

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

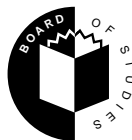
Letter

Figures

Words

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**Victorian Certificate of Education
1995**

CHEMISTRY

Common Assessment Task 3: Written examination

Thursday 9 November 1995: 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> |
|----------------------------|---|
| 8 | 8 |

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 marks allotted to each question are indicated at the end of the question. There is a total of 60 marks available.

All written responses should be in English.

At the end of the task

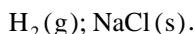
Hand in the question and answer booklet.

Instructions for students

There are 8 questions. Answer all questions.

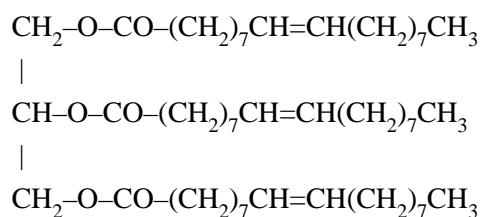
To obtain full credit for your responses, you should

- 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 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

**Question 1**

- a. The digestion of food is catalysed by a very large number of different enzymes. Briefly explain why so many different enzymes are needed for the complete digestion of food.

- b. The structure of a fat molecule sometimes consumed by humans is shown below.



- i. What are two functions of the fat stored in our bodies?

- ii. Briefly explain why fat molecules are almost insoluble in water.

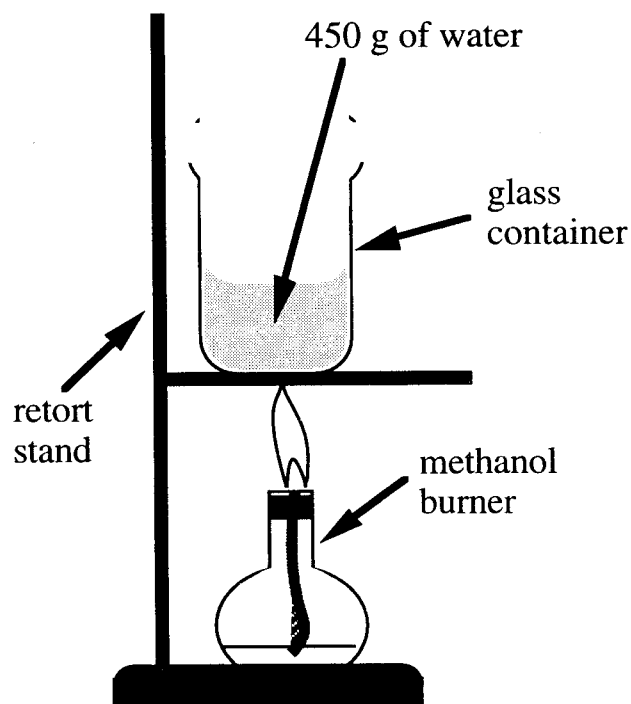
iii. Draw diagrams showing the structure and bonding of the functional groups that are present in the molecules formed when the fat molecule shown in part **b.** opposite is hydrolysed.

c. In a commercial food containing the fat shown in part **b.** opposite, an antioxidant has been added. Circle **one** structural feature of the molecule (shown opposite) that would be protected by the antioxidant.

1 + 6 + 1 = 8 marks

Question 2

An experiment was performed by a student to determine an approximate value of the heat of combustion of methanol (CH_3OH). The apparatus was set up as shown below.



It required 1.10 g of methanol to be burnt to raise the temperature of 450 g of water by 9.9°C .

- a. Use the experimental data given to calculate a value of the heat of combustion per mole of methanol given that the heat capacity of water is $4.18 \text{ J}^\circ\text{C}^{-1} \text{ g}^{-1}$.

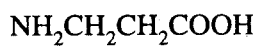
- b.** The correct value of the heat of combustion of methanol is 725 kJ mol^{-1} , a value considerably greater than the value you should have obtained from your calculation in part **a**. Suggest, and briefly justify, two simple changes to the experimental design that might lead to an experimental result closer to the 'correct' value. If you wish, you may use a simple diagram to show your suggested modifications.

