VCE CHEMISTRY 2010

YEAR 12 TRIAL EXAM UNIT 4

Time allowed: 90 minutes
Total marks: 76

20 Multiple Choice Questions
7 Short Answer Questions

An Answer Sheet is provided for Section A.
Answer all questions in Section B in the space provided.

To download the Chemistry Data Book please visit the VCAA website:
http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf *Page 20*

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Student Name....…….....

VCE Chemistry 2010 Year 12 Trial Exam Unit 4

Student Answer Sheet

Instructions for completing test. Use only a 2B pencil. If you make a mistake erase and enter the correct answer. Marks will not be deducted for incorrect answers.

Write your answers to the Short Answer Section in the space provided directly below the question. There are 20 Multiple Choice questions to be answered by circling the correct letter in the table below.

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

VCE Chemistry 2010 Year 12 Trial Exam Unit 4

Multiple Choice Questions – Section A

Section A consists of 20 multiple-choice questions.
Section A is worth approximately 25 per cent of the marks available.
*Choose the response that is **correct** or **best answers** the question.*
Indicate your choice on the answer sheet provided.

Question 1

Ethanol and ethanoic acid react to produce the ester ethyl ethanoate according to the equation

$$CH_3CH_2OH(l) + CH_3COOH(l) \rightleftharpoons CH_3COOCH_2CH_3(l) + H_2O(l)$$

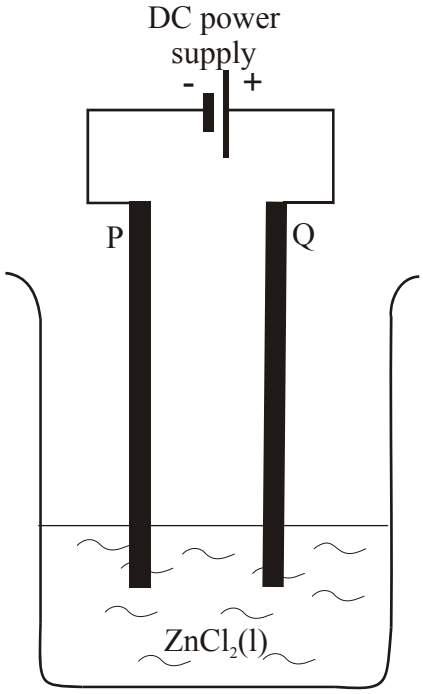
1 mol of ethanol is added to 1 mol of ethanoic acid and allowed to react in the presence of an acid catalyst.

When this reaction is as equilibrium,

A. the concentration fraction will equal 1.
B. the concentration of ethyl ethanoate equals the concentration of ethanol.
C. the rate of production of ethyl ethanoate equals the rate of its hydrolysis.
D. the pH will be 7.

Question 2

In the electrochemical cell represented below



A. chloride ions lose electrons at P.
B. chloride ions gain electrons at Q.
C. chloride ions gain electrons at P.
D. chloride ions lose electrons at Q.

Question 3

An equilibrium system represented by the equation below has $K = 2.3 \times 10^4$ at 30°C and $K = 92$ at 250°C.

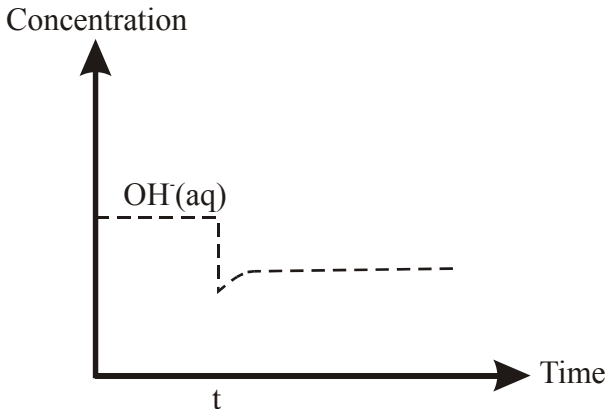
$$2X + Y \rightleftharpoons Z$$

On the basis of the information,

A. $\Delta H < 0$ and the yield of Z increases with decreasing temperature.
B. $\Delta H < 0$ and the yield of Z decreases with decreasing temperature.
C. $\Delta H > 0$ and the yield of Z increases with decreasing temperature.
D. $\Delta H > 0$ and the yield of Z decreases with decreasing temperature.

