PERIODIC TABLE 周期表

atomic number 原子序

relative atomic mass 相對原子質量

GROUP 族

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
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
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
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)

2025-DSE
CHEM
PAPER 2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2025

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.

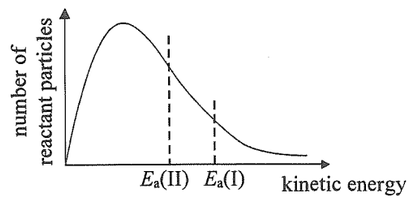
Not to be taken away before the end of the examination session

Section A Industrial Chemistry

Answer ALL parts of the question.

1. (a) (i) Write an overall chemical equation for the electrolysis of brine using a membrane electrolytic cell in the chloroalkali industry. (1 mark)

(ii) The graph below shows the Maxwell-Boltzmann distribution curve of the reactant particles in a gaseous reaction at a certain temperature, where E_a(I) is the activation energy of the reaction.



What change can be made so that the activation energy of the same reaction will become E_a(II) ? Explain your answer. (2 marks)

(iii) Two methods for producing $CH_3COOCH_2CH_2CH_2CH_3$ are shown below :

Method 1 :

$$CH_3CH_2CH_2CH_2OH + CH_3COOH \xrightleftharpoons[\text{heat under reflux}]{\text{conc. } H_2SO_4} CH_3COOCH_2CH_2CH_2CH_3 + H_2O$$

Method 2 :

$$CH_3COOH + SOCl_2 \xrightarrow{\text{room temperature}} CH_3COCl + SO_2 + HCl$$

$$CH_3CH_2CH_2CH_2OH + CH_3COCl \xrightarrow{\text{room temperature}} CH_3COOCH_2CH_2CH_2CH_3 + HCl$$

According to the principles of green chemistry, suggest TWO reasons to explain why Method 1 can be considered to be 'greener' than Method 2. (2 marks)

(b) Read the following passage and answer the questions that follow.

> Sulphuric acid can be produced by an industrial process in a chemical plant. In the reaction chamber, purified sulphur dioxide reacts with O_2(g) in excess purified air to form sulphur trioxide in the presence of a catalyst, as shown below :
>
> $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196 \text{ kJ mol}^{-1}$
>
> In this process, vanadium(V) oxide is used as the catalyst. The operation conditions in the reaction chamber are set at about 450 °C and 1 atm, and the yield of sulphur trioxide at equilibrium is about 98%. Finally, sulphur trioxide is converted to sulphuric acid.

(i) Explain why sulphur dioxide and air need to be purified before passing into the reaction chamber. (1 mark)

(ii) Explain why pure O_2(g) is NOT used to form sulphur trioxide in the above industrial process. (1 mark)

1. (b) (iii) Explain why solid catalysts used in industrial processes are usually in porous form instead of in the form of lumps. (1 mark)

(iv) (1) Explain why the operation temperature is NOT chosen at about 1 000 °C. (1 mark)

(2) Suggest TWO reasons to explain why the operation pressure is NOT chosen at about 200 atm. (2 marks)

(v) A fertiliser can be produced from the reaction between sulphuric acid and the product of the Haber process. Write a chemical equation for this reaction. (1 mark)

(c) The following equation shows the reaction between a pink substance Ɏ(aq) and OH^-(aq) :

$$\text{Ɏ(aq)} + OH^-(aq) \rightarrow \text{colourless product}$$

The rate equation for this reaction under certain conditions is given below :

$$\text{Rate} = k[\text{Ɏ(aq)}]^m [OH^-(aq)]^n$$

k is the rate constant
m is the order of reaction with respect to Ɏ(aq)
n is the order of reaction with respect to OH^-(aq)

Under the same conditions, an experiment was conducted to determine the order of reaction with respect to OH^-(aq). In each trial of the experiment, different volumes of 2.0 M NaOH(aq) and H_2O(l) were mixed with a fixed volume of 0.012 M Ɏ(aq), and the initial rate of disappearance of Ɏ(aq) was measured. The table below shows the data obtained :

	Volume of 2.0 M NaOH(aq) / cm^3	Volume of H_2O(l) / cm^3	Volume of 0.012 M Ɏ(aq) / cm^3	Initial rate of disappearance of Ɏ(aq) / mol dm^{-3} s^{-1}
Trial 1	8.0	0.0	2.0	8.72×10^{-3}
Trial 2	4.0	4.0	2.0	4.36×10^{-3}
Trial 3	3.0	5.0	2.0	r

(i) Suggest TWO reasons to explain why the total volume of the reaction mixture was made the same in each trial. (2 marks)

(ii) Deduce the order of reaction with respect to OH^-(aq), n. (1 mark)

(iii) Deduce the initial rate of disappearance of Ɏ(aq) in Trial 3, r. (1 mark)

(iv) It is given that the order of reaction with respect to Ɏ(aq), m, is 1.

(1) Describe how you can conduct an experiment and use a suitable graph to confirm that the reaction is first order with respect to Ɏ(aq). (3 marks)

(2) State the unit of k. (1 mark)

END OF SECTION A

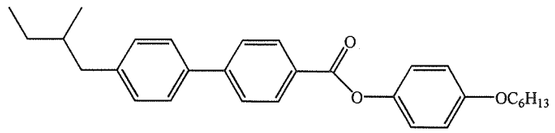
Go on to the next page

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) (i) A sample of bottled water is found to contain some plastic particles with sizes in the range of 5×10^{-8} m to 9×10^{-8} m. Explain whether these plastic particles are nanoparticles. (1 mark)

(ii) The structure of compound **Z** is shown below :



Z can exhibit liquid-crystalline behaviour between 103 °C and 116 °C.

