1996

CHEMISTRY

UNIT 3

TRIAL EXAM

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SECTION A.

MULTIPLE CHOICE ANSWER SHEET

ABSENT

SURNAME
GIVEN NAME(S)

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

Instructions

Answer **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.

All answers must be completed like this.

A	B	C	D

One answer per line ***One answer per line***

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D

10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	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 _____

VICTORIAN CERTIFICATE OF EDUCATION 1996

CHEMISTRY

COMMON ASSESSMENT TASK 1 (TRIAL)

Chemistry and the market place

(not to be used before Monday May 27, 1996)

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 (18 items)	1 (18 items)
B	6	6

Directions to students

Materials

Question and answer booklet of 19 pages, and a data page on the back of this sheet.

Answer sheet for multiple-choice items. You should have at least one HB pencil and an eraser.

An approved calculator may be used.

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 answer sheet for multiple-choice items.

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 a total of 72 marks available.

There is provision for rough working throughout the booklet

All written responses should be in English.

At the end of the task

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

1996 CHEMISTRY TRIAL CAT 1

DATA

(not all of these data are necessarily required)

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

Element	Symbol	Atomic No.	Relative Atomic Mass
Calcium	Ca	20	40.0
Carbon	C	6	12.0
Chlorine	Cl	17	35.5
Hydrogen	H	1	1.0
Iron	Fe	26	55.9
Magnesium	Mg	12	24.3
Nitrogen	N	7	14.0
Oxygen	O	8	16.0
Sodium	Na	11	23.0
Sulfur	S	16	32.1

TABLE 2: PHYSICAL CONSTANTS

Ideal gas molar volume of gas at SLC (298 K, 101.3 kPa) = 24.5 L mol^{-1}

Ionisation constant of water , K_w, at 298 K = 1.0×10^{-14} M^2

SECTION A

SPECIFIC INSTRUCTIONS FOR SECTION A

Section A, Question 1, consists of 18 multiple choice items and is worth 18 marks and therefore 25% of the total marks available for this examination.

You should therefore spend about 23 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

R_1 and R_2 have the chemical formula C_nH_{2n+1} where n is a number greater than 10. The chemical formulas of two commonly used detergents are $R_1N(CH_3)_3.Cl$ (detergent A) ane $R_2SO_3.Na$ (detergent B) Which one of the following statements is correct?

A. Both detergent A and detergent B are cationic detergents.

B. Detergent A is an anionic detergent and detergent B is a cationic detergent.

C. Detergent A is a cationic detergent and detergent B is an anionic detergent.

D. Both detergent A and detergent B are anionic detergents.

Item 2

Which one of the following is a property of a water in oil emulsion?

A. It mixes readily with water.

B. The electrical activity is higher than that of a oil in water emulsion.

C. It feels greasy on the fingers.

D. It can be coloured by adding a water soluble dye.

Item 3

In the blast furnace for the production of iron, the gaseous reductant is produced from the reaction between

A. carbon dioxide and coke.

B. limestone and air

C. carbon monoxide and carbon dioxide

D. coke and limestone

SECTION A

Item 4
In an acid-base titration, a 50 mL burette is filled with 0.0250 M H_2SO_4(aq). The number of mole of H^+(aq) in the burette is

A. 0.05

B. 6.25×10^{-4}

C. 1.25×10^{-3}

D. 2.50×10^{-3}

Items 5, 6 and 7 refer to the following information.

In a separate experiment, 30.25 mL of 0.0250 M H_2SO_4(aq) was required to react exactly with 28.5 mL of Na_2CO_3(aq).

Item 5
The number of mole of Na_2CO_3(aq) reacting is

A. 3.8×10^{-4} mol

B. 7.6×10^{-4} mol

C. 1.5×10^{-3} mol

D. 0.77 mol

Item 6
The concentration of Na_2CO_3(aq) is

A. 0.027 M

B. 0.053 M

C. 0.106 M

D. 0.212 M

Item 7
The pH of the resulting solution is

A. less than 7

B. equal to 7

C. greater than 7

D. there is insufficient information to determine the pH.

SECTION A

Items 8 and 9 refer to the following information.