5 + 2 = 7 marks

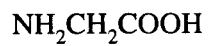
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Question 3

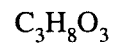
Most of the molecules A to H shown below are biologically important.



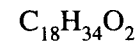
A



B



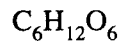
C



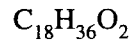
D



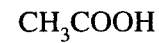
E



F



G



H

Identify the molecule or molecules from the set above that could have been formed by the hydrolysis of:

Cellulose

A B C D E F G H

Protein

A B C D E F G H

An unsaturated fat

A B C D E F G H

Starch

A B C D E F G H

A saturated fat

A B C D E F G H

Give your answer by circling the appropriate letter or letters in each case.

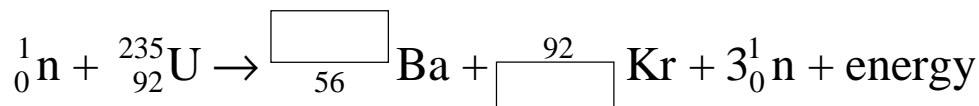
5 marks

Question 4

- a. The nature of atomic nuclei can be represented in the form ${}^A_Z E$, where E is the symbol for the element.
- i. What does the symbol A represent?
-

- ii. What does the symbol Z represent?
-

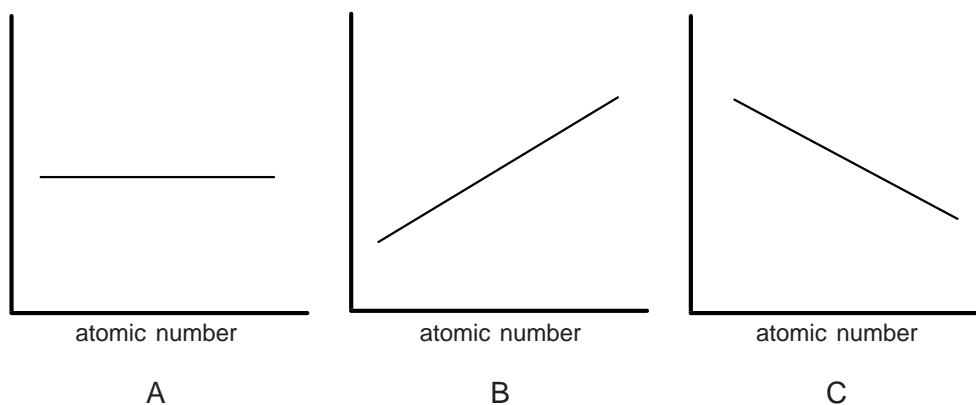
- iii. Complete the following nuclear equation by writing correct numerical values in the boxes provided.



- b. i. Give the electronic structure of the atom of atomic number 14.
-

- ii. In which group of the periodic table is the element whose atoms have an atomic number of 14?
-

- c. The following graphs show how certain properties vary either across a period or down a group of the periodic table.



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

- i. atomic radii of Li, Na, K, Rb
- ii. electronegativities of C, N, O, F
- iii. number of electrons in F^- , Ne, Na^+ , Mg^{2+}
- iv. first ionisation energies of Li, Na, K, Rb

- d. The oxides of the elements across a period show a trend in acid-base properties. Write balanced equations for each of the following reactions.

