Learning Materials
by Lisachem

VCE CHEMISTRY 2008

YEAR 12 TRIAL EXAM UNIT 4

Time allowed: 90 Minutes
Total marks: 83

Section A
Contains 20 Multiple Choice Questions
22 minutes, 20 marks

Section B
Contains 7 Short Answer Questions
68 minutes, 63 marks

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*

• **Biology** • **Physics** • **Chemistry** • **Psychology** • **Mathematics** •

Student Name.....……………..………………..

VCE Chemistry 2008 Year 12 Trial Exam Unit 4

Student Answer Sheet

Instructions for completing test. Use only an HB 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 questions 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 2008 Year 12 Trial Exam Unit 4

## Multiple Choice Questions – Section A

Section A consists of 20 multiple-choice questions.
Section A is worth approximately 24 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
The reaction between excess calcium carbonate and hydrochloric acid can be followed by plotting a graph of the total volume of carbon dioxide produced against time. The reaction occurs according to the equation

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

A plot of $V(CO_2)$ versus time for the reaction is shown below
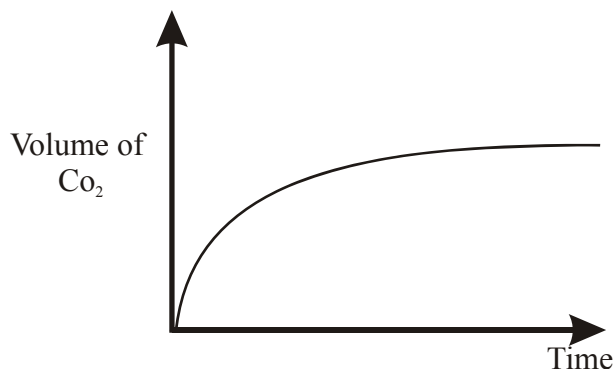
This graph is consistent with the observation that
A.   the rate of reaction increases with time because the surface area of the $CaCO_3$ increases.
B.   the rate of reaction increases with time because the acid becomes more dilute.
C.   the rate of reaction decreases with time because the surface area of the $CaCO_3$ increases.
D.   the rate of reaction decreases with time because the acid becomes more dilute.

Question 2
Two substances X and Y exist in equilibrium in a container of fixed volume.
The amount of X in the equilibrium mixture is increased by either
      i.   an increase in pressure at constant temperature, or
      ii.   an increase in temperature at constant pressure.

Which of the following equations accurately describes the equilibrium reaction?
A. $2X \rightleftharpoons 3Y, \quad \Delta H < 0$
B. $2X \rightleftharpoons 3Y, \quad \Delta H > 0$
C. $3X \rightleftharpoons 2Y, \quad \Delta H < 0$
D. $3X \rightleftharpoons 2Y, \quad \Delta H > 0$

Question 3
Consider the reaction between hydrogen and oxygen as described by the equation

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g); \quad \Delta H = \text{-484 kJ mol}^{-1}$$
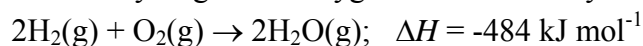
The ΔH value indicates that
A.   the chemical bonds within two hydrogen molecules and one oxygen molecule are stronger than the chemical bonds within two water molecules.
B.   the chemical bonds within two hydrogen molecules and one oxygen molecule are weaker than the chemical bonds within two water molecules.
C.   there are fewer chemical bonds in two water molecules than there are in two hydrogen molecules and one oxygen molecule.
D.   water has a higher boiling temperature that either hydrogen or oxygen.

