

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures

Words

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**Victorian Certificate of Education
1994**

CHEMISTRY

Common Assessment Task 3: Analysis and evaluation

Monday 7 November 1994: 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

<i>Number of questions</i>	<i>Number of questions to be answered</i>
7	7

Directions to students

Materials

Question and answer booklet of 15 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 time allocations and the marks allotted to each question are indicated at the end of the question. There is a total of 75 marks available.

All written responses should be in English.

At the end of the task

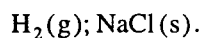
Hand in the question and answer booklet.

Instructions for students

There are 7 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



Some of the questions in this examination require comparison between elements in the periodic table, a knowledge of atomic numbers or relative atomic masses. A periodic table showing atomic numbers and relative atomic masses is given on the data sheet.

Question 1

- a. i. State the similarity in electronic configuration of the following elements:

O, S, Se

- ii. State the similarity in electronic configuration of the following elements:

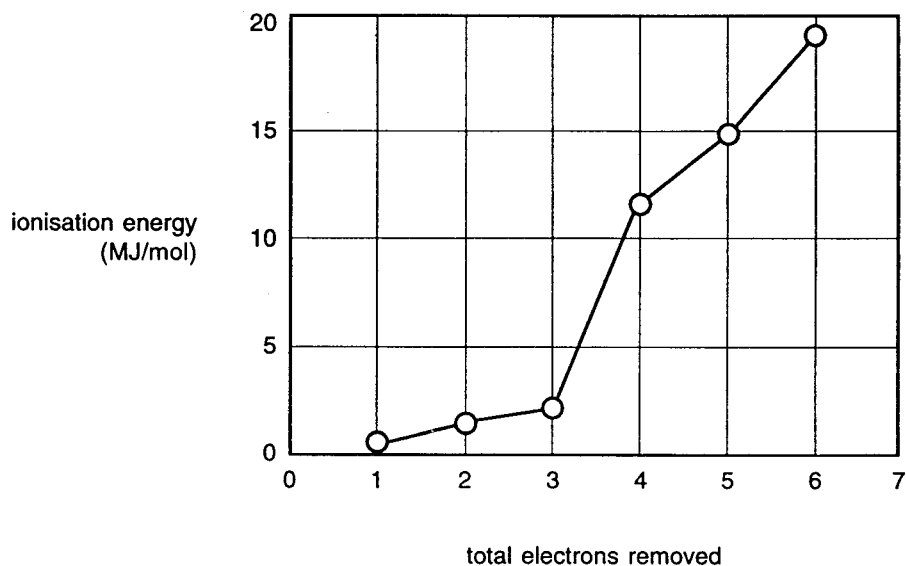
Fe, Co, Ni

- b. What is the expected trend in the atomic radii of the elements Mg, Ca and Sr? Briefly explain this trend.

- c. The symbol for the most common atom of carbon may be written in the form $^{12}_6\text{C}$. Use this notation to give the chemical symbol for the atom or ion which contains 12 protons, 12 neutrons and 10 electrons.

d. Ionisation energy is the energy necessary to remove an electron from an atom or ion.

The diagram below shows the ionisation energies as the first six electrons are successively removed from an aluminium atom.



i. Using subshell notation, write the electronic configuration of an atom of aluminium.

ii. Relate the trend in the ionisation energies for the first six electrons of aluminium to its electronic configuration.

2 + 2 + 1 + 4 = 9 marks
(suggested time: 12 minutes)

Question 2

This question refers to the transition elements of the periodic table.

- a. i. Explain why a transition series is made up of 10 elements.

- ii. Give the symbol of one element from **each** of the transition element series.

- b. i. In different compounds, the one transition element may occur in different oxidation states. Give the formulas of two different compounds of the **same** transition metal which show this property.

- ii. Describe, with an example, one other property which separates the transition metals or their ions from the metallic elements in groups I and II of the periodic table.

2 + 4 = 6 marks
(suggested time: 6 minutes)

Question 3

- a. A healthy adult person has approximately 15 kg of fatty tissue. When extra energy is required, some of the fat is converted to fatty acids which are then oxidised as in the following equation.



- i. What kind of reaction is involved in the conversion of the fat to fatty acids ?

- ii. What is the total amount of energy released by the oxidation of 150 g of fatty acid?

- b. The oxidation of carbohydrates also provides the body with energy. Glucose circulates in the blood, but in what form are carbohydrates stored in the human body?

- c. The label on a packet of 'KORN CHIPS' gives the following information about 100 g of the product.

Available energy in 100 g KORN CHIPS	2060 kJ
Composition of 100 g KORN CHIPS	
Protein	7.3 g
Fat	25.4 g
Carbohydrate	62.1 g
Sodium	600 mg
Potassium	190 mg
Water	4.4 g

- i. Using the following heats of combustion, calculate the total energy that would be released from the combustion of the contents of a 100 g packet of KORN CHIPS.

