SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	
CLASS	

CHEMISTRY 8872/02

Preliminary Examination **26 Aug 2009**
Paper 2 **2 hr**

Additional Materials: Data Booklet
Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough work.

SECTION A:
Answer **all** questions in the space provided.

SECTION B:
Answer any **two** questions on separate answer paper.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
MCQ P1	/30
A1	/10
A2	/10
A3	/10
A4	/10
B5	/20
B6	/20
B7	/20
Total	/110
Percentage	
Grade	

This document consists of **16** printed pages and **0** blank page

1 The industrial preparation of the polymer, poly(tetrafluoroethene), is based on the synthesis of its monomer, tetrafluoroethene (C_2F_4). Tetrafluoroethene is produced from the thermal cracking of chlorodifluoromethane ($CHClF_2$), as shown by the following equation:

$$2CHClF_2(g) \rightarrow C_2F_4(g) + 2HCl(g)$$

(a) Use relevant data from the *Data Booklet* to calculate the enthalpy change of the reaction. State any assumptions that you have made.

[3]

(b) By using your answer to **(a)** and the following information,

ΔH_f ($CHClF_2(g)$) = –485 kJ mol^{-1}
ΔH_f ($HCl(g)$) = –92 kJ mol^{-1}

calculate the enthalpy change of formation of $C_2F_4(g)$.

[2]

(c) **(i)** Explain the following phenomenon:
Chlorine can react with oxygen to form ClO^-, ClO_2^-, ClO_3^- and Cl_2O_7 but fluorine can react with oxygen to form OF_2 only.

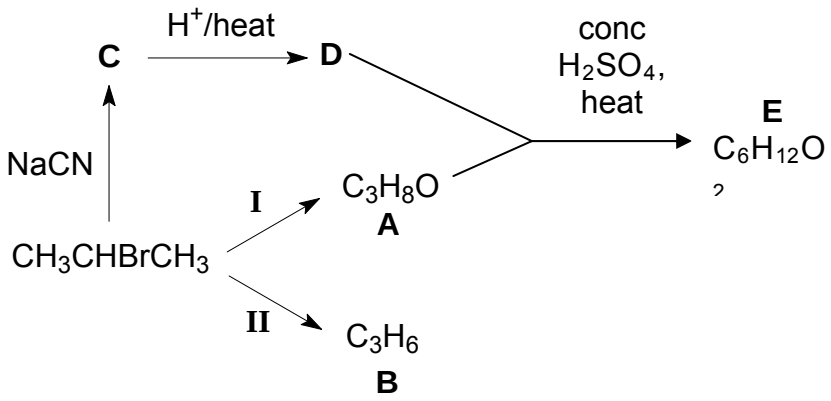
(ii) Predict, with reasoning, the shape of OF_2.

(iii) Predict, with reasoning, the solubility of OF_2 in CCl_4.

[5]
[Total: 10]

For Examiner's Use

2 (a) 2-bromopropane can react with sodium hydroxide in two different ways depending on conditions to give two different products **A** and **B**.



(i) Draw the 'dot-and-cross' diagram of NaOH.

(ii) Suggest and explain the polarity of 2-bromopropane.

(iii) Describe the condition(s) necessary for each one of the reactions **I** and **II**. In each case, state the type of reaction undergone.

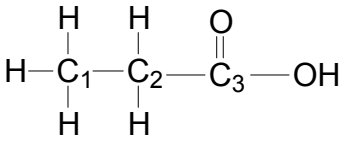
(iv) Using the above reaction scheme, draw the structural formulae of compounds **C, D** and **E**.

[7]

(b) Suggest a chemical test to distinguish 2-chloropropane, 2-bromopropane and 2-iodopropane, stating clearly the observations made.

[3]
[Total: 10]

3(a) Propanol can be converted to propanoic acid under appropriate condition. Suggest the type(s) of hybridisation of all the carbon atoms in propanoic acid.



C_1: _____

C_2: _____

C_3: _____

[1]

(b) Propyl propanoate is synthesised industrially mainly via the classic Fischer esterification reaction of propanol and propanoic acid which is exothermic in nature. This mixture will reach *dynamic equilibrium* and the ester will be produced at a yield of 65%.

(i) With the aid of an appropriate rate-time graph, explain what is meant by *dynamic equilibrium*.