Sodium oxide, Na_2O , with water

Aluminium oxide, Al_2O_3 , with excess hydrogen ions

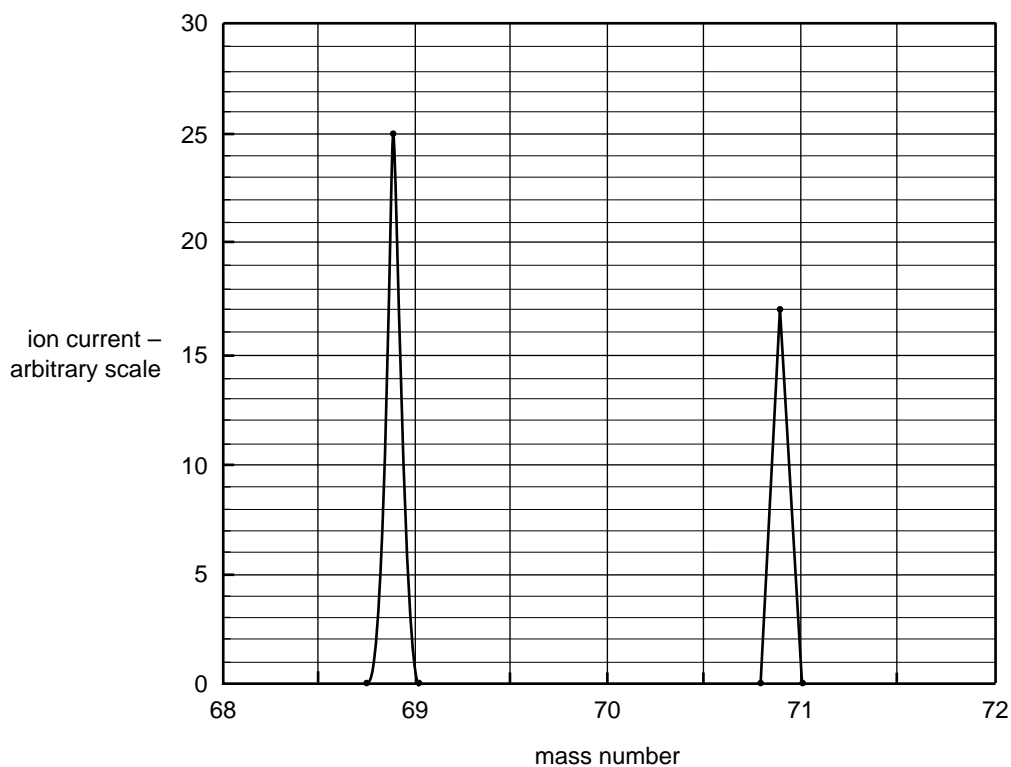
Aluminium oxide, Al_2O_3 , with excess hydroxide ions

Sulfur trioxide, SO_3 , with excess hydroxide ions

4 + 2 + 4 + 4 = 14 marks

Question 5

A sample of gallium metal was vaporised and the vapour introduced into the ionisation chamber of a mass spectrometer. The resultant mass spectrum is illustrated below and shows two peaks, one of isotopic mass 68.9 and the other of isotopic mass 70.9.



- a. What causes the ionisation of the gallium metal vapour in the ionisation chamber of the mass spectrometer?

- b. Use the data shown in the graph to calculate the percentage abundance of each of the isotopes.

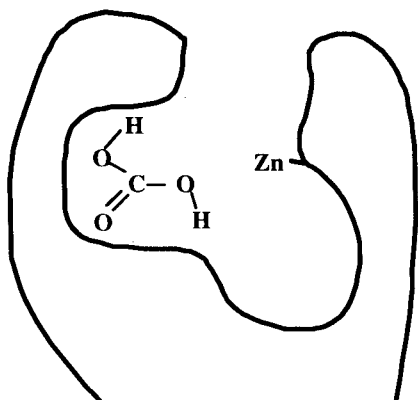
- c. Use the percentage abundances you have calculated in part b. to calculate a value of the relative isotopic mass of gallium.

1 + 2 + 2 = 5 marks

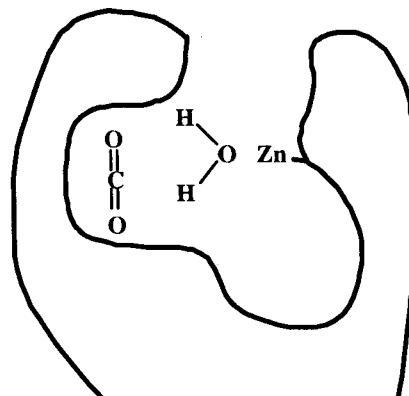
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Question 6

An important enzyme-catalysed reaction is the dehydration of the molecule carbonic acid to carbon dioxide and water by the zinc-containing enzyme, carbonic anhydrase. This reaction is a step in the removal from the body of CO_2 , a product of the oxidation of glucose. The reaction in the enzyme is shown in a diagrammatic form below.



carbonic acid held in position in the enzyme prior to decomposition



carbon dioxide and water immediately following decomposition of carbonic acid

- a. Carbonic acid, H_2CO_3 , is formed when the hydrogen carbonate ion reacts with a hydrogen ion. Write a chemical equation for this process.

