HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2015

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) A certain reaction is zeroth order with respect to $I_2(aq)$ and first order with respect to both $CH_3COCH_3(aq)$ and $H^+(aq)$.

(1) State the effect, if any, of a change in the concentration of $I_2(aq)$ in the reaction mixture on the rate of the reaction.

(2) Write the rate equation for the reaction.

(2 marks)

(ii) Write a chemical equation for the reaction in forming ammonia in the Haber process.

(1 mark)

(iii) The rate constant of a certain reaction doubles when the temperature is increased from 298 K to 308 K. Calculate the activation energy of the reaction.

(Gas constant $R = 8.31\ J\ K^{-1}\ mol^{-1}$; Arrhenius equation: $\log k = constant - \frac{E_a}{2.3RT}$)

(2 marks)

(b) Ethanoic acid can be produced by two routes as listed below :

Route (1)

$$\text{sugar solution} \xrightarrow{\text{yeast}} CH_3CH_2OH(aq) \xrightarrow[\text{catalyst}]{O_2(g)} CH_3COOH(aq)$$

Route (2)

$$CH_3OH(l) + CO(g) \xrightarrow[\text{catalyst}]{180^\circ C;\ 30\ atm.} CH_3COOH(l)$$

(i) The reactions in both **Routes (1)** and **(2)** require the use of catalysts.

(1) Draw, in the same sketch, TWO labelled energy profiles for a reaction, one with a catalyst and the other one without catalyst.

(2) Theoretically, catalysts are not consumed in reactions. Suggest why it is still necessary to replace the used catalyst from time to time in industrial processes.

(4 marks)

(ii) Suggest TWO reasons why **Route (1)** is considered as a green process.

(2 marks)

(iii) Suggest TWO reasons why ethanoic acid used in the plastic industry is manufactured by **Route (2)** instead of **Route (1)**.

(2 marks)

1. (c) Chlorine is one of the products manufactured in the chloroalkali industry. The electrolysis involved in the chloroalkali industry can be performed in a mercury electrolytic cell, a diaphragm electrolytic cell or a membrane electrolytic cell.

(i) State the raw material used in the chloroalkali industry.

(1 mark)

(ii) Suggest a criterion in choosing a site for building the chemical plant for a chloroalkali industry.

(1 mark)

(iii) Write an overall equation for the electrolysis involved in the chloroalkali industry.

(1 mark)

(iv) Explain why a mercury electrolytic cell is NOT considered to be environmentally friendly.

(1 mark)

(v) What is the advantage of a membrane electrolytic cell over a diaphragm electrolytic cell ?

(1 mark)

(vi) The chloroalkali industry can also manufacture chlorine bleach and hydrochloric acid. Explain, with the aid of a chemical equation, why chlorine bleach should not be stored together with hydrochloric acid.

(2 marks)

END OF SECTION A

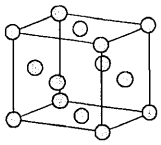
Go on to the next page

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) Answer the following short questions :

(i) The diagram below shows the unit cell of copper metal :



(1) State the meaning of the term 'unit cell'.

(2) Deduce the number of copper atoms in the unit cell.

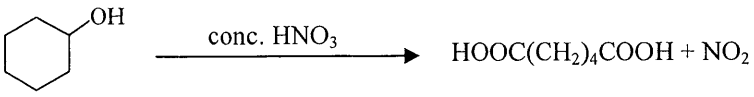
(2 marks)

(ii) Which one of the following items can be made from urea-methanal ?

balloon, electric socket, fishing line, plastic water pipe

(1 mark)

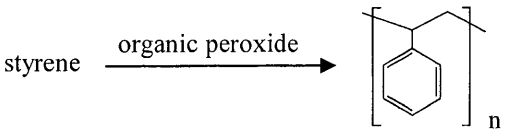
(iii) One of the monomers for making nylon-6,6 is $HOOC(CH_2)_4COOH$. Traditionally, it can be prepared by the following reaction path :



Suggest TWO reasons why the above reaction path is NOT considered to be green.

(2 marks)

(b) The equation below shows the formation of polystyrene (PS) from styrene.



PS

(i) Draw the structure of styrene.

(1 mark)

(ii) Name the type of polymerisation involved in forming PS.

(1 mark)

(iii) Expanded PS is commonly used in making disposable cups for containing hot drinks.

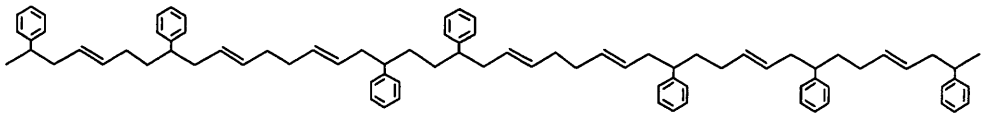
(1) Explain why expanded PS has good heat insulating property.

(2) Suggest a moulding method for making expanded PS cups.

(3) State TWO problems in recycling objects made from expanded PS.

