Neap

Trial Examination 2007

VCE Chemistry Unit 2

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A Multiple-choice	20	20	20	30
B Short-answer	7	7	45	60
			Total 65	Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 12 pages, with a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions.

Instructions

Detach the data sheet from the centre of this booklet during reading time.
Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.
All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A: MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

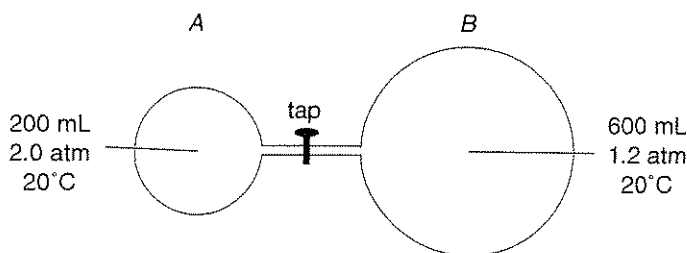No marks will be given if more than one answer is completed for any question.

Question 1

Which of the following shows the relationship between an acid (A) and its conjugate base (B)?

A. $A + H^+ \rightarrow B$

B. $B + H^+ \rightarrow A$

C. $A + B \rightarrow H^+$

D. $A + B \rightarrow H_2O$

Question 2

Consider a gas contained in the arrangement shown below.

If the gaseous contents of vessel B were forced into vessel A, the total pressure in vessel A at 20°C would become

A. 1.2 atm

B. 2.0 atm

C. 3.6 atm

D. 5.6 atm

Question 3

A beaker contains a saturated solution of copper(II) sulfate, together with some undissolved copper(II) sulfate.

Which of the following procedures would increase the concentration of the saturated solution?

A. heating the mixture

B. vigorously stirring the mixture

C. adding more $CuSO_4(s)$ to the mixture

D. adding water to the mixture

Question 4

In which of the following reactions is the gaseous product different from that of the other three reactions?

A.   thermal decomposition of potassium chlorate ($KClO_4$)

B.   photosynthesis

C.   decomposition of hydrogen peroxide in the presence of a MnO_2 catalyst

D.   incomplete combustion of methane
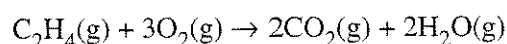
Question 5

A 0.50 mol sample of nitrogen dioxide (NO_2) has a volume of 7.0 L at a pressure of 3.0 atm.

The temperature of the NO_2 sample is

A.   5.0°C

B.   239°C

C.   512°C

D.   785°C

Question 6

Ethene burns in oxygen according to the equation

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$

When 0.20 mol of C_2H_4 burns in 0.40 mol of O_2, the amount of CO_2 expected to form would be

A.   0.20 mol

B.   0.27 mol

C.   0.40 mol

D.   0.80 mol

Question 7

An orange-coloured solution was prepared by dissolving 14.5 g of potassium dichromate ($K_2Cr_2O_7$) in water and making up the volume to 100.0 mL with distilled water. This solution (solution I) was used to prepare three further solutions as outlined below.

solution II: 10 mL of solution I added to 30 mL of water

solution III: 20 mL of solution I made up to 50 mL with water

solution IV: 40 mL of solution I added to 30 mL of water

The concentrations of these three solutions increase in the order

A.   II, III, IV.

B.   III, II, IV.

C.   II, IV, III.

D.   IV, III, II.

Question 8

Which of the following is common to the desalination processes of flash distillation and reverse osmosis?

A.   movement of water by diffusion

B.   reliance on the difference in boiling points of water and dissolved salts

C.   conditions of reduced pressure

D.   both are endothermic processes

Question 9

Which of the following unit conversions is **incorrect**?

A. $3.0 \text{ atm} = 2.3 \times 10^3 \text{ mmHg}$
B. $64 \text{ m}^3 = 6.4 \times 10^4 \text{ L}$
C. $-32°C = 241 \text{ K}$
D. $620 \text{ mmHg} = 83 \text{ Pa}$

Questions 10 and 11 refer to the following information.

8.55 g of $Ba(OH)_2$ was completely dissolved in water so that the final volume of the solution was 250.0 mL.

Question 10

The concentration of the $Ba(OH)_2$ solution was

A.   0.150 M
B.   0.200 M
C.   0.250 M
D.   0.300 M

Question 11

At 25°C, the pH of the solution would be
A.   12.3
B.   12.6
C.   13.3
D.   13.6

Question 12

A particular brand of vodka has an ethanol content of 40.0% v/v.

