SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Figures									Letter
Words									

Victorian Certificate of Education
1999
CHEMISTRY
Common Assessment Task 1: Written examination

Tuesday 8 June 1999: 11.45 am to 1.30 pm
Reading time: 11.45 am to 12 noon
Writing time: 12 noon to 1.30 pm
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*
A	20	20
B	6	6

Directions to students

Materials
Question and answer book of 14 pages, with a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions. You should have at least one pencil and an eraser.
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 and your **name** and **student number** in the space provided on the answer sheet for multiple-choice questions.
This paper consists of two sections, Section A and Section B.
Answer **all** questions from Section A. Section A is worth 20 marks.
Section A questions should be answered on the answer sheet provided for multiple-choice questions.
Answer **all** questions from Section B. Section B is worth 48 marks.
Section B questions should be answered in the spaces provided in this book.
There is a total of 68 marks available.
All written responses should be in English.

At the end of the task
Place the answer sheet for multiple-choice questions inside the front cover of this book.

SECTION A

Specific instructions for Section A

Section A consists of 20 multiple-choice questions. Section A is worth approximately 29 per cent of the marks available. You should spend approximately 26 minutes on this section.

Choose the response that is **correct** or **best answers the question**, and shade the square on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark, an incorrect answer is worth no marks. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

Question 1

The principal **reductant** in the reduction of iron ore to iron in the blast furnace is

A. calcium carbonate.

B. calcium silicate.

C. carbon dioxide.

D. carbon monoxide.

Question 2

The high temperature in the blast furnace is maintained by

A. an exothermic reaction of coke.

B. an endothermic reaction of coke.

C. the endothermic decomposition of calcium carbonate.

D. the exothermic formation of slag.

Question 3

Which of the following will **not** slow the corrosion of iron?

A. painting the iron surface

B. making the iron negatively charged by connecting it to a direct current power supply

C. increasing the amount of carbon in the iron

D. mixing chromium with the iron to make an alloy

Question 4

Pig iron is produced in a blast furnace and it is usually immediately made into steel. Pig iron is of limited use because it

A. contains unreacted iron oxide and lacks hardness.

B. contains a high concentration of silica and is too hard.

C. contains a high concentration of carbon and is too brittle.

D. is very pure and is too soft.

Question 5

The following are analytical instruments:

- gas-liquid chromatograph
- ultra-violet spectrometer
- atomic absorption spectrometer
- high-performance liquid chromatograph

Two features that are common to these instruments are

A. reference cells and a recorder.

B. detector and a recorder.

C. light source and carrier gas.

D. monochromator and detector.

Question 6

The following two monomers are mixed in an exact 1:1 mole ratio and placed in a reaction vessel.

$$CHCl{=}CHCl \text{ and } CH_3CH{=}CHCH_3$$

The mixture is heated and polymerisation occurs. The resulting product would be expected to

A. be made up of two different types of polymer corresponding to the two different monomers.

B. be made up of polymer chains in which the two monomer units alternate in every chain.

C. be quite hard and brittle.

D. have an empirical formula of C_3H_5Cl.

The following information is referred to in Questions 7 and 8.

An aqueous solution of hydrochloric acid was standardised with a 0.0500 M solution of sodium carbonate. A 20.0 mL aliquot of this sodium carbonate solution was pipetted into a conical flask and titrated against the hydrochloric acid solution.

Question 7

Which of the following correctly identifies the substance that should be used to rinse each piece of equipment?

	Conical flask	**Pipette**	**Burette**
A.	sodium carbonate solution	sodium carbonate solution	hydrochloric acid solution
B.	water	water	water
C.	sodium carbonate solution	water	water
D.	water	sodium carbonate solution	hydrochloric acid solution

Question 8

The indicator chosen for this titration is methyl orange, which changes colour from yellow to pink when all of the carbonate ions have been converted to carbon dioxide. This will occur when the number of

A. H^+ ions added just exceeds double the number of CO_3^{2-} ions present originally.

B. H^+ ions added just exceeds the number of CO_3^{2-} ions present originally.

C. CO_3^{2-} ions present originally is just double the number of H^+ ions added.

D. H^+ ions added just equals the number of CO_3^{2-} ions present originally.

The following information is referred to in Questions 9 and 10.

