

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures									
Words									



**Victorian Certificate of Education
1998**

CHEMISTRY

Common Assessment Task 3: Written examination

Tuesday 10 November 1998: 9.00 am to 10.45 am

Reading time: 9.00 am to 9.15 am

Writing time: 9.15 am to 10.45 am

Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Number of questions</i>	<i>Number of questions to be answered</i>
8	8

Directions to students

Materials

Question and answer book of 13 pages with a detachable Data sheet in the centrefold.

Working space is provided throughout this book.

An approved calculator may be used.

The task

Detach the Data sheet from the centre of this book during reading time.

Please ensure that you write your **student number** in the space provided on this book.

Answer **all** questions. Questions should be answered in the spaces provided in this book. The marks allotted to each question are indicated at the end of the question. There is a total of 66 marks available.

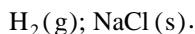
All written responses should be in English.

Instructions for students

There are 8 questions. Answer all questions.

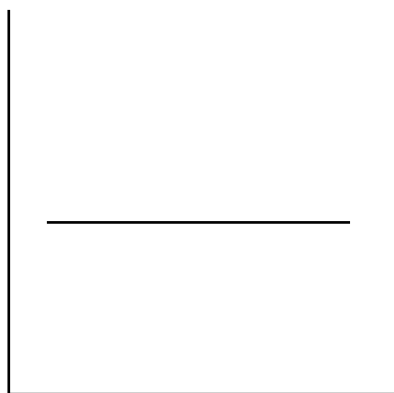
To obtain full credit for your responses, you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full credit
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working
- make sure chemical equations are balanced and that the formulas for individual substances include indications of state, for example

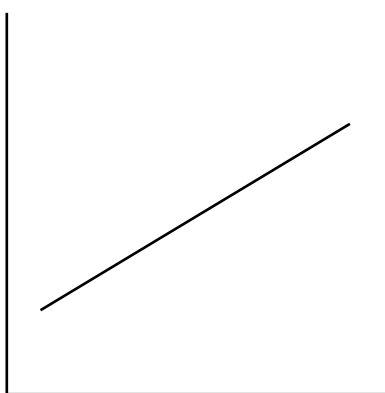


Question 1

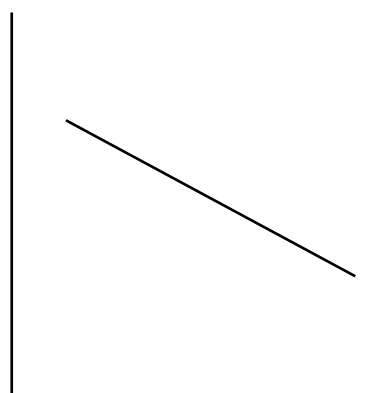
The following graphs show how certain atomic or ionic properties vary either within a period or within a group of the periodic table.



A



B



C

Select, from **A**, **B** and **C** above, the graph which would best represent the trend in each of the following.

- a. atomic radii from P to Na (P, Si, Al, Na) _____
- b. electronegativities from I to F (I, Br, Cl, F) _____
- c. number of electrons in the sequence Ca^{2+} , K^+ , Ar _____
- d. first ionisation energies from O to Ne (O, F, Ne) _____
- e. electronegativities from P to Na (P, Si, Al, Na) _____

Total 5 marks

Question 2

- a. Give the ground state electronic configurations of the atoms Mg and Co in terms of shells and subshells.

Mg _____

Co _____

2 marks

- b. i. Concentrated aqueous solutions of each of the following substances are prepared.



Some of the solutions are observed to be coloured while others are colourless. Circle the substances above that would give coloured solutions when dissolved in water.

- ii. Give the reason for your choices.

2 marks

- c. Solid magnesium chloride exists in a hydrated form of formula $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. The solid contains the hydrated ion $\text{Mg}(\text{H}_2\text{O})_6^{2+}$.

- i. Use a diagram to show the arrangement and orientation of the water molecules around the magnesium ion.

