CANDIDATE NAME _____ CLASS_____

**DUNMAN HIGH SCHOOL (SENIOR HIGH)**

**YEAR 6 PRELIMINARY EXAMINATION 2008**

# H1 CHEMISTRY 8872/02

**Paper 2** **17 September 2008**

**2 hours**

Candidates answer Section A on the Question Paper

***Additional Materials:***
Data Booklet
Answer Paper

## INSTRUCTIONS TO CANDIDATES

1 Write your **name** and **class** on this question paper and on all the work you hand in.

2 A *Data Booklet* is provided.

3 You may use a calculator.

4 The number of marks is given in brackets [ ] at the end of each question or part question.

5 At the end of the examination, fasten all your work securely together with this question paper.

**Section A**

6 Answer **all** questions.

7 Write your answers in the spaces provided on the question paper.

**Section B**

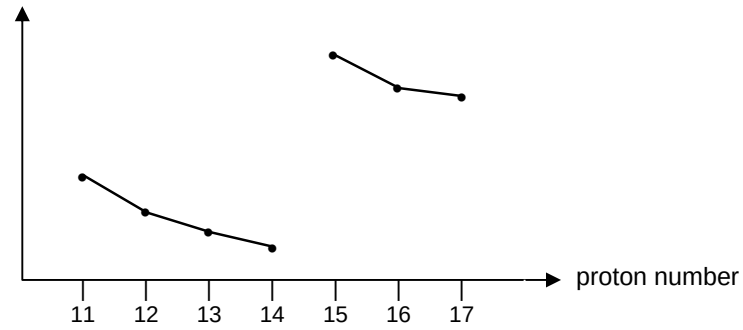
8 Answer **two** questions on separate answer paper.

| FOR EXAMINER'S USE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Section A | | | | Section B | | | Total | % |
| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
| Marks | 14 | 9 | 8 | 9 | 20 | 20 | 20 | [80] | |

## Section A

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

**1(a)** The graph below shows the trend in a particular property of Period 3 elements.




**(i)** Label on the y–axis of the graph, the property represented.

**(ii)** Briefly explain the trend of this property.

.....

.....

.....

.....

.....

.....

.....

[4]

**(b)** One student, Mr Piah, is given three aqueous solutions of the oxides of three Period 3 elements. He adds the indicator, thymol blue, to the three unknown solutions separately and noted the colours of the solutions.

**(i)** With reference to the pH range and colour of thymol blue indicator, identify each of these solutions in the spaces provided below.

| pH range | pH < 1.2 | 2.8 < pH < 8.0 | pH > 9.6 |
|---|---|---|---|
| colour of thymol blue | red | yellow | blue |

| solution | colour observed | identity of oxide |
|---|---|---|
| **1** | green | |
| **2** | blue | |
| **3** | red | |

**(ii)** Briefly outline the reaction of these oxides with water, supporting your answer with appropriate equations.

.....

.....

.....

.....

.....

.....

[4]

**(c)** One of the clearest ways in which atomic properties influence chemical behavior appears in the diagonal relationships of elements. One such example is beryllium and aluminium, from Group II and III respectively. Their oxides show similar chemical behaviour towards acids and bases. Write equations to show the reactions of beryllium oxide with the following:

NaOH (aq) : .....

HC*l* (aq) : .....

[2]

**(d)** Nickel is a silvery–white metal that takes on a high polish. It is a transition metal and is hard and ductile. Naturally occurring nickel is composed of five stable isotopes.

A mass spectrometer provides the following information about the relative abundance of the five isotopes.

| isotope | relative abundance / % |
|---|---|
| $^{58}Ni$ | 68.08 |
| $^{60}Ni$ | 26.22 |
| $^{61}Ni$ | 1.14 |
| $^{62}Ni$ | 3.63 |
| $^{64}Ni$ | 0.93 |

**(i)** Define the term *relative isotopic mass*.

.....

.....

**(ii)** Using the information, calculate the relative atomic mass of nickel to 4 significant figures. Show your working.

**(iii)** The most common oxidation state of nickel is +2. For the $^{58}Ni^{2+}$ ion, state

the number of protons .....

the number of neutrons .....

the number of electrons .....

[4]

[Total: 14]

**2(a)** Squalene is a natural unsaturated hydrocarbon found in high concentration in the livers of sharks. It is widely used in cosmetics as a moisturiser. Traditionally, squalene is obtained primarily from sharks, though there are botanic sources as well, such as rice bran and olives. In recent years, many cosmetic manufacturing companies are moving away from the use of shark–based squalene and switching to plant–based squalene instead.