Question 4

The concentration-time graph below shows how the $[OH^-]$ changes as a result of a change imposed on an equilibrium system. The self-ionisation of water is endothermic.



The graph is consistent with

A. the addition of a small amount of 1 M NaOH(aq) to an aqueous solution of ethanoic acid.
B. cooling pure water.
C. heating pure water.
D. adding 100 mL water to 100 mL of NH_3(aq).

Question 5

When 25 mL of 1.0 M NaOH at 24°C, is added to 25 mL of 1.0 M HCl at 24°C, the temperature of the solution formed is 30°C.

Which combination of reactants, both initially at 24°C, might also be expected to produce a temperature of 30°C when mixed?

A. 25 mL of 2.0 M NaOH and 25 mL of 2.0 M HCl.
B. 50 mL of 2.0 M NaOH and 50 mL of 2.0 M HCl.
C. 50 mL of 1.0 M NaOH and 50 mL of 1.0 M HCl.
D. 100 mL of 2.0 M NaOH and 100 mL of 2.0 M HCl.

Question 6

The self-ionisation constant of pure water, K_w, at 45°C is 4.0×10^{-14}.
On the basis of this information, in pure water at 15°C

A. the pH is < 7
B. the pH > 7
C. $[H_3O^+] > [OH^-]$
D. $[H_3O^+] < [OH^-]$

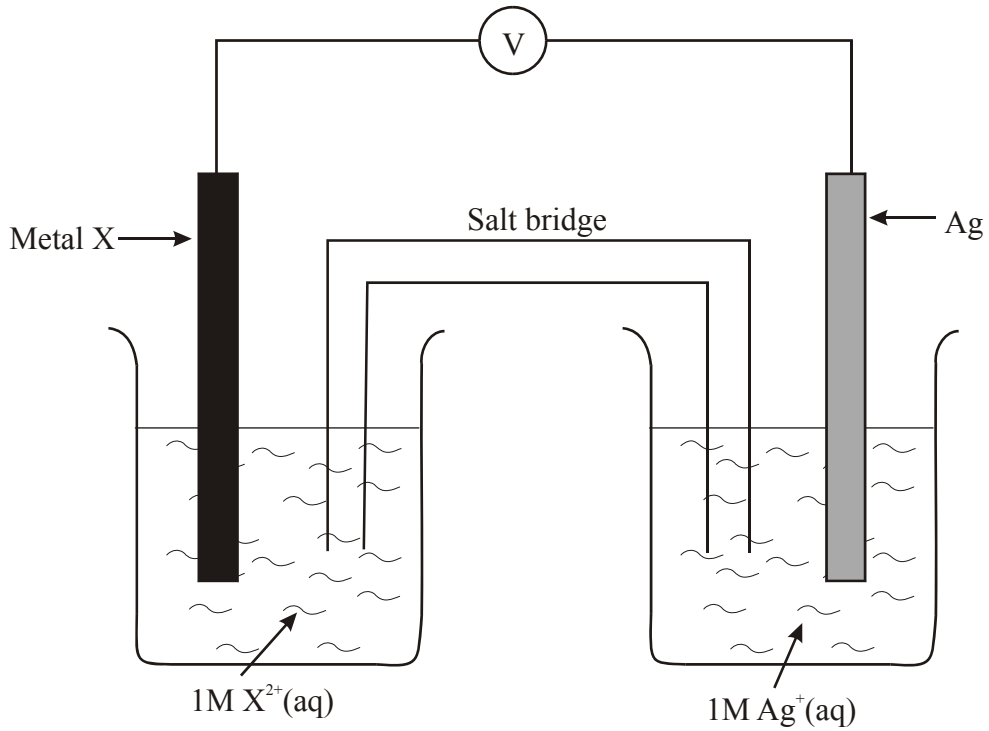
Question 7

During an electrolysis of 1 M H_2SO_4(aq), 2.0 g H_2 was produced at one electrode. The mass of gas produced at the other electrode would be expected to be

