulfur.

In your answer you should:

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

Aluminium and chlorine: $\text{Al}^{3+} + \text{Cl}^{-} \rightarrow \text{AlCl}_3$

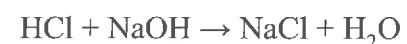
For every Aluminium you need 3 Chlorines to balance it out. Aluminium:Chlorine, 1:3
This ratio is related to the charge of ions as Aluminium ~~3~~ charge of 3^{+} has been given to the Chloride to symbolize that there are 3 chlorides ~~depending on how many~~. This is in order to have a full outer valence shell.

Aluminium and sulfur: $\text{Al}^{3+} + \text{S}^{2-} \rightarrow \text{Al}_2\text{S}_3$

For Aluminium and sulfur to balance out the ratio would be 2:3 Aluminium:Sulfur.
Al has a charge of 3^{+} while Sulfur has a charge of 2^{-} . These charges have become the amounts of each atom you would need to balance each other and to have a full valence shell.

QUESTION THREE

The chemical equation below represents the reaction between hydrochloric acid and sodium hydroxide:



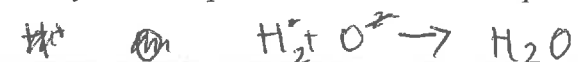
- (a) Complete the table below to show the approximate pH for each of the three solutions.

	Colour when UI is added	pH
HCl	red	1
NaOH	purple	14
H ₂ O	green	7

- (b) Water is formed in the reaction above.

Explain what ions form water in this reaction, and where they come from.

You may use an equation but this is not required.



Because oxygen has a negative charge of 2 and hydrogen has a charge of +. In order for them to be the same every oxygen needs two hydrogens this is taken from the oxygens charges. It cancels it out.

- (c) NaOH is gradually added to a solution of HCl with universal indicator present, until no further colour change occurs.

Discuss what is occurring in the beaker at each of the pH's shown, as the NaOH is added.

In your answer you should refer to:

- the colours that would occur at each pH
- the relative amounts of hydrogen and hydroxide present at each of the pH's shown.

pH = 1 (before any NaOH is added): The ~~red~~ colour would be red as it is acidic. There is only hydrogen ions present.

pH = 4: This colour would be an orange-yellow colour as it is still acidic but very weak. There are still more hydrogen ions present but there are some hydroxide ions present as well.

pH = 7: This is neutral and is the colour green. This is when both base and acid are at a neutral state. This means that there is an equal amount of hydrogen & hydroxide ions present.

pH = 10: This colour would be blue. It is now a ~~base~~ base but ~~very~~ weak one.

There are more hydroxide ions present but there are still hydrogen ions present.

pH = 13: This would be a ~~purple~~ dark blue-purple colour. There are ~~are~~ heaps of hydroxide ions with only 1 or 2 hydrogen ions. This is because it is such a strong base.

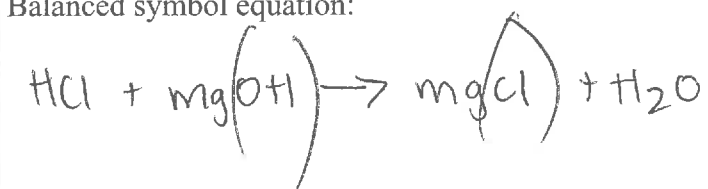
- (d) In a different chemical reaction, hydrochloric acid reacts with magnesium hydroxide.

Write a word equation and a balanced chemical equation for this reaction in the boxes below.

Word equation:

hydrochloric acid + magnesium hydroxide \rightarrow magnesium chloride + water

Balanced symbol equation:



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Q	Grade score	Annotation		
1	A3	<p>Candidate appreciated that the reaction occurred slower and finished at some point.</p> <p>There is also a correct symbol equation and a word equation.</p> <p>This candidate misinterpreted this graph and confused the amount of gas produced up the y-axis and talked about a change in temperature as if this experiment was gradually being heated up rather than producing gas. In Section C they talked about the same amount of gas being produced rather than no gas being produced. In this Section the reaction has completely stopped.</p>		
2	A4	<p>The candidate only talked about electrons in an atom and did not mention protons in this atom or the ratio of protons to electrons.</p> <p>The candidate talked about ionic bonds being formed by positively and negatively charged ions but they did not relate this understanding to the sulphide ion and chloride ion as asked for in the question.</p> <p>The formula for aluminium chloride and aluminium sulfide were correctly written but no explanation as to why they are formed was given. This explanation would have taken this candidate to the next level.</p>		
3	A4	<p>This candidate mentioned the correct pH in the table as well as the correct colours at pH= 4 and pH = 10.</p> <p>Added to the above the mention of pH= 7 being neutral as well as a correct word equation gained this candidate an A4.</p> <p>To get to a higher grade this candidate needed to appreciate that it is H⁺ ions and OH⁻ ions that form water and that both these ions are present in solutions of pH = 1 through to pH = 13 but just at differing concentrations.</p>		