The self-ionisation constant of water, derived from the reaction

$$2H_20(1) \Leftrightarrow H_30^+(aq) + OH^-(aq); \Delta H = +57 \text{ kJ mol}^{-1}$$

can be expressed as $K_w = [H_30^+][0H^-] = 10^{-14} M^2$ at 25 °C

Item 8

In acid solutions at 25 °C

A. 10^{-14} M > $[H_30^+]$ > $[OH^-]$

B. 10^{-14} M > $[OH^-]$ > $[H_30^+]$

C. $[OH^-] > 10^{-7}$ M > $[H_30^+]$

D. $[H_30^+] > 10^{-7}$ M > $[OH^-]$

Item 9

At 10^oC the pH of pure water will be

A. 14 exactly

B. >7.0

C. 7 exactly

D. <7.0

Item 10

The number of mole of chlorine molecules (Cl_2) that could be obtained from 3.85 g of $FeCl_3$ is closest to

A. 0.024

B. 0.036

C. 0.072

D. 0.108

Item 11

A sample of Fe_3O_4 contains 0.30 mole of iron atoms. The total mass of oxygen in the sample of Fe_3O_4 is closest to

A. 6.4 g

B. 4.8 g

C. 3.2 g

D. 1.6 g

SECTION A

The following information refers to items 12 and 13

Acidified potassium dichromate, $K_2Cr_2O_7$, can be used to oxidise methanol to formic 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) $CH_3OH(aq) + H_2O(l) \rightarrow HCOOH(aq) + 4H^+(aq) + 4e^-$

Item 12
The element being reduced in this reaction **and** the change in oxidation number of the element is

A. chromium; +7 to +3

B. chromium; +6 to +3

C. carbon; -2 to 0

D. carbon; +4 to +2

Item 13
The number of mole of methanol that will be oxidised to formic acid by 0.005 mole of potassium dichromate is

A. 0.0033 mol

B. 0.0075 mol

C. 0.0100 mol

D. 0.0150 mol

SECTION A

Item 14

Which one of the following will **increase** the rate of formation of magnesium oxide in the reaction between magnesium metal and air?

A. Add nitrogen gas to the magnesium/air mixture.

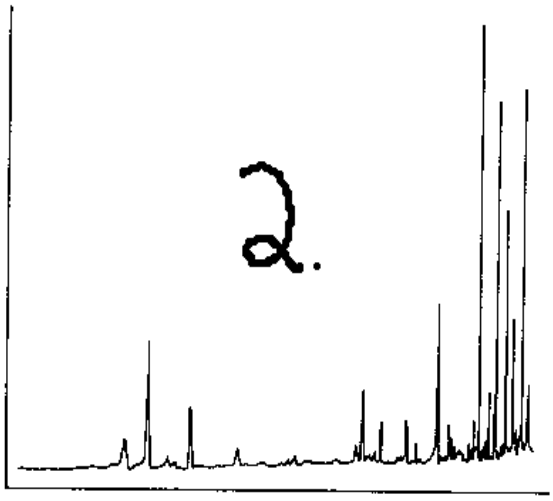
B. Decrease the temperature of the magnesium/air mixture.

C. Increase the concentration of oxygen in contact with the magnesium.

D. Use the metal in the form of magnesium ribbon instead of as finely powdered magnesium.

Item 15

A sample of an organic solvent was analysed with a gas chromatograph and labelled as sample **2** as shown below



This graph shows that sample **2** contains

A. only one chemical element.

B. only one chemical compound.

C. a mixture of chemical elements.

D. a mixture of chemical compounds.

SECTION A

The following information refers to items 16,17 and 18.