A. 8.0 g.
B. 16 g.
C. 32 g.
D. 64 g.

Question 8

Consider the electrochemical cell represented below



If, at 25°C, the voltmeter on this cell shows a reading of 0.94 V, then X is most likely to be

A. copper.
B. tin.
C. iron.
D. zinc.

Question 9

Consider the reaction represented by the equilibrium equation given below

$$2X_2(g) + 3Y_2(g) \rightleftharpoons 2X_2Y_3$$

In a particular investigation, a mixture of 1.0 mol X_2 and 6.0 mol Y_2 was allowed to reach equilibrium.

The amount of X_2Y_3 present at equilibrium could be

A. 0.5 mol.
B. 1.0 mol.
C. 2.0 mol.
D. 4.0 mol.

Question 10

At 200°C, nitrogen oxide reacts with oxygen to form nitrogen dioxide as follows:

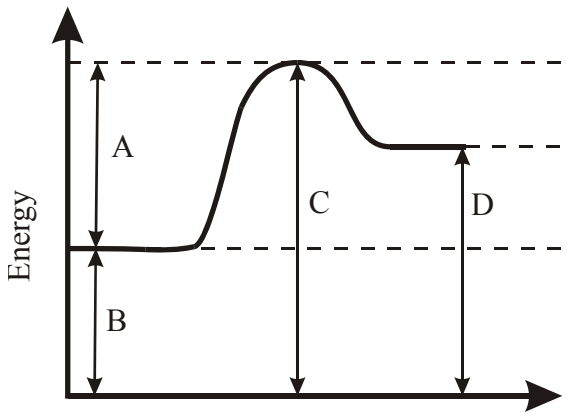
$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \quad K_c = 3 \times 10^6$$

If a one litre mixture of these three gases contains 0.10 mol NO, 0.10 mol NO_2 and 0.010 mol O_2, the reaction is

A. at equilibrium.
B. not at equilibrium and the pressure increases as it moves to equilibrium.
C. not at equilibrium and pressure decreases as it moves to equilibrium.
D. not at equilibrium and the rate of the forward reaction is slower than the rate of the reverse reaction.

Question 11

An energy profile for a reversible chemical reaction is represented below.



According to this profile, the activation energy of the reverse reaction is equal to

A. D.
B. C – B.
C. A – B.
D. C – D.

Question 12

When $Fe^{3+}(aq)$ reacts with $SCN^-(aq)$, the complex ion $Fe(NCS)^{2+}(aq)$ is produced as the equilibrium

$$Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons Fe(NCS)^{2+}(aq),\ \Delta H < 0$$

is established.

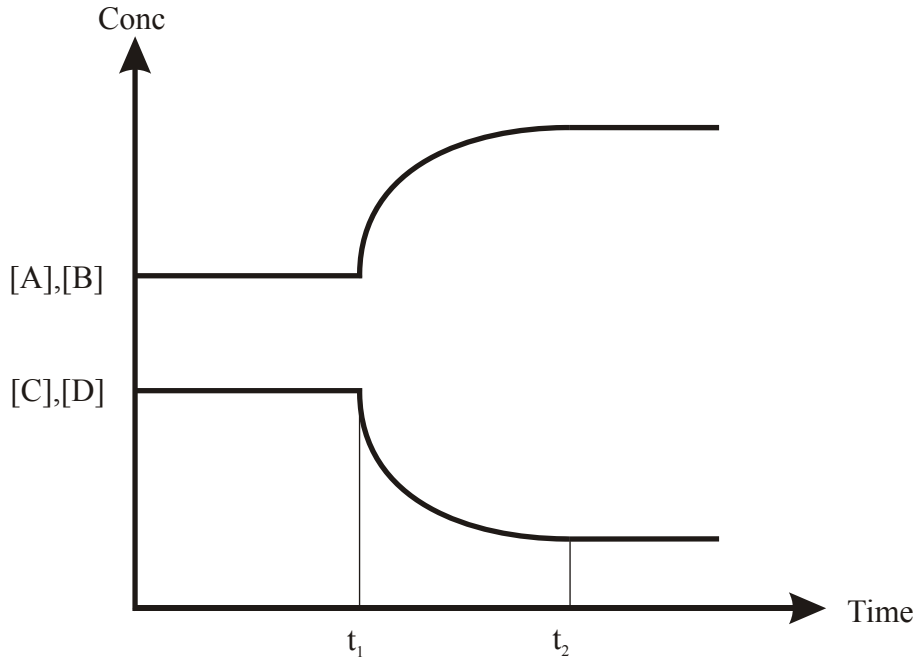
If 50 mL of this equilibrium mixture is added to 50 mL of water and allowed to return to equilibrium at the same temperature, then at the new equilibrium

