HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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.

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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) Consider the following reaction for the production of ethanol by using a certain catalyst in industry :

$$C_2H_4(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g) \qquad \Delta H = -45 \text{ kJ mol}^{-1}$$

Justify, under a pressure of 65 atm, why the operation temperature is set at 300°C with reference to equilibrium position and reaction rate.

(2 marks)

(ii) What does the area under a Maxwell-Boltzmann distribution curve represent ?

(1 mark)

(iii) Syngas is an important starting material in many industrial processes.

(1) State the TWO major constituent gases in syngas.

(2) Suggest one important chemical that can be made directly from syngas through catalytic process.

(2 marks)

(b) Consider the manufacture of ammonia by the Haber process in a chemical plant.

(i) Suggest how nitrogen gas can be obtained in industry.

(1 mark)

(ii) Explain why there is a need to install a heat exchanger in the chemical plant.

(2 marks)

(iii) If 420 kg of nitrogen and 96 kg of hydrogen are introduced into the reaction chamber, and with the yield of ammonia of 15 %, calculate the mass of ammonia produced.

(3 marks)

(iv) Nitric acid can also be produced in the chemical plant. Firstly, ammonia is oxidised to give nitrogen monoxide, and nitrogen monoxide is further oxidised to nitrogen dioxide. Finally, oxidation of nitrogen dioxide gives nitric acid. Write the chemical equation for each of the following reactions :

(1) oxidising ammonia to give nitrogen monoxide

(2) oxidising nitrogen dioxide to give nitric acid

(2 marks)

1. (c) The hydrolysis of sucrose can be represented by the following equation :

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}(aq)} + H_2O(l) \xrightarrow{HCl(aq)} \underset{\text{glucose}}{C_6H_{12}O_6(aq)} + \underset{\text{fructose}}{C_6H_{12}O_6(aq)}$$

(i) Three trials of an experiment were performed under the same experimental conditions to study the kinetics of the hydrolysis. The table below shows the data obtained :

	Initial concentration of $C_{12}H_{22}O_{11}(aq)$ / mol dm^{-3}	Initial concentration of HCl(aq) / mol dm^{-3}	Initial rate of disappearance of $C_{12}H_{22}O_{11}(aq)$ / mol dm^{-3} s^{-1}
Trial 1	0.010	0.10	6.0×10^{-7}
Trial 2	0.020	0.20	2.4×10^{-6}
Trial 3	0.010	0.30	1.8×10^{-6}

(1) Given that the order of reaction with respect to $H_2O(l)$ is zero, deduce the order of reaction with respect to $C_{12}H_{22}O_{11}(aq)$ and that to HCl(aq).

(2) State the rate equation for the reaction.

(3) Based on the result in Trial 1, calculate the rate constant under the experimental conditions.

(4 marks)

(ii) The hydrolysis of sucrose can also be performed by the action of a certain enzyme. Suggest the function of the enzyme in the hydrolysis.

(1 mark)

(iii) Enzymatic hydrolysis of starch eventually gives glucose as the only product. According to the principles of green chemistry, suggest TWO reasons why starch is considered to be more suitable than sucrose as a source of glucose.

(2 marks)

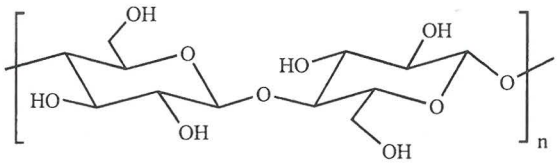
END OF SECTION A

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) Answer the following short questions :

(i) Cellulose is a natural polymer and its structure is shown below :



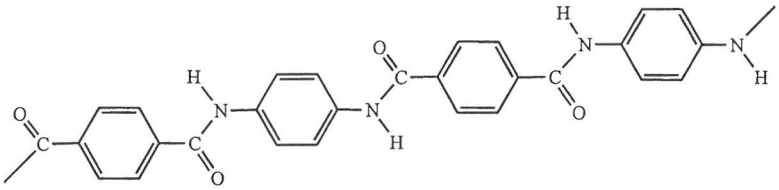
Explain why cellulose is considered to be environmentally friendly.