**(i)** Suggest two reasons why these companies are switching to use plant–based squalene.

.....

.....

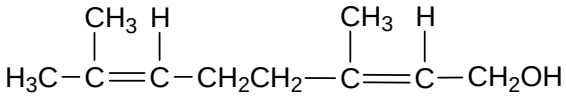
.....

**(ii)** A 0.100 mol sample of squalene reacted with 14.4 $dm^3$ of hydrogen, measured at r.t.p, to form saturated hydrocarbon $C_{30}H_{62}$. Calculate how many double bonds there are in each molecule of squalene. Hence, suggest the molecular formula of squalene.

**(iii)** Write a balanced equation to show how the saturated hydrocarbon $C_{30}H_{62}$ reacts with chlorine to form $C_{30}H_{61}Cl$ and state the type of reaction involved.

[6]

**(b)** Another unsaturated compound used in cosmetics is Geraniol.



geraniol

**(i)** Determine how many geometric isomers can geraniol exhibit.

**(ii)** Draw all the possible geometric isomers of geraniol.

[3]

[Total: 9]

**3(a)** This table compares the physical properties of some organic compounds:

| compound | melting point / °C | solubility in water | solubility in organic solvents |
|---|---|---|---|
| $CH_3CH(Cl)COOH$ | –13 | Soluble | Soluble |
| $CH_3CH(OH)COOH$ | 26 | Soluble | Soluble |
| $CH_3COO^-Na^+$ | 325 | Soluble | Insoluble |

Account for the difference in melting points between $CH_3CH(Cl)COOH$, $CH_3CH(OH)COOH$ and $CH_3COO^-Na^+$.

.....

.....

.....

.....

.....

.....

[3]

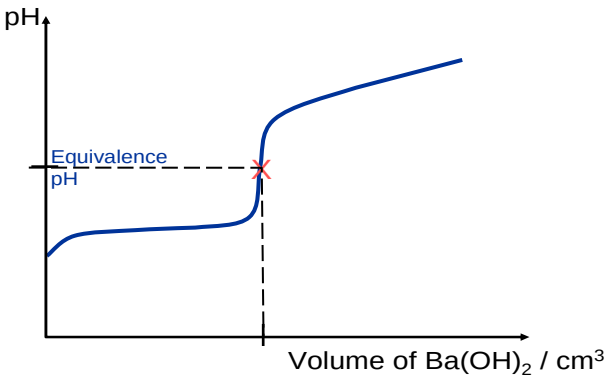
**(b)** Sodium ethanoate, $CH_3COO^-Na^+$ is a common product of organic chemistry reactions. In the table below, suggest two organic compounds, each with different functional group that would produce sodium ethanoate via different types of reaction. State the necessary reagents and conditions used and identify ***one*** other product formed (if any) in each reaction.

| *structural formula of compound* | *reagents & conditions* | *products* | |
|---|---|---|---|
| | | | $CH_3COO^-Na^+$ |
| | *type of reaction:* | | |
| | | | |
| | *type of reaction:* | | |

[5]

[Total: 8]

**4** Propanoic acid, $CH_3CH_2COOH$, is a *weak acid*. When 50 $cm^3$ of 0.1 mol $dm^{-3}$ of propanoic acid is titrated against 0.1 mol $dm^{-3}$ $Ba(OH)_2$, a strong base, the following graph was obtained.




**(a)** Explain what is meant by the term *weak acid*.

.....

.....

[1]

**(b)** **(i)** Circle on the graph above, the region where a buffer solution is formed.

**(ii)** With the help of suitable equations, explain how the buffer maintains a fairly constant pH when small amounts of NaOH or HC*l* is added to it.

[4]

**(c)** **(i)** Calculate the volume of $Ba(OH)_2$ required to reach equivalence point.

**(ii)** State a likely value for the equivalence pH and hence suggest a suitable indicator for the titration.

equivalence pH value: ..... indicator: .....