Question 4
The graphs below shows the concentrations, as a function of time, for a mixture of gases, X, Y and Z which react and come to equilibrium according to the equation
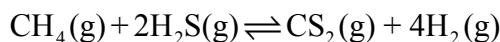
$$Y + 3Z \rightleftharpoons 2X$$
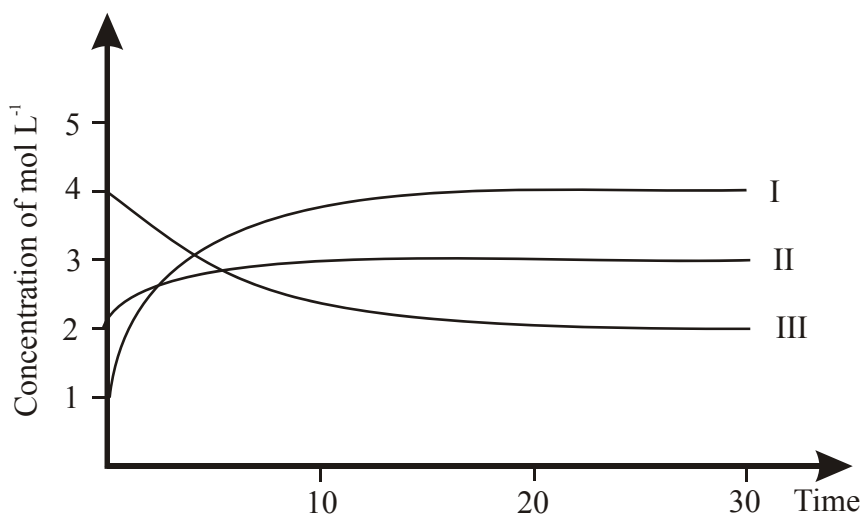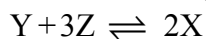
Which graph – I, II or III – best represents the change in concentration of Y?
A.   I
B.   II
C.   III
D.   It is not possible to identify the graph on the basis of the information given.

Question 5

The equilibrium constant for the reaction

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$

at 900°C is 3.59.

In an analysis of this reaction at 900°C, the concentration data collected was

$[CH_4]$ = 0.575 M, $[H_2S]$ = 0.600 M, $[CS_2]$ = 0.755 M, $[H_2]$ = 1.08 M

According to this data
A.   the reaction must continue to the left for equilibrium to be established.
B.   the reaction must continue to the right for equilibrium to be established.
C.   the reaction is endothermic.
D.   the reaction is at equilibrium .

Question 6

At 0°C, the self-ionisation constant of water, K_w, is 1.20×10^{-15}.
The pH of pure water at this temperature is
A.   6.88
B.   7.00
C.   7.46
D.   7.56

Question 7

Methanoic acid and propanoic acids are both weak monoprotic acids.
Which of the following statements relating to one molar aqueous solutions of these acids at 25°C is most likely to correct?
A.   Methanoic acid has a higher concentration of H_3O^+ and a lower pH.
B.   Methanoic acid has a higher concentration of H_3O^+ and a higher pH.
C.   Methanoic acid has a lower concentration of H_3O^+ and a lower pH.
D.   Methanoic acid has a lower concentration of H_3O^+ and a higher pH.

Question 8

When NO(g) reacts with O_2(g) to produce NO_2(g) equilibrium is established, according to

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g); \ \Delta H = -114 \, kJ \, mol^{-1}$$
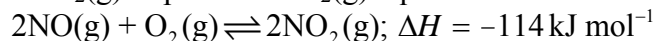
At 200ºC, the equilibrium constant has the value $7.10 \times 10^5 \, M^{-1}$
For the equilibrium $NO_2(g) \rightleftharpoons NO(g) + \frac{1}{2}O_2(g)$ at 200ºC, the numerical value of the equilibrium constant will be
A. 3.65×10^5
B. 1.41×10^{-6}
C. 1.19×10^{-3}
D.   604

Question 9

In designing a method for manufacturing a particular substance a chemical company incorporates the following strategies into its manufacturing processes.

Maximising energy efficiency

Using catalysts

Maximising atom economy

Minimising waste and

Using renewable raw materials

These strategies are most commonly associated with

A.   waste management.

B.   green chemistry.

C.   occupational health and safety.

D.   sustainability.

Question 10

Hydrogen may be produced by the reaction between methane and steam.

The equation for the equilibrium reaction is:

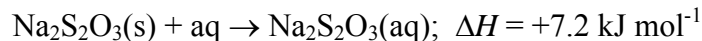$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g); \qquad \Delta H = +206.1 \, kJ \, mol^{-1}$$

Which of the following changes would **not** increase the yield of hydrogen?