Protein 24 kJ g⁻¹

Fat 39 kJ g⁻¹

Carbohydrates 17 kJ g⁻¹

- ii. Give two reasons for the difference between the result in part c. i. and the energy available from 100 g of KORN CHIPS (2060 kJ) as printed on the label.

- iii. Processed foods, such as KORN CHIPS, often contain food additives. Give two reasons why additives might be used in food.

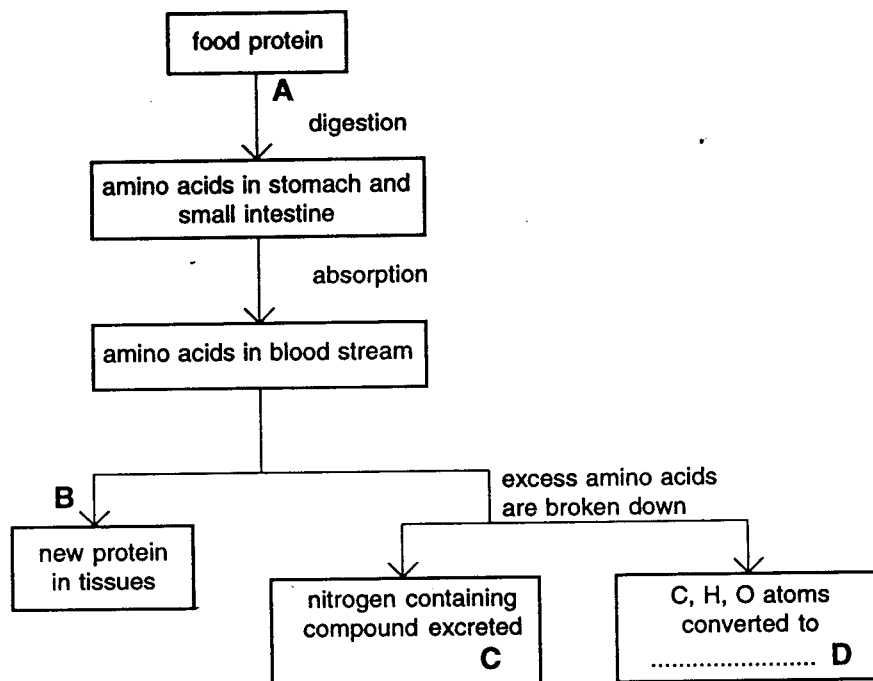
- d. Digestion of the fat in food occurs in the small intestine and is helped by the action of bile. How does bile help in the digestion of fat?

4 + 1 + 7 + 2 = 14 marks
(suggested time: 17 minutes)

Question 4

Proteins are one of the three major food groups.

- a. The following flow chart shows the digestion of proteins and the absorption and use of the products of protein digestion.



Use the flow chart to answer the following questions.

- i. Give an example of a food which is high in protein.

 - ii. Digestion of food occurs at A. What type of chemical reaction takes place when food is digested?

 - iii. What type of chemical reaction takes place at B?

 - iv. What is the name of the nitrogen containing compound formed at C?

 - v. What compound is formed at D?

- b. Some of the amino acids, from the digestion of protein in food, are classified as **essential** while others are **non essential**. Explain the difference between **essential** and **non essential** amino acids.

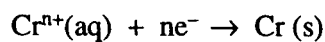
- c. Valine is one of the amino acids in food protein. It has a molecular formula of $C_3H_{11}O_2N$. Deduce and draw a possible structural formula for valine.

- d. Enzymes belong to an important group of proteins. Fresh pineapple contains an enzyme which stops jelly from setting. However, if the pineapple is boiled first, it can be added to jelly and the jelly will set. Suggest a reason why boiling the pineapple changes the way it acts.

5 + 1 + 3 + 1 = 10 marks
(suggested time: 12 minutes)

Question 5

An article is plated with the metal chromium by electrolysis of an aqueous solution of a salt of chromium. The half equation for the reaction is



- a. In the electroplating process, is the item to be plated attached to the positive or the negative electrode? Give a reason for your answer.

- b. The following data are relevant to this process

mass of article before plating	=	32.26 grams
mass of article after plating	=	36.60 grams
current used	=	2.24 amperes
time taken	=	3.00 hours

- i. Calculate the amount, in mole, of electrons that pass through the cell in this period of time.

- ii. Using the mass of the article before and after plating, calculate the amount, in mole, of chromium deposited.

