1994

CHEMISTRY

UNIT 3

TRIAL EXAM

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VCE CHEMISTRY 1994

CAT 1: Chemistry in a Practical Context

SECTION A. MULTIPLE CHOICE ANSWER SHEET

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ABSENT

SURNAME

GIVEN NAME(S)

How to complete this form

Please use an **HB PENCIL** only.
If you make a mistake, **ERASE** the incorrect answer.
DO NOT just cross it out.

EXAMPLE ONLY

9	**1**	**9**	**1**	**0**	**9**	**1**	**0**	**E**
0	0	0	0	0	0	0	0	A
1	1	1	1	1	1	1	1	E
9	9	9	9	9	9	9	9	X

Enter your Student Number (if one is provided) in the box below as shown in the example above

All answers must be completed like this.

A	B	C	D	E

ONLY mark ONE box per line.

STUDENT NUMBER

0	0	0	0	0	0	0	0	A
1	1	1	1	1	1	1	1	E
2	2	2	2	2	2	2	2	F
3	3	3	3	3	3	3	3	G
4	4	4	4	4	4	4	4	J
5	5	5	5	5	5	5	5	L
6	6	6	6	6	6	6	6	R
7	7	7	7	7	7	7	7	T
8	8	8	8	8	8	8	8	W
9	9	9	9	9	9	9	9	X

PLEASE TURN OVER

SECTION A.

MULTIPLE CHOICE ANSWER SHEET

Instructions

Complete **ALL** the questions.

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

NO mark will be given if more than **ONE** answer is completed for any question.

USE HB PENCIL ONLY.

	One answer per line					***One answer per line***			
1	A	B	C	D	11	A	B	C	D
2	A	B	C	D	12	A	B	C	D
3	A	B	C	D	13	A	B	C	D
4	A	B	C	D	14	A	B	C	D
5	A	B	C	D	15	A	B	C	D
6	A	B	C	D	16	A	B	C	D
7	A	B	C	D	17	A	B	C	D
8	A	B	C	D	18	A	B	C	D
9	A	B	C	D	19	A	B	C	D
10	A	B	C	D	20	A	B	C	D

Please DO NOT fold, bend or staple this form

DETACH THIS ANSWER SHEET AT THE START OF THE EXAMINATION

STUDENT NUMBER _____

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VICTORIAN CERTIFICATE OF EDUCATION 1994

CHEMISTRY

COMMON ASSESSMENT TASK 1 (TRIAL)
CHEMISTRY IN A PRACTICAL CONTEXT

(not to be used before Tuesday April 19, 1994)

Reading time: 15 minutes
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOKLET

Structure of booklet

Section	Number of questions	Number of questions to be answered
A	1 (20 items)	1 (20 items)
B	6	6

Directions to students

Materials

Question and answer booklet of 26 pages, including data on page 2.

Multiple choice answer sheet.

An approved calculator may be used.

The task

Answer **all** items from Section A.

Section A items should be answered on the multiple-choice answer sheet provided.

Answer **all** questions from Section B.

Section B questions should be answered in this booklet in the spaces provided following each question.

There is provision for rough working throughout the booklet

All written responses should be in English.

At the end of the task

Please ensure that you write your **student number** in the space provided on this booklet and your **name and student number** in the space provided on the multiple-choice answer sheet.

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

DATA

TABLE 1: RELATIVE ATOMIC MASS ($^{12}C = 12.00$)

Element	Symbol	Atomic No.	Relative Atomic Mass
Aluminium	Al	13	27.0
Barium	Ba	56	137.3
Bromine	Br	35	79.9
Calcium	Ca	20	40.1
Carbon	C	6	12.0
Chlorine	Cl	17	35.5
Copper	Cu	29	63.5
Iron	Fe	26	55.9
Hydrogen	H	1	1.0
Lithium	Li	3	6.9
Magnesium	Mg	12	24.3
Nitrogen	N	7	14.0
Sodium	Na	11	23.0
Oxygen	O	8	16.0
Phosphorus	P	15	31.0
Silver	Ag	47	107.9
Sulfur	S	16	32.1
Strontium	Sr	38	87.6
Zinc	Zn	30	65.4

TABLE 2: PHYSICAL CONSTANTS

Avogadro Constant (N_A)	6.023×10^{23} mol^{-1}
Gas Constant (R)	8.31 J K^{-1} mol^{-1}
Molar Volume of gas at STP	22 400 cm^3 mol^{-1} = 22.4 dm^3 mol^{-1}
Pressure	1 atmosphere = 101 325 Pa
Ionisation constant of water	$K_w = 1 \times 10^{-14}$

SECTION A

SPECIFIC INSTRUCTIONS FOR SECTION A

Section A, Question 1, consists of 20 multiple choice items and is worth 20 marks and therefore about 31% of the total marks available for this examination.

You should therefore spend about 28 minutes on Section A.

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

A correct answer scores 1, an incorrect answer scores 0. No credit will be given for an item if two or more letters are marked for that item. Marks will **not** be deducted for incorrect answers and you should attempt every item.

