HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2014

CHEMISTRY PAPER 2

11.45 am – 12.45 pm (1 hour)
This paper must be answered in English

INSTRUCTIONS

(1) This paper consists of **THREE** sections, Section A, Section B and Section C. Attempt **ALL** questions in any **TWO** sections.

(2) Write your answers in the **DSE(D)** Answer Book provided. Start each question (not part of a question) on a new page.

(3) A Periodic Table is printed on page 8 of this Question Paper. Atomic numbers and relative atomic masses of elements can be obtained from the Periodic Table.

Not to be taken away before the end of the examination session

Section A Industrial Chemistry

Answer **ALL** parts of the question.

1. (a) Answer the following short questions:

(i) What is meant by the term 'activation energy' ?

(1 mark)

(ii) At room temperature, ethanol can be produced by fermentation of sugars in the presence of yeast. State the function of yeast, and explain why this function fails at high temperatures.

(2 marks)

(iii) Vitamin C can be obtained from fruits. Explain why it is still necessary to synthesise vitamin C industrially.

(1 mark)

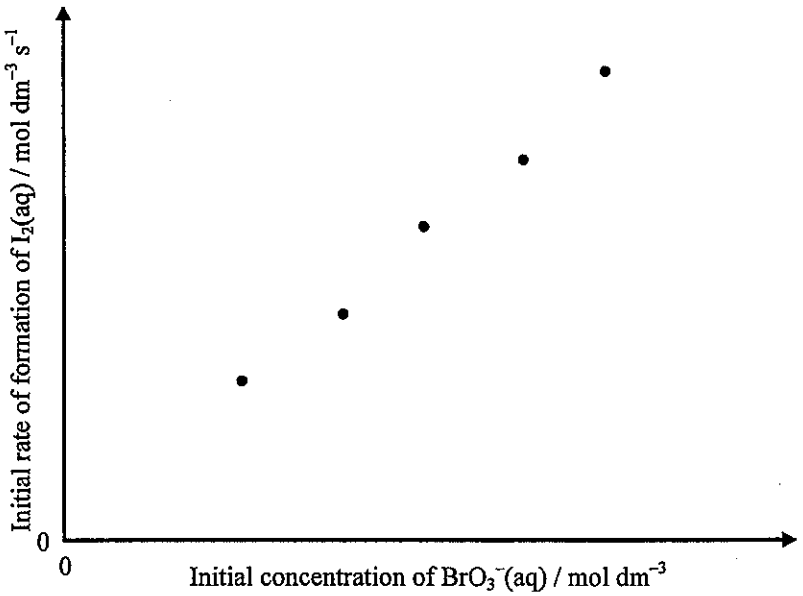
(iv) Give TWO important chemicals manufactured in chloroalkali industry.

(1 mark)

(b) The kinetics of the following reaction at a certain temperature were studied:

$BrO_3^-(aq) + 6I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + Br^-(aq) + 3H_2O(l)$

Several trials of an experiment were attempted under the same experimental conditions except varying the initial concentration of $BrO_3^-(aq)$ to measure the initial rate of formation of $I_2(aq)$. The following graph shows the experimental results obtained from these trials:



(i) What is meant by the term 'initial rate' ?

(1 mark)

(ii) Suggest a method, with justification, to follow the progress of the formation of $I_2(aq)$.

(2 marks)

(iii) With reference to the graph above, deduce the order of reaction with respect to $BrO_3^-(aq)$.

(2 marks)

1. (b) (iv) The table below lists the information for two trials of an experiment on the same reaction performed at the same temperature:

	Initial concentration / mol dm^{-3}			Initial rate of formation of $I_2(aq)$ / mol dm^{-3} s^{-1}
	$BrO_3^-(aq)$	$I^-(aq)$	$H^+(aq)$	
Trial 1	0.17	0.15	0.10	2.30×10^{-3}
Trial 2	0.17	0.30	0.20	1.84×10^{-2}

(1) Given that the order of reaction with respect to $I^-(aq)$ is 1, deduce the order of reaction with respect to $H^+(aq)$.

(2) Based on Trial 1, deduce the initial rate of reaction with respect to $BrO_3^-(aq)$ under the experimental conditions.

