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90944



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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.

Excellence

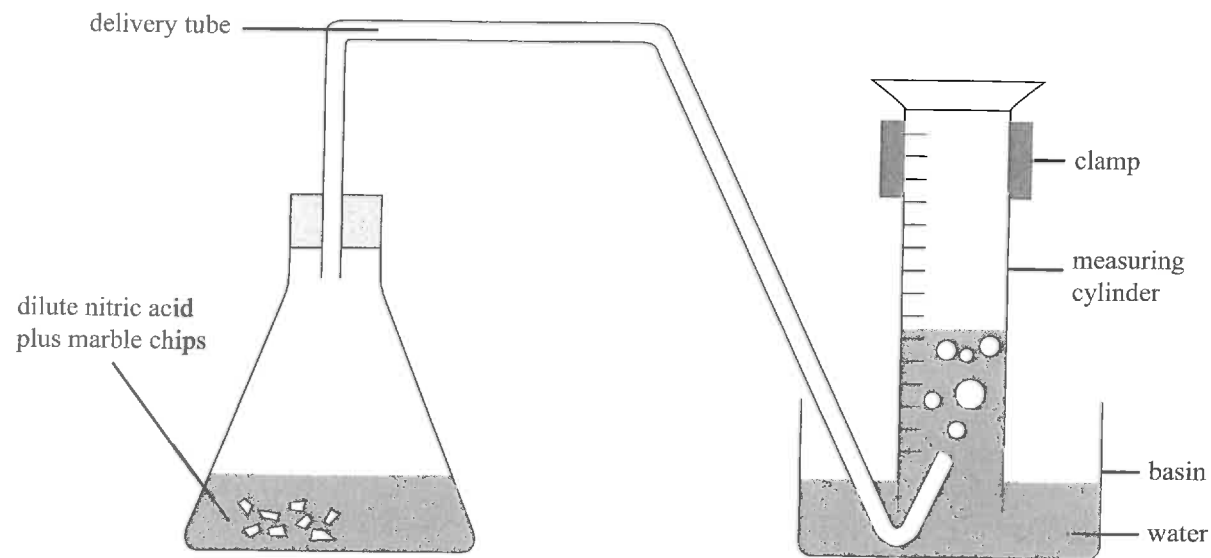
TOTAL

20

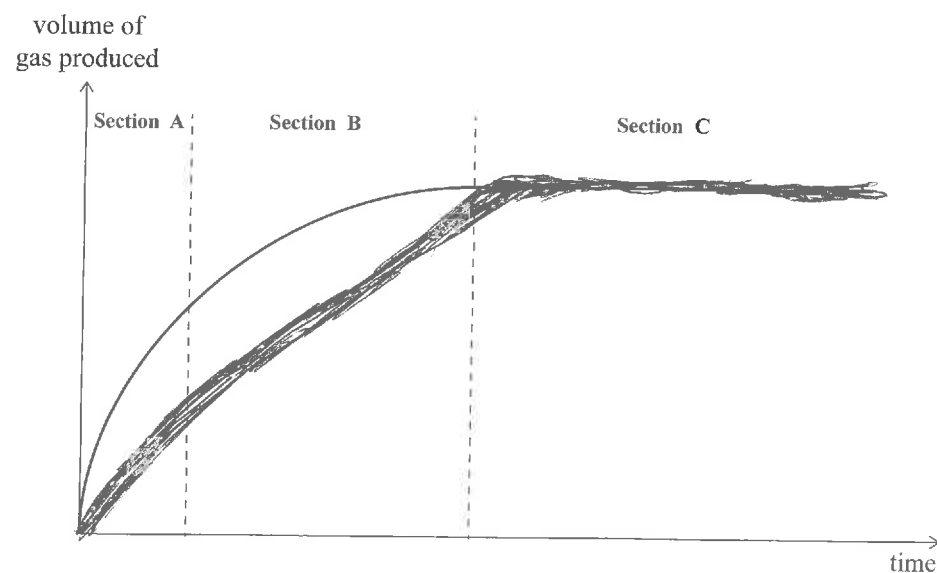
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QUESTION ONE

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: The volume of gas produced is rapidly increasing as the temperature of the acid means that each reactant particle has increased kinetic energy & is therefore moving quickly meaning that the frequency of collisions is high as lots of successful collisions are occurring per second as the particles are reaching activation energy easily & therefore the rate of reaction is high.

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Section B: The ratio of reactant particles to products is decreasing as many successful collisions have already occurred therefore the frequency of collisions has decreased & there are less successful collisions occurring per second, thus giving a decreasing rate of reaction, turning to a stop.

