SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2001

CHEMISTRY

Written examination 1

Tuesday 12 June 2001

Reading time: 11.45 am to 12 noon (15 minutes)
Writing time: 12 noon to 1.30 pm (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	22	22	22
B	5	5	53
			Total 75

Materials
- Question and answer book of 18 pages, with a detachable data sheet in the centrefold.
- Answer sheet for multiple-choice questions.
- At least one pencil and an eraser.
- One approved graphics calculator (memory cleared) and/or one scientific calculator.

Instructions
- Detach the data sheet from the centre of this book during reading time.
- Write your **student number** in the space provided on this book.
- Check 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.
- All written responses should be in English.

At the end of the examination
- 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 22 multiple-choice questions. Section A is worth approximately 30 per cent of the marks available. You should spend approximately 27 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 mass of one molecule of propane (C_3H_8), in gram, is

A. 44

B. $44 \times 6 \times 10^{23}$

C. $\frac{44}{6 \times 10^{23}}$

D. $\frac{6 \times 10^{23}}{44}$

Question 2

When the pH of a solution changes from 9 to 12 the

A. hydroxide ion concentration increases by a factor of 3.

B. hydrogen ion concentration increases by a factor of 3.

C. hydroxide ion concentration decreases by a factor of 1000.

D. hydrogen ion concentration decreases by a factor of 1000.

Question 3

10 mL of 0.1 M HCl is added to 1.0 L of water.

The pH of the resulting solution is most nearly

A. 1

B. 2

C. 3

D. 4

Question 4

18.0 g of magnesium is added to 200 mL of 2.00 M HCl.

The mass, in gram, of magnesium that is left behind after the reaction is closest to

A. 4.2

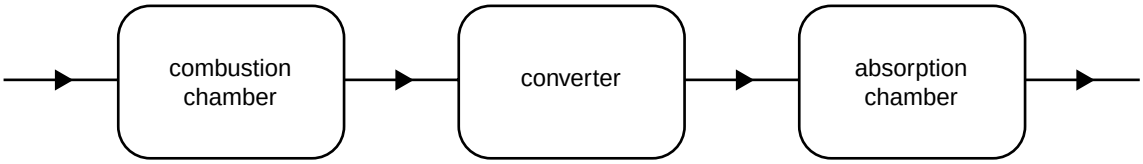
B. 8.4

C. 13.2

D. 15.6

The following information is referred to in Questions 5, 6 and 7.

The flow chart for the production of sulfuric acid is



Question 5

The chemicals formed in the combustion chamber and the absorption chamber are respectively

	combustion chamber	absorption chamber
A.	SO_2	H_2SO_4
B.	SO_3	H_2SO_4
C.	SO_2	$H_2S_2O_7$
D.	SO_3	$H_2S_2O_7$

Question 6

Which one of the following statements relating to the production of sulfuric acid is **incorrect**?

A. In the combustion chamber, the reaction that takes place is the oxidation of sulfur.

B. In the converter, beds of catalyst ensure efficient conversion of the incoming reactants.

C. In the converter, the pressure is normally several hundred atmospheres.

D. In the converter, the temperature is normally between 400ºC and 500ºC.

Question 7

In the reaction

$$H_2SO_4\,(l) + H_2O\,(l) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$$

H_2SO_4 behaves as

A. an oxidant.

B. a reductant.

C. a dehydrating agent.

D. an acid.

Question 8

A 1 M aqueous solution of nitric acid is

A. mostly ionised and a good conductor of electricity.

B. partially ionised and a good conductor of electricity.

C. mostly ionised and a poor conductor of electricity.

D. partially ionised and a poor conductor of electricity.

The following information is referred to in Questions 9, 10 and 11.

Nitrous acid ionises in water according to the following equation.

$$HNO_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$$

450 mL of water is added to a 50 mL solution of nitrous acid at constant temperature.