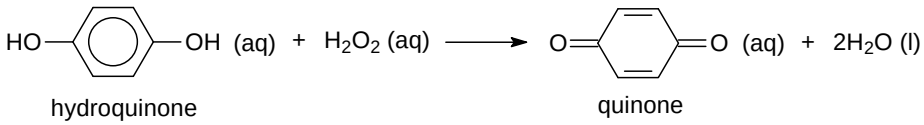
[4]

[Total: 9]

## Section B

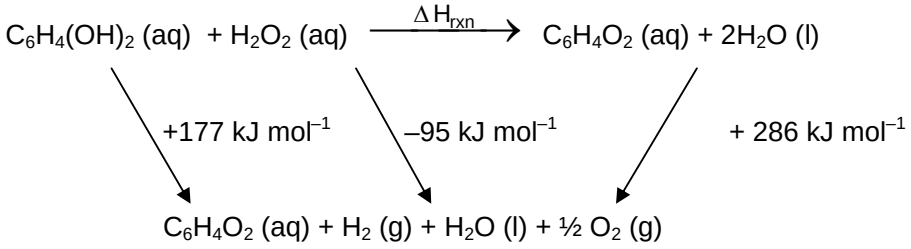
Answer **two** of the three questions in this section on separate paper.

**5(a)** When under attack, the bombardier beetle uses 'chemical warfare'. It defends itself from attack by mixing together solutions of hydrogen peroxide and hydroquinone ($C_6H_4(OH)_2$) in the presence of enzymes. This reaction releases free oxygen that produce enough energy to bring the mixture to boiling point. An audible explosion occurs as the beetle fires a hot spray at its attacker from its abdomen. Quinone, $C_6H_4O_2$ is one the products formed.




**(i)** State Hess' Law.

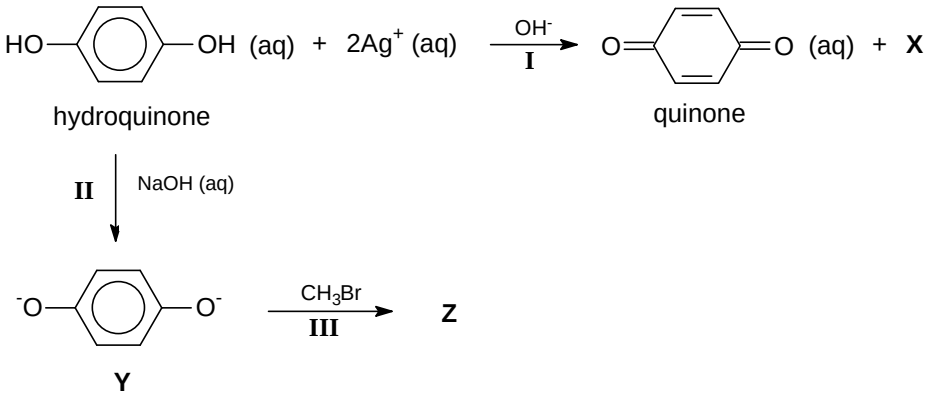
**(ii)** Given the energy cycle below, calculate the enthalpy change of reaction, $\Delta H_{rxn}$, inside the beetle.




**(iii)** Draw a labelled energy profile for the reaction above and indicate clearly the activation energy and enthalpy change of reaction.

[7]

**(b)** When developing exposed film from a camera, aqueous alkaline hydroquinone reacts with silver ions in a light–activated redox reaction in **I**.




**(i)** Identify **X** and state the role of hydroquinone in reaction **I**.

**(ii)** Given that compound **Y** undergoes substitution reaction with $CH_3Br$, suggest the structural formula of **Z**.

**(iii)** Write a balanced equation for the reaction between quinone and each of the following reagents:

**(1)** $LiAlH_4$ in dry ether

**(2)** HBr

**(iv)** State what would be observed when 2,4–dinitrophenylhydrazine is added a solution of quinone. Draw the structural formula of the organic product formed.

[8]

**(c)** Concentrated hydrogen peroxide is a dangerously reactive substance because the decomposition is very exothermic.

$$H_2O_2\ (l) \rightarrow H_2O\ (l) + \tfrac{1}{2}O_2\ (g)$$

**(i)** Draw a dot–and cross diagram for the $H_2O_2$ molecule and state its shape and bond angle.

**(ii)** With reference to the relevant bond energy values in the Data Booklet, calculate the enthalpy change of the decomposition reaction.

[5]

[Total: 20]

**6(a)** Methanoic acid decomposes in the gas phase at high temperatures as follows:

$$HCOOH\ (g) \rightarrow CO_2\ (g) + H_2\ (g)$$

The decomposition reaction is studied and following results are obtained.

| Time /s | 0 | 250 | 500 | 750 | 1000 | 1250 | 1500 |
|---|---|---|---|---|---|---|---|
| [HCOOH] /mol $dm^{-3}$ | 0.300 | 0.230 | 0.170 | 0.128 | 0.095 | 0.070 | 0.053 |

**(i)** What is meant by the term *order of reaction*?

**(ii)** Plot a suitable graph and determine the order of reaction. Show necessary working on your graph.

**(iii)** Write the rate equation and calculate the rate constant, specifying its units.

[7]

**(b)** Addition of some $TiO_2$ speeds up the decomposition reaction in part **(a)**. Explain, with the aid of a Boltzmann distribution curve, how the catalyst increases the rate of reaction.