(ii) Given that the equilibrium mixture at 298 K contains the following:

Propanol	0.33 mol
Propanoic acid	0.33 mol
Propyl Propanoate	0.66 mol
Water	0.66 mol

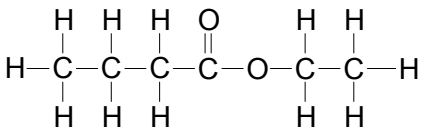
Calculate the value of K_c at 298 K for the reaction.

(iii) Predict, with reasoning, the effect on the value of K_c (if any) when more propanol is added to the equilibrium mixture.

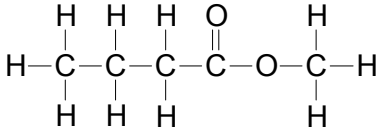
(iv) Predict, with reasoning, the composition of the equilibrium mixture when the system in **(b)(ii)** is subjected to an increase in temperature?

[5]

(c) The esters responsible for the aroma of pineapple and apple are illustrated below:



Pineapple aroma

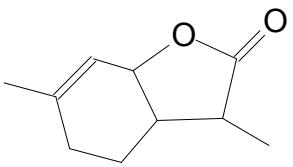


Apple aroma

Describe appropriate chemical test(s) to distinguish the two esters. In your description, state clearly the reagents and conditions used, and the observations made in each case.

[2]

(d)



Wine lactone

An ester with a sweet coconut scent was recently found to be responsible for the smell of white wine. It is identical to lactone found in wine and it can also be found in orange juice and black pepper.

Draw the structural formulae of the organic product(s) formed when wine lactone reacts with:

(i) Cl_2 in CCl_4, in the absence of catalyst and light

(ii) Cold alkaline $KMnO_4$

(iii) Hot acidified $KMnO_4$

[2]
[Total: 10]

For Examiner's Use

4 (a) Many new cars have air bags which rapidly inflate during an accident to protect the front passengers. The air bag contains sodium azide (NaN_3), silicon dioxide and potassium nitrate. To determine the amount of sodium azide in an impure sample, the azide present is first reacted with excess iodine:

$$2N_3^- + I_2 \rightarrow 3N_2 + 2I^-$$

The amount of unreacted iodine is then titrated with standard sodium thiosulphate solution:

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

0.120 g of an impure sample of sodium azide was dissolved in water. The mixture was reacted with 25.0 cm^3 of 0.050 mol dm^{-3} of aqueous iodine. The excess iodine was found to require 23.10 cm^3 of 0.040 mol dm^{-3} aqueous sodium thiosulphate for reaction.

Calculate the percentage purity of sodium azide in the sample.

[3]

(b) A compound **F** of sulphur has the formula SO_xCl_2. 23.8 g of compound **F** is made to react with water (in excess) and the chloride ion is completely precipitated as 57.4 g of silver chloride.

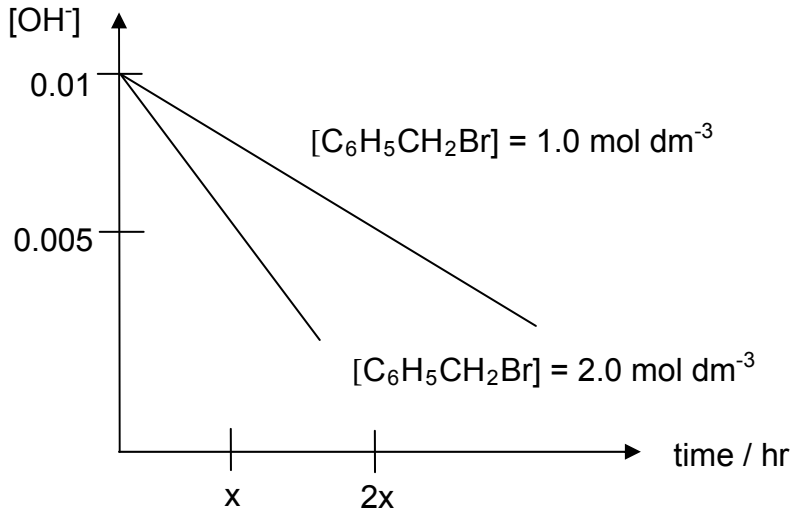
Calculate the relative molecular mass of **F** and determine the value of **x**.

[2]

(c) The reaction below is an example of a nucleophilic substitution reaction.

$$C_6H_5CH_2Br + OH^- \rightarrow C_6H_5CH_2OH + Br^-$$

The reaction kinetics of this reaction is determined by monitoring the change in the concentration of OH^- with time. The results are shown below:



Deduce the order of reaction with respect to **(i)** OH^- and **(ii)** $C_6H_5CH_2Br$.