Question 9

The acidity constant, K_a, for nitrous acid is given by

A. $\dfrac{[H_3O^+][NO_2^-]}{[HNO_2][H_2O]}$

B. $\dfrac{[H_3O^+][NO_2^-]}{[HNO_2]}$

C. $\dfrac{[HNO_2][H_2O]}{[H_3O^+][NO_2^-]}$

D. $\dfrac{[HNO_2]}{[H_3O^+][NO_2^-]}$

Question 10

As a result of the dilution, the

A. K_a of the acid decreases.

B. $[H_3O^+]$ in the solution increases.

C. pH of the solution increases.

D. K_a of the acid increases.

Question 11

As a result of the dilution, the amount in mole of

A. HNO_2 in solution increases.

B. H_3O^+ in solution increases.

C. H_3O^+ in solution decreases.

D. NO_2^- in solution remains constant.

Question 12

The following reaction was allowed to reach equilibrium.

$$U + V \rightleftharpoons xW$$

When the system is at equilibrium the concentration of each species present is

$$[U] = 0.3\ M \quad [V] = 0.4\ M \quad [W] = 0.5\ M$$

If the value of K is 1.04 for the given temperature of this experiment, then the value of x is

A. 1

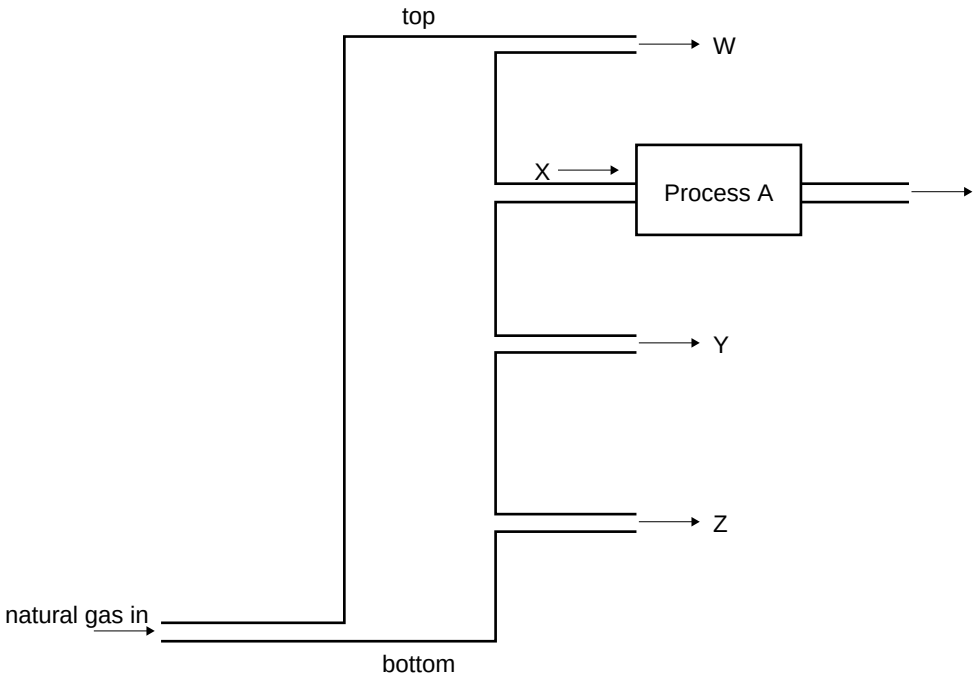
B. 2

C. 3

D. 4

The following information is referred to in Questions 13, 14 and 15.

Below is a diagram of a gas processing tower used for the fractional distillation of natural gas. The natural gas can be sourced from various locations and consists mainly of methane, ethane, propane and butane.



Question 13

The identities of W, X, Y and Z are

	W	**X**	**Y**	**Z**
A.	methane	ethane	propane	butane
B.	ethane	methane	propane	butane
C.	ethane	propane	butane	methane
D.	butane	propane	ethane	methane

Question 14

Which of W, X, Y and Z is removed at the lowest temperature?

A. W
B. X
C. Y
D. Z

Question 15

Process A immediately follows the fractional distillation.

This process is most likely to be

A. reduction.
B. hydration.
C. chlorination.
D. cracking.

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

The compounds HO–CH_2–CH_2–OH and HOOC–CH_2–COOH react together to form a polymer.