A.   Increasing the pressure.

B.   Increasing the temperature.

C.   Removing hydrogen as it is produced.

D.   Increasing the concentration of methane in the mixture.

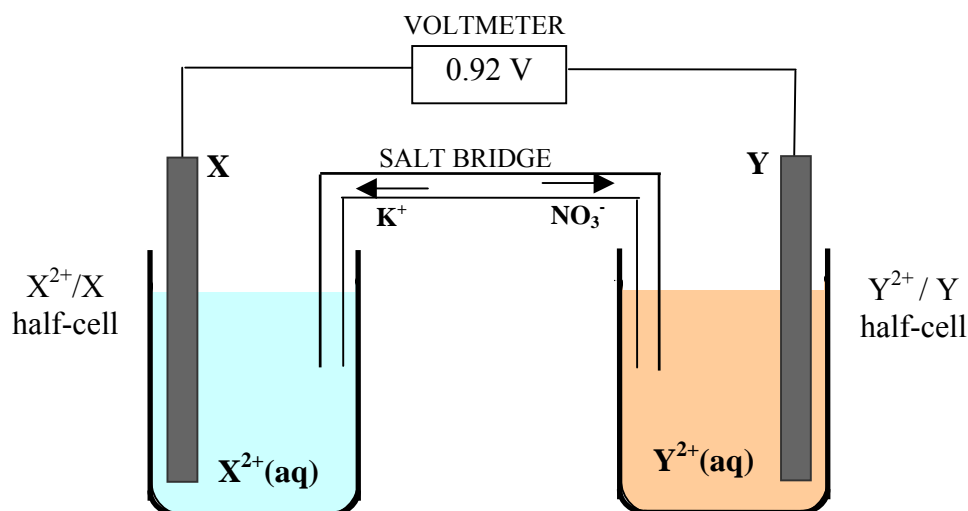**Question 11**

Consider the reaction

$$Na_2S_2O_3(s) + aq \rightarrow Na_2S_2O_3(aq); \ \Delta H = +7.2 \, kJ \, mol^{-1}$$

When 15.8 g of solid $Na_2S_2O_3$ (sodium thiosulfate) is dissolved in 500 mL of water

A.   3.6 kJ of energy is absorbed from the solution.

B.   0.72 kJ of energy is absorbed from the solution.

C.   3.6 kJ of energy is released into the solution.

D.   0.72 kJ of energy is released into the solution.

Question 12
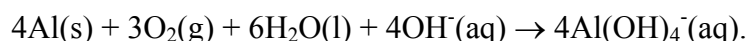Consider the galvanic cell represented below

In this cell
A. K^+ ions are moving towards the negative electrode.
B. NO_3^- ions are moving towards the cathode.
C. oxidation is occurring at electrode X.
D. oxidation is occurring at electrode Y.

Question 13
Aluminium-air cells have been investigated in the quest for enhanced performance in the conversion of chemical energy into electrical energy.
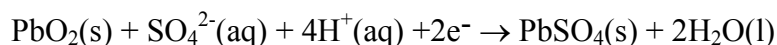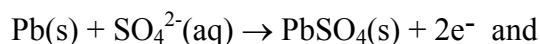In one type of aluminium-air cell, the overall redox reaction is described by the equation
$$4Al(s) + 3O_2(g) + 6H_2O(l) + 4OH^-(aq) \rightarrow 4Al(OH)_4^-(aq).$$
In this cell, aluminium, Al
A. forms the negative electrode, and is reduced.
B. forms the negative electrode, and is oxidised.
C. forms the positive electrode, and is reduced.
D. forms the positive electrode, and is oxidised.