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

- c. What is meant by the 'secondary structure' of an enzyme and how is the secondary structure maintained?

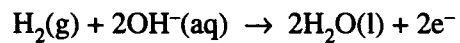
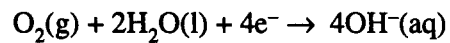
- d. By referring to the diagram shown opposite, explain how the tertiary structure of an enzyme determines its function.

- e. Holding carbonic anhydrase at a temperature of 60°C causes it to become denatured and thus ineffective in catalysing the dehydration of carbonic acid. Yet the primary structure of the enzyme remains unaffected. Give a probable explanation of why the enzyme has ceased to be effective.

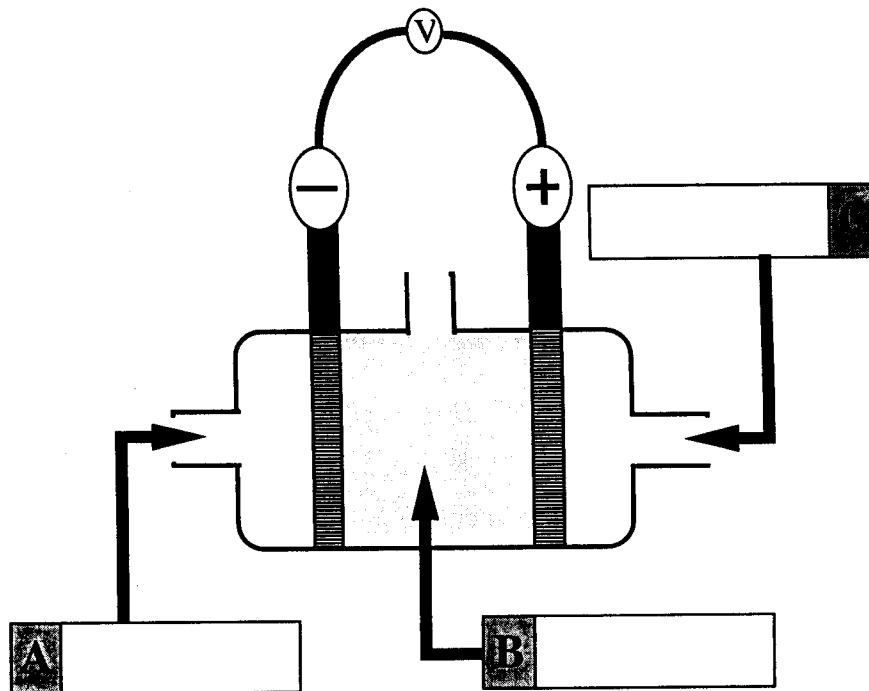
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Question 7

The hydrogen-oxygen fuel cell has been used as an energy source in many spacecraft. The two half reactions are:



- a. An incomplete diagram of a cell that uses an alkaline electrolyte is given below.



- i. Write the formulas of possible chemical species for A, B and C in the boxes provided beside the letters.
- ii. Indicate on the diagram the direction of electron flow.

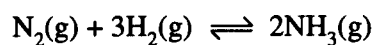
b. Write a balanced overall equation for the cell reaction.

c. Briefly describe two important functions of the electrodes in this cell.