Question 16

The best representation of the polymer structure is

A. –O–CH_2–CH_2–O–CO–CH_2–CO–O–CH_2–CH_2–O–

B. –CO–CH_2–CH_2–CO–O–CH_2–O–CO–CH_2–CH_2–CO–

C. –CO–CH_2–CH_2–CO–O–CH_2–CH_2–O–CO–CH_2–CH_2–CO–

D. –O–CH_2–O–CO–CH_2–CO–O–CH_2–O–CO–CH_2–CO–

Question 17

The other product formed in the polymerisation is

A. hydrogen.

B. oxygen.

C. water.

D. carbon dioxide.

Question 18

A sample of a pure hydrocarbon is burnt in pure oxygen and yields 13.2 g of CO_2(g) and 5.40 g of H_2O(l).

The empirical formula of the hydrocarbon is

A. CH

B. CH_2

C. CH_3

D. CH_4

Question 19

When 50 mL of 2.00 M HCl, 100 mL of 1.00 M HCl and 100 mL of 0.500 M HCl are mixed together, the resulting HCl concentration of the solution is

A. 0.25 M

B. 1.00 M

C. 3.50 M

D. 6.25 M

Question 20

Methanoic acid, HCOOH, has a K_a of 1.8×10^{-4}. Ethanoic acid, CH_3COOH, has a K_a of 1.7×10^{-5}.

In comparison with the pH of a 0.10 M solution of ethanoic acid, the pH of a 0.10 M solution of methanoic acid is

A. lower, because methanoic acid is the stronger acid.

B. higher, because methanoic acid is the stronger acid.

C. lower, because methanoic acid is the weaker acid.

D. higher, because methanoic acid is the weaker acid.

The following information is referred to in Questions 21 and 22.

Oxygen is carried around the human body in the bloodstream as a hemoglobin complex. This complex is formed in the equilibrium

$$\underset{\text{hemoglobin}}{Hb_4} + 4O_2(g) \rightleftharpoons \underset{\text{oxyhemoglobin}}{Hb_4(O_2)_4}$$

The equilibrium constant for this reaction may be written as

$$K = \frac{\left[Hb_4(O_2)_4\right]}{\left[Hb_4\right]\left[O_2\right]^4}$$

Question 21

In freshly oxygenated blood, the ratio of oxyhemoglobin to hemoglobin, $\frac{\left[Hb_4(O_2)_4\right]}{\left[Hb_4\right]}$, is

A. $\frac{K}{\left[O_2\right]}$

B. $\frac{K}{\left[O_2\right]^4}$

C. $K[O_2]$

D. $K[O_2]^4$

Question 22

Carbon monoxide poisoning results from the displacement of oxygen by carbon monoxide. This deprives the body of oxygen.

The reaction responsible for this displacement is

A. $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$

B. $4CO(g) + Hb_4(O_2)_4 \rightleftharpoons Hb_4(CO)_4 + 4O_2(g)$

C. $8CO(g) + Hb_4(O_2)_4 \rightleftharpoons Hb_4 + 8CO_2(g)$

D. $2CO(g) + 4H_2O(l) + O_2(g) \rightleftharpoons 2H_3O^+(aq) + 2HCO_3^-(aq)$

END OF SECTION A
TURN OVER

SECTION B

Specific instructions for Section B

Section B consists of five short-answer questions numbered 1 to 5; you must answer all of these questions. This section is worth 53 marks which is approximately 70 per cent of the total. You should spend approximately 63 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

In an experiment to study various factors affecting the rate of a chemical reaction, a student weighed out **two** different samples of solid calcium carbonate ($CaCO_3$) each of mass 2.00 g. Each sample is placed in a flask on the top pan of an electronic balance as shown in Figure 1 below.

