SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

Victorian Certificate of Education 2000

CHEMISTRY

Written examination 1

Tuesday 13 June 2000: 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 that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
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 44 marks.
Section B questions should be answered in the spaces provided in this book.
There is a total of 64 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 31 per cent of the marks available. You should spend approximately 28 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

Choose the best systematic name of the compound

$$CH_3CH_2CH_2CHCl.CH_2CH_3$$

A. 4-chlorohexane

B. 3-chlorohexane

C. 4-chloroheptane

D. 3-chloroheptane

Question 2

The number of structural isomers of C_4H_9Cl is

A. 2

B. 3

C. 4

D. 5

Question 3

100 mL of a 0.010 M solution of barium hydroxide ($Ba(OH)_2$) is diluted by adding 900 mL of water at 25 ºC. The pH of the resulting solution will be

A. 2.00

B. 2.70

C. 11.00

D. 11.30

Question 4

In which one of the following pairs is the second substance a stronger acid than the first?

A. HCl CH_3COOH

B. $H_2PO_4^-$ H_3PO_4

C. H_2SO_4 H_2CO_3

D. H_2O OH^-

Question 5

20.0 mL of 0.10 M HCl is added to 20.0 mL of an unknown solution. The pH of the resulting mixture is measured and found to be 2.0. The unknown solution could have been

A. 0.20 M NaOH

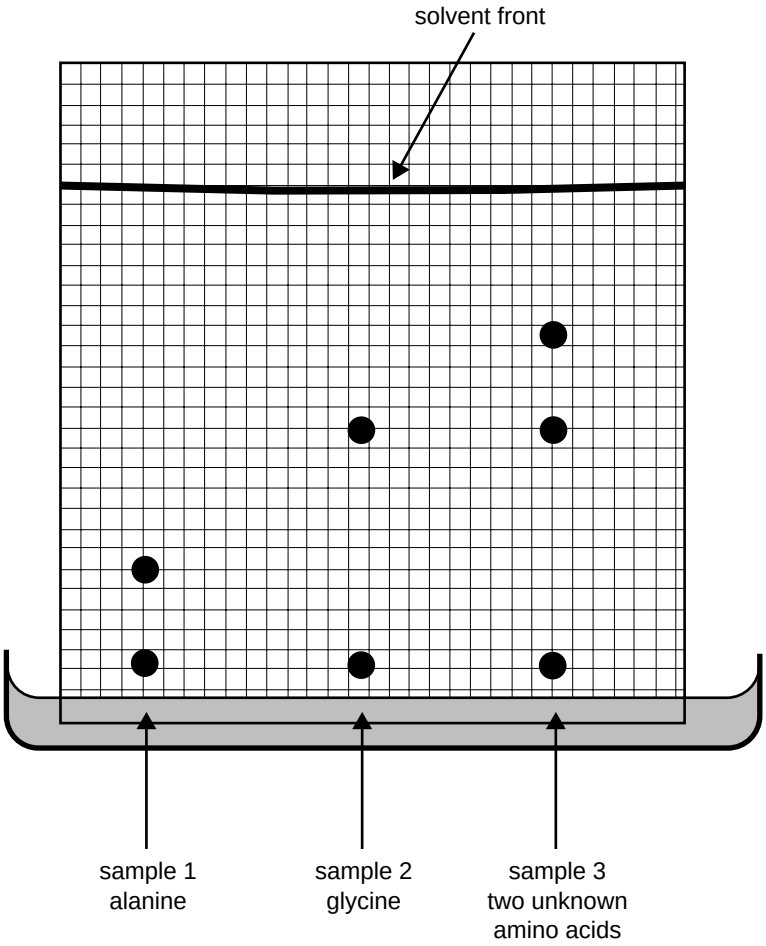
B. 0.10 M KOH

C. 0.04 M $Ca(OH)_2$

D. 0.0010 M HCl

The following information is referred to in Questions 6 and 7.

Three samples containing amino acids are placed at the same time on a sheet of chromatographic paper as shown below. Sample 1 contains alanine only; sample 2 contains glycine only; and sample 3 contains equal amounts of two unknown amino acids. The result of the chromatography experiment is shown in the figure below.