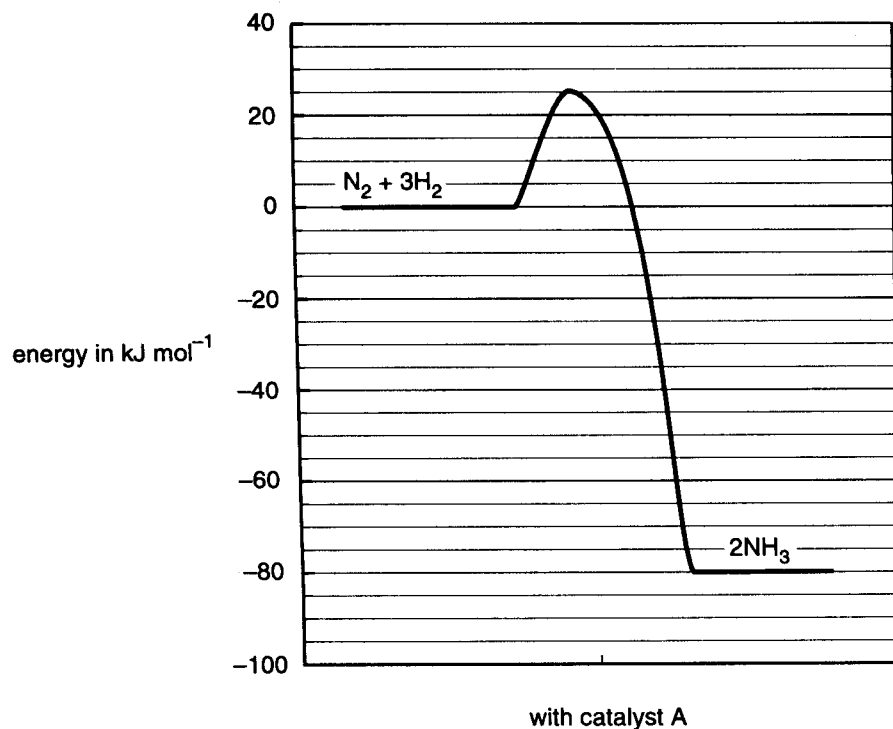
4 + 1 + 2 = 7 marks

Question 8

An energy profile is shown below for the reaction:



in the presence of a particular catalyst, identified as 'catalyst A'.



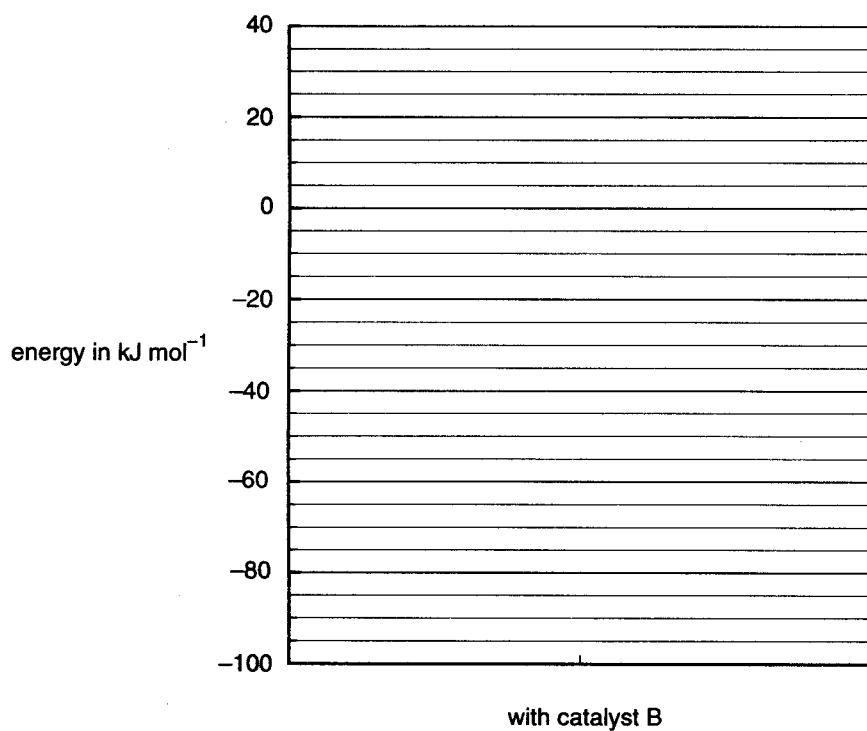
- Give the value and sign of the ΔH of the forward reaction.

- Give the value and sign of the activation energy of the forward reaction.

- Give the value and sign of the ΔH of the reverse reaction.

- Give the value and sign of the activation energy of the reverse reaction.

- e. Catalyst A is removed and is replaced with catalyst B, a more effective catalyst that makes the reaction go faster. Sketch on the blank graph below a possible form of the energy profile for the same reaction in the presence of catalyst B.



1 + 1 + 1 + 1 + 3 = 7 marks