CHEMISTRY
STAGE 2 SAMPLE EXAMINATION

Section 7 of the New WACE Manual: General Information 2006–2009 outlines the policy on WACE examinations.

Further information about the WACE Examinations policy can be accessed from the Curriculum Council website at http://newwace.curriculum.wa.edu.au/pages/about_wace_manual.asp.

The purpose for providing a sample examination is to provide teachers with an example of how the course will be examined. Further finetuning will be made to this sample in 2008 by the examination panel following consultation with teachers, measurement specialists and advice from the Assessment, Review and Moderation (ARM) panel.

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Question/Answer Booklet

CHEMISTRY
STAGE 2

Please place your student identification label in this box

Student Number: In figures

In words _____

_____

Time allowed for this paper
Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Material required/recommended for this paper

To be provided by the supervisor
Question/answer booklet
Separate multiple choice answer sheet
Data sheet

To be provided by the candidate
Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter
Special items: Scientific calculator

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

This paper is for students who have completed Units 2A and 2B.

Structure of this paper

Section	Suggested working time	Number of questions available	Number of questions to be attempted	% of paper	Marks
ONE Multiple choice	50 minutes	25	25	25	50
TWO	130 minutes	16	15	75	140

	Total marks	215

Instructions to candidates

1. The rules for the conduct of Curriculum Council examinations are detailed in the *Student Information Handbook*. Sitting this examination implies that you agree to abide by these rules.

2. Answer the questions according to the following instructions.
    Section One Answer **ALL** questions in the separate multiple choice answer sheet provided.
    Section Two Answer **ALL** questions in the spaces provided in this Question/Answer Booklet.

3. A blue or black ball point or ink pen should be used.

4. For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be ions, molecules or solids.

SECTION ONE—MULTIPLE CHOICE [*50 marks*]

This section has **TWENTY FIVE** questions. Attempt **ALL** questions.

A SEPARATE multiple choice answer sheet is provided for you to answer questions in this section. Use a **2B, B or HB** pencil for all entries. For each question, shade the box which indicates your answer.

Allow approximately 50 minutes for this section.

Question 1
Which one of the following is an observation?

a) Melting and sublimation are physical changes.
b) When sodium carbonate reacts with dilute hydrochloric acid solution carbon dioxide gas is produced.
c) Water boiling at $100^{o}C$ at 101.3 kPa.
d) A substance melts at $0^{o}C$, therefore it must be water.

Question 2
Which one of the following processes, on completion, would result in the formation of a heterogeneous system?

a) Neutralisation of sodium hydroxide solution with hydrochloric acid solution.
b) Formation of the alloy bronze by mixing molten tin and copper.
c) Addition of powdered zinc metal to nitric acid.
d) Addition of silver nitrate solution to sea water.

Question 3
A liquid is placed in a dish and evaporated by directing air from a fan over it. As the liquid evaporates, which one of the following occurs?

a) The kinetic energy of the remaining molecules in the liquid increases.
b) The rate of collision between the remaining molecules in the liquid increases.
c) The average velocity of the remaining molecules in the liquid decreases.
d) The temperature of the remaining liquid increases.

Question 4
Which one of the following characteristics does **not** apply to solutions?

a) They are homogeneous mixtures.
b) They contain two or more substances.
c) They have variable composition.
d) They have two or more phases present.

Question 5
Which one of the following statements is **not** one of the assumptions of the kinetic theory of gases?

a) All collisions are perfectly elastic.
b) All gases occupy 22.4 L at STP.
c) The average kinetic energy of all gases is the same at the same temperature.
d) There are no forces of attraction or repulsion between gas particles.