Sulfur trioxide gas is produced industrially in a reversible reaction involving sulfur dioxide gas and oxygen gas according to the equation $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$.
The reaction to produce sulfur trioxide gas is exothermic.
The equilibrium constant for the reaction $SO_3(g) \Leftrightarrow SO_2(g) + \frac{1}{2} O_2(g)$ at 600^oC is $0.471\ M^{0.5}$.

Item 16

At 600^oC, the equilibrium constant for the reaction $SO_2(g) + \frac{1}{2} O_2(g) \Leftrightarrow SO_3(g)$ is

A. 0.471

B. 1 - 0.471

C. 0.471 - 1

D. $\frac{1}{0.471}$

Item 17

If the temperature of the equilibrium mixture is decreased to 500^oC, the value of the equilibrium constant for the reaction $SO_3(g) \Leftrightarrow SO_2(g) + \frac{1}{2} O_2(g)$ will be

A. less than $0.471\ M^{0.5}$.

B. equal to $0.471\ M^{0.5}$.

C. greater than $0.471\ M^{0.5}$.

D. unable to be determined from the information provided.

Item 18

The equilibrium yield of sulfur trioxide could be increased by

A. increasing the temperature of the equilibrium mixture.

B. using a suitable catalyst

C. increasing the pressure of the equilibrium mixture.

D. using less oxygen in the equilibrium mixture.

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 54 marks or 75% of the total.
You should spend approximately 67 minutes on this section.

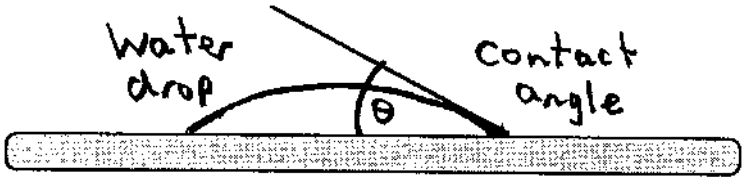
The marks allotted to each question and suggested time allocations are shown at the end of each question.

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

You should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not receive full marks.
- show all working in your answers to numerical questions. No marks can 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 2
The diagram below shows a water drop that has been placed on a clean surface. The diagram shows the drop a short time after it has started spreading.



a. Suggest a possible surface material that would produce this effect and explain why the water drop takes on this particular shape.

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_____

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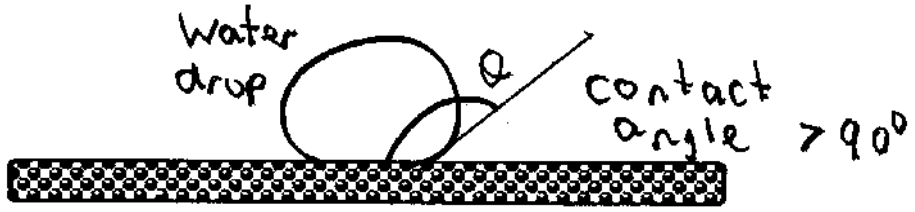
Question 2 (continued)

b. Explain what would happen to the contact angle if the drop is allowed to remain on this surface.

Another drop of water is placed on a different clean surface. A different shape is produced as shown in the diagram below.



c. Suggest a possible surface material that would produce this effect and explain why the water drop takes on this particular shape.

Question 2 (continued)

d. A drop of an anionic detergent is added to the drop of water in **c.**
Explain what is meant by an anionic detergent.

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e. Sketch the expected appearance of the drop a short time after the detergent has been added to the water.

2+2+2+1+2 = 9 marks
(suggested time = 11 minutes)

SECTION B

Question 3
Metallic iron is produced in the blast furnace from iron ore using a variety of materials.

a. What is the name of the mineral in the iron ore that is added to the blast furnace?

b. Coke is one of two solid materials added to the iron ore in the blast furnace. What is the purpose of coke in the blast furnace?

c. Limestone is the other solid material added to the iron ore in the blast furnace. What is the purpose of limestone in the blast furnace?

d. Write the balanced chemical equation for the production of iron in the blast furnace and explain why the reaction in the blast furnace is called an oxidation-reduction reaction.