(1 mark)

(ii) State TWO structural characteristics of liquid crystals.

(2 marks)

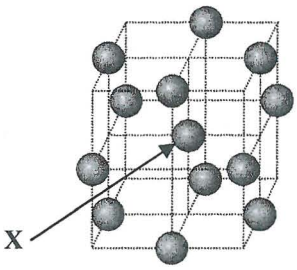
(iii) A portion of the structure of Kevlar is shown below :



With reference to the above structure, give TWO reasons why Kevlar is rigid.

(2 marks)

(b) Gold is a precious metal. The diagram below shows a unit cell of gold crystal.



(i) Name this type of crystal structure.

(1 mark)

(ii) Calculate the number of gold atoms in the unit cell.

(2 marks)

(iii) What is the coordination number of the gold atom labelled '**X**' ?

(1 mark)

2. (b) (iv) A sample of 18-carat gold is composed of 75% gold, 15% silver and 10% copper. Explain, from scientific point of view, the advantage of using this sample of 18-carat gold over using pure gold in making jewellery embedded with diamonds.

(2 marks)

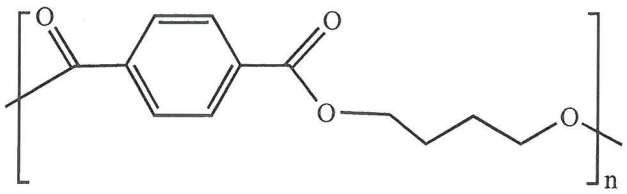
(v) Gold nanoparticles of various size exhibit different colours. Suggest one example of using gold nanoparticles in architecture.

(1 mark)

(c) Consider the following polymers :

polybutylene terephthalate (PBT), poly(tetrafluoroethene) (PTFE), poly(*p*-phenylene vinylene) (PPV)

(i) The keycap of a computer keyboard is made of PBT. The structure of PBT is shown below :



(1) Draw the structures of the various monomers of PBT.

(2) Name the type of polymerisation involved in the formation of PBT.

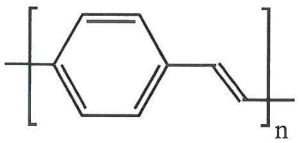
(3) Suggest a moulding method for making keycaps for computer keyboards.

(4 marks)

(ii) A burette stopcock is made of PTFE. Suggest TWO properties of PTFE rendering it suitable for making burette stopcocks.

(2 marks)

(iii) The conducting layer in an OLED display is made of PPV. The structure of PPV is shown below :



(1) Draw a portion of structure consisting of THREE repeating units of PPV.

(2) Would you expect PPV to exhibit optical activity ? Explain your answer.

(2 marks)

END OF SECTION B

Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) Answer the following short questions :

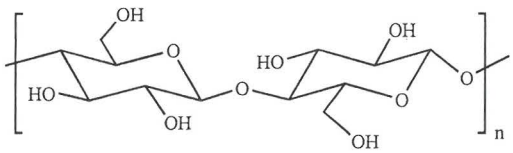
(i) Give one property of solid sodium hydroxide making it NOT suitable to be weighed for preparing a standard solution.

(1 mark)

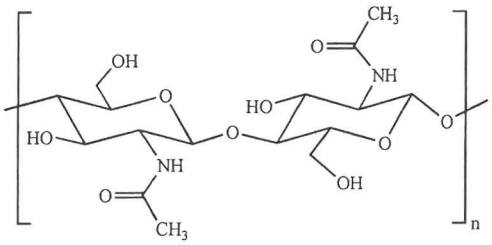
(ii) Suggest a chemical test to show the presence of hypochlorite ions in an aqueous solution.