Section C: All reactant particles have reacted & made products so there are no reactant particles left & therefore no collisions occurring. The rate of reaction is 0 as no more reactions can/are occurring. The experiment was finished.

- (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.

The slope of the line is ^{less steep} shallower as the rate of reaction is less than in the first experiment. The line stops further down the graph (ie to the right) as it takes longer to finish the reaction when the temperature & rate of reaction is lower. This is because when you increase the temperature, you increase the amount of kinetic energy each reactant

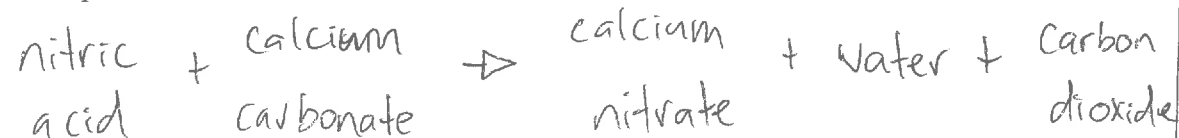
There is more space for your answer to this question on the following page.

4 reactant
 particle has $\$$ therefore the \uparrow particles are moving quicker. This increases the frequency of collisions. As the particles are moving quicker when they collide, it also means that they reach activation energy required for a successful collision more often $\&$ therefore the frequency of successful collisions increases also thus increasing the rate of reaction

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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:



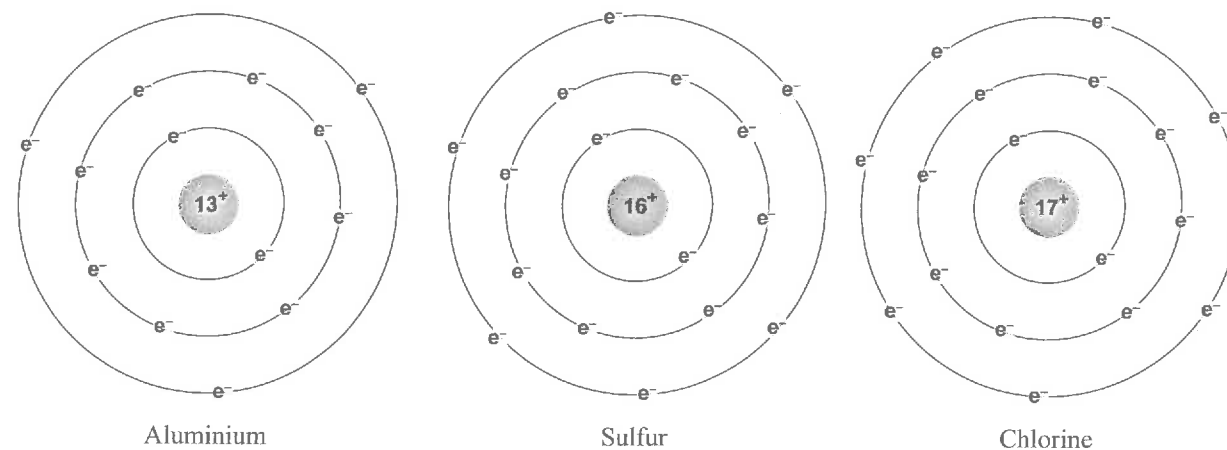
Balanced symbol equation:



E7

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+} : has charge of $3+$ as aluminium has electron arrangement of 2, 8, 3 \therefore to become an ion (complete $\&$ stabilise its valence shell) it needs to lose 3 electrons. ~~Aluminium has~~ 13 protons (positive charge) $\&$ (13-3) 10 electrons (negative charge) = 13-10 = +3 the charge of aluminium ion

Sulfide ion, S^{2-} : has charge of $2-$ as sulfur has electron arrangement of 2, 8, 6 \therefore to complete $\&$ stabilise its valence shell (become an ion) it needs to gain 2 electrons. 16 protons (positive charge) $\&$ (16+2) 18 negatively charged electrons = 16-18 = -2 thus the sulfide ion

Chloride ion, Cl^- : has charge of -1 as chlorine has electron arrangement of 2, 8, 7 \therefore to become an ion $\&$ complete $\&$ stabilise its valence shell it needs to gain 1 electron. 17 positively charged protons $\&$ (17+1) 18 negatively charged electrons = 17-18 = -1 thus the charge of Cl^-

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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 a metal & a nonmetal bonding due to their electrostatic attraction eg. positive charge to a negative charge. ~~Sulfide & chloride~~ Sulfide & chloride both have negative charges due to their electron arrangements. Sulfur: 2, 8, 6 & sulfide:

^{-2 charge} 2, 8, 8. Chlorine: 2, 8, 7 & chloride 2, 8, 8. charge meaning that both atoms have gained electrons to become ions (stable) (complete valence shell) & therefore both have negative charges & don't have an electrostatic attraction, they repel each other.