A. the mass of Fe^{3+} present will have increased.
B. the concentration of SCN^- will have increased.
C. the equilibrium constant will be smaller.
D. the total number of particles will have decreased.

Question 13

Consider the general equilibrium system $\mathbf{A + B \rightleftharpoons C + D,\ \Delta H < 0}$

The concentration-time graph below shows how this equilibrium responded to an imposed change at time $\mathbf{t_1}$ with equilibrium again being established at time $\mathbf{t_2}$



What change was imposed at time t_1?

A. The volume of the equilibrium system was increased.
B. More of reactants A and B were added to the system.
C. The temperature of the system was increased.
D. A catalyst was added to the system.

Question 14

Chemical disinfectants such as chlorine are added to swimming pools to prevent the growth and spread of bacteria and viruses. Chlorine is moderately soluble in water, reacting with it according to the equation

$$Cl_2(g) + 3H_2O(l) \rightleftharpoons Cl^-(aq) + ClO^-(aq) + 2H_3O^+(aq)$$

In an experiment to test the effect of chlorine as a disinfectant, the same amount was added to a 50 L sample of tap water and a 50 L sample of sea-water respectively, both of which were at room temperature.

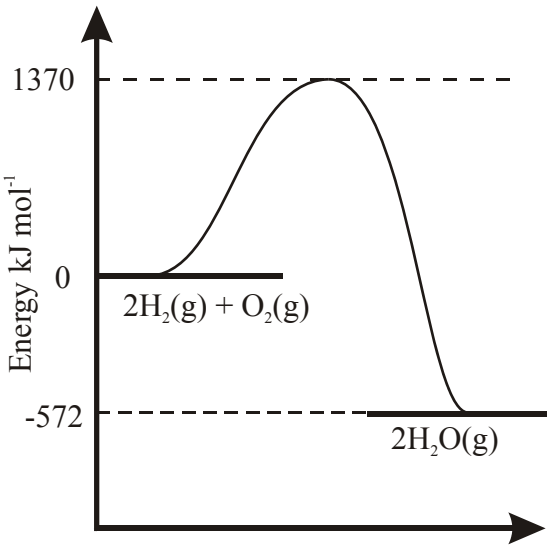
Which of the following outcomes would most likely be observed?

A. The $[ClO^-]$ would be equal in both samples.
B. The sea-water sample would have the higher pH.
C. The $[OH^-]$ would be lower in the sea-water sample.
D. The $[Cl^-]$ would be lower in the sea-water sample.

Question 15

Shown below is the energy profile for the reaction described by the equation:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$



According to the information in this profile, the energy, in kJ, released during the formation of the O-H bonds in one mole of water vapour is

A. 286 kJ
B. 572 kJ
C. 971 kJ
D. 1942 kJ

Question 16

What is the concentration of hydroxide ions, $OH^-(aq)$, in a 0.050 M solution of hypochlorous acid at 25°C?

A. 2.0×10^{-13} M
B. 2.6×10^{-10} M
C. 6.7×10^{-6} M
D. 3.8×10^{-5} M

Question 17

A current of 1.2 A is passed through 100 mL of 0.50 M $ZnSO_4(aq)$ for 5.0 minutes. The mass of substance produced at the cathode will be

A. 0.12 g
B. 0.24 g
C. 1.6 g
D. 3.3 g

Question 18

Vanadium is a metal that exhibits a wide variety of oxidation states.