Question 3 (continued)

e. The iron that is produced in the blast furnace is only 92% pure.
Name two other elements which would make up a considerable part of the remaining 8%.
In your answer, give the source of these two elements.

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1+2+2+2+2 = 9 marks
(suggested time = 11 minutes)

Question 4
An experiment is carried out on the following equilibrium system.

$$4HCl(g) + O_2(g) = 2H_2O(g) + 2Cl_2(g) \quad \Delta H = -113 \text{ kJ mol}^{-1}$$

a. Write the equilibrium constant expression for this equation.

b. 4 mol of HCl and 1 mol of O_2 are introduced into a 2000 mL vessel at a constant temperature of 350^oC until equilibrium is achieved according to this equation.
Is this information sufficient to calculate the equilibrium constant at 350^oC?
Explain your answer. (Do **not** attempt to calculate the value of the equilibrium constant)

c. How will the value of K_c for this equilibrium system at 350^oC compare with that at 550^oC if the pressure is held constant? Explain your answer.

Question 4 (continued)

d. How will the value of K_c for this equilibrium system at 350^{o}C and 101.3 kPa compare with that at 350^{o}C and 80.0 kPa? Explain your answer.

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e. A scientist wishes to obtain the largest possible yield of chlorine (Cl_2) from this reaction in the shortest possible time. Briefly explain the conditions she should use to achieve this result.

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1+2+2+2+2 = 9 marks
(suggested time = 11 minutes)

SECTION B

Question 5

Sodium carbonate can exist in both an anhydrous state (without water) and a hydrated state (with water).

A sample of sodium carbonate contains an unknown quantity of water and is represented by the formula $Na_2CO_3.xH_2O(s)$. Dilute hydrochloric acid can be used to determine the amount of water in this hydrated sodium carbonate.

In a laboratory experiment ,a student finds that 0.400 g of a **hydrated** form of sodium carbonate reacts exactly with 45 mL of 0.100 M HCl

a. Briefly describe how the student would have carried out this reaction between the hydrated sodium carbonate and the hydrochloric acid in the laboratory.

b. Write a balanced chemical equation for the reaction between solid hydrated sodium carbonate and dilute hydrochloric acid.

c. Calculate the number of mole of hydrochloric acid used and, hence, calculate the number of mole of hydrated sodium carbonate used in this experiment.

Question 5 (continued)

d. Calculate the value of *x* in the formula $Na_2CO_3.xH_2O$.

3+1+2+3 = 9 marks
(suggested time = 11 minutes)

SECTION B

Question 6

A scientist in a commercial laboratory has been given three analytical tasks to accomplish.

(A) To determine the concentration of copper in a sample of river water near a copper smelter.

(B) To determine the compounds present in a sample of an organic industrial solvent.

(C) To determine the sugar level in a blood sample.

His laboratory has the following analytical instruments:

(a) a Gas-Liquid Chromatograph.

(b) an Ultra-violet/visible (UV) Spectrometer

(c) an Atomic Absorption (AA) Spectrometer.

a. Which instrument will he use to accomplish task **(A)**?
Briefly explain how this instrument will achieve the desired result.

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Question 6 (continued)

b. Which instrument will he use to accomplish task **(B)**?
Briefly explain how this instrument will achieve the desired result.