Given that the density of ethanol is 0.785 g mL^{-1}, the mass of ethanol in a 40.0 mL glass of vodka is
A.   12.6 g
B.   16.0 g
C.   20.4 g
D.   31.4 g

Question 13

Several small pieces of nickel are added to a solution of copper(II) nitrate.

Which of the following observations would be expected?

A.   no reaction would occur
B.   The nickel pieces would dissolve, and the copper(II) nitrate solution would become a darker blue colour.
C.   A deposit of copper would form and the nickel pieces would dissolve.
D.   A precipitate of nickel nitrate would form and the copper(II) nitrate solution would fade in colour.

Questions 14 and 15 refer to the following information.

The graph below shows solubility curves for three metal salts: potassium nitrate (KNO_3), sodium nitrate ($NaNO_3$) and sodium chlorate ($NaClO_3$).
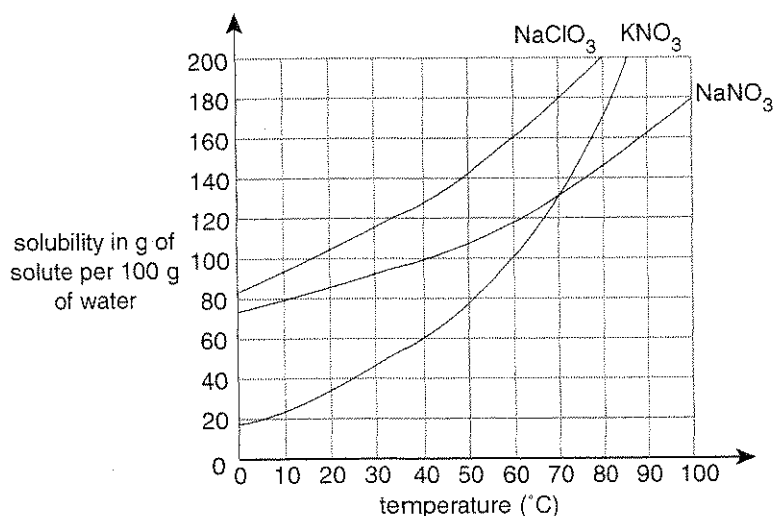
Question 14

80 mL of a saturated solution of KNO_3 was cooled from 70°C to 40°C.

What mass of KNO_3 would be expected to have crystallised from the solution?

A.   56 g
B.   60 g
C.   70 g
D.   80 g

Question 15

40.0 g samples of each salt were placed into separate beakers. 50.0 g of water was added to each beaker, and the beakers heated to 40°C.

In which beaker(s) would you expect all of the salt to dissolve?

A.   none of the beakers
B.   the KNO_3 beaker only
C.   the $NaNO_3$ and $NaClO_3$ beakers only
D.   all three beakers

Question 16

Which of the following is **not** an acid–base reaction?

A. $Na_2CO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$

B. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

C. $C_3H_8(g) + Cl_2(g) \rightarrow C_3H_7Cl(g) + HCl(g)$

D. $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

Question 17

Ammonia gas reacts with hydrogen chloride gas to form a white solid, NH_4Cl. A demonstration of this reaction and diffusion of the gases is to be carried out in the apparatus shown below.
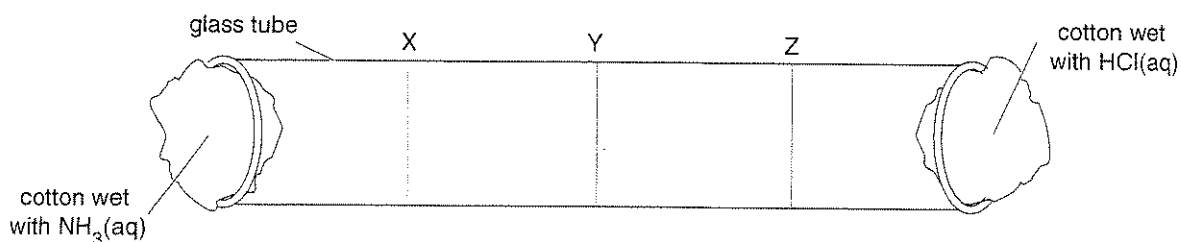
At which point (X to Z) would you expect to see the white solid NH_4Cl form in the tube?
A.   X
B.   Y
C.   Z
D.   No gas is present, so no solid will form.

Question 18

At SLC, the volume of a particular sample of gas is 298 mL.

If the temperature is increased to 30°C and the volume change to 400 mL, the new pressure would be
A.   76.7 mmHg
B.   576 mmHg
C.   628 mmHg
D.   679 mmHg

Question 19

Which of the following graphs represents the change in pressure of an ideal gas as the temperature is increased at constant volume?