Question 1

Item 1

During a school laboratory practical experiment, a flask was filled with concentrated sulfuric acid. During the filling, there was a major spill of the acid so that it spilled over the bench and some ran down onto the floor. The best method for safely removing the spilled acid would be to

A. cover the spill with solid sodium hydroxide before collecting and washing down the sink.

B. cover the spill with sodium carbonate before collecting and washing down the sink.

C. cover the spill with common salt before collecting and washing down the sink.

D. mop up the spill with paper towelling and place in the waste paper basket.

Item 2

In an acid-base titration, 0.0500 M H_3PO_4 is in a 50 cm^3 burette. An approximately 0.45 M solution of sodium hydroxide is to be added to the titration flask using a pipette so that the concentration of the sodium hydroxide solution can be determined by titration. The most appropriate volume for the pipette is

A. 2.00 cm^3

B. 5.00 cm^3

C. 10.00 cm^3

D. 20.00 cm^3

Item 3
A solution of 5.0 M sodium hydroxide was placed in a plastic dish and left open to the air for several days. During this time, several 5 cm^3 portions of the solution were removed from the dish and the concentration of hydroxide ions present determined by titration with a standard solution of hydrochloric acid. The hydroxide ion concentration of the solution in the dish was seen to decrease with time of exposure of the sodium hydroxide solution to the air. The most likely reason for this would be

A. evaporation of sodium hydroxide from the solution.

B. absorption of carbon dioxide from the air.

C. absorption of oxygen from the air.

D. reaction of sodium hydroxide with the plastic dish.

Item 4
An equilibrium mixture contains 0.25 mole of carbon monoxide gas, 0.50 mole of hydrogen gas and 0.50 mole of methanol gas in a 2.0 L vessel, at a constant temperature. The equilibrium constant represented by the equation

$$CO(g) + 2H_2(g) = CH_3OH(g) \; ; \; \Delta H = -91 \text{ kJ mol}^{-1}.$$

is

A. 0.03125 M^{-2}

B. 0.25 M^{-2}

C. 4.0 M^{-2}

D. 32 M^{-2}

Item 5
Both water and methanol are liquids at room temperature and pressure.
Water has a higher surface tension than methanol because

A. water molecules attract each other more strongly than methanol molecules.

B. methanol molecules attract each other more strongly than water molecules.

C. it is easier to increase the surface area of the water than to increase the surface area of the methanol.

D. the bonding inside the water molecule is stronger than the bonding inside the methanol molecule.

Item 6
The following diagrams represent drops of equal volume of
pure water; 75% water and 25% methanol; 25% water and 75% methanol; pure methanol
not necessarily in that order.

A. B.

C. D.

Which one of the diagrams would best represent a drop of pure water?

A. A

B. B

C. C

D. D

Item 7
Which one of the following is **not** a characteristic or a property of the gas ethene?

A. saturated.

B. flammable.

C. insoluble in water.

D. non-polar molecule.

Item 8
Which one of the following could be produced from ethene by a single step chemical reaction ?

A. methane

B. methanol

C. ethane

D. propane

Item 9
The burning of an alkene gas in excess air is best described by the chemical equation

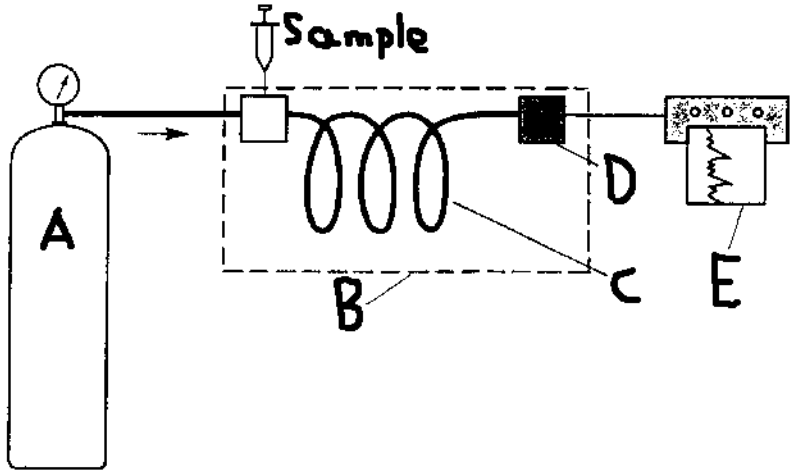
A. $C_nH_{2n}(g) + \frac{3n}{2} O_2(g) = nCO_2(g) + nH_2O(g)$

B. $C_nH_{2n}(g) + nO_2(g) = nCO(g) + nH_2O(g)$

C. $C_nH_{2n+2}(g) + \frac{3n+1}{2} O_2(g) = nCO_2(g) + (n+1)H_2O(g)$

D. $C_nH_{2n+2}(g) + \frac{2n+1}{2} O_2(g) = nCO(g) + (n+1)H_2O(g)$

Items 10, 11, 12 and 13 refer to the following diagram.