Question 6

The R_f value for alanine is

A. 0

B. 0.2

C. 0.8

D. 1.0

Question 7

We can conclude that the 'unknown' sample

A. contains glycine and may contain alanine.

B. does not contain alanine and may contain glycine.

C. does not contain alanine or glycine.

D. contains both alanine and glycine.

Question 8

Ammonium sulfate, $(NH_4)_2SO_4$, can be used as a source of soluble nitrogen for plants. The mass of nitrogen in 1 tonne (1000 kg) of ammonium sulfate, in kilograms, is

A. 106

B. 136

C. 212

D. 272

Question 9

A sample of 1.00 g of a pesticide is analysed for its arsenic content by precipitation of the arsenic as the sulfide, As_2S_3. If 0.123 g of the sulfide is obtained, the percentage by mass of arsenic in the pesticide is

A. 3.75

B. 7.50

C. 37.5

D. 75.0

Question 10

A sample of a high-performance fuel used by racing cars is thought to be contaminated. Chemists suspect that the contaminant is a carbon-based (organic) compound. Which one of the following analytical techniques would you expect to be the most useful in helping to identify the nature of the contaminant?

A. flame test

B. atomic absorption spectroscopy

C. acid-base titration

D. chromatography

Question 11

An aqueous solution of the weak acid, nitrous acid (HNO_2), is prepared at 25 °C. At equilibrium, the concentration of the molecular substance HNO_2 is measured to be 0.090 M and the pH of the solution is measured to be 2.19. The acidity constant K_a of nitrous acid at 25 °C is

A. 7.1×10^{-2}

B. 4.6×10^{-4}

C. 5.8×10^{-4}

D. 3.7×10^{-6}

Question 12

Gas X reacts with gas Y to produce gas Z. In a particular reaction some X and Y are reacted in a 2.0 L vessel. When equilibrium is reached, the vessel is found to contain 4.0 mol of X, 1.0 mol of Y and 3.0 mol of Z. At the temperature of the experiment, the numerical value of the equilibrium constant is 3.4. Which one of the following equations is consistent with the above information for this reaction?

A. $X(g) + Y(g) \rightleftharpoons Z(g)$

B. $X(g) + Y(g) \rightleftharpoons 2Z(g)$

C. $X(g) + Y(g) \rightleftharpoons 3Z(g)$

D. $4X(g) + Y(g) \rightleftharpoons 3Z(g)$

The following information is referred to in Questions 13 and 14.

The reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g);\ \Delta H = -197 \text{ kJ mol}^{-1}$$

is an important step in the industrial production of sulfuric acid when it occurs in the presence of a solid vanadium pentoxide catalyst.

Question 13

The above reaction would **achieve equilibrium most rapidly** under conditions of

A. high temperature and a high flow rate over the catalyst.

B. low temperature and a high flow rate over the catalyst.

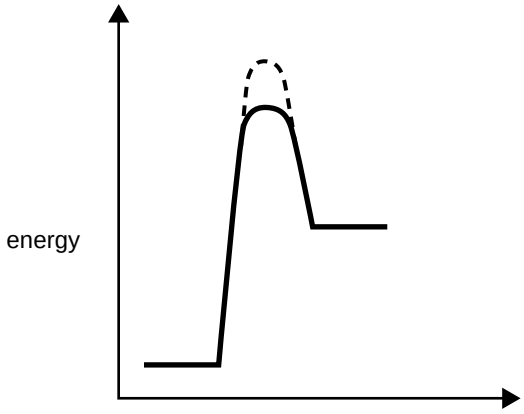
C. high temperature and a low flow rate over the catalyst.