SEE NEXT PAGE

Question 6

When 0.1 mol L^{-1} aqueous solutions of the substances in each of the following pairs are mixed, in which case will a precipitate **not** form?

    a) $NaCl$ and $Ba(NO_3)_2$
    b) $CaCl_2$ and K_2CO_3
    c) KI and $Pb(NO_3)_2$
    d) $MgCl_2$ and $NaOH$

Question 7

Which one of the following may have 19 protons, 20 neutrons and 19 electrons?

    a) K
    b) Sr
    c) Y
    d) Ca^+

Question 8

Which one of the following is the electron configuration of N^{3-}?

    a) 2, 2
    b) 2, 5
    c) 2, 8
    d) 2, 8, 3

Question 9

Which one of the following solids has the highest electrical conductivity?

    a) Graphite (C)
    b) Sulfur (S)
    c) Sodium sulfate (Na_2SO_4)
    d) Silica (SiO_2)

Question 10

Which one of the following statements best describes a covalent bond?

    a) The atoms have a noble gas configuration.
    b) The atoms have formed an infinite network.
    c) One of the atoms involved in the bond is a metal and the other is a non-metal.
   d) There is simultaneous attraction of both nuclei to a shared electron pair.

Question 11

Which one of the following equations represents as an endothermic reaction?

    a) $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(\ell)$ + energy
    b) $NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$ ΔH = -ve
    c) $H_2O(\ell)$ + energy $\rightarrow H_2O(g)$
    d) $H_2O(\ell) \rightarrow H_2O(s)$ + energy

SEE NEXT PAGE

Question 12
Consider the following potential energy diagram for a chemical reaction.

Reaction Coordinate
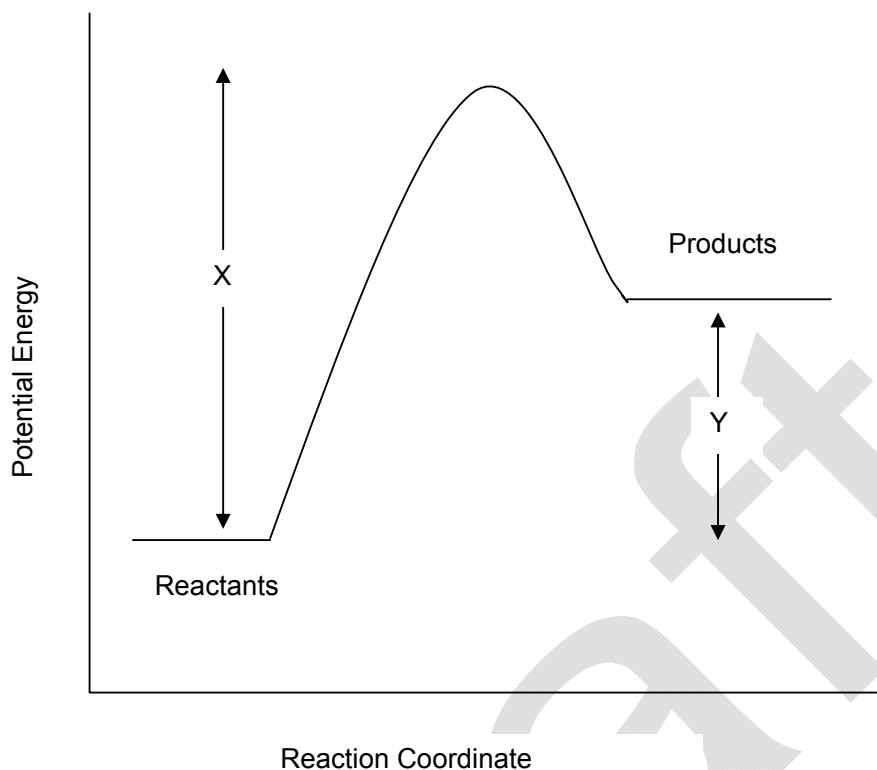
Which one of the following statements about this reaction is **incorrect**?

    a) The reaction mixture will become hotter as the reaction proceeds.
    b) The activation energy for the reverse reaction is X – Y.
    c) The ΔH for the reverse reaction is –Y.
    d) The forward reaction rate is likely to be slower than the reverse reaction rate.

Question 13
Which one of the following statements about the transition state in a chemical reaction is **false**?

    a) The transition state corresponds to a point where bond breaking and bond forming is occurring.
    b) The transition state is the highest energy state in the reaction.
    c) The transition state is unstable and will only exist for a short period of time.
    d) The transition state will be the same for a reaction whether a catalyst is used or not.