Some carbon monoxide and oxygen are mixed in a reaction vessel and heated so that the following equilibrium is established at 1000 °C

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g);\ \Delta H = -546 \text{ kJ mol}^{-1}$$

The equilibrium constant for the reaction is *K*.

Question 9

If the temperature is raised above 1000 °C and equilibrium is re-established

A. the value of *K* will decrease and $[CO_2]$ will increase.

B. the value of *K* will decrease and $[CO_2]$ will decrease.

C. the value of *K* will increase and $[CO_2]$ will increase.

D. the value of *K* will increase and $[CO_2]$ will decrease.

Question 10

The system is returned to 1000 °C and equilibrium at that temperature is established. If the volume of the vessel is then doubled

A. the value of *K* will decrease and $[CO_2]$ will decrease.

B. the value of *K* will decrease and $[CO_2]$ will remain unchanged.

C. the value of *K* will remain unchanged and $[CO_2]$ will decrease.

D. the value of *K* will remain unchanged and $[CO_2]$ will also remain unchanged.

Question 11

In which of the following species does oxygen have the highest oxidation number?

A. O_2

B. H_2O_2

C. Na_2O

D. H_2SO_4

Question 12

The half equation for the dichromate ion acting as an oxidising agent is

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + n\ e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

The value of *n* in this equation is

A. 3

B. 6

C. 9

D. 12

Question 13

If 150 mL of 0.10 M NaOH is mixed with 50 mL of 0.30 M HCl, then the pH of the resultant solution is closest to

A. 1

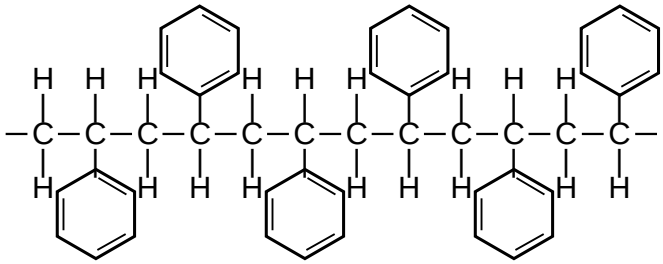
B. 2

C. 7

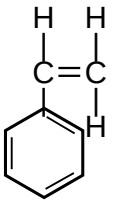
D. 13

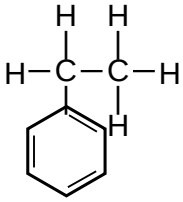
Question 14

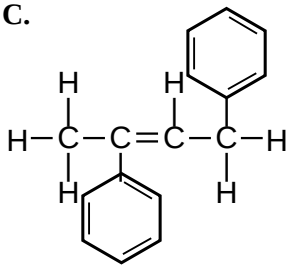
A section of a polymer chain is given below.

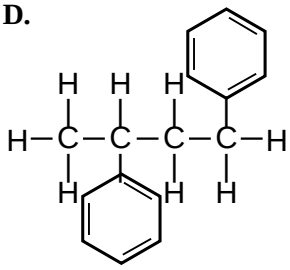


The monomer for this polymer would be

A. 

B. 

C. 

D. 

Question 15

You are in a car that is taken through four cleaning steps in a commercial car wash.

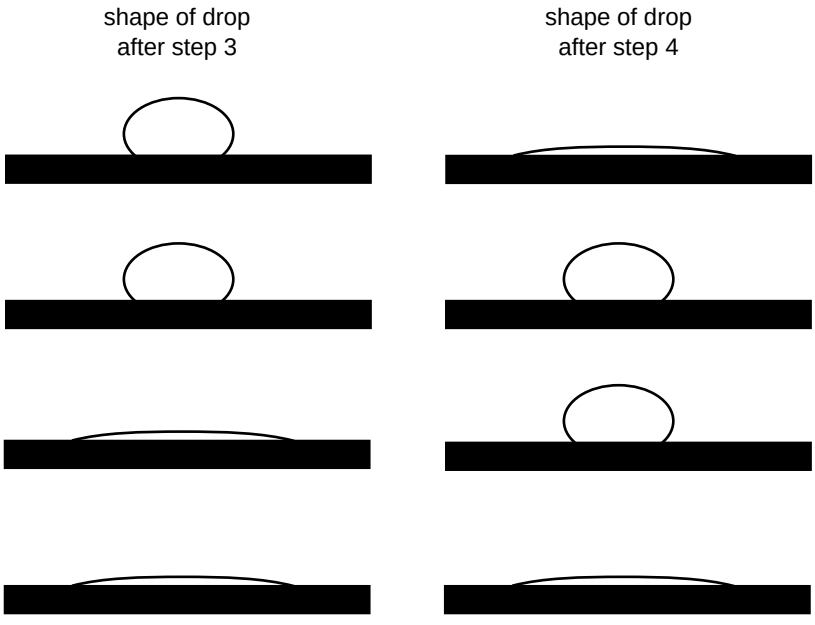
Step 1: A mixture of detergent and water is sprayed onto the car and brushes scrub the car's surface.