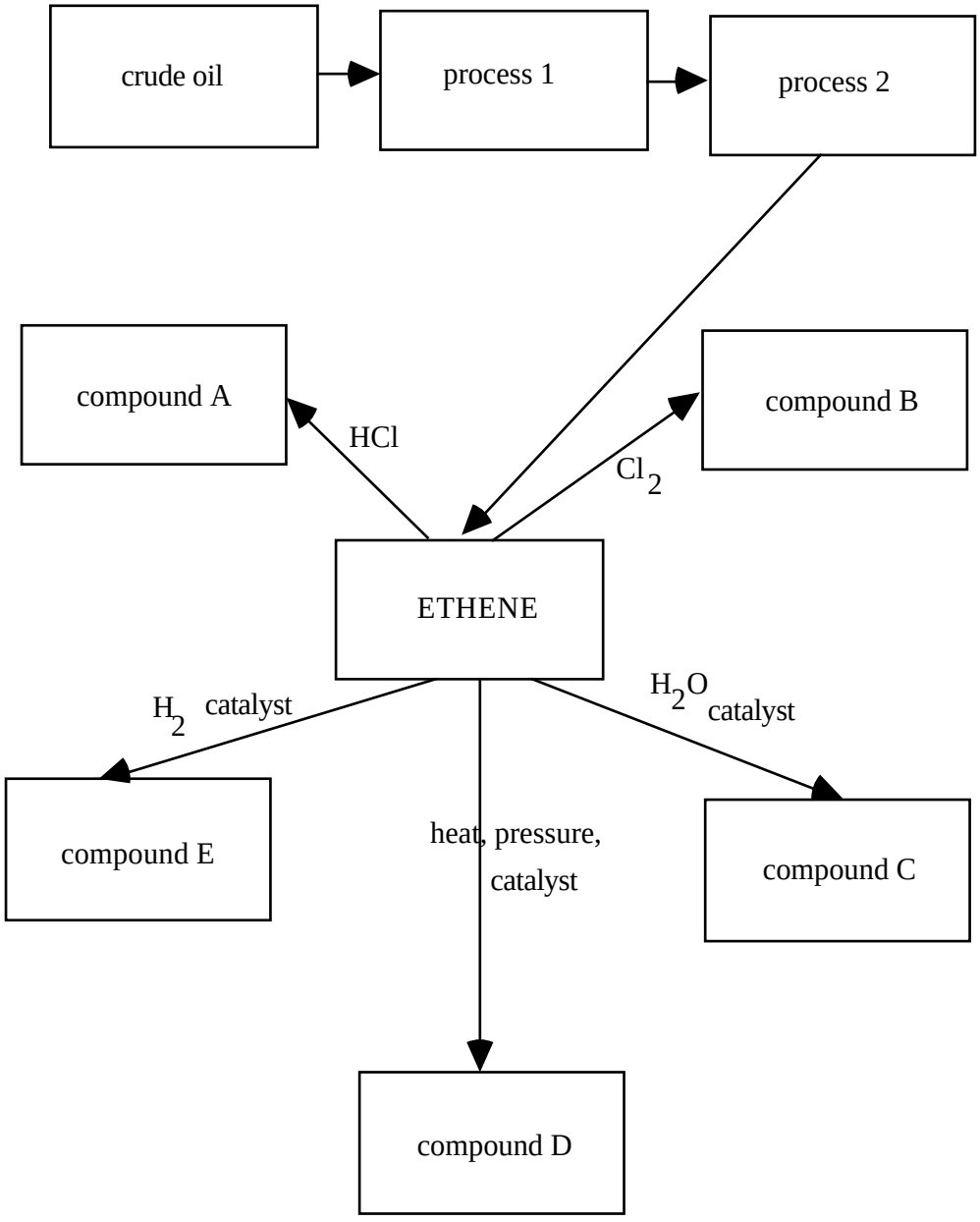
c. Which instrument will he use to accomplish task **(C)**?
Briefly explain how this instrument will achieve the desired result.

3+3+3 = 9 marks
(suggested time = 11 minutes)

SECTION B

Question 7

Ethene is one of the most important industrial materials used in twentieth century chemistry. The flowchart below can be used to summarise the production and use of ethene in the chemistry of an industrialised society.



SECTION B

Question 7

Identify each of the processes and compounds in the flowchart on page 17.
For each of the compounds, give the name and the chemical formula.

a. Process 1 _____

b. Process 2 _____

c. Compound A _____

d. Compound B _____

e. Compound C _____

f. Compound D _____

g. Compound E _____

h. Explain why process 2 is necessary in the production of ethene.

_____

_____

i. Write a typical balanced chemical equation for the production of ethene in process 2.