Item 10
The instrument above is best described as

A. a mass spectrometer.

B. an atomic absorption spectrometer.

C. a gas-liquid chromatograph.

D. a nuclear magnetic resonance spectrometer.

Item 11

Sections **A** and **D** shown on this diagram are respectively

A. the carrier gas and the oven.

B. the carrier gas and the detector.

C. the oven and the detector.

D. the column and the oven.

Item 12

The usual function of this instrument is to

A. determine the number of electrons in the sample.

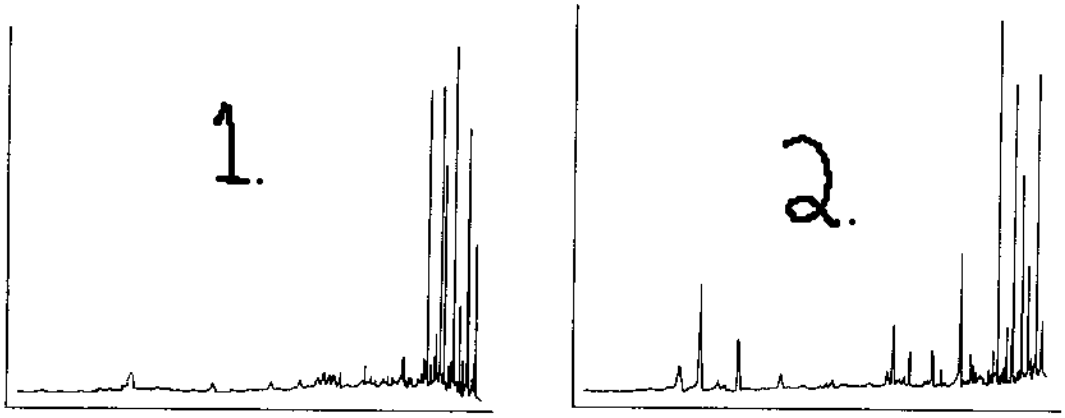
B. determine the mass to charge ratio of ions in the sample.

C. determine the quantity of a particular molecule in the sample.

D. determine the ratio of atoms to ions in the sample.

Item 13

When two samples of a particular food, labelled **1** and **2**, were passed through this instrument, the chart recorder, **E**, produced the two graphs below.



These graphs show that the two samples of food are

A. identical because the maximum peak height is approximately the same.

B. different because the average peak heights are different.

C. identical because most of the peaks are on the right.

D. different because the pattern of peaks is different.

The following information refers to items 14 and 15

20.0 cm^3 of a 0.10 M solution of hydrochloric acid was added to a 2.00 dm^3 volumetric flask and the volume was made up to 2.00 dm^3 with pure water.

Item 14
The hydrogen ion concentration in the resultant solution would be

A. 1×10^{-3} M

B. 2×10^{-3} M

C. 1 M

D. 2 M

Item 15
The pH of the resultant solution would be approximately

A. 3

B. 2.7

C. 0

D. -0.3

The following information refers to items 16 and 17

A small amount of vanadium pentoxide (a catalyst) is added to a gas mixture of 1.5 mol of sulfur dioxide gas and excess oxygen gas. Temperature and pressure conditions are chosen so that the reaction proceeds to completion

Item 16
When the reaction is completed, the volume of sulfur trioxide gas produced at STP would be

A. 1.2 dm^3

B. 22.4 dm^3

C. 33.6 dm^3

D. 44.8 dm^3

Item 17
In this reaction, the vanadium pentoxide catalyst

A. increases the purity of the sulfur dioxide gas used.

B. increases the yield of sulfur trioxide.

C. decreases the energy required to start the reaction.

D. increases the equilibrium constant of the reaction.

Item 18
A manufacturing company places an order with a chemical production company for 1 tonne (10^6 g) of polyethylene to be produced from gaseous ethylene (relative molecular mass = 28).

The volume of gaseous ethylene at 25^{o}C and 1000 kPa required to produce 1 tonne of polyethylene is closest to

A. 88 L

B. 88 m^3

C. 2.5 x 10^3 L

D. 2.5 x 10^3 m^3

The following information refers to items 19 and 20

Acidified potassium dichromate, $K_2Cr_2O_7$, can be used to oxidise ethanol to acetic acid in the laboratory according to the partial equations:

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

(2) $C_2H_5OH(aq) + H_2O(l) \rightarrow CH_3COOH(aq) + 4H^+(aq) + 4e^-$

Item 19
The element being reduced in this reaction **and** the change in oxidation number of the element is

A. chromium; +7 to +6

B. chromium; +6 to +3

C. carbon; -2 to 0

D. carbon; +4 to +2

Item 20
The number of mole of ethanol that will be oxidised to acetic acid by 0.050 mole of potassium dichromate is

A. 0.033 mol.

B. 0.050 mol.

C. 0.075 mol.

D. 0.100 mol.

WORKING SPACE

END OF SECTION A

SPECIFIC INSTRUCTIONS FOR SECTION B

Section B consists of six short-answer questions (questions 2 to 7 inclusive). You must answer all these questions. This section is worth 45 marks or approximately 69% of the total. You should spend approximately 62 minutes on this section.

The marks allotted to each question and suggested times are indicated at the start of the question.

Questions should be answered in the spaces provided in this booklet.

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 an indication of state, {for example $H_2(g)$; NaCl(s)}

Question 2 (3 + 3 + 2 = 8 marks, 12 minutes)

Copper metal reacts with concentrated nitric acid to produce nitrogen dioxide gas according to the equation:

$$Cu(s) + 4HNO_3(aq) = Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

(a) What volume of 14M nitric acid would be required to react exactly with 10.0 g of copper according to the above equation?