Hence, write the rate equation and calculate the rate constant, giving its units.

[5]
[Total: 10]

Section B

Answer any **two** questions from this section on separate answer paper.

5 (a) Compound **G** has the following composition by mass:

C, 31.9%; H, 5.3%; C*l*, 62.8%.

(i) Given that the relative molecular mass of compound **G** is 113.0, determine its molecular formula.

(ii) Draw all the structural isomers of compound **G** and identify the type of structural isomerism present.

(iii) Compound **H** with molecular formula, C_4H_8, exists as four isomers. The structures of two of the isomers are shown below.

$CH_3CH_2CH{=}CH_2$ $(CH_3)_2C{=}CH_2$

Draw the structural formulae of the other two isomers of C_4H_8 and state their geometry.

[10]

(b) 40 cm^3 of 3.0 mol dm^{-3} methanoic acid, HCOOH, was added to 60 cm^3 of 1.4 mol dm^{-3} potassium hydroxide in a polystyrene cup. The maximum temperature rise was recorded as 10.5 ^oC.

Given that the specific heat capacity of the solution = 4.2 J g^{-1} K^{-1}

(i) Define what is meant by the *standard enthalpy change of neutralisation*.

(ii) Write a balanced chemical equation for the neutralisation of methanoic acid with potassium hydroxide.

(iii) Calculate the standard enthalpy change of neutralisation for the reaction in **(b)(ii)**.

(iv) How would you expect the enthalpy change calculated in **(b)(iii)** to compare with the enthalpy change of neutralisation of nitric acid with potassium hydroxide?
Explain your answer.

[7]

(c) Refractory material is used to line the interior of a furnace because of its high melting point and low reactivity. By comparing the lattice energy of calcium nitride, Ca_3N_2 and beryllium nitride, Be_3N_2, predict and explain which compound would make a better refractory material.

[3]
[Total: 20]

6 (a) The compound Na_3CrO_4 is a green solid. When mixed with dilute H_2SO_4, it disproportionates to yield Cr^{3+} (aq) and $Cr_2O_7^{2-}$ (aq).

(i) Write balanced half equations for each of the following reactions:

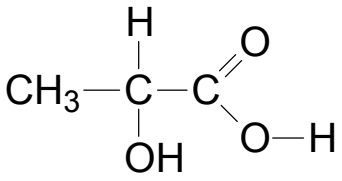
CrO_4^{3-} to Cr^{3+} and CrO_4^{3-} to $Cr_2O_7^{2-}$

(ii) Another sample containing 25.0 cm^3 of 0.200 mol dm^{-3} acidified $K_2Cr_2O_7$ was titrated with a sample of 0.075 mol dm^{-3} of Fe^{2+}, calculate the volume of Fe^{2+} solution required for complete reaction.

[5]

