SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME	
CLASS	**INDEX NUMBER**

CHEMISTRY 9746/02

Preliminary Examination **25 August 2008**
Paper 2 **1 hr 30 min**

Additional Materials: Data Booklet
Writing Papers

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.

Answer **all** questions in the space provided.

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

For Examiner's Use	
1	
2	
3	
4	
5	
Total	

This document consist of **12** printed pages and **0** blank page

1 Potassium manganate (VII) is an oxidising agent used in redox titrations.
A 50.0 cm^3 sample of iron (II) oxalate, FeC_2O_4, was dissolved in water and the solution made up to 250 cm^3. A 25.0 cm^3 portion of this solution was acidified and titrated with 20.80 cm^3 of 0.025 mol dm^{-3} potassium manganate (VII).

(a) **(i)** State the change in oxidation number for manganese.

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(ii) Write an ionic equation for the oxidation of oxalate ion to carbon dioxide.

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(iii) Write an overall equation for the reaction between potassium manganate (VII) and iron (II) oxalate.

(iv) Calculate the concentration of iron (II) oxalate in the original sample.

(v) State the colour change at the end point of the titration.

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[5]

In the above redox titration, carbon dioxide gas is produced. One of the uses of carbon dioxide is in the manufacture of carbonated drinks. Cola, a carbonated drink, was originally invented by chemist, John Pemberton, to stop headaches and calm nervousness.

Cylinders of pressurised carbon dioxide are used to produce cola. A commercial cola drink was manufactured using such cylinders, each with internal volume of 5 dm^3 and contains 2.58 kg of carbon dioxide. The pressure inside each of the cylinder was found to be 1.0×10^4 kPa at room temperature.

A glass of cola is fizzy because carbon dioxide has been dissolved in it under pressure. When 500 cm^3 of commercial cola drink is poured out from a bottle, the carbon dioxide is gradually released as bubbles of gas. On evolution of 1 dm^3 of carbon dioxide, the cola went flat, as the concentration of dissolved carbon dioxide decreases to its saturation level of 1.5 g dm^{-3} at room temperature.

(b) **(i)** Using the ideal gas equation $pV = nRT$, calculate the pressure the carbon dioxide would exert inside the cylinder at room temperature.

(ii) Suggest why the pressure you calculated in **b(i)** differs from the actual value.

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(iii) Calculate the total mass of carbon dioxide dissolved in the 500 cm^3 bottle of cola under pressure.

(iv) Determine the number of 500 cm^3 bottles of cola that could be manufactured using one cylinder of pressurised carbon dioxide.

[5]

[Total: 10]

2(a) Brine is water saturated or nearly saturated with sodium chloride salt, NaC*l*, and was historically used to preserve vegetables, fish, and meat.

Brine is electrolysed in the chloralkali process to make sodium hydroxide, chlorine and hydrogen, as well as the hypochlorite and chlorate salts on an industrial scale. In this case, the chloride ions are oxidised to chlorine, while water is reduced to hydrogen gas and hydroxide ions.

(i) Write the reactions that occur at the anode and the cathode and hence the overall equation for the electrolysis of brine.

Anode : .....

Cathode : .....

Overall : .....

(ii) During a random sampling it was found that sodium chlorate (I) was detected. Write a chemical equation to illustrate a possible reaction that causes this observation.

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(iii) The volume of chlorine gas collected 3 hours after the chloralkali process was 2700 cm^3. Assuming there is no contamination to the chlorine gas collected and the process efficiency was 80%, Calculate the current required to produce the specified quantity of chlorine gas at room temperature.

[4]

(b) Sedoneural is sodium bromide salt and is widely used as an anticonvulsant and a sedative.

Write the chemical equations when concentrated sulphuric acid was warmed with sodium bromide.

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[2]

(c) Hydrogen halides are formed from the chemical reaction of hydrogen with one of the halogen elements (fluorine, chlorine, bromine, iodine), which are found in Group VII of the periodic table. Hydrogen halides can be abbreviated as HX where H represents a hydrogen atom and X represents a halogen (fluorine, chlorine, bromine or iodine). Upon dissolving the hydrogen halides in water, acids are formed.

(i) With reference from the *Data Booklet*, explain and rank the pK_a of the following acids: HI, HBr and HC*l*.

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(ii) What would you expect to see when hydrobromic acid reacts with aqueous silver nitrate followed by concentrated ammonia?

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(iii) Explain your observation made in **c(ii)** when concentrated ammonia was added. Include equations in your answer

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[6]

[Total: 12]

3(a) Copper and iron are in the same period with chromium and are essential in all plants and animals. Most mollusks (such as mussels and scallops) and some arthropods (such as horseshoe crab and blue crab) use the copper-containing pigment hemocyanin rather than iron-containing haemoglobin for oxygen transport.

(i) Comment on values of the first ionisation energy of copper and iron as given in the *Data Booklet* with the aid of appropriate electronic configurations.

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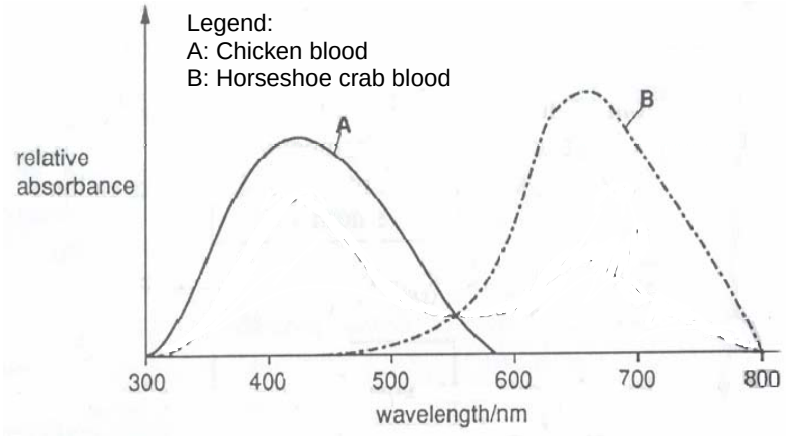
(ii) A sample of oxygenated horseshoe crab blood and chicken blood was analysed and the absorption spectrum was observed.