A.   B.   C.   D.
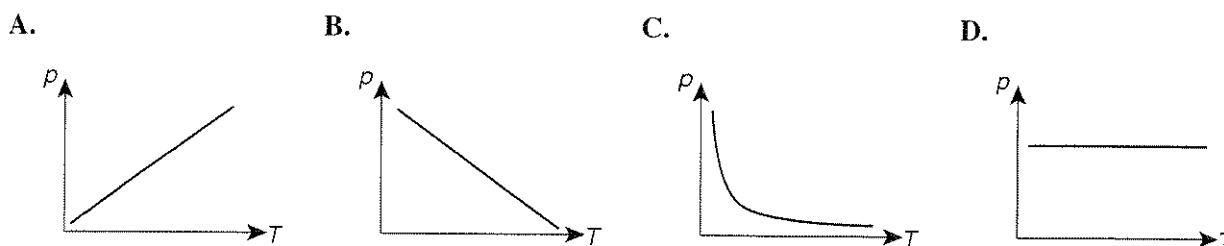
Question 20

Four 100 mL beakers were each half-filled with water. One of each of the gases listed below was bubbled into each beaker.

Which gas would cause the pH of the water to increase?
A. SO_2
B. O_2
C. NH_3
D. N_2

Trial Examination 2007

VCE Chemistry Unit 2

Written Examination

Data Sheet

Directions to students

This data sheet is provided for your reference.

Make sure that you remove this data sheet from the centrefold during reading time.

Any writing, jottings, notes or drawings you make on this data sheet will **not** be considered in the marking.
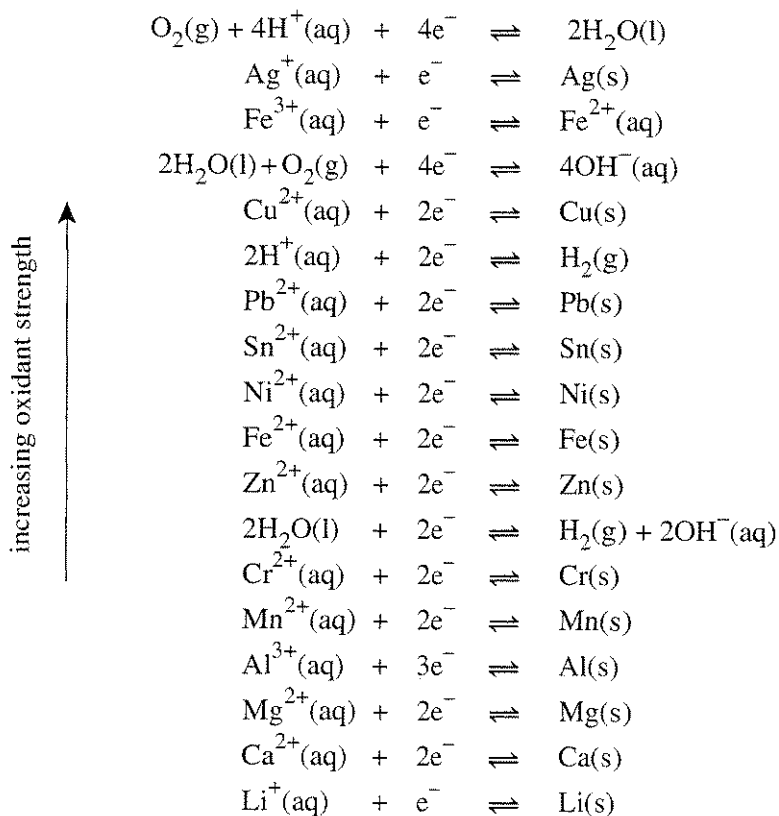
At the end of the examination, make sure that you do **not** leave the data sheet in the centrefold of the question and answer book.

You may keep this data sheet.

PHYSICAL CONSTANTS

Molar Volume at SLC = 24.5 L mol^{-1}

Molar Volume at STP = 22.4 L mol^{-1}

Ionisation constant for water at 25°C, $K_w = 1.0 \times 10^{-14}$ M^2

Universal gas constant, $R = 8.31$ J K^{-1} mol^{-1}

Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

AN ACTIVITY SERIES

$$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$$
$$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$$
$$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$$
$$2H_2O(l) + O_2(g) + 4e^- \rightleftharpoons 4OH^-(aq)$$
$$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$$
$$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$$
$$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$$
$$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$$
$$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$$
$$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$$
$$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$$
$$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$$
$$Cr^{2+}(aq) + 2e^- \rightleftharpoons Cr(s)$$
$$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$$
$$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$$
$$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$$
$$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$$
$$Li^+(aq) + e^- \rightleftharpoons Li(s)$$

increasing oxidant strength ↑

TEVCHEMU2_DS_07.FM

THE PERIODIC TABLE OF THE ELEMENTS

1																	2
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 20.2
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 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	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 195.1	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)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

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 (251)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

END OF DATA SHEET

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer **all** questions in the spaces provided.