- ii. Describe the nature of the bonding that exists between the Mg^{2+} ion and the water molecules in hydrated magnesium chloride.

2 marks

Total 6 marks

TURN OVER

Question 3

- a. An element of period 3 can burn in oxygen at high temperatures to give an oxide. This oxide is insoluble in water but can react with concentrated aqueous solutions of both HCl and NaOH.

Name the element _____

Give the reason for your choice _____

Give the equation for the reaction with HCl(aq) _____

Give the equation for the reaction with NaOH(aq) _____

4 marks

- b. An element forms an ion of oxidation state +3. The electronic configuration of this ion is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$.

Name the element _____

The other common oxidation state of this element is _____

2 marks

- c. An element burns readily in oxygen to form an oxide of formula XO_2 . The percentage by mass of oxygen in the compound is 50%.

Name the element _____

Give the reason for your choice _____

Give the equation for the reaction of XO_2 with water _____

3 marks

- d. Gaseous fluorine, $F_2(g)$, is slightly soluble in water. A saturated solution of fluorine is prepared at room temperature and allowed to stand.

After a short time small bubbles appear in the solution and a gas is slowly evolved.

Name the gas evolved _____

Give the equation for the chemical reaction responsible for the formation of the gas

During the evolution of the gas, the pH of the solution will be observed to

rise

remain constant

fall

(Circle the correct response.)

3 marks

- e. A compound containing nitrogen is formed as a major end product of the human body's use of protein. It is very soluble in water.

Give the name of the compound _____

Give the formula of the compound _____

Explain the compound's high solubility in water.

3 marks

Total 15 marks

TURN OVER

Question 4

Two hikers have only 13 g of butane left in the gas bottle of their stove. They wish to boil water in a small kettle to make some coffee.

- a. Write an equation for the complete combustion of butane (C_4H_{10}) in oxygen.

2 marks

- b. Calculate the volume of water that can be raised to its boiling temperature with the 13 g of butane, on the following assumptions.

- The initial temperature of the water is 12 °C.
- One mole of butane releases 2886 kJ of heat when it is burned completely in air.
- It takes 4.20 J of energy to raise the temperature of 1.00 mL of water by 1 °C.
- 65% of the heat released by burning the butane is wasted and is unavailable for heating the water in their small kettle.

5 marks

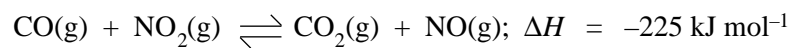
- c. Give two possible ways in which the heat of the burning butane is wasted so that it is unavailable for heating the water.