Question 14
The lead acid-accumulator, used as a common car battery, converts chemical energy into electrical energy via the electrode reactions.
$$Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^- \text{ and}$$
$$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$$
When the lead acid accumulator is recharged
A. Pb is produced at the negative electrode.
B. the pH increases.
C. $PbSO_4$ is produced at the positive electrode.
D. The changes in the oxidation numbers of lead are from 0 to +2 and +4 to +2.
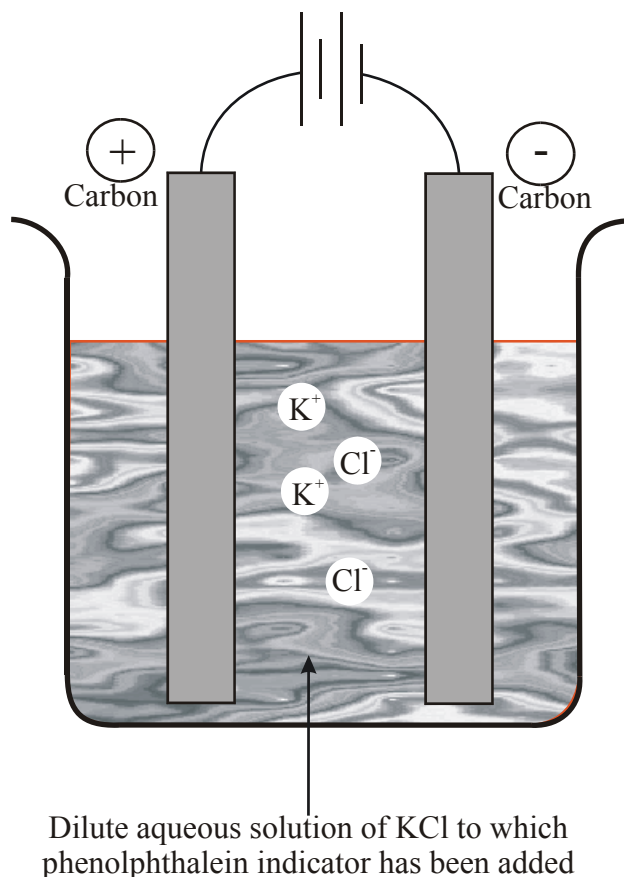
Question 15
When comparing the two types of electrochemical cells, i.e. galvanic cells with electrolytic cells, which of the following statements is correct?
A.   The anode is positive and the cathode negative in all electrochemical cells.
B.   Reduction occurs at the negative electrode in a galvanic cell.
C.   Reduction occurs at the cathode in all electrochemical cells.
D.   Oxidation occurs at the cathode in an electrolysis cell.

The following information applies to Questions 16 and 17
Consider the electrolytic cell represented below

Dilute aqueous solution of KCl to which
phenolphthalein indicator has been added

Question 16
When an electric current is passed through the cell
A.   bubbles of oxygen gas are produced at the negative electrode.
B.   a pink colour appears around the negative electrode.
C.   bubbles of chlorine gas are produced at the positive electrode.
D.   sodium metal is produced at the positive electrode.

Question 17
The chemical equation describing the overall redox reaction occurring in this cell is
A. $2K^+(aq) + 2Cl^-(aq) \rightarrow 2K(l) + Cl_2(g)$
B. $4K^+(aq) + 2H_2O(l) \rightarrow 4K(l) + O_2(g) + 4H^+(aq)$
C. $2Cl^-(aq) + 2H_2O(l) \rightarrow Cl_2(g) + H_2(g) + 2OH^-(aq)$
D. $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Question 18

0.300 g of silver is to be plated onto a sporting trophy electrolytically from an aqueous solution of Ag^+ ions. Assuming the process is 100 % efficient, how long should the trophy be left in the plating cell if a current of 6.00 A is being applied?

A.   22.4 seconds.
B.   1.80 minutes.
C.   44.7 seconds.
D.   4.47 minutes.

Question 19

When 0.0100 mol of an alkanol is completely reacted with oxygen, the heat evolved raises the temperature of 200 g of water by 24.0°C.

Assuming the transfer of energy to the water is 100 per cent efficient then, the alkanol was most likely to be

A.   1-butanol.
B.   ethanol.
C.   methanol.
D.   1-propanol.

Question 20

Which of the following sets of chemical species contains only species that can, depending on their chemical environment, act as either oxidants or reductants?

A. $Sn^{2+}(aq)$, $H_2O_2(l)$, $OH^-(aq)$, $Fe^{2+}(aq)$
B. $H_2O(l)$, $Fe^{3+}(aq)$, $O_2(g)$, $Sn^{4+}(aq)$
C. $Sn^{2+}(aq)$, $H_2O_2(l)$, $Fe^{2+}(aq)$, $H_2O(l)$
D. $Sn^{4+}(aq)$, $H_2O(l)$, $Fe^{3+}(aq)$, $H_2S(g)$

End of Section A

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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 76 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

In your study of the 'industrial production of a selected chemical' during Unit 4 you should have encountered one of the following equilibria.

1. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

2. $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

3. $C_3H_8(g) \rightleftharpoons C_2H_4(g) + CH_4(g)$

4. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

Choose **one** of the equilibria given, by circling the number preceding it, and

a.   Give the name of the 'selected chemical' that is associated with the equilibrium.

(1 mark)

b.   State whether the forward reaction in the equilibrium is exothermic or endothermic.

(1 mark)

c.   State whether the yield of product(s) in the equilibrium is favoured by low or high temperatures, and describe the impact that rate considerations have on the temperature used.

(2 marks)

d.   State whether high or low pressure favours the yield of product(s) in the equilibrium and relate this to Le Chatelier's principle.

(2 marks)

e.   State one 'waste management' procedure used in the production of the 'selected chemical'.

(1 mark)

f.   State one 'occupational health and safety' issue associated with the production of the 'selected chemical'
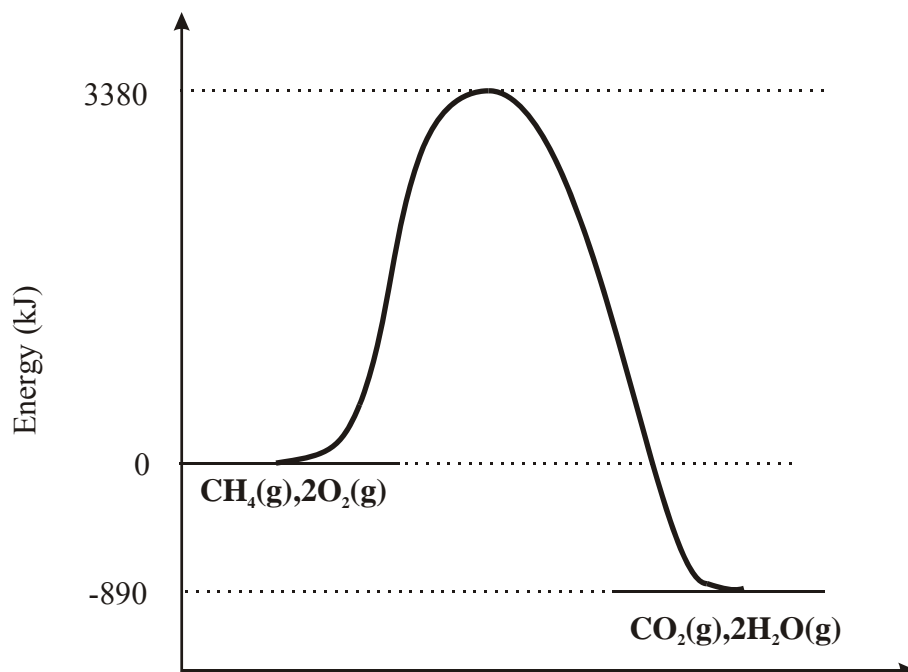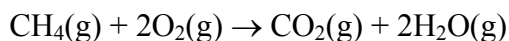
(1 mark)

g.   Give one use of the 'selected chemical'.

(1 mark)

Total 9 marks

Question 2
Shown below is an energy profile for combustion of methane according to:
$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

a.   Describe how the energy profile is related to 'bond breaking' and 'bond forming' and
        how the amounts of energy associated with these processes determine the
        thermochemistry of the reaction.

(3 marks)

b.   What is the value of the activation energy, in kJ, for the reaction
$$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$$

(1 mark)

c.   What determines whether or not a mixture of methane and oxygen reacts?

(1 mark)

d.   Explain why the use of a catalyst would be expected to increase the rate of reaction between methane and oxygen but not affect the relative positions of the reactants and products on the energy profile.

(2 marks)

Total 7 marks

Question 3
A well-insulated bomb calorimeter was used to determine experimentally the molar enthalpy of combustion (ΔH_c) of pentane, C_5H_{12}.

A 1.44 g sample of pentane was ignited in a bomb calorimeter in an atmosphere of pure oxygen. The temperature of the water surrounding the bomb in the calorimeter was observed to rise from 21.250°C to 24.164°C.