Some of its oxidation state changes are represented in the standard half-cell potentials below

$$VO_3^-(aq) + 4H^+(aq) + e^- \rightarrow VO^{2+}(aq) + 2H_2O(l) \qquad E^o = 1.00 \text{ V}$$

$$VO^{2+}(aq) + 2H^+(aq) + e^- \rightarrow V^{3+}(aq) + H_2O(l) \qquad E^o = 0.32 \text{ V}$$

$$V^{3+}(aq) + e^- \rightarrow V^{2+}(aq) \qquad E^o = -0.26 \text{ V}$$

The colours associated with the oxidation states of vanadium are:

+2 – purple; +3 – green; +4 – blue; +5 – yellow

If each of the following substances were added, in excess, to separate aqueous solutions of ammonium vanadate, $NH_4VO_3(aq)$, which one would produce a green solution?

A. Zn(s)
B. KI(aq)
C. NaCl(aq)
D. Sn(s)

Question 19

Nickel-hydrogen (Ni-H_2) batteries possess very good electrical properties that have made them attractive for energy storage in satellites and space probes.
Ni-H_2 cells using 26% potassium hydroxide (KOH) as an electrolyte have shown a service life of 15 years or more.
The cathode is made from porous nickel plaque, which contains nickel hydroxide, NiO(OH).
The anode includes a Teflon-bonded platinum black catalyst.
The reaction occurring at the (+) electrode when this battery is delivering energy is

$$NiOOH(s) + H_2O(l) + e^- \rightarrow Ni(OH)_2(s) + OH^-(aq)$$

The reaction at the (-) electrode is most likely to be

A. $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-$
B. $2H^+(aq) + 2e \rightarrow H_2(g)$
C. $H_2(g) \rightarrow 2H^+(aq) + 2e^-$
D. $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$

Question 20

For the reaction KOH(s) + aq $\rightarrow$ KOH(aq), ΔH = -55.6 kJ mol^{-1}.
The temperature of water in a calorimeter is measured and then 1.00 g KOH is dissolved in the water. In order to return calorimeter to the temperature it was prior to the addition of the KOH,

A. 991 J of energy must be supplied from outside the calorimeter.
B. 991 kJ of energy must be removed from the calorimeter.
C. 55.6 kJ of energy must be supplied from outside the calorimeter.
D. 55.6 kJ of energy must be removed from the calorimeter.