D. low temperature and a low flow rate over the catalyst.

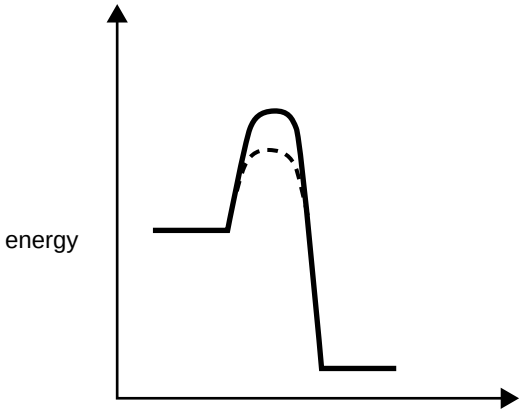
Question 14

Which one of the following energy profiles best illustrates the energy change of the reaction both in the absence (solid lines) and presence (dotted lines) of a catalyst.

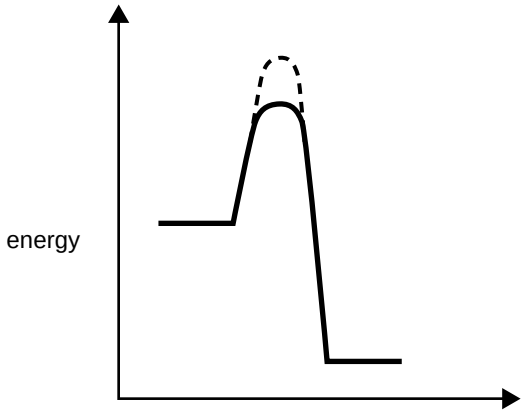
A.



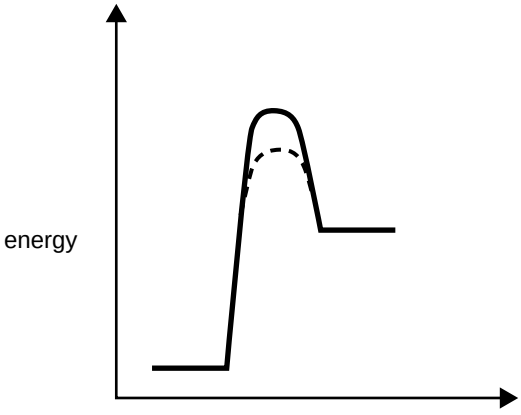
B.



C.



D.



Question 15

In general, when a chemical reaction reaches equilibrium,

A. the rate of the forward reaction is less than when the reactants were first mixed.

B. all the reactants have been used up.

C. the concentration of the products is greater than the concentration of the reactants.

D. the concentration of the reactants is greater than the concentration of the products.

Question 16

Deuterium, symbol D, is an isotope of hydrogen. The molecule HD may be prepared from a mixture of pure H_2 and pure D_2 by establishing the equilibrium

$$H_2(g) + D_2(g) \rightleftharpoons 2HD(g)$$

The equilibrium constant for this reaction is 1.92 at 100 ^oC and 3.37 at 500 ^oC. To maximise the yield of HD the reaction is carried out at 500 ^oC where the equilibrium constant for the formation of HD is greater. It follows that the reaction is

A. endothermic – and the yield of HD would be unaffected by the pressure.

B. endothermic – and the yield of HD could be increased by carrying out the reaction at a high pressure.

C. exothermic – and the yield of HD would be unaffected by the pressure.

D. exothermic – and the yield of HD could be increased by carrying out the reaction at a high pressure.

Question 17

Polyvinyl chloride or 'PVC' is a common plastic that is made by polymerising vinyl chloride, $CHCl=CH_2$. The structure of PVC is best represented as

A. –CHCl.CHCl.CHCl.CHCl.CHCl.CHCl.CHCl.CHCl.CHCl.CHCl–

B. –CHCl.CH_2.CHCl.CH_2.CHCl.CH_2.CHCl.CH_2.CHCl.CH_2–

C. –CHCl.CH_2.CH_2.CH_2.CHCl.CH_2.CH_2.CH_2.CHCl.CH_2–

D. –CHCl.CHCl.CHCl.CH_2.CH_2.CHCl.CHCl.CHCl.CH_2CH_2–

Question 18

A major component of some nail polish removers is ethyl ethanoate. The correct formula for ethyl ethanoate is

A. $CH_3CO.OC_2H_5$

B. $C_2H_5CO.OCH_3$

C. $CH_3CO.OCH_3$

D. $C_2H_5CO.OC_2H_5$

Question 19

Which one of the following reactions shows sulfuric acid acting as an oxidising agent?

