SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

Victorian Certificate of Education 1996

CHEMISTRY

Common Assessment Task 3: Written examination

Thursday 7 November 1996: 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 BOOKLET

Structure of booklet

Number of questions	*Number of questions to be answered*
9	9

Directions to students

Materials
Question and answer booklet of 13 pages with a detachable data sheet in the centrefold.
Working space is provided throughout this booklet.
An approved calculator may be used.

The task
Detach the data sheet from the centre of this booklet during reading time.
Please ensure that you write your **student number** in the space provided on this page.
Answer **all** questions. Questions should be answered in the spaces provided in this booklet. The suggested times and 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.

At the end of the task
Hand in the question and answer booklet.

Instructions for students

There are 9 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 can 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

$$H_2(g);\ NaCl(s).$$

Question 1

The elements, Na, Mg, Al, Si, P, S and Cl are all members of the third period of the periodic table. Consider the following properties of these elements.

a. atomic radius

i. Which of the elements listed above has the smallest atomic radius?

_____

ii. Explain the **trend** in the atomic radius of the listed atoms.

_____

_____

_____

_____

1 + 2 = 3 marks

b. metallic and non-metallic character

i. Give **three** of the listed elements that are non-metals.

_____

ii. Which element in the third period best exhibits a mixture of metallic and non-metallic properties?

_____

1 + 1 = 2 marks

c. oxidising and reducing strength

i. Identify the element in the third period that is the

- strongest oxidant _____
- strongest reductant _____

ii. Write a balanced equation to describe the reaction that would occur if these two elements were mixed.

_____

_____

_____

2 + 1 = 3 marks

d. properties of the oxides

i. Some oxides of the third period elements react with water to form acidic solutions. Give the formula of an oxide of this type **and** write a balanced equation for its reaction with water.

_____

_____

_____

ii. Some oxides of the third period elements react with water to form basic solutions. Give the formula of an oxide of this type **and** write a balanced equation for its reaction with water.

_____

_____

_____

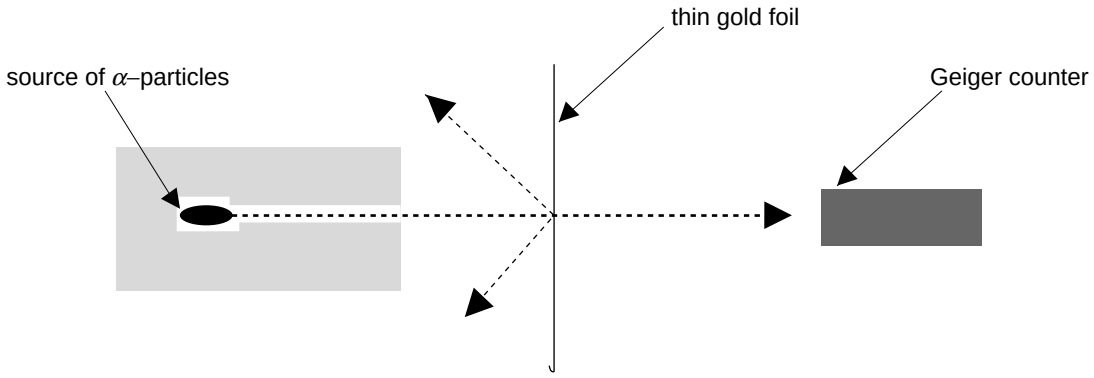
2 + 2 = 4 marks

Total 12 marks

(*suggested time: 15 minutes*)

Question 2

In the early 20th century, high speed α-particles (small positively charged particles) were used by scientists to investigate the internal structure of the atom. In a now famous experiment carried out by Geiger and Marsden, two students of Rutherford, a beam of α-particles was directed at a thin piece of gold foil.



Most of the α-particles passed straight through the gold foil. However, to the surprise of the scientists, about one in every 10 000 α-particles bounced right back. Rutherford is quoted as saying, 'It was almost as incredible as if you had fired a 15 inch (38 cm) shell (large bullet) at a paper tissue and it came back and hit you.'

a. Explain how the results of the experiment with α-particles enabled Rutherford to develop a new way of describing the structure of an atom.

3 marks

b. The modern picture of the atom is now much more complete than the simple model first proposed by Rutherford. Give two additional features of the structure of the atom that have been discovered since Rutherford's time.