(b) What volume of nitrogen dioxide gas at STP would be produced in this reaction?

(c) Explain why this reaction is an oxidation-reduction reaction.

SECTION B

Question 3 (2 + 3 + 3 + 3 = 11 marks, 14 minutes)
The drug, aspirin, is often recommended by doctors not only for pain relief but also as a means of preventing heart attack and stroke. Pure aspirin is an acid that exists in equilibrium with its ionised form in aqueous solution according to the following equation

$$\underset{\text{aspirin}}{C_9H_8O_4(aq)} + H_2O(l) \quad = \quad C_9H_7O_4^-(aq) + H_3O^+(aq)$$

(a) Write an expression for the equilibrium constant for this equation.

(b) A certain brand of aspirin tablet contains aspirin mixed with sodium bicarbonate ($NaHCO_3$). One of these aspirin tablets is dissolved in water.

Will the concentration ratio $\frac{[C_9H_8O_4(aq)]}{[C_9H_7O_4^-(aq)]}$ be greater or smaller in this solution than this same ratio for **pure** aspirin dissolved in water? Explain your answer.

(c) When aspirin reaches the stomach, it dissolves in an acidic solution. What will happen to the concentration ratio $\frac{[C_9H_8O_4(aq)]}{[C_9H_7O_4^-(aq)]}$ in the stomach? Explain your answer.

(d) Sodium bicarbonate($NaHCO_3$) is also the main constituent of indigestion tablets which are used to neutralise excess stomach acid (HCl) according to the equation:

$$NaHCO_3(aq) + HCl(aq) = NaCl(aq) + H_2O(l) + CO_2(g)$$

A particular indigestion tablet weighs 1.0 g and 60% of this tablet (by mass) is $NaHCO_3$. If two tablets exactly are required to neutralise the excess stomach acid, calculate this mass of HCl.

SECTION B

(Do ONE ONLY of the questions on COPPER, IRON and NITRIC ACID)

Question 4 (COPPER) (3 + 1 + 1 + 3 = 8 marks, 12 minutes)

Two important steps in the processing of the copper ore chalcopyrite, $CuFeS_2$, are:
(1) concentrating the ore by flotation and (2) roasting in air.

(a) Explain how the flotation step separates the ore from other material.

(b) Write the balanced chemical equation for the roasting of chalcopyrite in air.

(c) One of the products from (b) is sulfur dioxide. When this gas is dissolved in water, a weakly acidic solution is produced. Write a balanced chemical equation for this reaction.

(d) It is also possible to use sulfur dioxide to produce an acid **different** from the acid produced in (c). Briefly outline how the industrial production of this acid differs from the method used in (c).

SECTION B

(Do ONE ONLY of the questions on COPPER, IRON and NITRIC ACID)

Question 4 (IRON) (3 + 1 + 1 + 3 = 8 marks, 12 minutes)

The production of iron by chemical reactions from iron ore is just one part of the **IRON CYCLE**. When iron is used much of it is converted into compounds similar to the ore from which it came.

(a) Write the name and chemical formula for each of the following materials in this part of the iron cycle.

IRON CYCLE	NAME	FORMULA
iron ore added to the blast furnace		
solid reductant added to the blast furnace		
the reductant gas produced in the blast furnace		

(b) When pig iron is formed in the blast furnace, it contains impurities. What is the name of the major impurity?

(c) What is the oxidation number of iron in rust?

(d) Explain why limestone is added to the blast furnace in the production of iron.
Use chemical equations in your answer.

SECTION B

(Do ONE ONLY of the questions on COPPER, IRON and NITRIC ACID)

Question 4 (NITRIC ACID) (3 + 1 + 1 + 3 = 8 marks, 12 minutes)

Nitric acid can be manufactured from the element nitrogen using the steps:

$$N_2 \xrightarrow{\textbf{1}} NH_3 \xrightarrow{\textbf{2}} NO \xrightarrow{\textbf{3}} NO_2 \xrightarrow{\textbf{4}} HNO_3$$

(a) Describe the changes in oxidation number which occur during steps **1**, **2**, **3** and **4** and name the oxidant or reductant which is used for each step.

(b) Write the balanced chemical equation for step **2**.

(c) What is the purpose of the catalyst that is used in step **2**?