_____

_____

1+1+1+1+1+1 +1+1+1+1+1 = 9 marks
(suggested time = 12 minutes)

END OF QUESTION AND ANSWER BOOKLET

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SUGGESTED SOLUTIONS SECTION A

Question 1

Item 1 ANS C

The formulas are (A) $R_1N(CH_3)_3^+$ and (B) $R_2SO_3^-$. An anion is a negative ion and a cation is a positive ion. Hence, detergent A is an cationic detergent and detergent B is a anionic detergent.

Item 2 ANS C

A water in oil emulsion will not accept a water soluble dye for colouring purposes. It does not mix with water, has a lower electrical conductivity than an oil in water emulsion. It is greasy on the fingers.

Item 3 ANS A

The gaseous reductant is carbon monoxide (CO) which is produced from the reactions:
$C(s) + O_2(g) = CO_2(g)$ and then $CO_2(g) + C(s) = 2CO(g)$

Item 4 ANS D

$n(H^+(aq)) = 2 \times n(H_2SO_4(aq) = 2 \times 0.050 \times 0.0250 = 2.5 \times 10^{-3}$ mol

Item 5 ANS B

The balanced equation for the reaction is
$H_2SO_4(aq) + Na_2CO_3(aq) = Na_2SO_4(aq) + H_2O(l) + CO_2(g)$.
Notice that 1 mole of sulfuric acid reacts exactly with 1 mole of sodium carbonate.

From the balanced chemical equation
$n(Na_2CO_3) = n(H_2SO_4) = 0.03025 \times 0.0250 = 7.6 \times 10^{-4}$ mol

Item 6 ANS A

$$c(Na_2CO_3) = \frac{0.03025 \times 0.0250}{0.0285} = 0.0265 \text{ M} = 0.027 \text{ M}$$

Item 7 ANS C

The balanced equation for the reaction is
$H_2SO_4(aq) + Na_2CO_3(aq) = Na_2SO_4(aq) + H_2O(l) + CO_2(g)$.

Since this is an exact reaction, all of the $H_2SO_4(aq)$ and the $Na_2CO_3(aq)$ have been used up.
$Na_2SO_4(aq)$ is neutral in solution but a solution of $CO_2(g)$ in water is slightly alkaline.
Hence, the pH is greater than 7.

SUGGESTED SOLUTIONS **SECTION A**

Question 1 (continued)

Item 8 ANS D
In acid solutions, the concentration of hydronium ions is greater than the concentration of hydroxide ions. Because the product of these two concentrations must equal 10^{-14}, $[H_30^+] > 10^{-7}$ M > $[OH^-]$

Item 9 ANS B
The forward reaction is endothermic. Hence, a decrease in temperature will favour the reverse reaction. Hence, the concentrations of both OH^- and H_3O^+ will decrease and the value of K_w will decrease.
Hence, the concentration of H_3O^+ in pure water will be less than 10^{-7}M.
Hence, the pH of pure water will be **greater than** 7.0

Item 10 ANS B
Using the data given , $n(FeCl_3) = \frac{3.85}{55.9 + (3 \times 35.5)} = \frac{3.85}{162.4}$
Hence, $n(Cl) = 3 \times \frac{3.85}{162.4}$. Hence, $n(Cl_2) = \frac{1}{2} \times 3 \times \frac{3.85}{162.4} = 0.036$ mol.

Item 11 ANS A
From the chemical formula , $n(O) = \frac{4}{3} \times n(Fe) = \frac{4}{3} \times 0.30 = 0.40$.
Hence, m(O) = 0.40 x 16 = 6.4 g

Item 12 ANS B
The oxidation number of Cr in $Cr_2O_7^{2-}$ is +6. The oxidation number of Cr in Cr^{3+} is +3.
Hence, Cr has been reduced from +6 to +3.