Step 2: The car is rinsed and a second spray of detergent and water is applied.

Step 3: The car is rinsed thoroughly to remove all traces of the detergent.

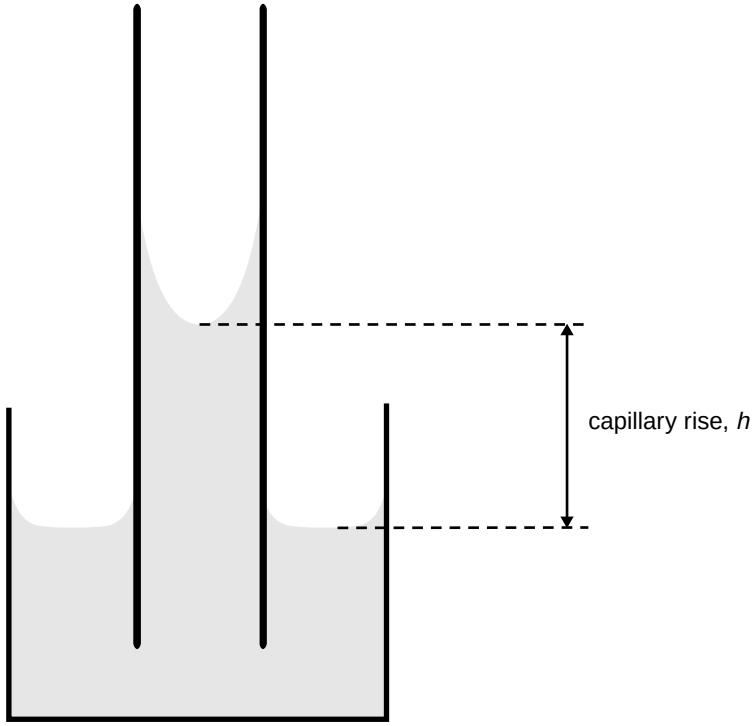
Step 4: Wax is applied to the car to protect the surface.

Imagine the shapes of the drops of water that are on the roof of the car at the end of steps 3 and 4. The shapes would be best represented as:



The following information is referred to in Questions 16 and 17.

Shown below is a representation of a liquid rising up a very narrow glass capillary. The case illustrated shows a liquid such as water that wets glass. The height to which the water rises in the capillary is given by *h.*



Question 16

Comparing a sample of pure water and an aqueous solution of a detergent, the detergent solution would have a

A. higher surface tension than water and a higher value of *h.*

B. higher surface tension than water and a lower value of *h.*

C. lower surface tension than water and a higher value of *h.*

D. lower surface tension than water and a lower value of *h.*

Question 17

Two liquids, A and B, have identical surface tensions. However, liquid A wets glass while liquid B does not wet glass. Comparing these two liquids,

A. the value of *h* would be the same for both A and B.

B. both liquids would have positive values of *h*, but *h* would be greater for A than for B.

C. both liquids would have positive values of *h*, but *h* would be smaller for A than for B.

D. liquid A would have a positive value of *h* while liquid B would have a negative value of *h.*

Question 18

Two drops of mercury are close to each other on a clean glass surface. The glass is moved slightly and the two drops collide, quickly combining to form a single larger drop. The best explanation for this observation is that