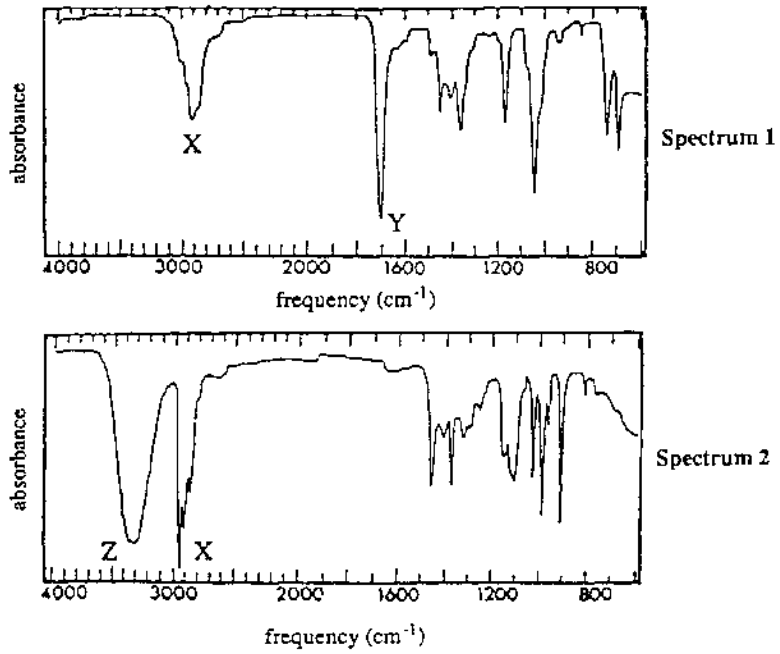
(d) When one mole of NO(g) (relative molecular mass = 30) reacts completely with half a mole of O_2(g) (relative molecular mass = 32) at 20^oC, the gas mixture produced has an average molar mass that is much greater than 46. Explain this observation by using chemical equations.

SECTION B

QUESTION 5 (4 + 2 = 6 marks, 8 minutes)
Chemists often use an analytical technique called ***INFRA-RED SPECTROSCOPY*** which identifies the stretching frequencies of covalent bonds in molecules. By examining the pattern of peaks in the spectra, a particular substance can be identified. Three common stretching frequencies are given in the table below.

C - H	2850 - 2950 cm^{-1}
O - H	3200 - 3400 cm^{-1}
C = O	1680 - 1750 cm^{-1}

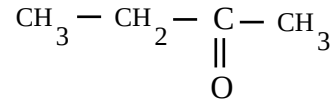
Infra-red spectra were recorded on pure liquid samples of substances **A** and **B**. These spectra were not labelled. The spectra are shown below.



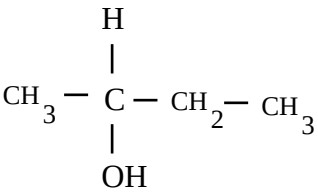
(a) Use the table above to identify the peaks **X** and **Y** in spectrum 1, and the peaks **X** and **Z** in spectrum 2.

(b) The formulae of substances **A** and **B** are shown below.

A.



B.



Determine which spectrum was recorded for substance **A**. Give reasons for your choice.

SECTION B

Question 6 (1 + 1 + 1 + 1 + 1 + 1 = 6 marks, 8 minutes)

Write down the structural formulae and names for the products, labelled **A , B , D , E , F , G** in each of the following reactions.

(a) C_2H_4 + Cl_2 → **A**
ethylene

(b) C_2H_4 + HCl → **B**
ethylene

(c) **B** + NH_3(dissolved in alcohol) → **D**

(d) C_2H_4 + H_2(nickel catalyst) → **E**
ethylene

(e) C_2H_4 + H_2O (H_2SO_4 catalyst) → **F**
ethylene

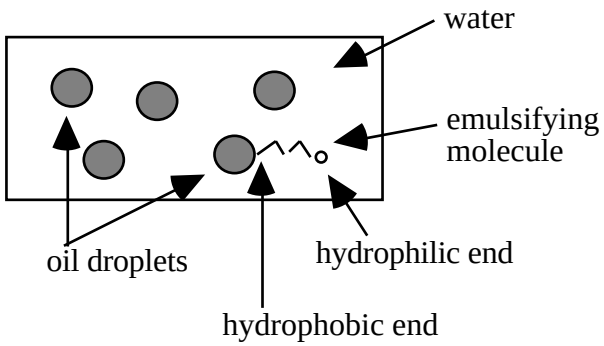
(f) **F** + strong oxidant → **G**
(e.g. acidified $K_2Cr_2O_7$)

A	B	D
name_____	name_____	name_____

E	F	G
name_____	name_____	name_____

SECTION B

Question 7 (3 + 3 = 6 marks, 8 minutes)
The following diagram shows the structure of an oil-in-water emulsion.



(a) Explain the function of each of the components in this emulsion.

(b) Mercury has a surface tension approximately seven times greater than water.
Surface tension can be described as the "energy required to form a surface".
Explain the meaning of this with reference to the forces in liquid mercury and liquid water.

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END OF 1994 VCE CHEMISTRY TRIAL CAT 1

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SUGGESTED SOLUTIONS

QUESTION 1

ITEM 1 ANS B

Sodium carbonate is a weak base. It will neutralise the concentrated sulfuric acid to produce sodium sulfate, carbon dioxide and water according to the equation:

$$Na_2CO_3(s) + H_2SO_4(l) = Na_2SO_4(aq) + CO_2(g) + H_2O(l)$$

Spills of acids must be neutralised before disposal takes place.
Sodium hydroxide is a strong base and corrosive. It must not be used. Concentrated sulfuric acid will react with common salt (sodium chloride) to produce chlorine! Concentrated sulfuric acid will also react with paper and must never be allowed to come into contact with skin.