Question 14
Which one of the following substances will have the highest melting point?

    a) carbon dioxide
    b) nitrogen dioxide
    c) silicon dioxide
    d) sulfur dioxide

SEE NEXT PAGE

Question 15
Which one of the following will give an acidic solution when dissolved in water?

    a) SO_2
    b) Al_2O_3
    c) $NaCl$
    d) N_2

Question 16
Which one of the following would **not** allow you to clearly distinguish between an acidic solution and a basic solution?

    a) Using a pH meter.
    b) Testing the conductivity of the solutions metal.
    c) Adding a piece of magnesium.
    d) Adding Universal indicator.
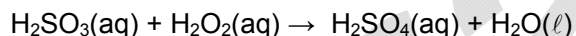
Question 17
Which one of the following equations does **not** represent the donation and acceptance of protons?

    a) $2H^+(aq) + 2e^- \rightleftharpoons H_2(aq)$
    b) $H^+(aq) + OH^-(aq) \rightleftharpoons H_2O(\ell)$
    c) $H_2O_2(aq) + OH^-(aq) \rightleftharpoons HO_2^-(aq) + H_2O(\ell)$
    d) $H_2C_2O_4(aq) + CO_3^{2-}(aq) \rightleftharpoons HC_2O_4^-(aq) + HCO_3^-(aq)$

Question 18
For the following equation:

$$H_2SO_3(aq) + H_2O_2(aq) \rightarrow H_2SO_4(aq) + H_2O(\ell)$$

Which one of the following statements is **true**?

    a) Hydrogen peroxide is acting as an acid.
    b) Hydrogen peroxide is acting as an acid and a base.
    c) Hydrogen peroxide is acting as an oxidising agent only.
    d) Hydrogen peroxide is acting as an oxidising and reducing agent.

Question 19
When the pH of a 0.01 mol L^{-1} solution of sulfuric acid is measured it is found to be significantly lower than the pH of a 0.01 mol L^{-1} solution of phosphoric acid. What is the reason for this?

    a) Phosphoric acid is a triprotic acid, while sulfuric acid is only diprotic, therefore the concentration of hydrogen ions is higher in the phosphoric acid solution than in the sulfuric acid solution.
    b) Phosphoric acid is a stronger acid than sulfuric acid, so the phosphoric acid is more likely to produce hydrogen ions in solution than the sulfuric acid.
    c) The sulfuric acid solution is weaker than the phosphoric acid solution, therefore there will be less hydrogen ions in the sulfuric acid solution than the phosphoric acid solution.
    d) Sulfuric acid is a stronger acid than phosphoric acid, so there are more hydrogen ions in the sulfuric acid solution than the phosphoric acid solution.
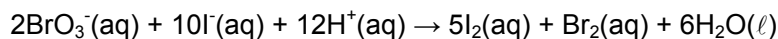
Question 20
In which one of the following does manganese have an oxidation state of +6?

    a) Mn_2O_3
    b) MnO_2
    c) MnO_4^{2-}
    d) MnO_4^-

SEE NEXT PAGE

Question 21

Which one of the following species is being oxidised?

$$2BrO_3^-(aq) + 10I^-(aq) + 12H^+(aq) \rightarrow 5I_2(aq) + Br_2(aq) + 6H_2O(\ell)$$

a) BrO_3^-
b) I^-
c) H^+
d) I_2

Question 22

Which one of the following reactions does **not** represent an oxidation-reduction reaction?

a) $2MnO_4^-(aq)+ 2H_2O(\ell) + 3C_2O4_2^-(aq) \rightarrow 2MnO_2(aq) + 6CO_3^{2-}(aq) + 4H^+(aq)$
b) $Cr_2O_7^{2-}(aq) + H_2O(\ell) \rightarrow 2CrO_4^{2-}(aq) + 2H^+(aq)$
c) $2Br_2(aq) + N_2H_5^+(aq) \rightarrow N_2(g) + 5H^+(aq) + 4Br^-(aq)$
d) $6I^-(aq) + 14H^+(aq) + Cr_2O_7^{2-}(aq) \rightarrow 3I_2(aq) + 7H_2O(\ell) + 2Cr^{3+}(aq)$

Question 23

Which one of the following compounds will have geometric (cis/trans) isomers?

a) 1, 1-dichloroethane
b) 1, 2-dichloroethane
c) 1, 1-dichloroethene
d) 1, 2-dichloroethene

Question 24
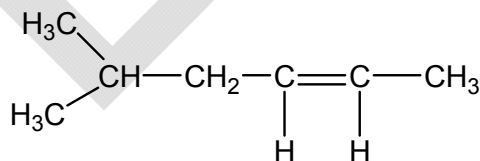
What types of reactions will butane undergo?