(2 marks)

(iii) Both cellulose and chitin are natural polymers. Their structures are shown below :



cellulose



chitin

By referring to the data given in the table below, suggest one similarity and one difference between the infra-red spectra of cellulose and chitin.

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
O–H	Alcohols, phenols (hydrogen-bonded)	3230 to 3670

(2 marks)

(b) The concentration of a $Na_2Cr_2O_7(aq)$ sample **A** was determined by volumetric analysis; while the concentration of another $Na_2Cr_2O_7(aq)$ sample **B** was determined by colorimetry.

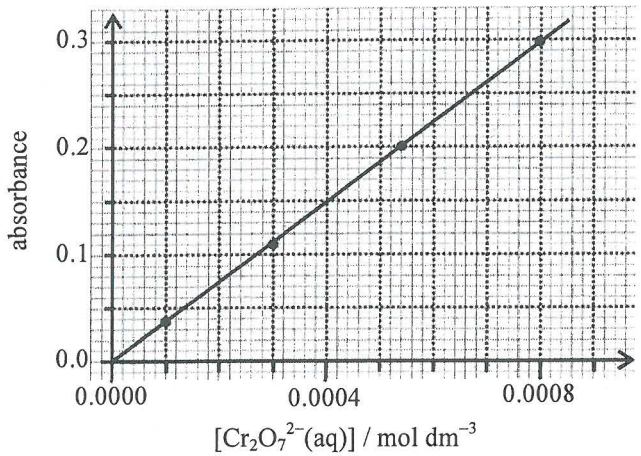
(i) 25.00 cm^3 of sample **A** was transferred to a conical flask and acidified with dilute $H_2SO_4(aq)$. Then the mixture was titrated with 0.0642 mol dm^{-3} $Fe^{2+}(aq)$ solution with a suitable indicator. It required 26.88 cm^3 of the $Fe^{2+}(aq)$ solution to reach the end point.

(1) Write a balanced equation for the reaction involved.

(2) Calculate the concentration of $Na_2Cr_2O_7(aq)$ in **A**.

(3 marks)

3. (b) (ii) In colorimetry, various standard $Cr_2O_7^{2-}(aq)$ solutions were first prepared, and then the absorbance of these solutions were measured with a colorimeter installed with a blue filter. The calibration curve below shows the variation of absorbance with the concentration of $Cr_2O_7^{2-}(aq)$ ions.



(1) Suggest why a blue filter was used.

(2) With reference to the above calibration curve, state the relationship between absorbance and $[Cr_2O_7^{2-}(aq)]$.

(3) Sample **B** was diluted 100 times. The absorbance of the diluted solution was measured as 0.26 by the colorimeter. Based on the information given from the above calibration curve, calculate the concentration of $Na_2Cr_2O_7(aq)$ in **B**.

(4 marks)

(iii) Explain whether volumetric analysis or colorimetry is more appropriate in determining the concentration of a very dilute $Na_2Cr_2O_7(aq)$, such as around 10^{-4} mol dm^{-3}.

(1 mark)

(c) **X** and **Y** are isomeric compounds with their structures shown below :

X **Y**

(i) Suggest, with explanation, how **X** and **Y** can be differentiated from their respective mass spectra.

(2 marks)

(ii) The melting point of **X** is 50 °C while that of **Y** is 77 °C. Both of them are insoluble in water but soluble in dichloromethane. When treated with dilute $Na_2CO_3(aq)$, no reaction occurs for **X** but reaction occurs for **Y** to form a soluble salt.

(1) You are provided with dilute $Na_2CO_3(aq)$ and dilute $H_2SO_4(aq)$. Outline an experimental procedure, based on solvent extraction, to separate solid **Y** from a solution of **X** and **Y** in dichloromethane.

(2) Suggest how you can identify that the solid obtained in (1) is pure compound **Y**.

(5 marks)

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
				1 **H** 1.0													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)