A current of 2.90 A was then passed through a heater immersed in the water surrounding the bomb at a potential difference of 6.50 V for three minutes and the temperature rose to 24.388°C.
a.   Calculate the calibration factor of the calorimeter.

(3 marks)

b.   Use the experimental data to calculate the ΔH_c of pentane.

(3 marks)

c.   Suggest a reason for the difference between the calculated ΔH_c for pentane and the value given in the Data Booklet.
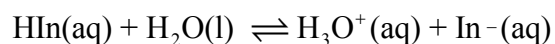
(1 mark)

Total 7 marks

Question 4
a.   An aqueous solution of benzoic acid, a weak acid, has a pH of 2.45 at 25°C. What is the concentration of the solution with respect to benzoic acid?
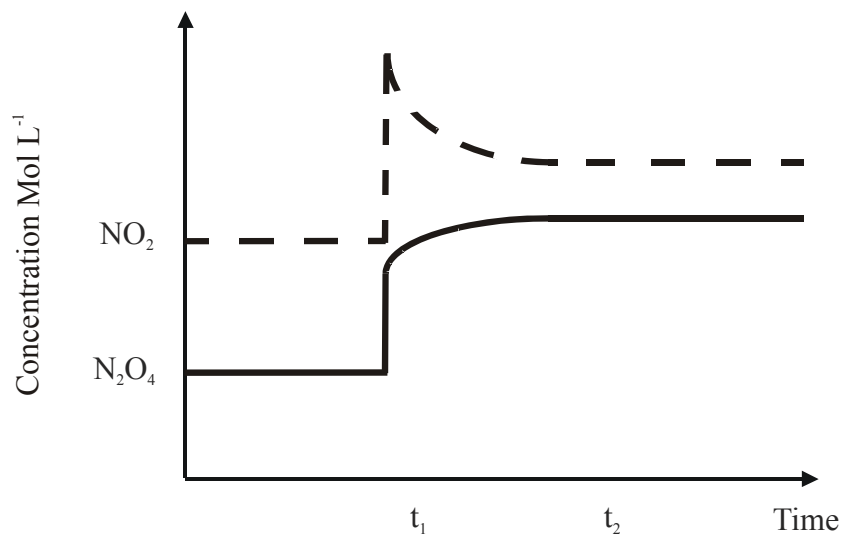
(4 marks)

b.   The acid-base indicator bromphenol blue is an equilibrium mixture of a weak acid and its conjugate base. The equilibrium may be represented by the equation

$$HIn(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + In^-(aq)$$

At what pH will the ratio [HIn] / [In⁻] in bromphenol blue be 100 / 1?

(3 marks)

c.   Shown below is a set of concentration-time graphs for the equilibrium system
$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

i.   What change was imposed on the equilibrium system at time t_1?

ii. How did the system respond to the imposed change?

iii. When equilibrium is regained at time t_2 is the mass of NO_2 present less than, equal to, or greater than the mass present at the original equilibrium?
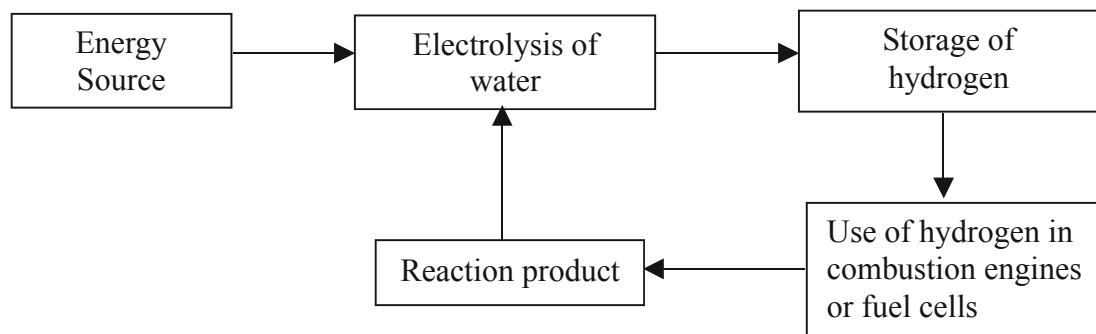
(1+1+1 = 3 marks)

Total 10 marks

Question 5
Continued increases in the price of oil has sharpened focus on alternative fuels for motor vehicles, particular biochemical fuels and hydrogen. Hydrogen can be produce from water and used in hydrogen internal combustion engines or fuel cells.