ITEM 2 ANS C

It requires three mole of sodium hydroxide to react with one mole of phosphoric acid as shown in the equation:

$$H_3PO_4(aq) + 3NaOH(aq) = Na_3PO_4(aq) + 3H_2O(l).$$

The concentration of the sodium hydroxide is approximately nine times that of the phosphoric acid.
From the equation, $n(NaOH) = 3 \times n(H_3PO_4)$

Hence, $c(NaOH) \times V(NaOH) = 3 \times c(H_3PO_4) \times V(H_3PO_4)$

Hence, $V(NaOH) = \frac{3 \times 0.05}{0.45} \times V(H_3PO_4) = \frac{0.15}{0.45} \times V(H_3PO_4) = \frac{1}{3} \times V(H_3PO_4)$.

Hence, the volume of sodium hydroxide will be approximately one third the volume of phosphoric acid. Therefore, the most appropriate volume for the pipette is 10 cm^3 so that the maximum possible volume of phosphoric acid will be used in the titration **without** having to refill the burette. Notice that a 20.00 cm^3 aliquot would require 60 cm^3 of phosphoric acid.

ITEM 3 ANS B

Sodium hydroxide reacts with carbon dioxide in the air according to the equation:
$2NaOH(aq) + CO_2(g) = Na_2CO_3(aq) + H_2O(l)$. As a result, the concentration of sodium hydroxide decreases with time. Sodium hydroxide does not react with oxygen or plastic. Water would evaporate from the solution but not the sodium hydroxide.

ITEM 4 ANS D

The concentrations at equilibrium are :

$[CO] = \frac{0.25}{2} = 0.125$ M ; $[H_2] = \frac{0.50}{2} = 0.25$ M ; $[CH_3OH] = \frac{0.50}{2} = 0.25$ M.

Hence, the equilibrium constant $= \frac{[CH_3OH]}{[CO]\,[H_2]^2} = \frac{0.25}{0.125 \times (0.25)^2} = 32\ M^{-2}$.

ITEM 5 ANS A

A liquid has a high surface tension when a large amount of energy is required to increase the surface area of the liquid. This increase in surface area takes place by overcoming the forces of attraction **between** the molecules of the liquid. The bonding inside the molecules is not directly relevant. The hydrogen bonding between water molecules is greater than the hydrogen bonding between methanol molecules. It is more difficult to increase the surface area of the water than to increase the surface area of the methanol.

SUGGESTED SOLUTIONS

QUESTION 1 **(continued)**

ITEM 6 ANS B
A sphere has the smallest possible surface area for a given volume. Hence, the closer in shape to a sphere the drop is, the greater the surface tension of that drop of liquid. Pure water has the highest surface tension of the liquids listed. Therefore, the correct order would be B , A , C , D.

ITEM 7 ANS A
Ethene gas (ethylene) has the molecular formula $C_2H_4(g)$. It is **unsaturated** because there is a double covalent bond between the two carbon atoms. It has a symmetrical structure which makes it non-polar. Hence, it is insoluble in water. It burns easily (flammable) in excess oxygen to produce carbon dioxide and water.

ITEM 8 ANS C
Methane (CH_4) and methanol (CH_3OH) have one less carbon atom than ethene (C_2H_4). Propane (C_3H_8) has one more carbon atom than ethene. To produce these from ethene would probably require more than a single step chemical reaction. On the other hand, ethene will react with hydrogen gas in the presence of a catalyst to produce ethane according to the equation:

$$C_2H_4(g) + H_2(g) = C_2H_6(g)$$

ITEM 9 ANS A
An alkene has the general formula C_nH_{2n} and in the presence of **excess** air, carbon dioxide will be produced. Equation A is the balanced chemical equation.

ITEM 10 ANS C
This is a gas-liquid chromatograph. The liquid sample is injected into the column (C), vaporised by the heat of the oven (B), carried through the column by the carrier gas (A) to the detector (D). The chart recorder (E) prints out the results.

ITEM 11 ANS B
Sections A and D are the carrier gas (usually nitrogen) and the detector (often a flame ionisation detector).

ITEM 12 ANS C
A gas-liquid chromatograph determines the quantity of a particular molecule in the sample. The sample is often a complex mixture of molecules. The molecules which are least soluble in the liquid stationary phase in the column are moved through the column most quickly by the carrier gas and registered first by the detector.

ITEM 13 ANS D
Each peak on the graph represents a different molecule. Hence, these food samples are different because the pattern of peaks is different. The peak height gives an indication of the amount of the molecule present.

SUGGESTED SOLUTIONS

ITEM 14 ANS A

Number of mole of HCl = n(HCl) = c x V = 0.10 x 0.020 = 0.0020.

Hence, when dilution occurs, $c(H^+) = c(HCl) = \frac{0.0020}{2.00} = 0.0010 = 1 \times 10^{-3}$ M

ITEM 15 ANS A

$pH = -\log_{10}[H^+] = -\log_{10}(10^{-3}) = -(-3) = 3$

ITEM 16 ANS C

The balanced chemical equation is $2SO_2(g) + O_2(g) = 2SO_3(g)$.

Hence, the number of mole of SO_3 produced = the number of mole of SO_2 used up = 1.5 mol.

Hence, the volume of SO_3 produced at STP = 1.5 x 22.4 = 33.6 dm^3.