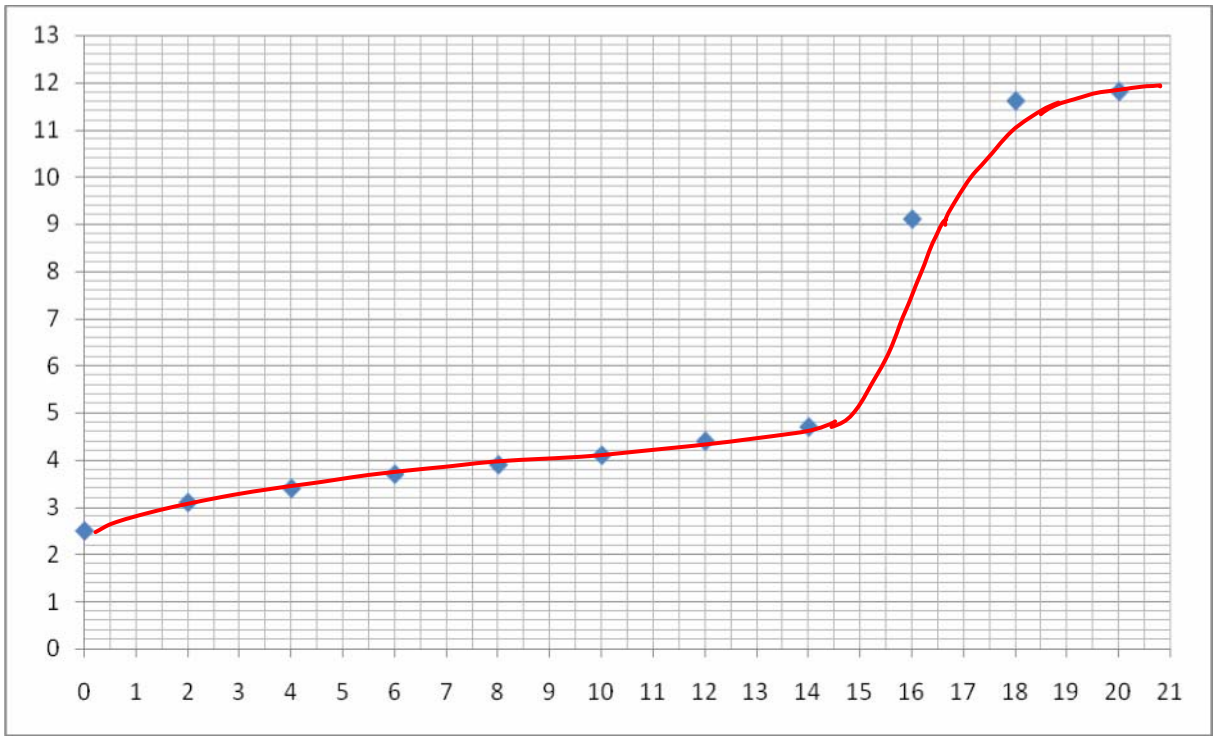
(b) The major acidic component of sour milk is lactic acid, $CH_3CH(OH)CO_2H$:

Structural formula of lactic acid:



When 10.0 cm^3 of a solution of lactic acid (monoprotic acid) was titrated against 0.050 mol dm^{-3} sodium hydroxide, the following graph was obtained:

Graph of pH against volume of NaOH added



(i) Calculate the initial concentration of H^+ (aq) in lactic acid.

(ii) Suggest a suitable indicator for the titration, giving a reason for your choice.

(iii) From the graph, deduce the equivalence volume of sodium hydroxide used.

(iv) Write a balanced equation for the reaction between lactic acid and sodium hydroxide. Hence, calculate the initial concentration of lactic acid in the solution.

(v) Comparing your answers in **(b)(i)** and **(b)(iv),** state and account for the difference between the two sets of results.

(vi) Predict and explain whether lactic acid or propan-1-ol will be a stronger acid.

(vii) Suggest a chemical test to confirm the presence of lactic acid in milk.

[12]

(c) (i) What do you understand by the term "buffer solution"?

(ii) Explain how a mixture of lactic acid, $CH_3CH(OH)CO_2H$ and its salt, $CH_3CH(OH)CO_2^-Na^+$ can act as a buffer.

[3]

[Total: 20]

7 **(a)** Some data for eight elements, lettered **P** to **W** are given below**.**
(These letters do not correspond to the symbols of the respective element)

Element	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**
Atomic no	n	n+1	n+2	n+3	n+4	n+5	n+6	n+7
1st ionisation energy / kJ mol^{-1}	1090	1400	1310	1680	2080	494	736	577

(i) Using the above information, predict and explain whether elements **P** to **W** belong to the same period in the Periodic Table.

(ii) Hence, deduce the Group number, physical state at room temperature and chemical structures of elements **T** and **U**.

[6]

(b) Magnesium oxide, MgO, and phosphorous oxide, P_4O_{10}, are oxides of two elements from period 3 in the Periodic Table.

(i) Illustrate the nature of the two oxides by writing balanced equation(s) to show their reaction(s), if any, with aqueous sodium hydroxide and aqueous hydrochloric acid.

(ii) The following statements regarding the properties of oxides were found on a website:

"Both magnesium oxide and phosphorous oxide do not conduct electricity at room temperature. However, when heated above their respective melting points, one of the two oxides can conduct electricity."

Explain the above statements in terms of structure and bonding.

[6]

(c) When heated in chlorine, magnesium and phosphorus form chlorides.
Describe the reactions, if any, of the chlorides with water, suggesting the pH of the resulting solutions and writing equations where appropriate.

[4]

(d) The boiling points of the three compounds are shown in the table below:

Compound	Boiling point
SO_2	-14 ^oC
SO_3	45 ^oC
H_2O	100 ^oC

With reference to their chemical structures, explain the differences in boiling points of the three compounds.

[4]

[Total: 20]

~END OF PAPER~