Colour	Wavelength (nm)
Violet	380 – 450
Blue	450 – 495
Green	495 – 570
Yellow	570 – 590
Orange	590 – 620
Red	620 – 750

Suggest from the spectrum and the data available the colour of the oxygenated horseshoe blood and explain why this colour arises.

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(iii) Explain, with aid of appropriate equations, what you will observe when dilute ammonia is gradually added until in excess to an extract of oxygenated horseshoe blood containing $Cu^{2+}(aq)$ ions.

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[9]

(b) Iron is an important component of several biological molecules especially in haemoglobin. What is the function of haemoglobin in the body and how does it carry out this function?

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[3]

(c)(i) A half-cell containing copper electrode and copper (II) solution was connected to another half-cell containing iron (III) and iron (II) solution with platinum electrode. Determine the $E^{\ominus}_{cell}$ of the reaction.

(ii) Deduce the direction of electron flow in the set-up mentioned in **c(i)**.

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(iii) Suggest what will happen to the $E^{\ominus}_{cell}$ when sodium hydroxide was added to the half-cell containing copper and copper (II) solution.

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[4]

[Total: 16]

4(a) Chlorine triflouride, C*l*F_3, is one of the most reactive compounds known and was used in incendiary bombs in World War II. C*l*F_3 reacts explosively with water and many organic compounds.

(i) Draw a 'dot-and-cross' diagram of the C*l*F_3 molecule. Hence, predict the shape of this molecule.

(ii) Suggest a value of F-C*l*-F bond angle in the C*l*F_3 molecule.

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[2]

(b) C*l*F_3 is also a powerful fluorination agent and it reacts with MgO as follows:

$$4ClF_3(g) + 6MgO(s) \rightarrow 6MgF_2(s) + 2Cl_2(g) + 3O_2(g)$$

(i) Use the data below to calculate the standard enthalpy change of reaction for the above reaction.

Compound	ΔH_f^{θ} / kJ mol^{-1}
C*l*F_3	-158.87
MgO	-601.24
MgF_2	-1124.24

(ii) Using relevant data from **(b)(i)** and the *Data Booklet*, estimate the average bond energy of the C*l*-F bond.

[3]

(c) Using the following data, together with relevant data from the *Data Booklet* and **(b)(i),** calculate a value for the lattice energy of MgO(s).

Enthalpy change of atomisation of magnesium	+150 kJ mol^{-1}
Sum of the first two electron affinities of oxygen atoms	+702 kJ mol^{-1}

[3]

(d) Suggest and explain how you would expect the magnitude of the lattice energy of MgS to compare with the value you obtained in **(c)**.

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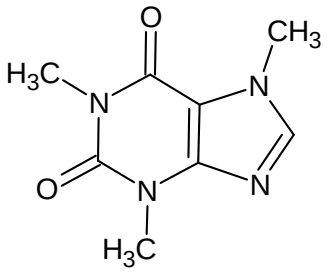
[2]

[Total: 10]

5 Caffeine, a stimulant found in coffee and tea, was discovered by a German chemist, Friedrich Ferdinand Runge, in 1819.

The structure of caffeine is given below.



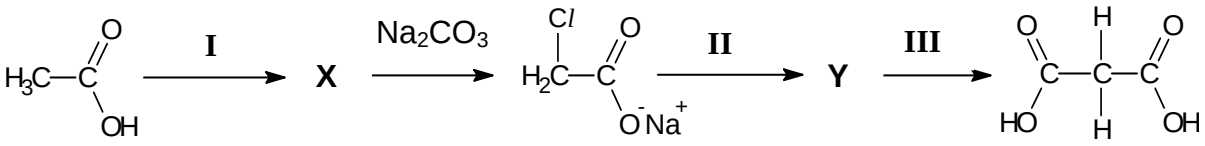
(a) State the number of carbon atoms with the following hybridisations in caffeine.

sp^2: .....

sp^3: ..... **[1]**

(b) Caffeine can be synthesised in the laboratory using dimethyl urea, $(CH_3)NHCONH(CH_3)$ and malonic acid, $HOOC(CH_2)COOH$.

Malonic acid is usually prepared from ethanoic acid as follows:



(i) Draw the structures of the intermediates **X** and **Y**.

(ii) Suggest reagents and conditions for step **I**, **II** and **III** in the reaction sequence.

Step **I**
reagent: .....

condition: .....

Step **II**
reagent: .....

condition: .....

Step **III**
reagent: .....

condition: .....

[5]

(c) Malonic acid on reaction with an alcohol under appropriate condition forms a sweet smelling liquid of molecular formula $C_7H_{12}O_4$.

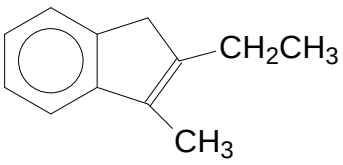
(i) Draw the displayed formula of this sweet smelling liquid.

(ii) The sweet smelling liquid was heated with aqueous sodium hydroxide. State the type of reaction and draw the organic products formed.

Type of reaction: .....

[4]

(d) Describe a chemical test that would distinguish the following two compounds.



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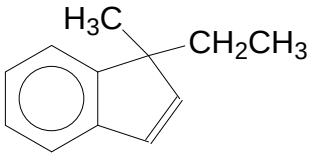

B

[2]
[Total: 12]

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