Item 13 ANS B
There are six electrons in partial equation (1) and four electrons in partial equation (2). To balance these electrons multiply equation (1) by 2 and equation (2) by 3. Hence, 2 mole of $Cr_2O_7^{2-}$ will react exactly with 3 mole of CH_3OH.
Hence, $n(CH_3OH) = \frac{3}{2} \times n(Cr_2O_7^{2-}) = \frac{3}{2} \times 0.005 = 0.0075$ mol.

Item 14 ANS C
The chemical reaction is $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
Increases in temperature, **concentration** and surface area will **usually** increase the rate of a chemical reaction.

SUGGESTED SOLUTIONS **SECTION A**

Question 1 (continued)

Item 15 ANS D
Gas chromatograms are used to detect very small amounts of chemical compounds. Each peak on the gas chromatogram indicates a particular chemical compound and the height of the peak is an indication of its relative abundance.

Item 16 ANS D
The equilibrium constant expression for the equation

$SO_3(g) \Leftrightarrow SO_2(g) + \frac{1}{2} O_2(g)$ is $K_c = \frac{[SO_2][O_2]^{0.5}}{[SO_3]} = 0.471$

Hence, the value of the equilibrium constant expression $\frac{[SO_3]}{[SO_2][O_2]^{0.5}} = \frac{1}{0.471}$.

Item 17 ANS A
When the temperature is decreased for this endothermic reaction, the reverse reaction is favoured and the equilibrium constant will decrease. K_c will be less than 0.471 $M^{0.5}$.

Item 18 ANS C
Since the production of sulfur trioxide involves a decrease in the number of mole of gas, then, by Le Chatelier's Principle, an increase in pressure will favour the production of sulfur trioxide. Note that a catalyst does not change the yield of an equilibrium reaction. It just gets the reaction to equilibrium faster.

SUGGESTED SOLUTIONS **SECTION B**

Question 2

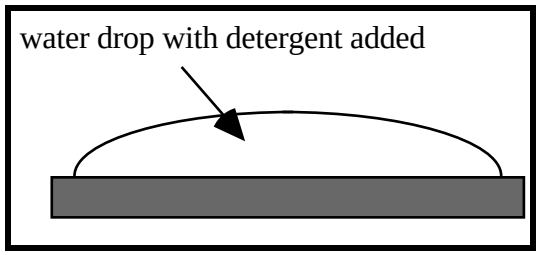
a. Water will wet **glass** in this manner. The polar water molecules are attracted to the polar chemicals that make up the glass and the water spreads out.

b. The contact angle will decrease as the drop spreads out and will approach zero.

c. Water behaves like this on a surface such as **polyethene**. The polar water molecules are not attracted to the non-polar molecules of polyethene and so the water drop maintains an approximately spherical shape (as near as the force of gravity will allow)

d. An anionic detergent has a non-polar organic end and a negatively charged polar end such as SO_3^-. The polar end is attracted to the polar water molecules.

e. When a detergent is added to water, the surface energy of the water decreases and the water spreads out more over a surface thereby enabling the water to wet the surface more efficiently. This is shown in the diagram below.



Question 3

a. The mineral in the iron ore is haematite with the formula Fe_2O_3 with iron in the +3 oxidation state.

b. The solid reductant added to the blast furnace with haematite is coke (carbon , C)
The oxygen from the air reacts with the coke to produce the gaseous reductant, carbon monoxide, according to the overall equation: $2C(s) + O_2(g) = 2CO(g)$.

c. Limestone or calcium carbonate is added to the blast furnace to help to remove some of the impurities from the molten iron. (The major impurity that remains is carbon at approximately 4%).The heat of the blast furnace causes the calcium carbonate to decompose according to the equation $CaCO_3(s) = CaO(s) + CO_2(g)$ and then $CaO(s) + SiO_2(s)$ (impurity from the ore) $= CaSiO_3(l)$.
Calcium oxide also reacts with aluminium and manganese oxides. This 'slag' floats on top of the molten iron at the base of the blast furnace and is easily removed.

d. The production of iron in the blast furnace is shown by the equation:

$Fe_2O_3(s) + 3CO(g) = 2Fe(l) + 3CO_2(g)$.
In this reaction, iron is reduced from +3 to 0 and carbon is oxidised from +2 to +4.

e. Carbon and silicon are the major impurities in the pig iron. Carbon comes from the coke that is added and silicon comes from the SiO_2 in the original ore.