A hydrogen energy cycle for the use of hydrogen as a fuel is represented below.

a. Identify one concern currently associated with the production of biochemical fuels.

(1 mark)

b. What is the main environmental impact of the use of brown coal to generate electricity?

(1 mark)

c. Identify two sources of electricity which may be used for the electrolysis of water but do not have the environmental impact of brown coal.

(1 mark)

d. Give the sign of the electrode at which hydrogen is produced during the electrolysis of water and write the associated half-equation.

(2 marks)

e.   Why is electrolyzing a dilute aqueous solution of sodium chloride a more efficient way to produce hydrogen than electrolyzing water.

(1 mark)

f.   Write the half-equation for the reaction occurring at the positive electrode in an operating hydrogen-oxygen fuel cell, using an alkaline electrolyte.

(1 mark)

g.   State three distinct properties which are desirable in the electrodes used in a fuel cell.

(2 marks)

h.   i.   Write a balanced equation describing the overall reaction occurring in both a hydrogen-oxygen fuel cell and the consumption of hydrogen in a combustion engine.

(1 mark)

ii.   Explain why hydrogen is described as a non-polluting energy source.

(1 mark)

Total 11 marks

Question 6

The isolation of fluorine from its compounds proved to be one of the most difficult and dangerous challenges of the late nineteenth century. In 1906 Henri Moissan was awarded the Nobel Prize in Chemistry '*in recognition of the great services rendered by him in his investigation and isolation of the element fluorine ……………*'

Earlier Moissan wrote about his work in isolating fluorine.

"I obtained the fluorine from a fluorine compound that had been added to a mineral having a low melting point and in which the fluorine compound dissolved readily. The use of electricity produced the fluorine at the positive terminal. Difficulty was experienced in getting any material for that terminal that would resist the chemical action of the gas."

a.   How does the position of fluorine on the electrochemical series explain why Moissan found it difficult to find any material that would resist the chemical action of the gas?

(1 mark)

b.   Write half-equations for the electrode reactions which occur during the electrolysis of molten potassium fluoride.

(+) electrode

(-) electrode

(2 marks)

c.   How long should it take to produce 5.00 g of fluorine gas in an electrolytic cell operating at 5.00 A and 12.0 V if the cell was operating at 100 per cent efficiency?

(3 marks)

d.   Explain why fluorine, F_2, is not produced during the electrolysis of a dilute aqueous solution of potassium fluoride, and give the half-equation for the reaction occurring at the anode.
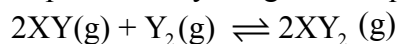
(2 marks)

e.   Why is it that copper can be produced by the electrolysis of an aqueous solution of Cu^{2+} ions, but lithium cannot be produced by the electrolysis of an aqueous solution of Li^+ ions?

(2 marks)

Total 10 marks

Question 7
Consider the equilibrium system represented by the general equation
$$2XY(g) + Y_2(g) \rightleftharpoons 2XY_2 \ (g)$$
a.   In a laboratory test of this equilibrium 6.00 mol of XY and 2.50 mol of Y_2 are added to 2.00 L reaction vessel and allowed to come to equilibrium.
If 4.00 mol XY_2 is present at equilibrium what is the value of the equilibrium constant?

(3 marks)

b.   In a second test 6.00 mol of XY and 2.50 mol of Y_2 are added to 2.00 L reaction vessel and allowed to come to equilibrium at a higher temperature. This time only 3.20 mol of XY_2 was present at equilibrium. What does this indicate about the reaction, $2XY(g) + Y_2(g) \rightarrow 2XY_2(g)$?

(1 mark)

c.   When neon gas is added to an equilibrium mixture of XY, Y_2 and XY_2, the pressure in the reaction vessel noticeably increases. However the position of equilibrium does not shift! Explain.

(2 marks)

d.   i.   What would you expect to happen to the position of equilibrium if some XY_2 was removed from the equilibrium system.

       ii.   In terms of reaction rates, how does the change in equilibrium position come about.

(1+2 = 3 marks)

Total 9 marks

End of Section B

End of Trial Exam