I   Substitution
II   Addition
III   Combustion

a) I only
b) I and II only
c) I and III only
d) I, II and III

Question 25

What is the correct name for the following formula?

a) cis-5-methyl-2-hexene
b) trans-5-methyl-2-hexene
c) 5, 5-dimethyl-2-pentene
d) cis-1, 1-dimethly-3-hexene

END OF SECTION ONE

SECTION TWO   *[140 marks]*

This section has 16 questions. Attempt **ALL** questions in the spaces provided below.

Any calculations are to be set out in detail. Marks will be awarded for correct equations and clear setting out, even if you cannot complete the calculation. Express numerical answers to three (3) significant figures and provide units where appropriate.

Information which may be necessary to answer questions is located on the separate Chemistry data sheet.

Allow approximately 130 minutes for this section
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Question 1   *[6 marks]*

For each of the following, describe briefly a test and an observation by which you could distinguish between the substances listed. You must indicate which of the two substances tested gives rise to the observation. No equations are necessary.

    a) Sodium nitrate solution and sodium sulfate solution.   *[2 marks]*

Test: _____

Observation:_____

    _____

    b) Solid magnesium hydrogencarbonate and solid lead(II) sulfate.   *[2 marks]*

Test: _____

Observation: _____

    _____

    _____

    c) Hexane and 1-hexene.   *[2 marks]*

Test: _____

Observation: _____

    _____

SEE NEXT PAGE

Question 2 *[2 marks]*

Vitamin C is a water soluble vitamin that helps the body in fighting infection. Humans cannot produce this vitamin and it is best obtained from fruits and vegetables in their diet. The results of an analysis of vitamin C showed that it has an empirical formula of $C_3H_4O_3$ and an approximate formula mass of 180.

Use this information to determine the molecular formula of Vitamin C.

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Question 3 *[8 marks]*

Complete the table below by identifying by name a substance found around the home that exhibits the bonding type indicated. Describe its use and the related property.
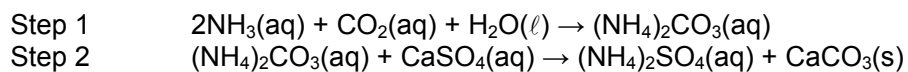
[Each answer is worth one (1) mark]

| Bonding type	Name	Use and related property
Metallic		
Covalent Molecular		
Ionic		
Covalent network		

Question 4 *[8 marks]*

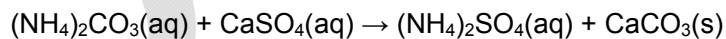Ammonium sulfate can be produced using a two-step process that can be represented by the following reactions:

Step 1 $2NH_3(aq) + CO_2(aq) + H_2O(\ell) \rightarrow (NH_4)_2CO_3(aq)$
Step 2 $(NH_4)_2CO_3(aq) + CaSO_4(aq) \rightarrow (NH_4)_2SO_4(aq) + CaCO_3(s)$

In step one, excess carbon dioxide gas is bubbled through 520.0 mL of a 0.225 mol L^{-1} solution of ammonia.

$$2NH_3(aq) + CO_2(aq) + H_2O(\ell) \rightarrow (NH_4)_2CO_3(aq)$$
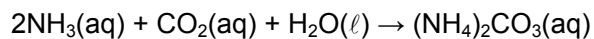
(a) Assuming the volume of the solution does not change, what will be the concentration of ammonium carbonate produced?

[5 marks]

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(b) In step two, excess calcium sulfate solution is then added to the ammonium carbonate solution. What mass of ammonium sulfate will be produced?

$$(NH_4)_2CO_3(aq) + CaSO_4(aq) \rightarrow (NH_4)_2SO_4(aq) + CaCO_3(s)$$

[3 marks]

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SEE NEXT PAGE

Question 5 *[4 marks]*

Electrolysis is a process that can be used to produce metals from their compounds. In 1806, Sir Humphry Davy produced sodium metal for the first time through the electrolysis of molten sodium bromide.