(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:

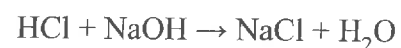
- consider the ratio of ions in each formula, and explain how the ratio is related to the charge on the ions
- relate the ratio of ions in each formula to the number of electrons lost or gained by each atom when forming ions.

Aluminium and chlorine: Aluminium has electron arrangement of 2, 8, 3 so to complete its valence shell & become an ion it wants to lose 3 electrons. Chlorine has electron arrangement of 2, 8, 7 & wants to gain 1 electron to become an ion (be stable). The formula for aluminium chloride is $AlCl_3$ meaning that there are 3 chlorides for every aluminium ion. This is because having 3 chlorines means there will be (3×1) 3 electrons ~~that~~ spaces that it wants to fill - that the aluminium with 3 valence electrons will provide (charge of Al^{3+})

Aluminium and sulfur: Again, aluminium has electron arrangement of 2, 8, 3 & in order to become an ion ^{& be stable} it loses these 3 (3+ charge) sulfur has electron arrangement of 2, 8, 6 & wants to gain 2 electrons in order to complete & stabilize its valence shell (-2 charge) the formula for aluminium sulfide is Al_2S_3 meaning that there are 2 aluminium ions for every 3 sulfides. This is because having 2 aluminiums means there are (3×2) 6 valence electrons it wants to get rid of yet sulfur only has 2 spaces so having 3 sulfides means that there would be (2×3) 6 spaces for electrons, that the 6 from aluminium would provide ion

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.

As the Cl from HCl & the Na from NaOH form sodium chloride, it leaves behind the H from HCl & OH from NaOH these 2 ions form water - $\text{H} + \text{OH} = \text{H}_2\text{O}$

- (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): It is a strong acid & would show red meaning that there would be a large excess of hydrogen ions (& no hydroxides)

pH = 4: Neutralisation is occurring. the colour would be orange-yellow reflecting a ~~weak~~ ^{moderate} acid. Hydroxide ions are present but there is still an excess of hydrogen ions.

pH = 7: The solution is neutral - colour green & hydrogen ions = hydroxide ions.

pH = 10: The solution is a ~~weak~~ moderate base, colour blue. An excess of hydroxide ions (hydrogen ions present.) The neutralisation has gone past neutral (pH 7) to pH 10.

pH = 13: The solution is a strong base - colour purple. Large excess of hydroxide ions (few hydrogen ions)

- (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 → magnesium chloride + water

Balanced symbol equation:



Achieved with Excellence exemplar for 90944 2015		Total score	20
Q	Grade score	Annotation	
1	E7	<p>This candidate appreciated that the reaction occurred slower and finished at the same point as the reaction at a higher temperature. These two points were indicated on the graph.</p> <p>They could explain that as one or both of the reactant particles are becoming used up (in Section B) or completely used up (in Section C) the reaction slows and eventually stops.</p> <p>Both the word equation and symbol equation are correct</p> <p>This candidate explained that as the temperature is lowered the speed of particles decreases and hence the frequency of effective collisions.</p> <p>To obtain an E8 they needed to mention that both graphs end up at the same point because you start with the same number of reaction particles it is just the temperature that has changed.</p>	
2	M6	<p>This candidate discussed the ratio of negative electrons to positive protons to give an ion that is both charged with a full valence shell and stable, and a good discussion of the formation of an ionic bond and why the sulfide and chloride ions do not bond.</p> <p>The ratio of the two compounds in part (c) had started with ideas of ratio and formula. What was needed was the idea that these ratios of electrons were exchanged to form a neutral compound. This stopped this student getting excellence for this question.</p>	
3	E7	<p>All three pH's were correct in the table</p> <p>The discussion of the formation of water from hydrogen ions and hydroxide ions was good.</p> <p>The formula equation is correct.</p> <p>This candidate mentioned that H⁺ ions and OH⁻ are in differing concentrations in solutions of pH = 4 through to pH = 10 is missing. Stating that there are no hydroxide ions present at pH= 1 stopped this candidate getting to an E8 for this question.</p>	