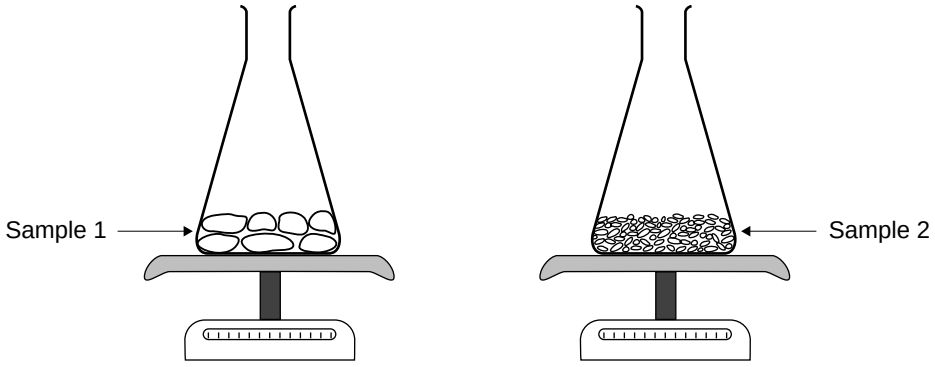


Figure 1

Sample 1 consists of large pieces of $CaCO_3$. Sample 2 consists of much smaller pieces of $CaCO_3$. 100 mL of 0.500 M HCl is added to sample 1 and the following reaction occurs at a temperature of 18ºC.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

The change of mass is recorded at 20 s intervals for the first 10 minutes of the reaction as shown in the graph in Figure 2 below.

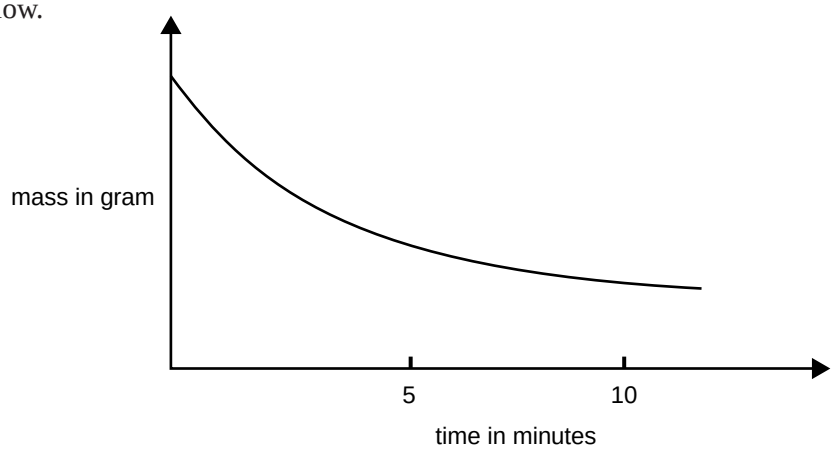


Figure 2

a. Considering the reaction of sample 1 with the HCl

i. assume that HCl is in excess. Calculate, in litres, the volume of CO_2 evolved at 18°C and one atmosphere pressure **when all the calcium carbonate has been used up**.

ii. calculate the total **change** in mass recorded by the balance **when all the calcium carbonate has been used up**.

iii. calculate the concentration of HCl remaining **when all the calcium carbonate has been used up**.

3 + 2 + 4 = 9 marks

b. A further experiment is carried out by adding 100 mL of 0.500 M HCl to sample 2, again recording the change of mass at 20 s intervals for 10 minutes.

Sketch on the graph (Figure 2) the result you would expect for sample 2 **and** give a reason for your answer.

2 marks

Total 11 marks

Question 2

The amount of ethanol in a white wine can be determined by colorimetry. A 0.50 mL sample of wine is diluted to 90 mL. 10.0 mL of 0.100 M acidified potassium dichromate ($K_2Cr_2O_7$) is added and the resulting test solution is warmed at 50°C for 15 minutes.

The reaction occurring is

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

a. Why is the test solution held at 50°C for 15 minutes before proceeding with the analysis?

1 mark

b. The amount of unreacted dichromate in the test solution is then determined by colorimetry. Aqueous solutions containing the dichromate ion are orange in colour. The colorimeter available for this analysis can be fitted with either a source of **orange light** or a source of **green light**. State which of these light sources you would choose for this analysis **and** give a reason for your choice.

1 mark

c. Using the calibration curve given in Figure 3 below, the concentration of dichromate in the test solution is found to be 0.0028 M.

What was the absorbance of the test solution?