A. $H_2SO_4(aq) + ZnCO_3(s) \rightarrow ZnSO_4(aq) + CO_2(g) + H_2O(l)$

B. $3H_2SO_4(aq) + Fe_2O_3(s) \rightarrow Fe_2(SO_4)_3 + 3H_2O(l)$

C. $5H_2SO_4(aq) + 4Zn(s) \rightarrow H_2S(g) + 4ZnSO_4(aq) + 4H_2O(l)$

D. $H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7(l)$

Question 20

At 25 ^oC, the K_w of water is

A. greater than 10^{-7} in alkaline solution and less than 10^{-7} in acidic solution.

B. less than 10^{-7} in alkaline solution and greater than 10^{-7} in acidic solution.

C. equal to 10^{-7} in both acidic and alkaline solutions.

D. equal to 10^{-14} in both acidic and alkaline solutions.

END OF SECTION A

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 44 marks which is approximately 69 per cent of the total. You should spend approximately 62 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

a. Primary standards for volumetric analysis are used in analytical procedures to standardise solutions. Give **two** characteristics of a primary standard.

2 marks

b. Anhydrous sodium carbonate, Na_2CO_3, is a suitable primary standard that can be used to prepare a standard solution of hydrochloric acid. Describe, in detail, how you would prepare 250 mL of 0.10 M sodium carbonate solution, given a sample of pure anhydrous Na_2CO_3. Include in your answer the relevant calculations you would need to carry out.

You may present your answer as a flow chart or in point form.

5 marks

Total 7 marks

Question 2

People in many countries around the world celebrated the recent arrival of a new century with colourful fireworks displays. Few probably realised the role chemistry played in these displays.

a. A rocket is powered by a controlled exothermic reaction between two or more solids that generates a large volume of hot gas which propels the rocket upwards. The following reaction is suggested as the basis of a simple rocket propellant.

$$\text{Solid oxidant} + 3C(s) \rightarrow 3CO_2(g) + \text{other solid products}$$

A particular rocket contains 24 g of carbon together with excess oxidant. When the rocket is fired, the strongly exothermic reaction described above causes the CO_2 gas to be formed and ejected at a temperature of 500 ^oC. If the reaction occurs steadily over a 6-second period of time, calculate the volume of gas formed, in litres per second, at 500 ^oC and a pressure of one atmosphere.

4 marks

b. In making a rocket, the size of the particles packed in the mixture must be carefully controlled. Suggest a reason why particle size is so important.

1 mark

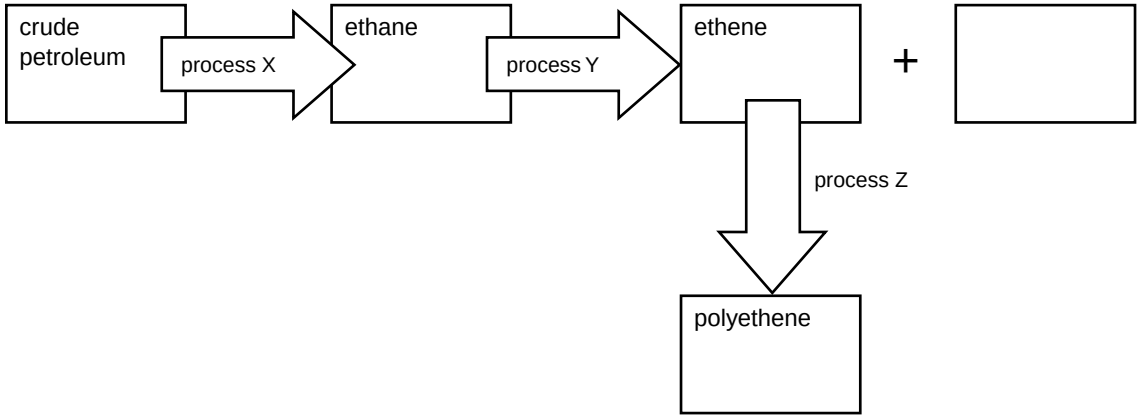
c. Many rockets used in fireworks displays are designed to explode in a shower of coloured light when they are well above the ground. Different metal salts are added to a rocket to produce the colour in the explosion. Strontium salts, for example, produce red light while barium salts produce green light and sodium salts yellow light. Explain how the presence of different salts produces light of different colours as the rocket explodes.