The diagram below is a simplified representation of the type of electrolytic cell that Davy may have used to produce sodium metal. The electrodes were made out of platinum.
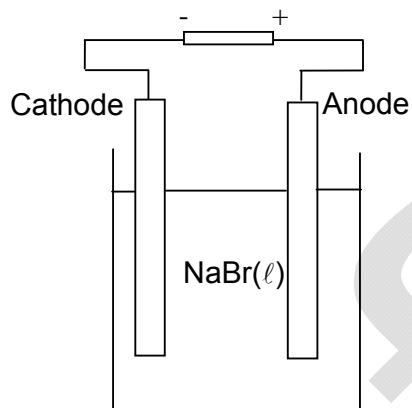
(a) Write a half equation to represent the formation of sodium at the cathode.

[2 marks]

(b) Write a half equation to represent the formation of bromine at the anode.

[2 marks]

Question 6   *[5 marks]*

Ethanoic acid (acetic acid) is the compound responsible for the sour taste and characteristic odour of vinegar. Vinegar can have a number of uses around the home. It can be used to remove the deposits left when tap water is boiled in kettles; it inhibits the growth of bacteria and so is used as a preservative. It is also used as flavouring in cooking and salad dressings.

Using the information above, and your knowledge of chemistry, answer the following questions.

(a) Acetic acid in the form of vinegar is suitable for human consumption. Suggest reasons why 0.1 mol L^{-1} acetic acid in vinegar can be consumed, but other acids such as 0.1 mol L^{-1} hydrochloric and 0.05 mol L^{-1} sulfuric acids are not.

[3 marks]

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(b) The most common deposit left in kettles is calcium carbonate. Write an equation to illustrate how acetic acid removes the calcium carbonate.

[2 marks]

Question 7 *[4 marks]*

A student was given a sample of butter, containing only saturated fats, and a polyunsaturated margarine. Both of these compounds have long hydrocarbon chains.

(a) What do the terms 'saturated' and 'unsaturated' mean in this context?
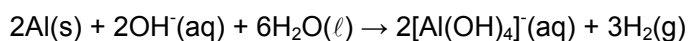
[2 marks]

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(b) Describe a simple chemical test that the student could use to determine which sample was the margarine. Include any relevant observations.

[2 marks]

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Question 8   *[11 marks]*

The reaction between aluminium metal and concentrated sodium hydroxide is often used to produce hydrogen gas to fill weather balloons. The reaction involved can be represented by the equation:

$$2Al(s) + 2OH^-(aq) + 6H_2O(\ell) \rightarrow 2[Al(OH)_4]^-(aq) + 3H_2(g)$$

(a) 452 g of aluminium was added to excess concentrated sodium hydroxide solution. What volume of hydrogen gas will be produced at S.T.P.?

[5 marks]

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(b) As the weather balloon rises, the external temperature and pressure will decrease. Describe and explain the effects these changes will have on the volume of the balloon.

[6 marks]

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Question 9   *[8 marks]*

The molecular formula for the hydrocarbon C_5H_{10} can be drawn a number of different ways. These different representations of the molecular formulae are called isomers. Draw four isomers for this compound, including two geometric isomers of an alkene and one cycloalkane isomer. You must name each isomer using IUPAC nomenclature.

[Each answer is worth two (2) marks.]

Structure	Name

Question 10　　　　　　　　　　　　　　　　　　　　　　　　*[4 marks]*

An unknown molecular compound consists of carbon, hydrogen and oxygen. Burning 5.27 g of the unknown compound produced 7.72 g of carbon dioxide and 3.16 g of water. Using this information determine the empirical formula ($C_xH_yO_z$) of the unknown compound.

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Question 11 *[10 marks]*

Hydrogen fluoride is often used to purify quartz, a mineral which is composed of SiO_2. It also has the ability to etch and corrode glass containing silicon dioxide. As a result, hydrogen fluoride cannot be stored in glass bottles. It is usually stored in plastic or metal containers.