(3 marks)

(c) Read the following passage regarding the Haber process and answer the questions that follow.

> Haber process is an important industrial process. It needs natural gas and air as raw materials. In order to speed up the reaction involved in Haber process, iron catalyst in highly porous form is used for increasing the efficiency of the catalyst. Haber process also needs suitable reaction temperature and pressure. Moreover, two factors related to chemistry have been considered before setting the optimal reaction conditions at about 500 °C and 200 atm. Under these conditions, the reaction yield at equilibrium is about 20%. Through some designs, without changing the optimal reaction conditions, the overall conversion percentage of nitrogen in the process can be increased significantly.

(i) Explain why the Haber process is an important industrial process.

(1 mark)

(ii) Why does the Haber process need natural gas as a raw material ?

(1 mark)

(iii) Explain why making the catalyst in highly porous form can increase the efficiency of the catalyst.

(1 mark)

(iv) State TWO factors related to chemistry that have been considered before setting the optimal reaction temperature and pressure.

(2 marks)

(v) Suggest one design so that the overall conversion percentage of nitrogen in the process can be increased significantly without changing the optimal reaction conditions.

(1 mark)

(vi) The South American country Chile has a lot of natural nitrate mines. History tells us that the success of the Haber process had led to some impacts on the society of Chile. Suggest one of these impacts.

(1 mark)

END OF SECTION A

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) Answer the following short questions:

(i) Sketch a unit cell for each of the following metallic crystal structures:

(1) cubic close-packed structure

(2) body-centred cubic structure

(2 marks)

(ii) State TWO structural features of the molecules of the substances that exhibit liquid crystal behaviour.

(2 marks)

(iii) Classify the following plastics into thermoplastics and thermosetting plastics:

polyvinyl chloride, polystyrene, urea-methanal

(1 mark)

(b) Both silicates and ceramics are important materials having a wide variety of applications.

(i) (1) State one common structural feature of silicates and ceramics.

(2) State the difference between the ways of obtaining silicates and ceramics.

(2 marks)

(ii) Talc is a commonly used silicate material having the chemical formula $Mg_3(Si_4O_{10})(OH)_2$.

(1) State the chemical formula of the silicate repeating unit of talc.

(2) Quartz is also a silicate material. Explain why talc and quartz are very different in hardness.

(4 marks)

(iii) Suggest why ceramics are suitable for making cutting tools.

(1 mark)

2. (c) The diagram below shows a plastic bottle for cough syrup made from polyethene (PE):

(i) Suggest a moulding method for making this plastic bottle.

(1 mark)

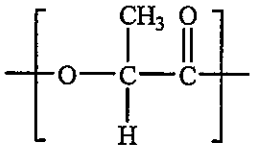
(ii) Give the TWO common types of PE. Explain, from molecular level, which type of PE is more suitable in making this plastic bottle.

(2 marks)

(iii) Explain, from molecular level, why bottles made from poly(ethylene terephthalate) (PET) would generally be harder than bottles made from PE.

(2 marks)

(iv) Some people suggest, from the perspective of environmental protection, switching from using PE and PET to using polylactide (PLA) in making this type of plastic bottles. The repeating unit of PLA is shown below:



(1) It is known that PLA can be produced from the polymerisation of lactic acid through esterification. Give the structure of lactic acid.

(2) Explain why the switching might be environmentally friendly.

(3) Suggest a potential problem of widely replacing PE and PET by PLA.

(3 marks)

END OF SECTION B

Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) Answer the following short questions:

(i) Suggest a chemical test to show the presence of each of the following:

(1) HCl(g)

(2) $>C=O$ functional group

(4 marks)

(ii) Which of the following chemicals is most suitable for drying ethyl ethanoate ?

anhydrous magnesium sulphate, concentrated sulphuric acid, solid sodium hydroxide

(1 mark)

(b) A powdered limestone sample mainly consists of $CaCO_3$, and a small amount of $MgCO_3$ and $FeCl_3$. The following steps were performed in an experiment to determine the percentage of $CaCO_3$ by mass in the sample.

Step 1 : 2.025 g of the limestone sample was added to excess amount of 6 M HCl(aq).