2 marks

Total 5 marks

(*suggested time: 7 minutes*)

Question 3

a. In answering this part of the question you will need to select some or all of the following substances.

A	**B**	**C**	**D**	**E**
CH_4	CO_2	H_2O	O_2	$C_6H_{12}O_6$
(methane)	(carbon dioxide)	(water)	(oxygen)	(glucose)

F	**G**	**H**	**I**	**J**
N_2	NH_4^+	NO_3^-	NH_3	$CO(NH_2)_2$
(nitrogen)	(ammonium ion)	(nitrate ion)	(ammonia)	(urea)

All three of the major food groups, **proteins**, **carbohydrates** and **fats**, can be used by the human body as energy sources.

From the list above, identify **all** of the end products formed when each of these foods is used to produce energy **in the human body**. Give your answer by circling the appropriate letters in the table below.

~~food~~	~~circle all the end products formed when food is used to produce energy~~									
protein	A	B	C	D	E	F	G	H	I	J
carbohydrate	A	B	C	D	E	F	G	H	I	J
fat	A	B	C	D	E	F	G	H	I	J

3 marks

b. In answering this part of the question you will need to select some or all of the following substances.

A	**B**	**C**	**D**
CH_4	CO_2	H_2O	O_2
(methane)	(carbon dioxide)	(water)	(oxygen)

E	**F**	**G**	**H**
$C_6H_{12}O_6$	N_2	NH_4^+	NO_3^-
(glucose)	(nitrogen)	(ammonium ion)	(nitrate ion)

The food we eat is all derived ultimately from plant material and contains the elements carbon, hydrogen, oxygen and nitrogen.

From the list of substances above, identify **all** of the sources of these elements **that can be directly absorbed by green plants** and used as ‘building blocks’ for their proteins, carbohydrates and fats. Give your answer by circling the appropriate letters in the table below.

~~element~~	~~circle all the sources of this element that can be directly absorbed by plants~~							
carbon	A	B	C	D	E	F	G	H
hydrogen	A	B	C	D	E	F	G	H
oxygen	A	B	C	D	E	F	G	H
nitrogen	A	B	C	D	E	F	G	H

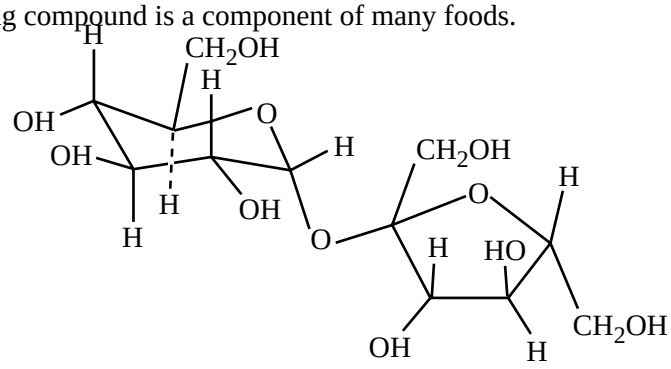
4 marks
Total 7 marks

TURN OVER

(*suggested time: 10 minutes*)

Question 4

a. The following compound is a component of many foods.



i. To which of the three major food groups – proteins, carbohydrates and fats – does this compound belong? Circle the correct response below.

protein

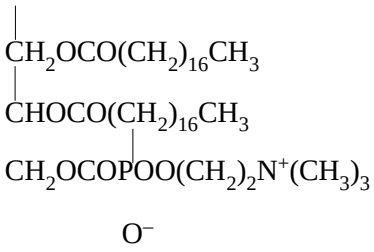
fat

carbohydrate

ii. During digestion, the compound whose structure is shown above is hydrolysed. Sketch the structures of the products of this hydrolysis.

1 + 2 = 3 marks

b. Some foods contain emulsifiers as additives. One common emulsifier is lecithin.



i. Why are emulsifiers added to some foods?

ii. Which features of the lecithin molecule shown above make it suitable as an emulsifier?

1 + 2 = 3 marks

Total 6 marks

(*suggested time: 8 minutes*)

Question 5

A chemist needed to determine the energy content of a new brand of biscuit using a bomb calorimeter. The following series of experiments was carried out.