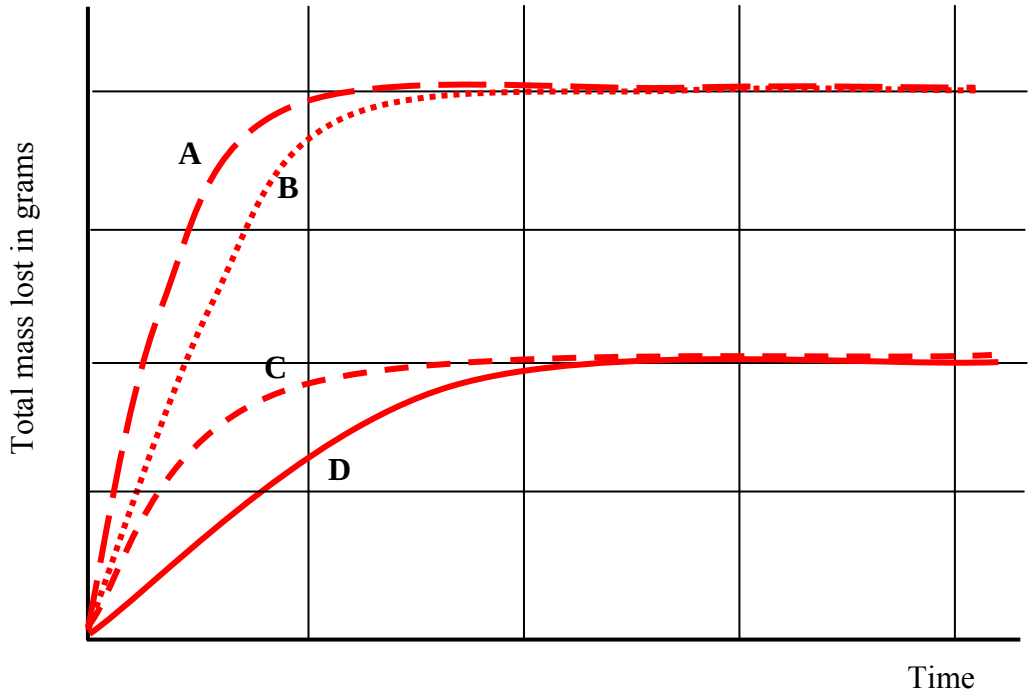
End of Section A

VCE Chemistry 2010 Year 12 Trial Exam Unit 4

Short Answer Questions – Section B

Section B consists of 7 short answer questions.
You should answer all of these questions.
This section is worth approximately 75 per cent of the total marks available.
The marks allotted are shown at the end of each part of each question.
Questions should be answered in the spaces provided.

Question 1
Following a four part experimental investigation of the effect of concentration and particle size on the rate of the reaction between excess calcium carbonate, in the form of limestone, and hydrochloric acid, a student produces the set of graphs shown below.



a. Write a balanced equation for the reaction between calcium carbonate and hydrochloric acid.

(1 mark)

b. According to the Law of Conservation of Mass, there is 'no loss of mass' during a chemical reaction. How then could the student have used 'total mass loss' in this investigation?

(2 marks)

c. At what stage in the reaction do the graphs level off and become parallel to the horizontal (time) axis?

(1 mark)

d. In each part of the investigation, calcium carbonate was in excess and the student investigated the effect of one of the four possible combinations of limestone lumps, limestone powder, 1 M HCl(aq) and 2 M HCl(aq).
Indicate which of the graphs - A, B, C, D - corresponds to each of the four sets of reaction conditions listed below

1. limestone lumps and 200 mL of 2.0 M HCl(aq) :- _____
2. limestone lumps and 200 mL of 1.0 M HCl(aq) :- _____
3. powdered limestone and 200 mL of 2.0 M HCl(aq) :- _____
4. powdered limestone and 200 mL of 1.0 M HCl(aq) :- _____

4 x ½ = (2 marks)

e. Explain, referring to collision theory, why the rate of the reaction represented by graph A is so much greater than the rate of the reaction represented by Graph D.

(3 marks)

f. Why is the total mass loss shown in graphs A and B eventually twice the total mass loss shown in graphs C and D?

(1 mark)

g. Suggest an alternative method of monitoring the rate of the reaction between calcium carbonate and hydrochloric acid.

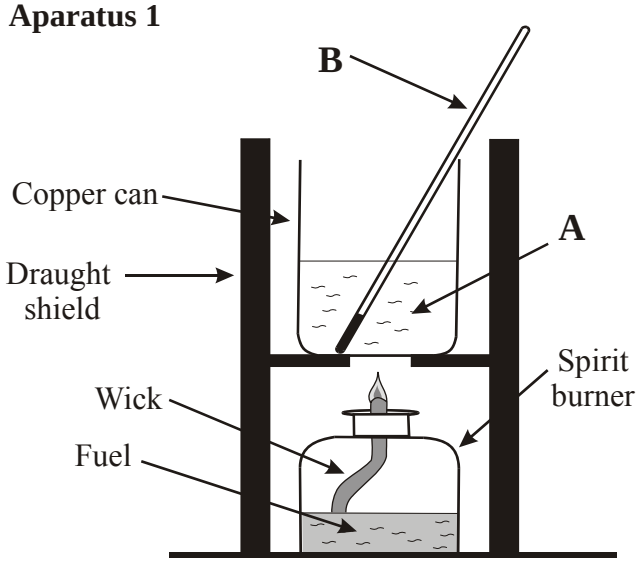
(1 mark)