SUGGESTED SOLUTIONS **SECTION B**

Question 4

a. $K_c = \dfrac{[H_2O]^2_e[Cl_2]^2_e}{[HCl]^4_e[O_2]_e}$ where e stands for the equilibrium concentration.

b. This information is not sufficient to calculate the value of the equilibrium constant. Only the initial concentrations can be calculated. To calculate the value of K_c, the **equilibrium concentrations** must be known.

c. When the temperature is increased, the reverse reaction is favoured (the endothermic reaction). Hence, the value of K_c will decrease.

d. The value of K_c depends only on the chemical equation and the temperature. Hence, the value of K_c will be the same since the temperature is the same.

e. The conditions that will increase the yield of Cl_2 in the shortest possible time are:

(1) use high pressure since the forward reaction involves a decrease in the number of mole of gas
(2) use excess reactants.
(3) use as low a temperature as possible since the forward reaction is exothermic.
(4) for increased rate, use a high temperature (conflict with (3) and a catalyst.

Question 5

a. The hydrated sodium carbonate is weighed accurately on a balance and then dissolved in pure water in a conical flask. An indicator is added to the sodium carbonate solution.(eg methyl orange) The hydrochloric acid is titrated from a burette into the conical flask until the appropriate colour change occurs.

b. $Na_2CO_3xH_2O(aq) + 2HCl(aq) = 2NaCl(aq) + H_2CO_3(aq) + xH_2O(l)$

c. n(HCl) = 0.045 x 0.100 = 0.0045 mol.

Hence, n(hydrated sodium carbonate) = $\frac{1}{2}$ x 0.0045 = 0.00225 mol **ANS**

d. $n(Na_2CO_3xH_2O) = 0.00225 = \dfrac{0.400}{(46 + 12 + 48 + 18x)} = \dfrac{0.400}{106 + 18x}$.

Hence, $18x + 106 = \dfrac{0.400}{0.00225} = 177.8$.

Hence, $18x = 177.8 - 106 = 71.7$.

Hence, $x = 3.98 = 4$ **ANS**

SUGGESTED SOLUTIONS **SECTION B**

Question 6

a. The concentration of copper in a sample of river water near a copper smelter is best determined by an Atomic Absorption Spectrometer. Light of a particular wavelength is passed through a flame containing an atomic vapour from a solution of the sample. The amount of light absorbed shows the quantity of the element in the original sample.

b. The compounds present in a sample of an organic industrial solvent are best determined by a Gas-Liquid Chromatograph. A carrier gas transports the sample through a column packed with a particular molecule. The least soluble components of the sample in this stationary phase are swept out first into the detector.

c. The sugar level in a blood sample is best determined by an Ultraviolet/visible Spectrometer. The absorption of the sample is measured at a particular wavelength and then compared with the absorption of a series of standard solutions.

SUGGESTED SOLUTIONS **SECTION A**

Question 7

a. Process 1 is fractional distillation.

b. Process 2 is cracking.

c. Compound A is CHLOROETHANE , CH_3CH_2Cl

d. Compound B is 1,2 DICHLOROETHANE, CH_2ClCH_2Cl

e. Compound C is ETHANOL, CH_3CH_2OH

f. Compound D is POLYETHENE , $(C_2H_4)_n$

g. Compound E is ETHANE , C_2H_6

h. Unsaturated molecules such as ethene are required in much greater quantities than occur naturally in crude oil. Hence, the process of 'cracking' is necessary.

i. $C_3H_8(g) = C_2H_4(g) + CH_4(g)$ is a typical cracking reaction.

END OF SUGGESTED SOLUTIONS

1996 CHEMISTRY TRIAL CAT 1

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