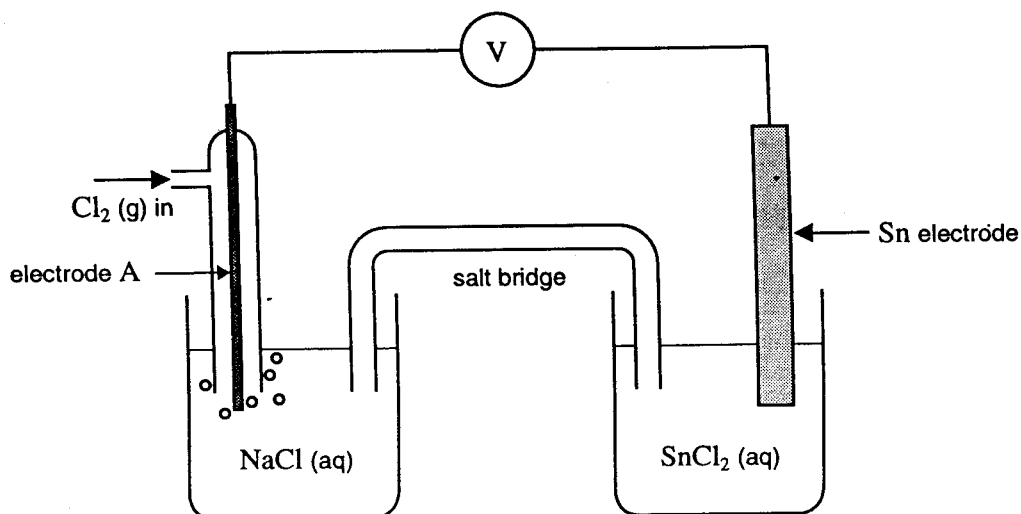
- iii. From your calculations in i. and ii. calculate the charge on the chromium ion used in this electroplating process. (You **must** show your working in order to gain credit for this part.)

- c. Explain why it would **not** be possible to electroplate the article with aluminium from an aqueous solution of a salt of aluminium.

1 + 7 + 2 = 10 marks
(*suggested time: 12 minutes*)

Question 6

a. The following diagram represents a galvanic cell.



i. Name a suitable material for electrode A.

ii. State whether electrode A is positive or negative when the cell is working.

iii. Give the formula of an ionic compound that can be used in the salt bridge.

iv. On the diagram itself, show

- the direction of flow of electrons in the external circuit.
- the direction in which the anions and cations of your selected compound move in the salt bridge.

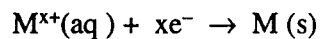
v. for this galvanic cell, write equations for the oxidation half reaction

reduction half reaction

overall cell redox reaction

vi. The galvanic cell above is a **primary cell**. How does a primary cell differ from a secondary cell?

b. Bubbling hydrogen gas through a solution containing metal ions may cause a reduction reaction of the type



i. Use the electrochemical series to choose **two** metal ions which would be expected to react in this way. Write balanced equations for these reductions.

ii. It sometimes happens that the reaction expected on the basis of the electrochemical series is not, in fact, observed. Give **two** reasons for this.

10 + 4 = 14 marks
(suggested time: 15 minutes)

Question 7

A number of scientists have helped our understanding of atomic theory and the periodic table. Some examples are described below. Use the information given to answer the questions in each section.

1 Democritus (460–357 BC)

Democritus first suggested that matter was not continuous but made up of pieces which he called atoms. His model of matter stated:

- all matter is made up of tiny particles called atoms.
- atoms are solid.
- atoms are indivisible.
- atoms of different substances differ in size.

a. i. List the parts of Democritus' theory of matter which are thought to be correct today.

ii. Explain why the other parts of Democritus' theory are no longer thought to be correct.

2 Lothar Meyer (1830–1895)

The periodic table provides a useful framework for the study of chemistry. One of the early tables was by Lothar Meyer who wrote that:

- if elements are arranged in order of increasing atomic mass, their properties vary periodically.

b. i. How does the way in which the elements were ordered by Meyer differ from that used today?

ii. Suggest one reason why Meyer would have been unable to organise the elements as we do today.

3 Ernest Rutherford (1871–1937)

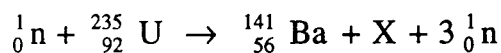
As a result of experiments involving the firing of high energy, positively charged particles at a piece of gold foil, Rutherford put forward the theory that:

- all the positive charge and almost all the mass of the atom is concentrated in a very small nucleus.
 - most of the volume of the atom is occupied by the electrons of which there are enough to make the atom neutral.
- c. Give **two further** pieces of information which we now know about the electrons around the nucleus of the atom.

4 Lise Meitner (1878–1968)

In the 1930s, experiments were being performed in which a sample of uranium was bombarded with neutrons. When the uranium target was analysed at the end of the experiment, traces of barium (an element with atomic mass about half that of uranium) were found. Lise Meitner and her colleagues called this type of reaction nuclear **fission**.

An equation for such a fission reaction is given below.



- d. i. Give the symbol, including the mass number and atomic number, of particle X.

- ii. Another kind of nuclear reaction is nuclear **fusion**. How does nuclear fusion differ from nuclear **fission**?

- iii. What is the source of the energy released in nuclear fusion reactions?

4 + 2 + 2 + 4 = 12 marks
(suggested time: 16 minutes)