ITEM 17 ANS C

A catalyst does not change the position of equilibrium in a reaction. Hence, **B** and **D** are false. A catalyst does not affect the purity of the reactants. **A** is false. A catalyst does lower the activation energy of a reaction. That is, it decreases the energy required to start a reaction.

ITEM 18 ANS B

$V(\text{ethylene}) = \frac{nRT}{P} = \frac{1 \times 10^6 \times 8.31 \times (273 + 25)}{28 \times 1000 \times 10^3} = 88.4\ m^3$. Notice that volume units are **m^3** and not **L** when R = 8.31 J K^{-1} mol^{-1} and P is given in Pa (Nm^{-2}).

ITEM 19 ANS B

In $Cr_2O_7^{2-}$, the oxidation number of chromium can be calculated from:

2Cr + (7 x -2) = -2. Hence, Cr = +6.

In Cr^{3+}, the oxidation number of chromium = +3.

Hence, the chromium has been reduced from +6 to +3.

ITEM 20 ANS C

The overall equation for the reaction can be obtained by multiplying the first equation by 2, the second equation by 3 and adding the equations.

Hence, 2 mole of $Cr_2O_7^{2-}$ will react exactly with 3 mole of C_2H_5OH.

That is, $n(\text{ethanol}) = \frac{3}{2}$ x n(potassium dichromate) $= \frac{3}{2}$ x 0.050 = 0.075 mol.

SUGGESTED SOLUTIONS

SECTION B

QUESTION 2

(a) $n(HNO_3) = 4 \times n(Cu) = 4 \times \frac{10.0}{63.5} = \frac{40}{63.5}$.

Hence, $V(HNO_3) = \frac{n}{c} = \frac{40}{63.5} \times \frac{1000}{14} = 44.9\ cm^3 = 45\ cm^3$ **ANS**

(b) $n(NO_2) = 2 \times n(Cu) = 2 \times \frac{10.0}{63.5} = \frac{20}{63.5}$.

Hence, $V(NO_2)$ at STP $= n(NO_2) \times 22.4\ dm^3$

$= \frac{20}{63.5} \times 22.4 = 7.06\ dm^3 = 7.1\ dm^3$ **ANS**

(c) This reaction is an oxidation-reduction reaction because the oxidation number of copper changes from 0 in copper metal to +2 in copper(II) nitrate and the oxidation number of nitrogen changes from +5 in nitric acid to +4 in nitrogen dioxide.

QUESTION 3

(a) $K_c = \frac{[C_9H_7O_4^-(aq)][H_3O^+(aq)]}{[C_9H_8O_4(aq)][H_2O(l)]}$

(b) When sodium bicarbonate dissolves in water, it produces hydroxide ions according to the equation: $HCO_3^-(aq) + H_2O(l) = H_2CO_3(aq) + OH^-(aq)$. The OH^- ions remove the H_3O^+ ions from the original equilibrium, thereby forcing the reaction to the right to give more $C_9H_7O_4^-(aq)$ and less $C_9H_8O_4(aq)$. Hence, the concentration ratio will decrease. **ANS**

(c) In the stomach H_3O^+ ions are present. This will force the reaction to the left to give more $C_9H_8O_4(aq)$ and less $C_9H_7O_4^-(aq)$. Hence, the concentration ratio will increase. **ANS**

(d) $m(NaHCO_3)$ in two tablets $= 2 \times \frac{60}{100} \times 1.0 = 1.2$ g

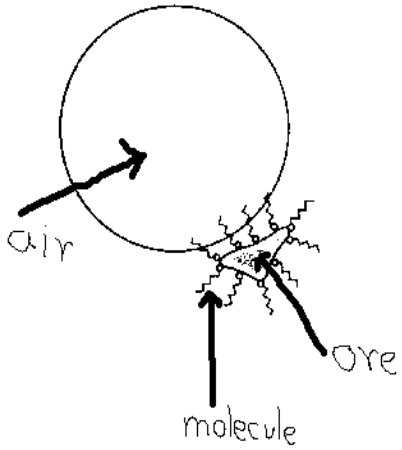
$n(HCl) = n(NaHCO_3) = \frac{1.2}{(23 + 1 + 12 + (3 \times 16))} = \frac{1.2}{84}$.

Hence, $m(HCl) = \frac{1.2}{84} \times (35.5 + 1) = \frac{1.2}{84} \times 36.5 = 0.52$ g **ANS**

SUGGESTED SOLUTIONS

QUESTION 4 (COPPER)

(a) Sodium ethyl xanthate (a surfactant molecule) is added to the mixture containing the copper ore. One end of this molecule is charged and attaches itself to the ions in the ore particles. The other end is non-polar and therefore, hydrophobic, and is repelled by the water. When air is blown through the water, the hydrophobic ore particles collect in the bubbles and are carried to the top in a froth. This is illustrated in the diagram below.



(b) $2CuFeS_2(s) + 4O_2(g) \rightarrow Cu_2S(l) + 2FeO(l) + 3SO_2(g)$

Other correctly balanced equations with products such as Cu_2O and FeS would also be acceptable.