2 marks

Total 9 marks

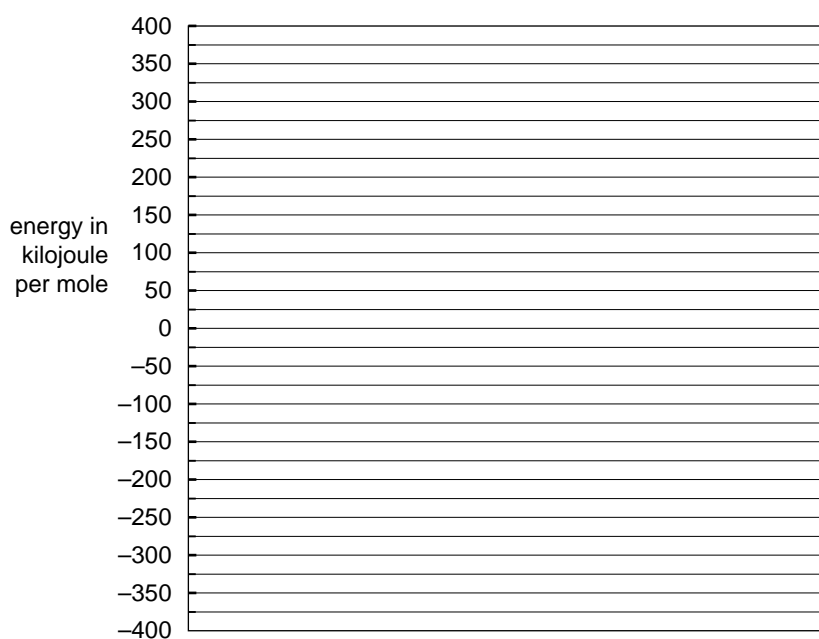
Question 5

Consider the reaction



The activation energy for the **reverse** reaction is $+350 \text{ kJ mol}^{-1}$. Taking the energy of the reactants $\{\text{CO(g)} + \text{NO}_2\text{(g)}\}$ as the zero of energy, mark and label on the diagram below

- i. the energies of the reactants and products
- ii. an uncatalysed reaction profile
- iii. a possible catalysed reaction profile.



reaction profile

Total 4 marks

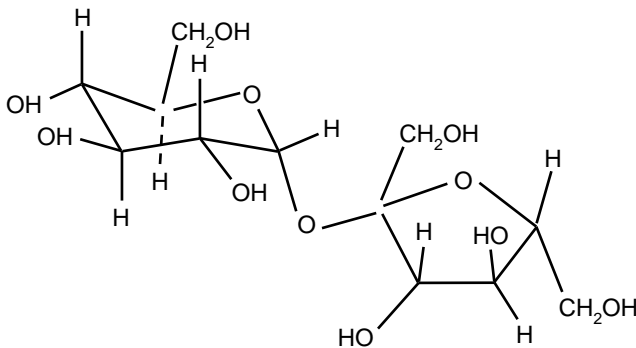
Working space

TURN OVER

Question 6

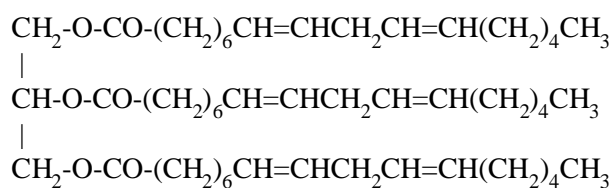
- a. Sucrose, $C_{12}H_{22}O_{11}$, is a disaccharide present in many foods. With the aid of the enzyme invertase, sucrose is hydrolysed into the monosaccharides fructose and glucose.

Complete the table below by giving the structural formulas of the products of the hydrolysis of sucrose.

sucrose structure	structures of hydrolysis products
	

2 marks

- b. The following structural formula represents a molecule of a lipid.



- i. During the digestion process this lipid undergoes **hydrolysis**. What is meant by the term 'hydrolysis'?

- ii. The products of the hydrolysis are a fatty acid and one other product. Give the name and structural formula of this other product.

3 marks

- c. If a solution of the enzyme invertase is boiled before mixing it with sucrose, it can no longer catalyse the hydrolysis even though the primary structure of the enzyme remains unaffected by the boiling.

- i. What is meant by the primary structure of an enzyme?

- ii. Explain why the primary structure of the enzyme is not affected by boiling a solution of the enzyme.

- iii. Explain what effect the boiling has had on the structure of the enzyme.

- iv. Explain why the enzyme can now no longer catalyse the hydrolysis of the sucrose.

5 marks

Total 10 marks

TURN OVER

Question 7

a. Below is shown a dipeptide molecule.

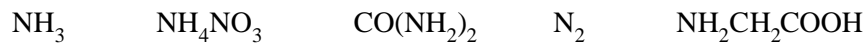


i. This dipeptide is dissolved in an acid solution and hydrolysed. Give the structure of each of the individual amino acids that could be formed by this hydrolysis reaction **in the form that they would exist in an acid solution**.

ii. Choose **one** of the amino acids you have given and imagine that it is dissolved in a solution of high pH. Give its structure as it would exist in the alkaline solution.