3 marks

Total 8 marks

Question 3

The simplified flowchart below refers to a production of polyethene from crude petroleum.



a. What name is given to process X?

_____

1 mark

b. What name is given to process Y?

_____

1 mark

c. In the empty box in the flowchart, give the formula of the other product when ethene is formed by process Y.

1 mark

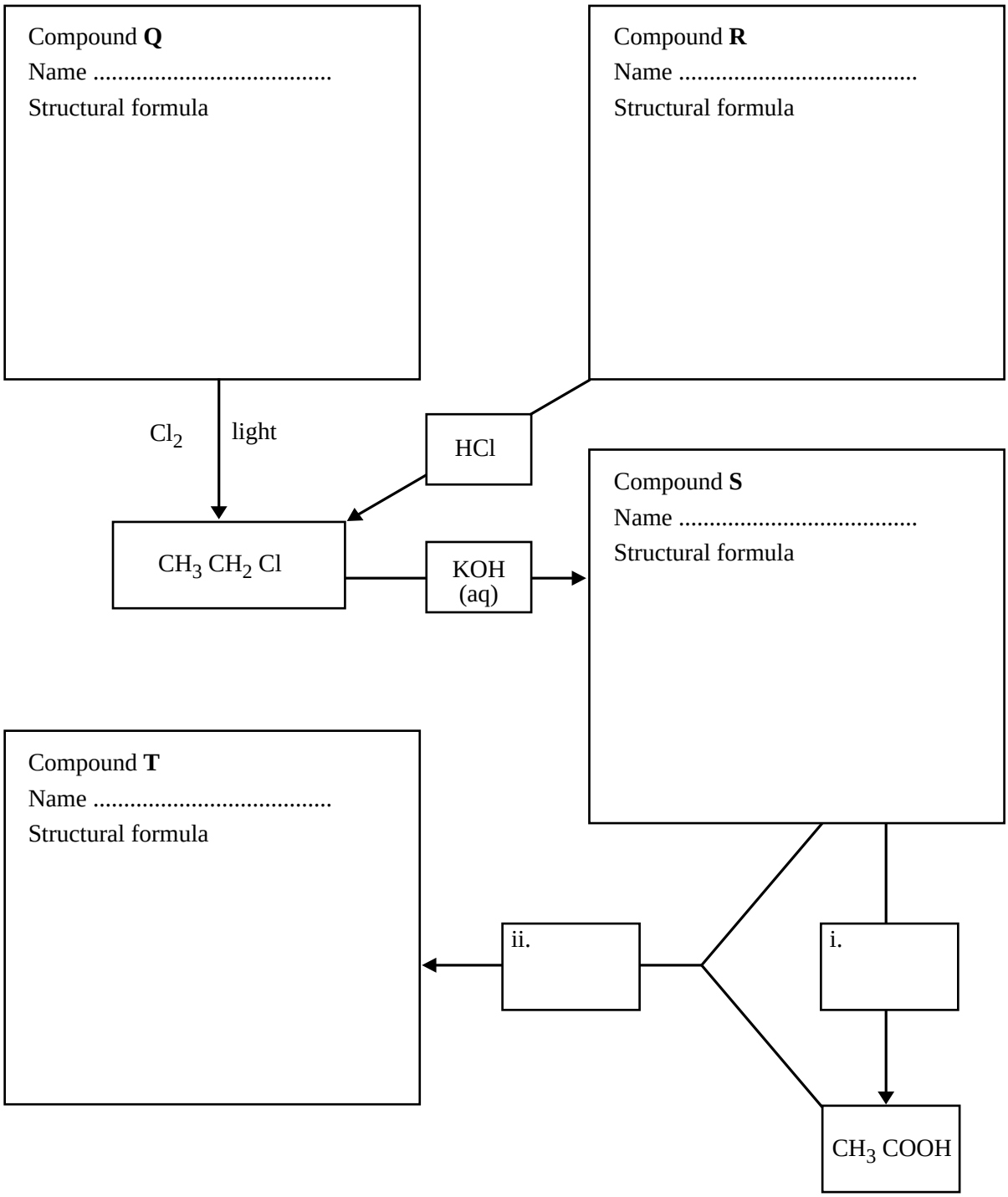
d. Write an equation showing the formation of polyethene from ethene.