The reaction between hydrogen fluoride and the silica in glass can be represented by the following equation:

$$4HF(\ell) + SiO_2(s) \rightarrow SiF_4(g) + 2H_2O(\ell)$$
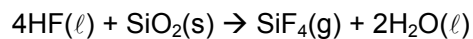
If 3.44 g of silicon dioxide was added to 24.5 g of liquid hydrogen fluoride, then:

(a) Determine the limiting reagent in the reaction. Justify your decision. *[4 marks]*

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(b) What mass of silicon tetrafluoride was produced? *[3 marks]*

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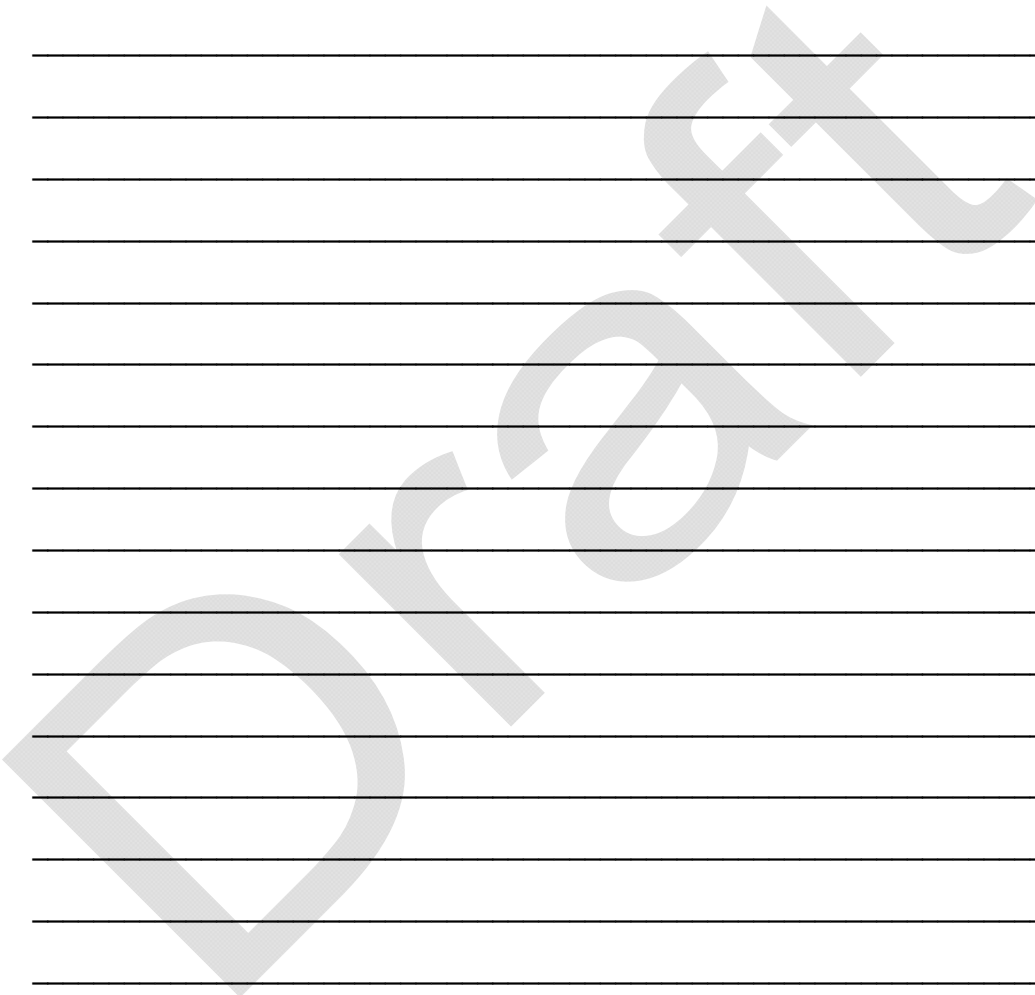
(c) What is the mass of the excess reagent after the reaction is complete? *[3 marks]*

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Question 12   *[10 marks]*

A student preparing a mixture of salts to make a fertiliser is given a white salt that is one of the following:

>   potassium ethanoate, potassium chloride or potassium carbonate.