A. the total surface energy of the mercury is lowered.

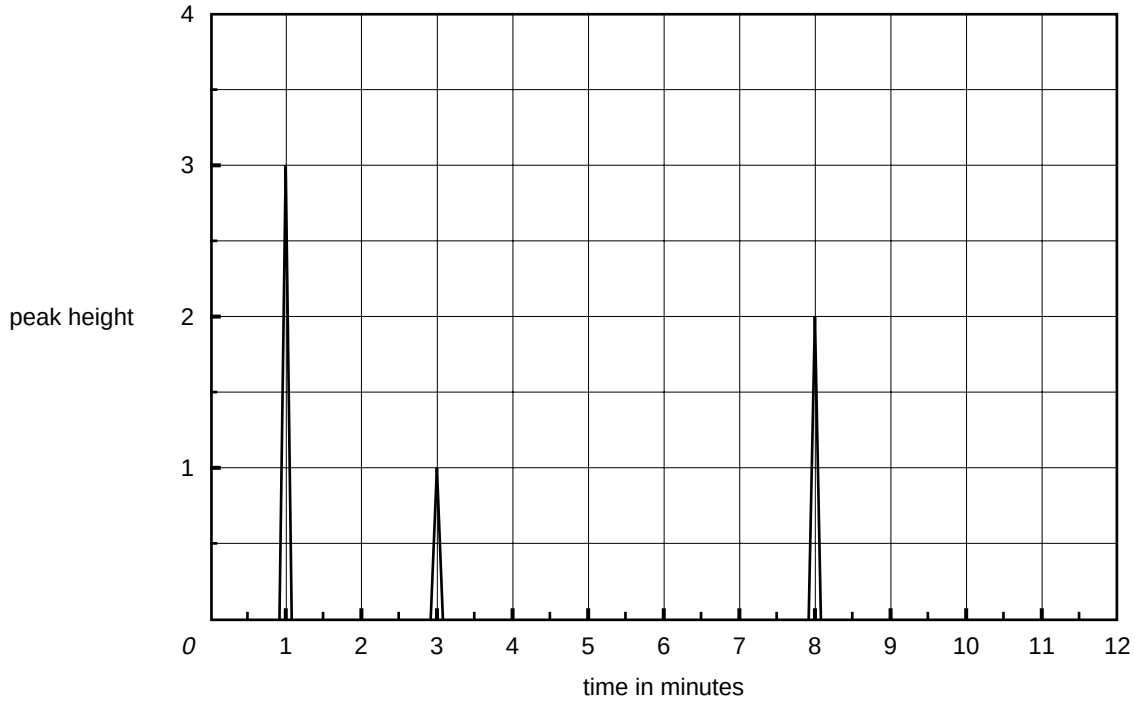
B. the contact angle between the mercury and the glass is decreased.

C. the surface tension of the mercury is lowered.

D. mercury does not wet clean glass.

Question 19

A mixture of butane (C_4H_{10}), pentane (C_5H_{12}) and hexane (C_6H_{14}) was analysed in a gas-liquid chromatography column. The following output was obtained.



Given that the sensitivity of the detector is the same per mole for all three substances, the mole percentage of hexane in the sample is closest to

A. 20

B. 30

C. 33

D. 50

Question 20

Which combination of the following factors will affect the time taken for a sample to pass through a high-performance liquid chromatography column?

I temperature

II length of the column

III flow rate of the carrier gas

A. I and II

B. II and III

C. I and III

D. I, II and III

END OF SECTION A
TURN OVER

SECTION B

Specific instructions for Section B

Section B consists of six short-answer questions numbered 1 to 6; you must answer all of these questions. This section is worth 48 marks which is approximately 71 per cent of the total. You should spend approximately 64 minutes on this section.

The marks allotted to each question are shown at the end of each question.