1 mark

Total 4 marks

Question 4

Consider the following scheme which shows the reactions of some simple organic molecules.



a. Write in the name and structural formula of each of the compounds Q, R, S and T.

4 marks

b. In the boxes provided, give the formulas of the

i. reactant(s) needed for the conversion of compound S to CH_3COOH

ii. catalyst needed for the reaction between compound S and CH_3COOH to give compound T.

1 + 1 = 2 marks

c. Classify the organic reactions given below by their class (that is, as substitution, addition or condensation reactions) by ticking **one** box in the table for each reaction.

chemical reaction	substitution reaction	addition reaction	condensation reaction
$CH_2{=}CHCH_2CH_3(g) + H_2(g) \xrightarrow{\text{catalyst}}$			
$C_2H_4(g) + H_2O(g) \xrightarrow{\text{catalyst}}$			
$HCOOH(aq) + CH_3CH_2CH_2CH_2OH(aq) \xrightarrow{\text{catalyst}}$			
$CH_3CH_2CH_2CH_3(g) + Cl_2(g) \xrightarrow{\text{light}}$			
$CH_3CH_2CH_2Cl(aq) + OH^-(aq) \xrightarrow{\text{catalyst}}$			

5 marks

Total 11 marks

CONTINUED OVER PAGE

Question 5

On the label of a 750 mL bottle of white wine is the statement

13.5% Alc/Vol
CONTAINS APPROX 8 STANDARD DRINKS

Note: 13.5% Alc/Vol means that every 100 mL of the wine contains 13.5 mL of pure ethanol, C_2H_5OH. The density of pure ethanol is 0.790 g mL^{-1} at room temperature.

a. Calculate the volume of ethanol in one 750 mL bottle of the wine at room temperature.

1 mark

b. Calculate, to the nearest gram, the mass of ethanol in one standard drink.

2 marks

One way to determine the alcohol content in wine involves the oxidation of ethanol to ethanoic acid (CH_3COOH) using acidified dichromate as the oxidant. The equation for the oxidation of ethanol with dichromate in acid solution is

$$2Cr_2O_7^{2-}(aq) + 16H^+(aq) + 3C_2H_5OH(aq) \rightarrow 3CH_3COOH(aq) + 4Cr^{3+}(aq) + 11H_2O(l)$$

c. The half equation for dichromate as an oxidant is

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

Write the half equation for the oxidation of ethanol to ethanoic acid in acid solution.

1 mark

d. A 10.0 mL sample of this white wine was diluted to 250 mL in a volumetric flask. Then 25.0 mL aliquots of the diluted wine were titrated against 0.0750 M acidified potassium dichromate solution ($K_2Cr_2O_7$). The mean titre was 20.61 mL.

i. Calculate the number of mole of $Cr_2O_7^{2-}$ reacting with the 25.0 mL aliquot.

ii. Calculate the number of mole of ethanol in the 25.0 mL aliquot.

iii. Calculate the number of mole of ethanol in the 10.0 mL sample of white wine.

1 + 1 + 1 = 3 marks

Total 7 marks

Question 6

Methanol, CH_3OH, can be used as a fuel. The reaction for the commercial production of methanol can be represented by the equation