From your knowledge of the solubility rules and reactions, describe what tests you could use to determine the identity of the salt. You must include any relevant observations and equations for each test in your answer. You may wish to use flow charts, tables etc. to represent your answer. The third unknown can be determined by the process of elimination.

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Question 13 *[16 marks]*

The process of growing crops often depletes the soil of elements that are vital for the production of healthy plants. Some of these important elements are nitrogen, potassium, phosphorous and sulfur. Nitrogen based fertilisers can be in the form of nitrate and ammonium salts.

Ammonia is a common starting point for the production of fertilisers. Ammonia is produced by the reaction between nitrogen gas and hydrogen gas. This reaction is exothermic but very slow at room temperature and pressure.

a) Write an equation to represent the reaction between nitrogen and hydrogen to produce ammonia, including a representation of heat of reaction.

[2 marks]

b) It is important that commercial chemical processes occur as rapidly as possible at a reasonable cost. Describe and explain in terms of your understanding of collision theory what methods could be used to speed up the rate of reaction between nitrogen and hydrogen. You must include diagrams/graphs in your answer where appropriate.

[10 marks]

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c) Ammonia can be injected directly into the soil to act as a fertiliser, but more often it is converted to other forms, such as ammonium nitrate, ammonium sulfate and ammonium hydrogenphosphate.

Ammonium sulfate can be produced by addition of ammonia to sulfuric acid.

Write an equation to represent the formation of ammonium sulfate.   *[2 marks]*

d) Draw an electron dot structure for ammonia.   *[2 marks]*

Question 14 *[13 marks]*

A student tested the conductivity of solutions of:
- (a) sodium hydroxide
- (b) acetic acid
- (c) sugar.

a) Draw a labelled diagram of the apparatus you would use to test the conductivity of the solutions.

[4 marks]

The student recorded the following observations.

Solution	Electrical conductivity
0.1 mol L^{-1} NaOH	Good
0.1 mol L^{-1} CH$_3$COOH	Moderate
0.1 mol L^{-1} C$_6$H$_{12}$O$_6$ (sugar)	Nil

b) Explain how an electrolyte is able to conduct an electric current.   *[2 marks]*

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c) Explain the observations that have been recorded in the table. Your answer should include equations that explain the differences in conductivity where appropriate.

[7 marks]

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Question 15 *[8 marks]*

Thermal conductivity is a measure of a substance's ability to conduct heat.

A company wishes to develop a new frying pan with a non-stick surface. They investigate the properties of a number of substances which are given in the table below. From this information and your understanding of bonding and structure, identify the materials you would use to make the base and handle of the frying pan. Explain your choices in detail.

handle

base

Substance	Thermal conductivity	Ductility	Non-stick properties	Cost
Teflon	Very poor	Poor	Excellent	Moderate
Diamond	Excellent	Poor	Good	High
Stainless steel	Moderate	Moderate	Moderate	Moderate
Aluminium	Good	Good	Moderate	Low
Copper	Good	Good	Moderate	Moderate
Silver	Good	Good	Moderate	High
Glass	Very poor	Poor	Poor	Low

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Question 16 *[23 marks]*

The South American bombardier beetle has an unusual way of dealing with predators. When threatened, it releases an explosive spray of a boiling hot corrosive liquid containing benzoquinone.

Inside the beetle there are two separate chambers; one containing a solution of hydroquinone and hydrogen peroxide, the other containing a mixture of two enzymes. Enzymes are biological catalysts.

When the beetle is attacked, the mixture of hydroquinone and hydrogen peroxide is released into the reaction chamber containing the enzymes. Exothermic reactions then occur to produce benzoquinone and oxygen which is released explosively as a hot spray from a gland on the tip of its abdomen.

The equations for the two reactions are given below.