- 2.63 g of the dried biscuit was placed in the bomb, which was then filled with excess oxygen and placed in a water-bath. The temperature settled to a value of 23.76 °C.
- The mixture of biscuit and oxygen was ignited and the temperature then rose from 23.76 to 24.63 °C.
- An electric current of 1.35 A at a potential difference of 7.50 V was passed for five minutes through a small electrical heater inside the bomb. The temperature then rose from 24.63 to 25.90 °C.

a. Calculate the calibration factor of the calorimeter in J K^{-1}.

3 marks

b. Calculate the energy content of the biscuit in kJ g^{-1}.

2 marks

c. Explain why one of these biscuits might release less energy per gram when eaten and used by a human body to provide some energy.

1 mark

d. Why is the energy content of biscuit given in kJ g^{-1} rather that in kJ mol^{-1}?

1 mark

e. Methane (0.055 g) was burnt with excess oxygen in a different calorimeter that had a calibration factor of 3550 J $°C^{-1}$. Calculate the rise in temperature that you would expect to observe.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g);\ \Delta H = \ -890\ kJ\ mol^{-1}$$

3 marks

Total 10 marks

(*suggested time: 14 minutes*)

Question 6

a. Molten copper (I) chloride is electrolysed by a current of 3.00 A which flows for 2200 seconds. 4.40 g of copper is deposited at the cathode. Show that the copper ion in copper (I) chloride exists as Cu^+.

_____

_____

_____

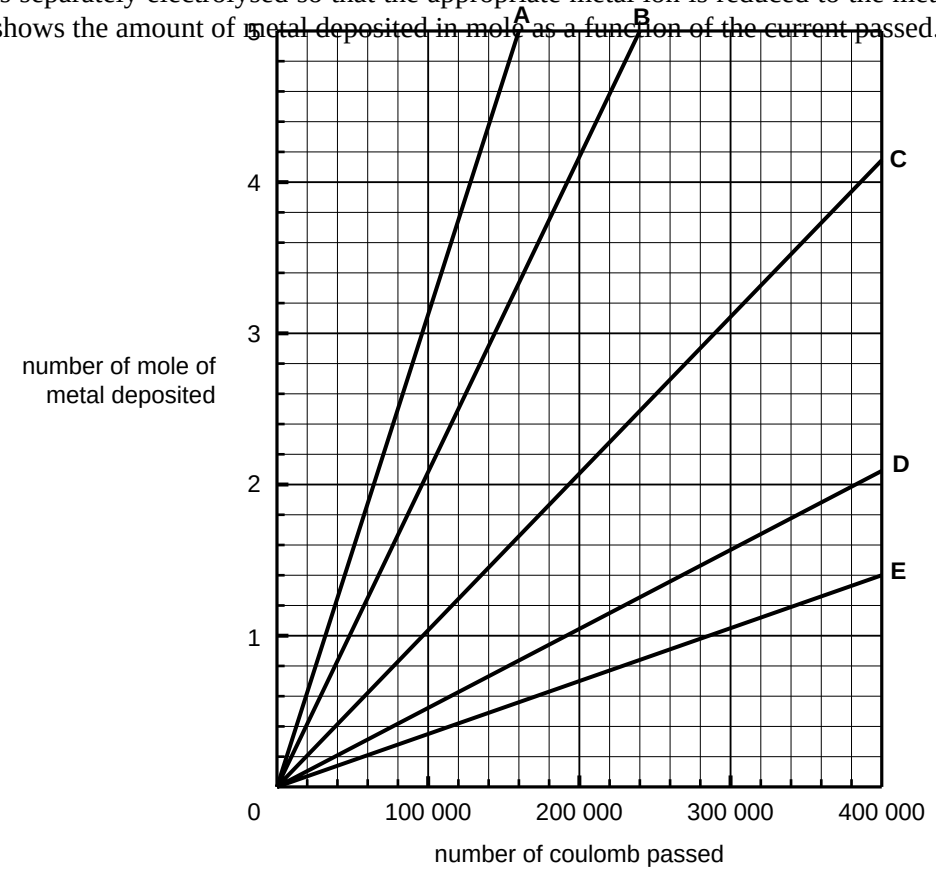
_____

_____

_____

3 marks

b. Three different solutions are prepared containing the ions Ag^+, Pb^{2+} and Cr^{3+} respectively. Each solution is separately electrolysed so that the appropriate metal ion is reduced to the metal. The following graph shows the amount of metal deposited in mole as a function of the current passed.