1 mark

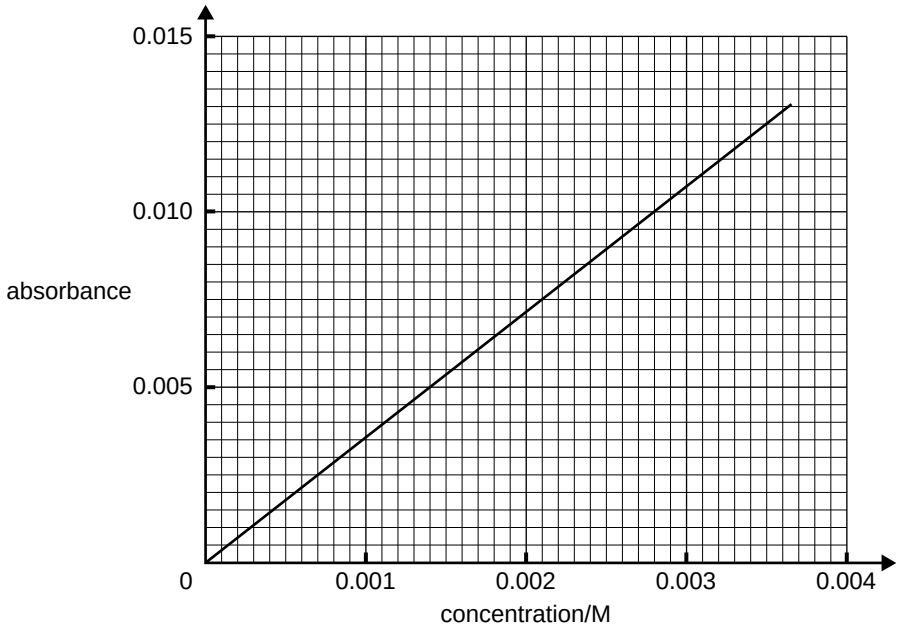


Figure 3

d. Calculate the amount, in mole, of ethanol that reacted with dichromate in the original test solution.

4 marks

e. Calculate the mass of ethanol per mL present in the original sample of white wine.

2 marks

Total 9 marks

Question 3

A small sample of a solution containing different coloured compounds is placed ('spotted') onto one end of a strip of filter paper. The paper is hung vertically so that the end is dipping into a solvent. The solvent soaks up the paper and patches of different colours are seen at various points on the paper.

a. What is the name given to this analytical technique?

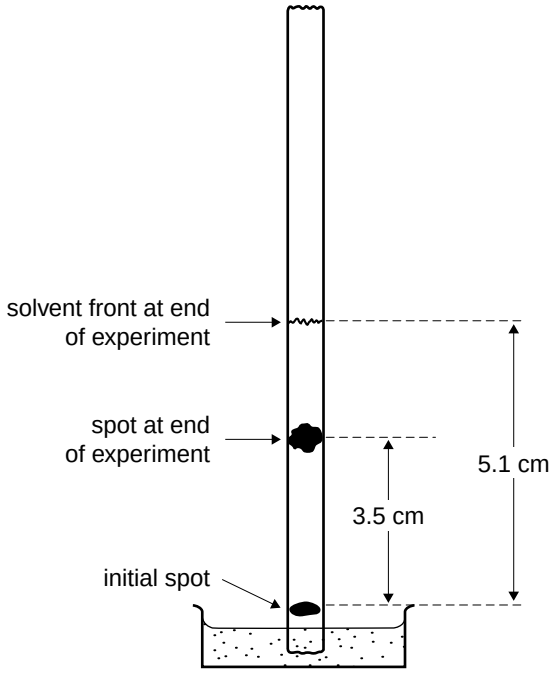
1 mark

b. Explain why different substances travel up the paper at different rates.