(Equation 1)

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$
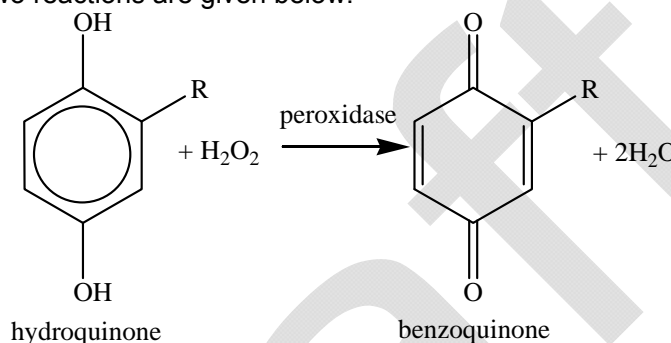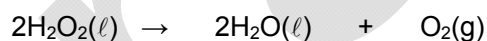
(Equation 2)

(a) Explain in terms of the equations shown above why the spray released from the gland of the bombardier beetle is hot. *[2 marks]*

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(b) Refer to Equation 2 to explain why the spray released from the gland of the bombardier beetle sprays out of the back of the beetle very rapidly. *[2 marks]*

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(c)   A student investigates the effect of the concentration of hydrogen peroxide on the rate of the decomposition reaction (equation 2) in the laboratory. She adds a solid catalyst to hydrogen peroxide solution and measures the rate at which oxygen is given off.

     i)   List TWO variables you would expect to control in this experiment.   *[2 marks]*

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     ii)   List ONE variable you **have to** measure and ONE other variable that you **could** measure to determine the rate of reaction.

[2 marks]

Variable you **have to** measure _____

Variable that you **could** measure _____

     iii)   Suggest an appropriate method for this experiment. You may include a diagram in your answer.
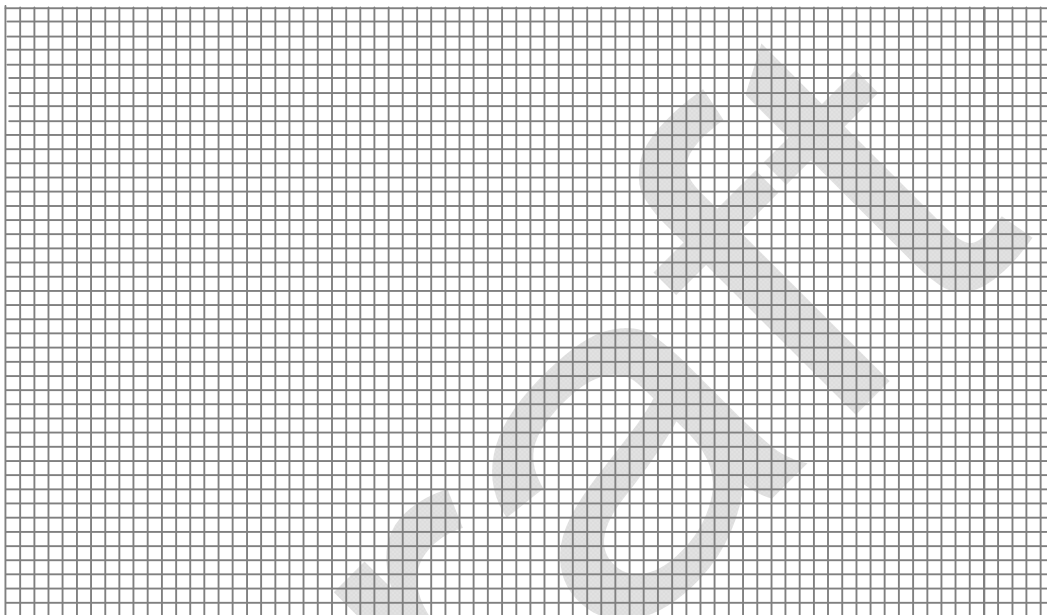
[5 marks]

iv) The table below shows the results of a series of experiments in which the initial rate of the reaction was found for different starting concentrations of hydrogen peroxide.

Hydrogen peroxide concentration (mol L^{-1})	Rate of decomposition (s^{-1})
0.05	0.13
0.10	0.27
0.15	0.41
0.20	0.53
0.25	0.75
0.35	0.94

Plot the data on the graph paper below.   *[5 marks]*

v) Based on the data above, write a conclusion for this experiment.   *[2 marks]*

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vi) Identify THREE potential sources of error in the experiment.   *[3 marks]*

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END OF PAPER

SEE NEXT PAGE

ACKNOWLEDGEMENTS