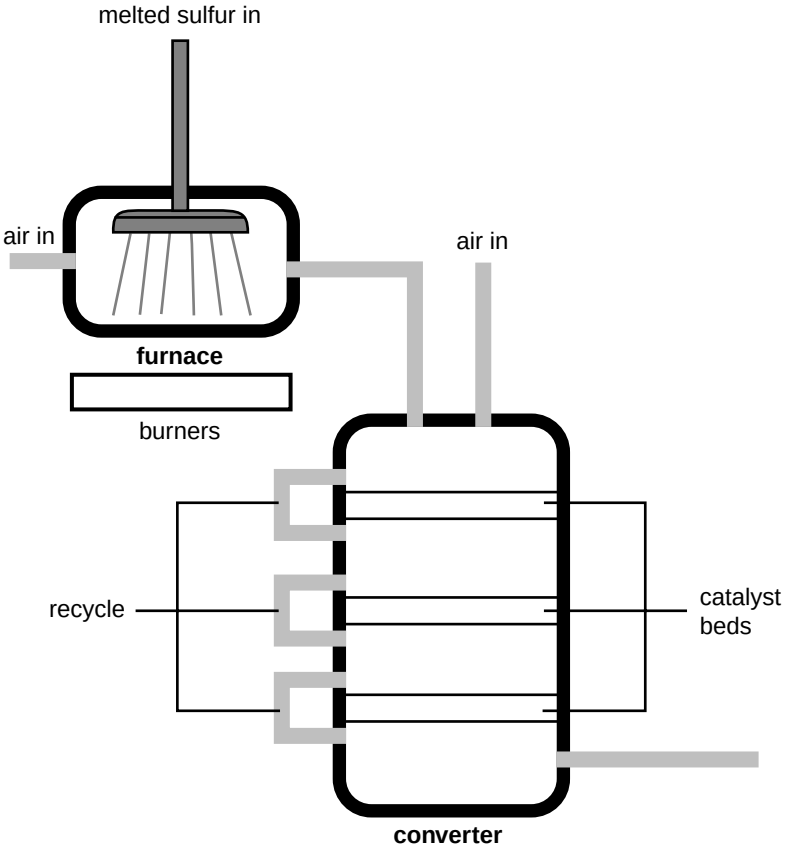
Questions must be answered in the spaces provided in this book.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- 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 all chemical equations are balanced and that the formulas for individual substances include an indication of state (for example, $H_2(g)$; NaCl(s)).

Question 1

Below is a diagram illustrating the first two stages of the **contact** process for the production of sulfuric acid.



a. Give the equation for

the reaction occurring in the furnace

_____

the reaction occurring in the converter

_____

2 marks

b. The reaction occurring in the converter is reversible and exothermic. Given that equilibrium is achieved in the converter, state two conditions that will help maximise the amount of the desired product.

2 marks

c. In this process it is desirable to maximise the contact between the catalyst and the reactant. Explain how this is achieved in the converter.

2 marks

d. Write an equation to show sulfuric acid acting as an acid.

1 mark

e. Write an equation to show sulfuric acid acting as an oxidant.

1 mark

f. Give the formula of a compound that would be dehydrated by reaction with concentrated sulfuric acid.

1 mark

Total 9 marks

Question 2

The substances in the table below are referred to in the rest of this question.

$CH_3CH_2CH=CH_2$	H_2O	Fe	Fe_2O_3
N_2	$CaCO_3$	NH_3	C (coke)
HNO_3	CO_2	$CH_3CH_2CH_3$	$CH_3CH_2CH_2SO_3H$
Cl_2	CO	SO_2	H_2O_2

a. Select two substances from the above table that can undergo a redox reaction together.

the oxidant _____ the reductant _____

Write an equation for the reaction.

_____

2 marks

b. Write an equation (different from the one you have given in **a.**) in which two substances from the above table react together to form a gas.

_____

1 mark

c. Identify a substance from the above table that can be made to polymerise.

_____

1 mark

d. **i.** Identify a substance from the above table that can act as a surfactant.

_____

ii. Describe the two features of your chosen molecule that are responsible for its ability to act as a surfactant.

_____

_____

_____

1 + 2 = 3 marks

e. Select one substance from the above table which is a common atmospheric pollutant and identify a common source of that particular pollutant.

_____

_____

2 marks

Total 9 marks

Question 3

Peter is preparing a salad. He makes a simple salad dressing by mixing three parts of olive oil with one part of vinegar and shaking the mixture. However, the mixture quickly separates into two layers on standing. When some fresh egg yolk is added to the mixture and it is again shaken, a stable emulsion is formed that does not quickly separate into two layers.

a. What type of substance must be present in the egg yolk in order to have this effect?

1 mark

b. Describe two simple tests that would enable you to determine whether a salad dressing is an oil-in-water emulsion or a water-in-oil emulsion.

2 marks

c. Given that your tests indicate that the salad dressing is an oil-in-water emulsion, what results would have been obtained in your tests?

1 mark

d. Sketch and label a diagram of the structure of the emulsion, illustrating how the substance in the egg yolk keeps the two liquids from separating.