Identify the labelled lines in the graph above by circling the appropriate letter in each of the following.

Ag deposition	A	B	C	D	E
Pb deposition	A	B	C	D	E
Cr deposition	A	B	C	D	E

3 marks

Total 6 marks
(*suggested time: 8 minutes*)

Question 7

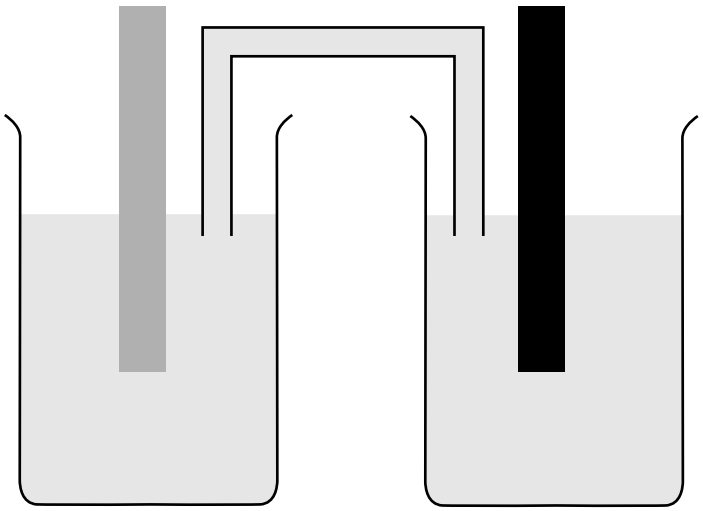
A galvanic cell is to be constructed using silver metal, zinc metal and aqueous solutions of silver and zinc nitrates.

a. Label the following diagram, giving the following information.

i. the metal electrodes **and** the contents of the half cells

ii. the direction of flow of electrons in the external circuit

iii. a suitable electrolyte that could be used in the salt bridge



1 + 1 + 1 = 3 marks

b. Complete the following table for the reactions occurring when the cell is producing a current.

	equation for half reaction	electrode (cathode or anode?)
oxidation		
reduction		

3 marks

c. Give the net reaction that occurs when the cell delivers an electric current.

_____

_____

_____

1 mark

TURN OVER

Total 7 marks

(*suggested time: 9 minutes*)

Question 8

A bright blue aqueous solution of chromium (II) chloride, $CrCl_2(aq)$ is prepared. The solution contains the ions $Cr^{2+}(aq)$ and $C1^{-}(aq)$.

You may need to refer to the Data Sheet in answering some of the following questions.

a. The aqueous solution is divided into three parts and the following experiments are carried out.

Sample 1: The solution is acidified and oxygen is bubbled through. The colour rapidly changes from blue to green. When a solution of sodium hydroxide is added to the green solution, a green precipitate forms.

i. Give an equation for the reaction that occurs when oxygen is bubbled through the solution.

_____

_____

_____

ii. Give an equation for the reaction that occurs when the green precipitate forms.

_____

_____

_____

Sample 2: The solution is acidified and placed in a vessel with no oxygen present. A gas is evolved very slowly and the colour of the solution slowly changes to green.

iii. Give an equation for the reaction that occurs.

_____

_____

_____

Sample 3: A solution containing the thiocyanate ion (SCN^{-}) is added and the colour of the solution changes to red.

iv. State the type of reaction that has probably occurred.

_____

_____

2 + 1 + 1 + 1 = 5 marks

b. Give the electronic configuration of the chromium atom.

_____

_____

1 mark

Total 6 marks

(*suggested time: 9 minutes*)

Question 9

a. Explain how it is that the hydrogen atom, with a single electron, has an emission spectrum with many lines.

3 marks

b. The formation of helium from hydrogen in the Sun releases a huge amount of energy. What is the source of the energy released?

1 mark

c. Write an overall equation for the formation of helium from hydrogen in the Sun.

1 mark

d. The core of planet Earth contains a considerable amount of iron. How and where did this iron originate?

2 marks

END OF QUESTION AND ANSWER BOOKLET

Total 7 marks

(*suggested time: 10 minutes*)