Total Marks: 11 marks

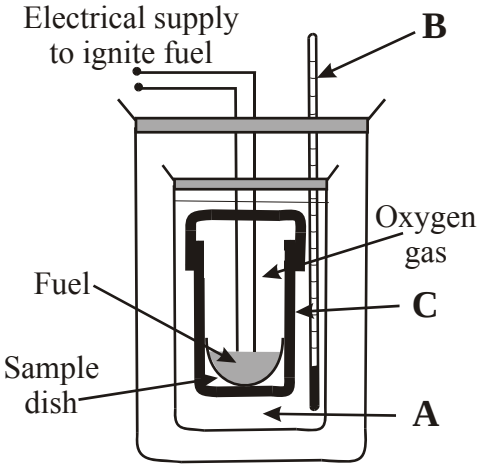
Question 2

Two sets of laboratory apparatus used to determine the molar enthalpy of combustion of a fuel are represented in the diagrams below.

Aparatus 1



Aparatus 2



a. Identify the piece of equipment or chemical substance which is represented by

A: _____

B: _____

C: _____

(3 marks)

b. In an experimental investigation a 5.00×10^{-3} mol sample of a fuel was allowed to react completely in Apparatus 2. A temperature change of 37.5°C was recorded. When 1.52 kJ of electrical energy was added to the apparatus, a temperature change of 2.78°C was recorded.
Work out the molar enthalpy of combustion of fuel and use information from the Data Book to identify the fuel.

(3 marks)

c. When the same fuel was burnt in Apparatus 1 a temperature change of 15.35 °C was recorded in the 200 mL of liquid being heated. The mass of the spirit burner changed from 86.450 g to 86.025 g.
The density of the liquid being heated was 1.00 g mL^{-1}.

i. Calculate the energy absorbed by the 200 mL of liquid.

(1 mark)

ii. Calculate the number of mole of the fuel consumed.

(1 mark)

iii. Calculate the molar enthalpy of combustion of the fuel based on these data.

(1 mark)

d. Give two reasons for the difference in your answers to (b) and (c iii).

(2 marks)

Total 11 marks

Question 3

Methanoic acid is present in the stings of many insects, including bees and ants, which use it as a defence mechanism. During a bite an ant injects 4.0 mg methanoic acid.

a. Write a balanced equation for the ionisation of methanoic acid in aqueous solution.

(1 mark)

b. Write the equilibrium law for the ionisation of methanoic acid.

(1 mark)

c. The same amount of methanoic acid, as injected during an ant bite, was dissolved in water to produce 2.5 mL of solution. Calculate the pH of that solution.

(3 marks)

Total 5 marks

Question 4

Methanol can be produced by direct combination of carbon monoxide and hydrogen, according to the equilibrium.

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

a. Explain how you can deduce the impact of an increase in temperature of the equilibrium mixture, on the yield of methanol.

(1 mark)

b. The industrial manufacture of methanol using this reaction is usually carried out at around 400 °C in the presence of a Cr_2O_3/ZnO catalyst. What would be the main reasons for using this combination of conditions?

(1 mark)

c. Explain how you can decide how the pressure on the equilibrium system should be altered in order to increase the yield of methanol.

(2 marks)

d. Write a balanced equation for the complete combustion of liquid methanol.

(1 mark)

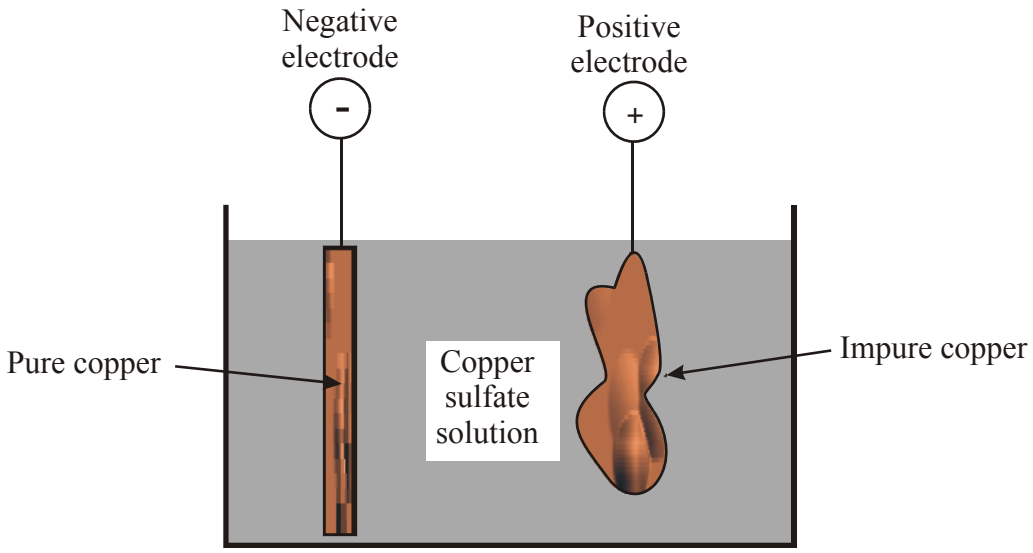
e. Liquid methanol is used in methanol-oxygen fuel cells, using an acid electrolyte. Write a balanced half-equation for the reaction occurring at the (-) electrode in such a methanol-oxygen fuel cell.