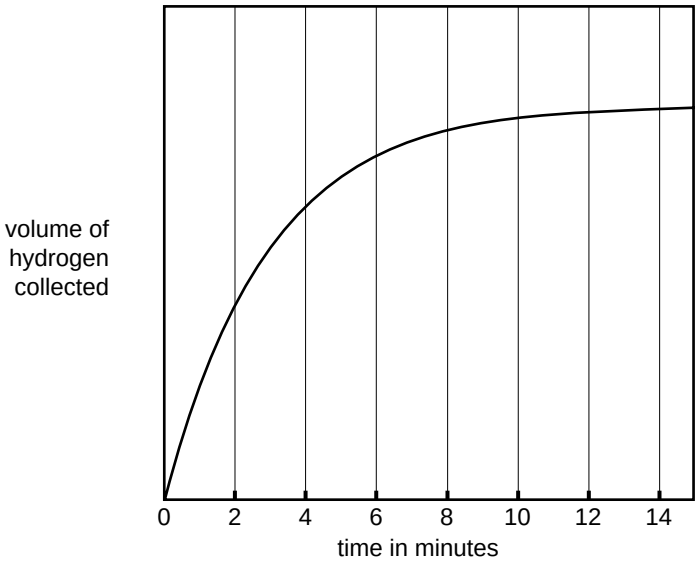
3 marks

Total 7 marks

Question 4

0.012 g of powdered magnesium was added to 250 mL of 0.010 M hydrochloric acid. (This was more than enough hydrochloric acid to react completely with all the magnesium.) The hydrogen gas produced was collected in a gas syringe and its volume recorded every minute. During this time the temperature of the syringe was held at 23 ^{o}C.

The following graph shows the volume of hydrogen collected every minute at 23 ^{o}C at a pressure of 102.0 kPa.



a. Write an equation for the reaction that occurs.

1 mark

b. What amount, in mole, of hydrochloric acid will have been used up when the reaction is complete?

2 marks

c. What volume of hydrogen in mL will have been collected in the syringe when the reaction is complete?

3 marks

d. The reaction between magnesium and hydrochloric acid described above is repeated at a higher temperature, with all other conditions the same. On the axes above, sketch the graph you would expect to obtain.

1 mark

Total 7 marks

SECTION B – continued

Question 5

A local chemical manufacturer uses the process of catalytic cracking to prepare ethene and propene.

a. **i.** Give the structure of one molecule that could be fed into the cracking tower to produce either ethene (C_2H_4) or propene.

ii. Draw the structures of ethene and propene.

1 + 2 = 3 marks

b. Ethene can be reacted further to produce a variety of widely used chemicals. Complete each of the four reactions given below.

Reaction 1: $C_2H_4 \xrightarrow{H_2O/\text{catalyst}}$

Draw the structure of the product.

Give the name of the product of reaction 1. _____

Reaction 2: $C_2H_4 \xrightarrow{H_2/\text{catalyst}}$

Draw the structure of the product.

Give the name of the product of reaction 2. _____

Reaction 3: $C_2H_4 \xrightarrow{HBr}$

Draw the structure of the product.

Reaction 4: $C_2H_4 \xrightarrow{\text{catalyst}}$

Draw the structure of the product.

6 marks

Total 9 marks

Question 6

Five vitamin C tablets (vitamin C = ascorbic acid, $C_6H_8O_6$) of total mass 6.67 g were crushed and dissolved in 200.0 mL of distilled water. A 25.00 mL sample was taken from the solution and quickly titrated against a standardised iodine solution whose concentration was 0.110 M. Starch was used as an indicator. The titration was then carefully repeated three more times. The following gives the complete set of titres obtained.

Titration number	Titration in mL
First	26.5
Second	25.10
Third	25.21
Fourth	25.17

The equation for the reaction is

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

a. Imagine you had performed this experiment in the laboratory and had obtained the set of titration results shown above. Examine the titres given and then calculate the average titre you would use to calculate the concentration of the vitamin C solution.

1 mark

b. What amount, in mole, of molecular iodine reacted with the ascorbic acid?

2 marks

c. What amount, in mole, of ascorbic acid was present in the 200 mL of the ascorbic acid solution?

1 mark

d. What mass of ascorbic acid was present in each vitamin C tablet?

2 marks

e. What is the percentage by mass of ascorbic acid in each tablet?

1 mark

Total 7 marks

END OF QUESTION AND ANSWER BOOK