Step 2 : The mixture obtained was gently heated until no signs of further reaction. It was then allowed to cool to room temperature.

Step 3 : The cooled mixture was diluted with distilled water, and made slightly alkaline by adding $NH_3(aq)$ to precipitate the $Fe^{3+}(aq)$ ions present.

Step 4 : The mixture obtained was filtered to collect the filtrate.

Step 5 : Excess ammonium oxalate solution, $(NH_4)_2C_2O_4(aq)$, was added to the filtrate, and the mixture obtained was then made slightly alkaline by using $NH_3(aq)$ to selectively precipitate the calcium oxalate formed.

Step 6 : The mixture was filtered. After washing and drying, 2.374 g of calcium oxalate solid was collected.

(i) Why is it necessary to heat the mixture in Step 2 ?

(1 mark)

(ii) (1) How does one know when the reaction involved in Step 2 has been completed ?

(2) State the observation in Step 3.

(2 marks)

(iii) It is given that magnesium oxalate is soluble in alkaline solutions but calcium oxalate is not. Calculate the percentage of $CaCO_3$ by mass in the limestone sample.

(3 marks)

(iv) State the quantitative analysis method used in this experiment.

(1 mark)

3. (c) Under room temperature, **T** ($C_xH_yO_z$) is a colourless oily liquid and is immiscible with water. Moreover, **T** does not react with $NaHCO_3(aq)$.

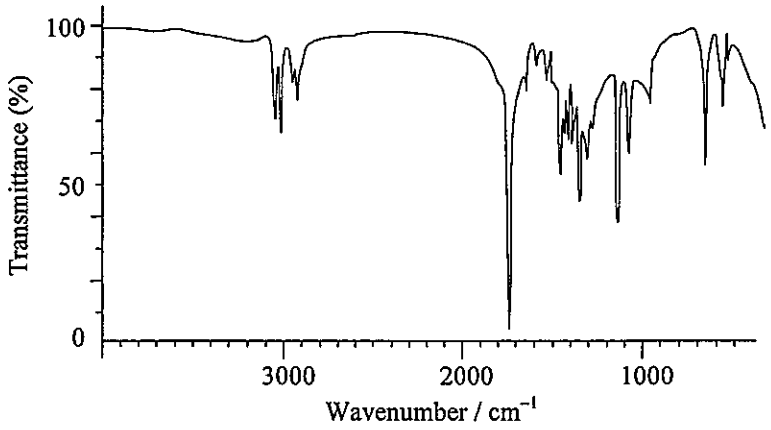
(i) A sample of **T** contains an organic acid as impurity. Outline the experimental steps for purifying the sample by using $NaHCO_3(aq)$ and pentane.

(2 marks)

(ii) With reference to the information given below, deduce the functional group(s) that **T** may have.

(I) **T** is NOT an ester, and it gives negative result with Tollens' reagent.

(II) **T** gives the following infra-red spectrum:



Characteristic Infra-red Absorption Wavenumber Ranges (Stretching modes)

Bond	Compound type	Wavenumber range / cm^{-1}
C=C	Alkenes	1610 to 1680
C=O	Aldehydes, ketones, carboxylic acids and derivatives	1680 to 1800
C≡C	Alkynes	2070 to 2250
C≡N	Nitriles	2200 to 2280
O–H	Acids (hydrogen-bonded)	2500 to 3300
C–H	Alkanes, alkenes, arenes	2840 to 3095
O–H	Alcohols, phenols (hydrogen-bonded)	3230 to 3670
N–H	Amines	3350 to 3500

(3 marks)

(iii) The mass spectrum of **T** shows a parent peak at m/z = 134, and a strong peak at each of m/z = 43 and 91. Suggest one chemical species corresponding to each of the signals at m/z = 43 and 134.

(2 marks)

(iv) Draw one possible structure of **T**.

(1 mark)

END OF SECTION C
END OF PAPER

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

relative atomic mass 相對原子質量

I	II										III	IV	V	VI	VII	0
																2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0										5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3										13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 * **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ** **Ac** (227)	104 **Rf** (261)	105 **Db** (262)													

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
**	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)