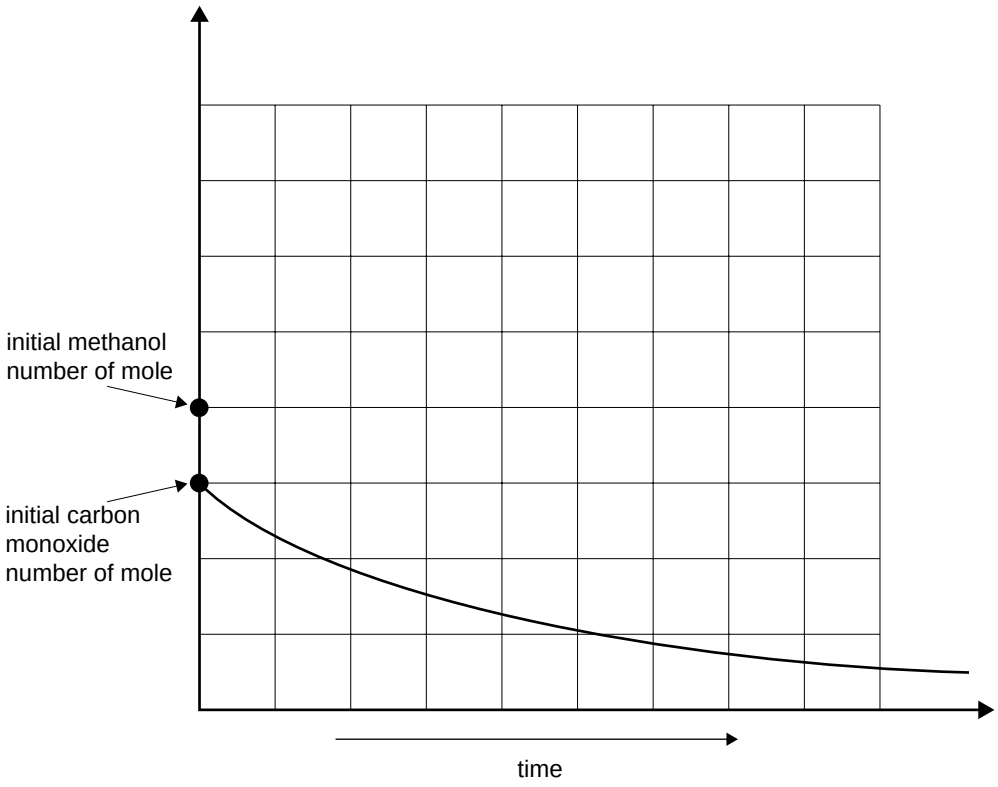
$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g); \Delta H = -90 \text{ kJ mol}^{-1}$$

a. The following changes are made to a gaseous equilibrium mixture of CO, H_2 and CH_3OH at 300 ºC. Indicate in the table below the effects on the masses of CO, CH_3OH and H_2 present at equilibrium by entering the words 'increase' or 'decrease' as appropriate.

change	effect on mass of CO(g) at equilibrium	effect on mass of $CH_3OH(g)$ at equilibrium	effect on mass of $H_2(g)$ at equilibrium
More H_2 is added at constant temperature and volume.			
The volume of the vessel is increased at constant temperature.			

6 marks

b. The following graph represents the change in the number of mole of carbon monoxide with time during an experiment in which the volume of the vessel is changed at constant temperature.



On this graph sketch and label a line showing how the number of mole of methanol would have changed over the same period of time.

1 mark

Total 7 marks

END OF QUESTION AND ANSWER BOOK

CHEMISTRY

Written examination 1

DATA SHEET

Directions to students

Detach this data sheet during reading time.

This data sheet is provided for your reference.

Physical constants

$F = 96\,500\ \text{C mol}^{-1}$

$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$

1 atm = 101 325 Pa = 760 mmHg

0 °C = 273 K

Ideal gas equation

$pV = nRT$

The electrochemical series

	$E°$ in volt
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightarrow Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(1)$	+1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$S(s) + 2H^+(aq) + 2e^- \rightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	–1.03
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.34
$Na^+(aq) + e^- \rightarrow Na(s)$	–2.71
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	–2.87
$K^+(aq) + e^- \rightarrow K(s)$	–2.93
$Li^+(aq) + e^- \rightarrow Li(s)$	–3.02

Periodic table of the elements

1 H 1.0																	2 He 4.0
3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.1
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 44.9	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.6	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.1	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 197.0	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)															

Lanthanides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.3	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0

Actinides

90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (255)	103 Lr (256)

END OF DATA SHEET