2 marks

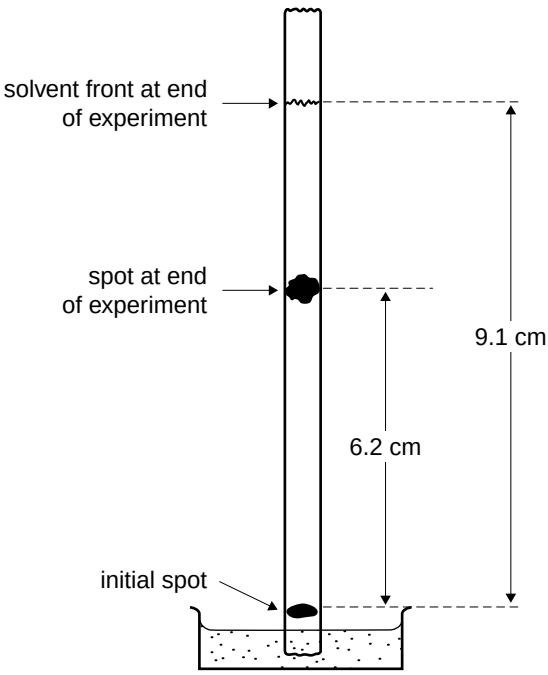
In a laboratory exercise, two students are each given a sample of a yellow solid that is dissolved in water. They are asked to use the technique described above to help them decide whether or not the two yellow substances are identical. Each student's results are shown below, together with each student's interpretation of the data.

Student A's results



Student A says: In my experiment I observe that the yellow spot has moved 3.5 cm while in B's experiment the spot has moved 6.2 cm. From my analysis of the data I conclude that the two substances cannot possibly be the same because they have moved different distances.

Student B's results



Student B says: The results of our experiments do look different, but my analysis of both sets of data shows that the two yellow substances **could** be the same.

c. Do you agree with student A or student B? Explain your answer, showing how you use the information given to reach a conclusion.

4 marks

Total 7 marks

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Question 4

Consider a solution in which the following equilibrium is established.

$$Br_2(aq) + 2OH^-(aq) \rightleftharpoons OBr^-(aq) + Br^-(aq) + H_2O(l); \Delta H = 15 \text{ kJ mol}^{-1}$$

The molecular bromine (Br_2) gives the aqueous solution a reddish brown colour. All the other species present are colourless.

The following tests are carried out on separate samples of the solution.

Test 1 A few mL of a concentrated solution of sodium bromide are mixed into the solution.

Test 2 A few mL of a concentrated HCl solution are mixed into the solution.

Test 3 The solution is heated from room temperature to 40°C.

a. For each of the above tests, predict whether the mixture would become darker or lighter in colour by ticking the appropriate box and, in each case, give a reason for your prediction in the adjoining box.

	Test result		Explanation of test result
	darker	lighter	
Test 1			
Test 2			
Test 3			

6 marks

b. Give the oxidation number for bromine in each of the three species in the table below.

Species	Oxidation number
Br_2	
Br^-	
OBr^-	

3 marks

Total 9 marks

CONTINUED OVER PAGE

Question 5

a. There are millions of different organic compounds. Many of these compounds have similar chemical properties and can be grouped into various homologous series.

In the following table, name the homologous series to which propane and propene belong.

	Name of homologous series
propane	
propene	

2 marks

b. Propane reacts with chlorine.

Complete the table below giving the

- chemical equation for a reaction between propane and chlorine in the presence of ultraviolet light
- structure of the organic product formed in the reaction you have chosen
- name of the organic reaction product you have prepared
- type of reaction.

Chemical equation	
Structure of organic reaction product	
Name of the organic reaction product	
Reaction type	

4 marks

c. Propene reacts with chlorine.

Complete the table below, giving the

- chemical equation for the reaction between propene and chlorine
- structure of the organic reaction product
- type of reaction.

Chemical equation	
Structure of organic reaction product	
Reaction type	

3 marks

d. You are given a sample of pure ethanol only (that is, just pure ethanol and no other organic compounds).

Explain how you could use the ethanol to prepare a sample of ethyl ethanoate. In your answer you should include the formulas of all organic compounds used and formed, together with the formulas of all the inorganic reagents used.

5 marks

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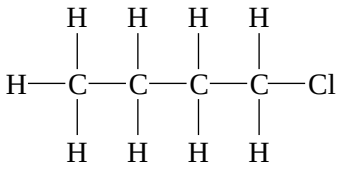

e. Shown above is a sketch of the structure of 1-chloro butane. Omitting the structure of 1-chloro butane shown above, provide similar structures for each of the other structural isomers of C_4H_9Cl.

3 marks

Total 17 marks

END OF QUESTION AND ANSWER BOOK

Click here for Data Sheet

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)