[4]

**(c)** An experiment is conducted to determine the enthalpy change of neutralisation between methanoic acid and aqueous sodium hydroxide. Some solid methanoic acid is added to sodium hydroxide solution. The changes in temperature and amount of reagents mixed are recorded as follows:

| | | |
|---|---|---|
| initial temperature | /°C | 24.0 |
| final temperature | /°C | 34.5 |
| mass of HCOOH added | /g | 1.84 |
| volume of 1 mol $dm^{-3}$ NaOH (aq) used | /$cm^3$ | 50.0 |

**(i)** Define *standard enthalpy change of neutralisation*.

**(ii)** Use the above data to calculate the enthalpy change of neutralisation, assuming that 4.2 J is required to raise the temperature of 1 $cm^3$ solution by 1 °C.

**(iii)** The magnitude of enthalpy change of neutralisation between aqueous nitric acid and aqueous sodium hydroxide is found to be larger than the value calculated in part **(ii)**. Explain why this is so.

[6]

**(d)** Methanoic acid reacts with potassium dichromate (VI) in a redox reaction.

**(i)** Given that the half equation for the oxidation of methanoic acid is

$$HCOOH \rightarrow CO_2 + 2H^+ + 2e$$

construct a balanced equation for the reaction between methanoic acid and dichromate (VI) ion.

**(ii)** Identify the type of hybrid orbital around the carbon atom in methanoic acid and state the number of $\pi$ and $\sigma$ bonds in the methanoic acid molecule.

[3]

[Total: 20]

**7(a)** Biodiesel is a non–petroleum based diesel fuel consisting of short chain alkyl esters made by trans–esterification of vegetable oil (triglyceride), and is hence a renewable source of fuel. It can be used alone, or blended with conventional petrodiesel in unmodified diesel–engine vehicles. The generic trans–esterification reaction of biodiesel synthesis is shown below:

$$(RCOO)_3C_3H_5\ (l) + 3CH_3OH\ (l) \rightleftharpoons C_3H_5(OH)_3\ (l) + 3RCOOCH_3\ (l)$$

| triglyceride | methanol | glycerol | methyl esters *(biodiesel)* |
|---|---|---|---|

This reaction is an example of a dynamic equilibrium.

**(i)** Explain what is meant by the term *dynamic equilibrium*.

**(ii)** Write an expression for the equilibrium constant, $K_c$ of this reaction.

**(iii)** A mixture containing 0.5 mol of triglyceride and 1.5 mol of methanol is set up and allowed to come to equilibrium at 298 K. The number of moles of biodiesel formed at equilibrium is found to be 0.9. The final volume of solution is V $dm^3$. Calculate the value of $K_c$ at 298 K.

**(iv)** Suggest and explain how the yield of biodiesel would be affected if the initial concentration of methanol was increased.

[6]

**(b)** Use the information below to identify compounds **A** to **F**. State the types of reactions involved.

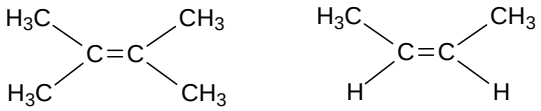
Compounds **A** and **B** have the same molecular formula, $C_3H_6O_2$. When both **A** and **B** are separately subjected to hot aqueous sodium hydroxide, both reacts differently. While **A** produces a crystalline salt, **C** with a fairly high melting point upon crystallisation, **B** forms an organic product **D** together with a crystalline salt, **E**. Treatment of **D** with concentrated sulfuric acid at 170 °C produces **F**. When **F** reacts with hot acidified potassium manganate(VII), $CO_2$ is formed as the only carbon–containing product.

[6]

**(c)** By chemical reactions, describe how you would distinguish between the pair of compounds below. State clearly how each compound behaves in the test.

**(i)**

**(ii)**



[5]

**(d)** Equal amounts of $CH_3Cl$ and $CH_3I$ are treated separately with boiling aqueous sodium hydroxide. The products for each compound are then acidified with nitric acid and treated with silver nitrate solution. For $CH_3Cl$, a precipitate is formed after 10 minutes; whereas for $CH_3I$, a precipitate is formed immediately. By making use of relevant bond energy values from the Data Booklet, explain the difference in the time taken for the precipitate to appear.

[3]

[Total: 20]