(4 marks)

2. (b) (iv) Styrene can polymerise with buta-1,3-diene to give a high impact polystyrene (HIPS) in which the monomers randomly join together. A portion of the structure of a certain HIPS is shown below :



Suggest why the hardness of HIPS is lower than that of PS.

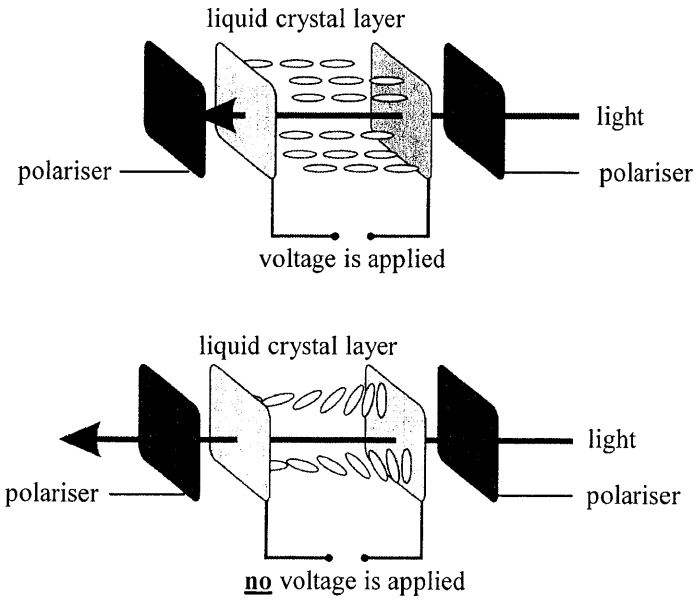
(2 marks)

(c) Liquid crystals can be used to make displays for mobile phones.

(i) How do molecules arrange in the smectic phase of liquid crystals ?

(1 mark)

(ii) The following diagram illustrates the basic working principle of one pixel in liquid crystal displays.



Explain why the pixel appears dark when a voltage is applied to the liquid crystal layer.

(4 marks)

(iii) Some scientists suggested that the use of nanomaterials may increase the resolution of displays.

(1) State the meaning of the term 'nanomaterials'.

(2) Suggest why the use of nanomaterials may increase the resolution of displays.

(2 marks)

END OF SECTION B

Go on to the next page

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 $Br^-(aq)$.

(2 marks)

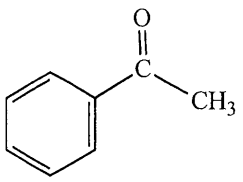
(ii) Suggest an instrumental method for determining the content of octane in a petrol sample.

(1 mark)

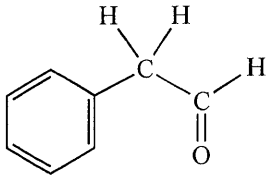
(iii) Suggest how copper powder can be obtained from a mixture of copper powder and iron(III) oxide by chemical method.

(2 marks)

(b) Compounds **X** and **Y** shown below are isomers with relative molecular mass 120.



X



Y

(i) Each of **X** and **Y** can react with 2,4-dinitrophenylhydrazine solution to give a similar observation. State the observation.

(1 mark)

(ii) Suggest a chemical test to distinguish between **X** and **Y**.

(2 marks)

(iii) Illustrate how **X** and **Y** can be distinguished from their mass spectra.

(2 marks)

(iv) With reference to the information given in the table below, suggest whether infra-red spectroscopy can be used to distinguish between **X** and **Y**.

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

(2 marks)

3. (c) An experiment consisting of the following four steps was performed to determine the amount of nitrogen in a milk powder sample :

Step (1) : 3.00 g of the milk powder sample was heated with excess concentrated sulphuric acid so as to turn all nitrogen in it into $(NH_4)_2SO_4(aq)$.

Step (2) : The reaction mixture obtained was heated with excess NaOH(aq) to liberate $NH_3(g)$. All $NH_3(g)$ liberated was then absorbed by 50.00 cm^3 of 1.00 M HCl(aq).

Step (3) : The solution formed was diluted to 250.0 cm^3 with deionised water.

Step (4) : 25.00 cm^3 portions of the diluted solution were titrated with 0.100 M KOH(aq) using methyl orange as an indicator. An average of 13.55 cm^3 of the KOH(aq) was required to reach the end point.

(i) Write the chemical equations for the following reactions in Step (2) :

(1) the reaction of $(NH_4)_2SO_4(aq)$ with NaOH(aq)

(2) the reaction of $NH_3(g)$ with HCl(aq)

(2 marks)

(ii) State the colour change at the end point of the titration in Step (4).

(1 mark)

(iii) Calculate the percentage by mass of nitrogen in the milk powder sample.
(Relative atomic mass: N = 14.0)

(4 marks)

(iv) In finding out the protein content in a milk powder sample, a common method is to determine the amount of nitrogen, but not to directly determine the amount of protein in the sample. Suggest one limitation of this common method.

(1 mark)

END OF SECTION C
END OF PAPER

PERIODIC TABLE 周期表

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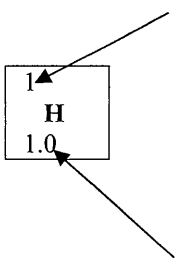

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 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)