4 marks

b. The following nitrogen-containing molecules all have a role to play in the biosphere.



i. Select from the above list **one** substance that could **conveniently** be used as a source of nitrogen for indoor plants.

ii. Select from the above list **one** substance that could undergo a condensation reaction with itself.

iii. Select from the above list **one** substance that would act as a strong electrolyte when dissolved in water.

3 marks

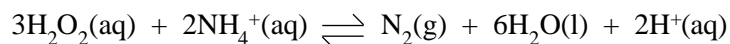
Total 7 marks

Working space

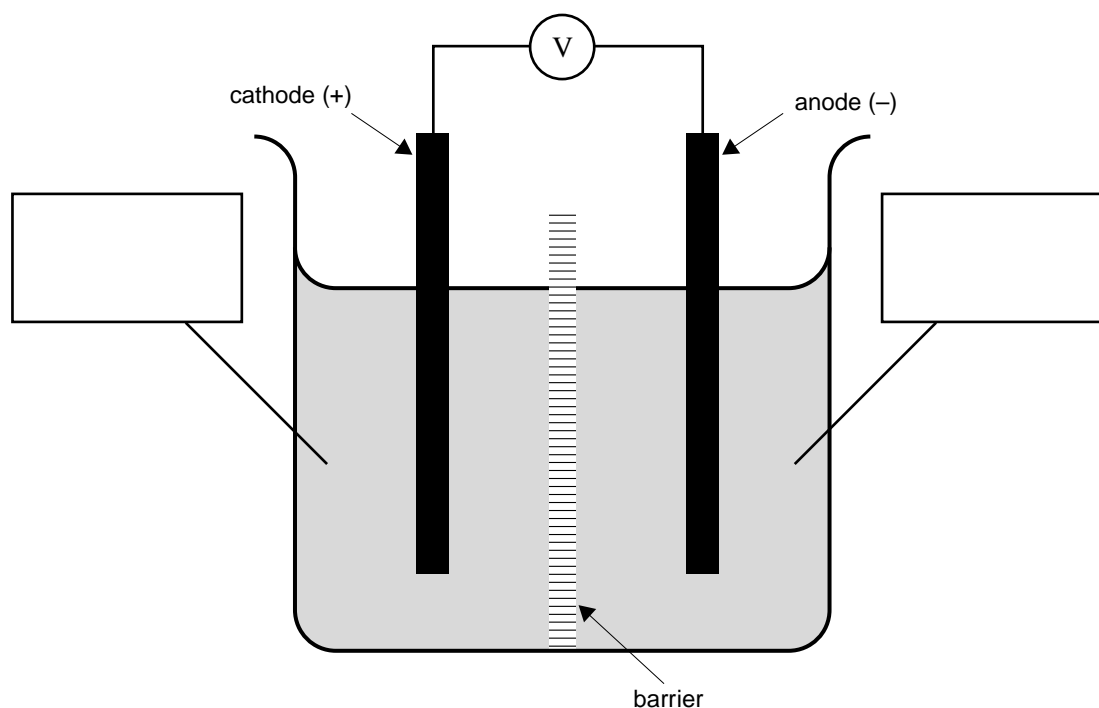
TURN OVER

Question 8

The chemical reaction



proceeds very slowly in aqueous solution. However, it can proceed quite quickly in the presence of a suitable catalyst. It is proposed that a galvanic cell be made using this reaction as a cell reaction in the cell shown below.



- a. In the boxes provided above show the chemical substances in the half-cells (you may need to use some of the data from the detachable Data sheet).

2 marks

- b. Assuming the barrier is made of a chemically inert material, what other important property must the barrier possess?

1 mark

- c. Give the half-cell reactions that occur as the cell discharges.

reaction at positive electrode (cathode)

reaction at negative electrode (anode)

2 marks

Question 8 – continued

- d. What are two necessary properties of the electrode materials used?

2 marks

- e. Given that the maximum voltage of a single cell is approximately 1.3 V, explain how you would recharge a cell that had been discharged.

2 marks

- f. What reaction would occur in the cell when it was being recharged?

1 mark

Total 10 marks

Working space