(c) $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ (sulfurous acid)

(d) If sulfur dioxide is reacted with oxygen in the presence of a catalyst, it is oxidised to sulfur trioxide. When sulfur trioxide is reacted with water (indirectly in the Contact Process), sulfuric acid is produced according to the equation:

$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

SUGGESTED SOLUTIONS

Question 4 (IRON)

(a)

IRON CYCLE	NAME	FORMULA
iron ore added to the blast furnace	haematite	Fe_2O_3
solid reductant added to the blast furnace	coke	C
the reductant gas produced in the blast furnace	carbon monoxide	CO

(b) The major impurity is carbon at approximately 4%.

(c) In rust, $Fe_2O_3.xH_2O$, the oxidation number of iron is +3.

(d) Limestone, $CaCO_3$, decomposes in the heat of the furnace according to the equation: $CaCO_3(s) = CaO(s) + CO_2(g)$. The calcium oxide formed reacts with the major impurity silica to produce a slag according to the equation: $SiO_2(l) + CaO(s) = CaSiO_3(l)$. Calcium oxide also reacts with aluminium and manganese oxides. The slag floats on top of the molten iron at the bottom of the blast furnace and is easily removed.

SUGGESTED SOLUTIONS

Question 4 (NITRIC ACID)

(a)The changes in the oxidation number of nitrogen are $N_2(0)$, $NH_3(-3)$, $NO(+2)$, $NO_2(+4)$, $HNO_3(+5)$. The nitrogen is reduced to ammonia and then oxidised to nitrogen monoxide, nitrogen dioxide and finally to nitric acid. The reductant in step **1** is hydrogen. The oxidant in steps **2**, **3** and **4** is oxygen.

(b) The balanced chemical equation is: $4NH_3(g) + 5O_2(g) = 4NO(g) + 6H_2O(g)$

(c) The purpose of the catalyst is to promote the formation of NO(g) rather than the production of $N_2(g)$ which is more favoured when the catalyst is not present.

(d) Nitrogen monoxide reacts with oxygen according to the equation:
$NO(g) + \frac{1}{2} O_2(g) = NO_2(g)$. The product, nitrogen dioxide, has a relative molecular mass of 46. However, nitrogen dioxide exists in equilibrium with dinitrogen tetroxide according to the equilbrium: $2NO_2(g) = N_2O_4(g)$. The relative molecular mass of dinitrogen tetroxide is 92. The exact position of equilbrium depends on the temperature. The average molar mass of the gas produced will lie between 46 and 92.

SUGGESTED SOLUTIONS

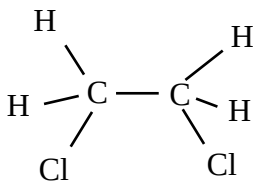
QUESTION 5

(a) Peak X is approximately 2900 cm^{-1}. This is the C-H bond.
Peak Y is approximately 1700 cm^{-1}. This is the C=O bond.
Peak Z is approximately 3300 cm^{-1}. This is the O-H bond.

(b) Both **A** and **B** contain C-H bonds. However, **A** has a C=O bond and no O-H bond while **B** has an O-H bond but no C=O bond. Hence, spectrum 1 is substance **A** and spectrum 2 is substance **B**.

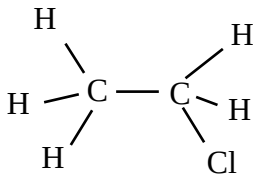
QUESTION 6

A



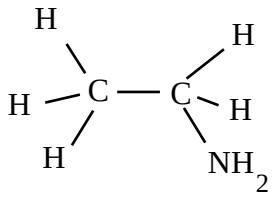
1,2 dichloroethane

B



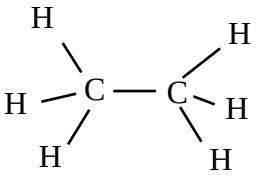
chloroethane

D



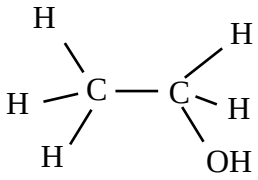
aminoethane

E



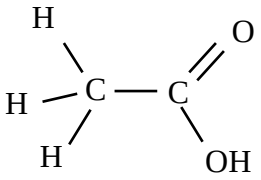
ethane

F



ethanol
(hydroxyethane)

G



ethanoic acid
(acetic acid)

SUGGESTED SOLUTIONS

Question 7

(a) An oil-in-water emulsion has oil droplets suspended in water. The surface of each oil droplet is coated with a molecule that has a hydrophobic (non-polar) end attached to the oil and a hydrophilic (polar) end pointing into the water. This molecule is contained in the emulsifier that has been added to the mixture. The emulsifier has thus reduced the surface tension between the two liquids and stopped their natural tendency to separate into layers.

(b) Surface tension is the force required to change a surface (measured in newtons per metre). Mercury (Hg) has a higher surface tension than water because the forces of attraction between the mercury ions and mobile electrons (metallic bonding) are greater than the hydrogen bonds between the water molecules. Hence, it is more difficult to stretch or deform the surface of mercury than the surface of water. This is shown by the fact that unlike water, mercury does not wet a glass surface.

END OF 1994 VCE CHEMISTRY TRIAL CAT 1 SOLUTIONS

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