To obtain full marks 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 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 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. Write the symbol or formula for

    i. the conjugate base of $H_2PO_4^-$.

    _____

    ii. the conjugate reductant of Sn^{2+}.

    _____

    iii. the product of the denitrification process carried out by bacteria in the soil.

    _____

    iv. the noble gas found in the largest concentration in the atmosphere.

    _____

    v. a metal which is a stronger reductant than zinc.

    _____

$1 + 1 + 1 + 1 + 1 = 5$ marks

b. Write a balanced **formula** equation that represents

    i. the formation of cloudiness when carbon dioxide is bubbled through limewater $(Ca(OH)_2)$ solution.

    _____

    ii. the reaction occurring when magnesium carbonate powder $(MgCO_3)$ is added to dilute sulfuric acid solution.

    _____

$1 + 1 = 2$ marks

c. Write a balanced **ionic** equation to represent

    i. the reduction of nickel ions in aqueous solution by magnesium atoms in magnesium ribbon.
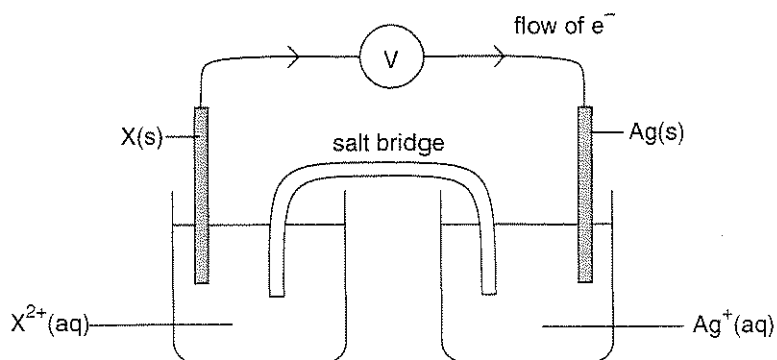
    _____

    ii. the formation of a precipitate when solutions of barium hydroxide $(Ba(OH)_2)$ and sodium sulfate are mixed.

    _____

$1 + 1 = 2$ marks
Total 9 marks

Question 2

A galvanic cell is formed by the combination of two half-cells: $X^{2+}(aq)/X(s)$ and $Ag^+(aq)/Ag(s)$. When the cell is operating, the electron flow is as shown.

a.　**i.**　Write a balanced ionic equation for the reaction occurring in the cell.

_____

ii.　Which electrode (X or Ag) is the anode?

_____

iii.　Which electrode (X or Ag) carries a positive charge?

_____

iv.　In which direction (towards X or towards Ag) do cations move through the salt bridge?

_____

v.　Give the formula for a substance that would be suitable for use in the salt bridge of this cell.

_____

<div align="right">1 + 1 + 1 + 1 + 1 = 5 marks</div>

b.　After some time the change in mass at the Ag electrode was found to be 2.10 g, while the change at electrode X was 2.02 g.

Identify metal X. Show your working.

_____

_____

_____

_____

<div align="right">4 marks
Total 9 marks</div>

Question 3

a.   The table below shows the relationship between properties of various samples of compounds or elements. Complete the table by indicating whether the quantity in the first column is greater than (>), less than (<) or equal to (=) the quantity in the second column. The first entry is completed as an example.

Quantity 1	>, < or =	Quantity 2
number of atoms of He in 1.0 mol of He	=	number of atoms of Ne in 1.0 mol of Ne
pH of an 0.10 M HCl solution		pH of an 0.10 M CH_3COOH solution
volume of 0.20 M HNO_3 (a strong acid) required to completely react with 20.0 mL of 0.20 M KOH solution		volume of 0.20 M HCN (a weak acid) required to completely react with 20.0 mL of 0.20 M KOH solution
number of molecules of N_2 in 3.0 L of N_2 gas at 2.0 atm and 20°C		number of molecules of O_2 in 4.0 L of O_2 gas at 1.5 atm and 20°C

3 marks

b.   With the aid of the relevant calculations, explain the answer you gave in the last row of the table above.

_____

_____

_____

2 marks
Total 5 marks

Question 4

The label shown below is taken from a bottle of a carbonated apple drink.