(1 mark)

Total 6 marks

Question 5

a. Impurities in a sample of impure copper may include gold and nickel. A sample of impure copper may be purified by controlled electrolysis. The diagram below shows a cell which may be used in such a purification. The impure copper acts as the positive electrode and a piece of pure copper as the negative electrode. An external power supply provides a controlled voltage which ensures transfer of only Cu atoms from the impure copper on to the pure copper sheet.



i. When the external power supply is connected to this cell which terminal of the power supply is connected to the impure copper electrode?

(1 mark)

ii. Write a balanced half-equation for the reaction occurring at the impure copper electrode.

(1 mark)

iii. On the basis of information available in the electrochemical series, what will happen to the gold and nickel impurities present in the impure copper?

(2 marks)

b. Fluorine gas is bubbled through a sample of purified water for a period of time. After some time, the pH of the water is tested and it is found to have decreased. There was no change in temperature of the water.
Explain, using an appropriate equation, why the pH of the water decreases as result of fluorine gas being bubbled through it.

(3 marks)

Total 7 marks

Question 6

The decomposition of hydrogen iodide occurs according to the equilibrium

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g), \qquad \Delta H = 52.1 \text{ kJ mol}^{-1}$$

a. During an investigation of this equilibrium the following data were recorded.

Experiment	Initial amount - mol			Equilibrium amount - mol		
	HI	I_2	H_2	HI	I_2	H_2
1	0.070	0.00	0.00	0.020		
2	0.00	0.025	0.040		0.005	

i. Calculate the value of the equilibrium constant, *K*, for Experiment 1.

(2 marks)

ii. Calculate the value of the equilibrium constant, *K*, for Experiment 2.

(2 marks)

iii. In which experiment, 1 or 2, was equilibrium established at the higher temperature? Explain your answer.

(1 mark)

b. During Unit 4 you studied one of the following chemicals in detail.

ammonia nitric acid ethane sulfuric acid

Circle the chemical you studied.

i. Write the chemical formula of the chemical you studied.

(1 mark)

ii. Write a balanced equation for the significant equilibrium reaction associated with the production of this chemical, and indicate whether the equilibrium constant for this equilibrium increases or decreases with temperature.

(2 marks)

iii. State one chemical property of this chemical and give an example of a use of the chemical which depends on this property.

(2 marks)

Total 10 marks

Question 7

An unknown metal M forms a soluble compound, $M(NO_3)_2$.
An aqueous solution of $M(NO_3)_2$ is electrolysed.
When a constant current of 2.50 amperes is applied for 35.0 minutes, 3.06 grams of the metal M is deposited.

a. Calculate the molar mass of M and identify the metal.

(3 marks)

b. On an extended electrochemical series, the metal appears in a half-equation with $E^0 = -40$ V.
A galvanic cell is constructed in which this metal is the reductant and the other cell contains $Cu^{2+}(aq)$ ions.

i. State the theoretical voltage of this cell and explain why the voltage generated could be significantly less.

(2 mark)

ii. Give the chemical formula of a compound which could be used in the salt-bridge solution and explain how this compound interacts with half-cell containing the metal, M.

(1 marks)

Total 6 marks

End of Section B

End of Trial Exam