Ingredients
Carbonated water, apple juice, sugar, glucose syrup, malic acid, preservative, artificial sweetener.

a.   Malic acid ($C_4H_6O_5$) is added to improve the apple flavour of the drink. Malic acid is a *weak, diprotic acid*.
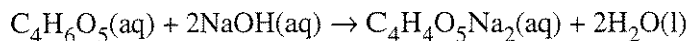
Explain what is meant by the term

i.   'weak acid'.

_____

_____

ii.   'diprotic acid'.

_____

_____

1 + 1 = 2 marks

b. During a titration experiment, it was found that 25.0 mL of the apple drink was neutralised by 15.0 mL of 0.10 M sodium hydroxide solution. The reaction was assumed to occur according to the equation

$$C_4H_6O_5(aq) + 2NaOH(aq) \rightarrow C_4H_4O_5Na_2(aq) + 2H_2O(l)$$

i. Calculate the amount (in mol) of sodium hydroxide used in the titration reaction.

_____

_____

ii. Hence find the concentration of malic acid (in M) in the apple drink.

_____

_____

_____

iii. Suggest why the calculated concentration of malic acid in the apple drink is considerably higher than the actual (true) concentration.

_____

_____

1 + 2 + 1 = 4 marks

c. The structure of the glucose molecule found in the apple drink is shown below.

With the aid of a labelled diagram, explain why glucose is soluble in water.

_____

_____

_____
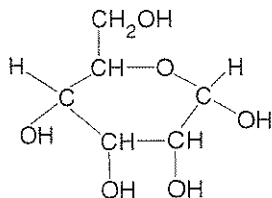
2 marks

Total 8 marks

Question 5

2.5 g (an excess) of iron (Fe) was added to 50.0 mL of 0.50 M sulfuric acid solution (H_2SO_4). When the reaction was complete and all the hydrogen gas had bubbled out of the solution, the mixture of iron sulfate and unreacted iron was filtered to obtain the iron. When dried, the unreacted iron had a mass of 1.1 g.

a. Determine

    i. the mass of iron that reacted with the sulfuric acid.

_____

    ii. the amount (in mol) of iron that reacted with the sulfuric acid.

_____

    iii. the amount (in mol) of sulfuric acid that reacted.

_____

$1 + 1 + 1 = 3$ marks

b. Using the values obtained in part **a**, write the balanced equation for the reaction. Hence determine the formula of the iron sulfate formed.

_____

_____

_____

2 marks
Total 5 marks

Question 6

Emissions from motor vehicles are a major contributor to air pollution. These emissions may include CO_2, CO, NO_x, H_2O and unburnt hydrocarbons.

a. Write a balanced equation to show how

    i. CO may be produced in an engine using octane (C_8H_{18}) as fuel.

_____

    ii. NO may be produced in a car engine.

_____

$1 + 1 = 2$ marks

b. Uncontrolled emissions of NO_x may contribute to acid rain.

    i. What is meant by the term 'acid rain'?

_____

    ii. State one problem caused by acid rain.

_____

$1 + 1 = 2$ marks

c. Since 1986, all new cars in Victoria have been required to be fitted with catalytic converters to reduce these pollutants. Three-way converters are commonly used to reduce emissions of CO, NO_x and hydrocarbons, but these converters emit up to five times as much N_2O and up to fifteen times as much CO_2.

State one reason why the increased emission of N_2O is an environmental concern.

_____

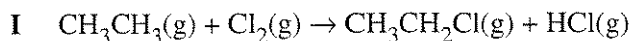_____

1 mark

Total 5 marks

Question 7

a. Atom economy is an important consideration in the production of chemicals according to green chemistry principles.

Explain what is meant by the term 'atom economy'.

_____

_____

1 mark

b. Chloroethane (CH_3CH_2Cl) may be used as an organic solvent and as a refrigerant. It may be prepared by two different methods, the overall equations for which are shown below.

$$\textbf{I} \quad CH_3CH_3(g) + Cl_2(g) \rightarrow CH_3CH_2Cl(g) + HCl(g)$$
$$\textbf{II} \quad CH_2CH_2(g) + HCl(g) \rightarrow CH_3CH_2Cl(g)$$

In terms of the atom economy of these reactions, which reaction would be the preferred method of preparation of CH_3CH_2Cl? Explain your choice.

_____

_____

_____

2 marks

c. State one other factor which would need to be considered when deciding which method of preparation is preferable according to green chemistry principles.

_____

_____

1 mark

Total 4 marks

END OF QUESTION AND ANSWER BOOKLET