(1) Explain whether **Z** can exhibit the cholesteric phase of liquid crystals. (1 mark)

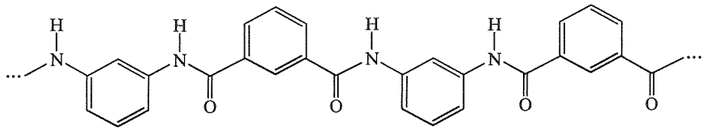
(2) Which of the following can best describe the appearance of **Z** at 110 °C ?

A. transparent solid
B. opaque solid
C. clear fluid
D. milky fluid

(1 mark)

(iii) From molecular level, explain why cotton (mainly containing cellulose) absorbs water easily but it is insoluble in water. (2 marks)

(b) Polymer **X** is a synthetic polyamide and has a high tensile strength. It can be used to make protective jackets for firemen. The diagram below shows a portion of the structure of **X** :



(i) Draw the structures of the TWO monomers for making **X**. (2 marks)

(ii) Explain whether the atom economy of the formation of **X** from monomers is 100%. (1 mark)

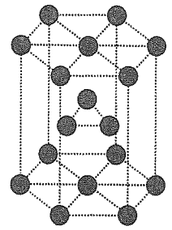
(iii) The structure and properties of **X** are similar to those of Kevlar. Suggest TWO reasons to explain why **X** has a high tensile strength. (2 marks)

(iv) Suggest another property of **X** rendering it suitable for making protective jackets for firemen. (1 mark)

(v) Explain why the prolonged exposure of **X** to strong acids should be avoided. (1 mark)

(vi) Wool is a natural polyamide. Suggest a reason to explain why wool is considered to be more environmentally friendly than **X** as a textile material. (1 mark)

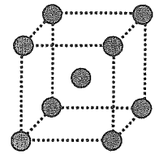
2. (c) (i) Titanium has crystal structure **A** at room temperature. The diagram below shows a structural portion of **A**. Repetition of this structural portion can generate the whole titanium crystal.



(1) Name crystal structure **A**. (1 mark)

(2) What is the coordination number of each titanium atom in **A** ? (1 mark)

(ii) Titanium has crystal structure **B** under certain conditions. The diagram below shows a unit cell of **B**.



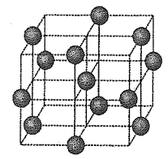
Deduce the number of titanium atoms in this unit cell. (1 mark)

(iii) A titanium alloy containing a small amount of metal **Y** is harder than pure titanium. It can be used to make artificial human joints.
(It is given that the size of an atom of metal **Y** is different from the size of a titanium atom.)

(1) Explain why this alloy is harder than pure titanium. (1 mark)

(2) Besides hardness, suggest another property that this alloy should have so that it is suitable for making artificial human joints. (1 mark)

(iv) Some metals have crystal structure **C**. The diagram below shows a unit cell of **C**.



Which one of the crystal structures (**A**, **B** or **C**) has the highest percentage of empty space in its structure ? Explain your answer. (2 marks)

END OF SECTION B

Go on to the next page

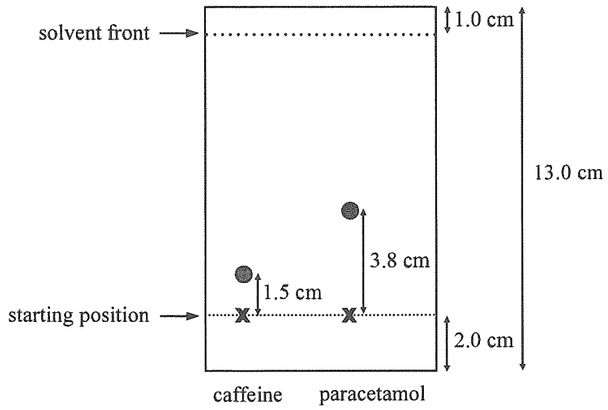
Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) (i) A physical method can increase the concentration of an aqueous ethanol solution from 12% to about 50%. Name this method. (1 mark)

(ii) Suggest a chemical test for detecting chlorine gas. (2 marks)

(iii) The chromatogram obtained from the thin-layer chromatography of caffeine and paracetamol is shown below :



(1) Calculate the R_f value for paracetamol. (1 mark)

(2) Paracetamol moves farther than caffeine as shown in the above chromatogram. Suggest a reason for this result based on the principle of chromatography. (1 mark)

(b) A student carried out an investigation to determine the concentration of $Cl^-(aq)$ ions in an impure water sample. 25.0 cm^3 of the sample was diluted to 250.0 cm^3 with distilled water. Then 10.0 cm^3 of the diluted sample was titrated with 0.0802 M $AgNO_3(aq)$ using a suitable indicator. The end point was reached when all $Cl^-(aq)$ ions were precipitated out.

The titration was repeated several times and the titration results are listed below :

Trial	1	2	3	4
Volume of $AgNO_3(aq)$ used / cm^3	8.30	7.80	7.10	7.75	7.85

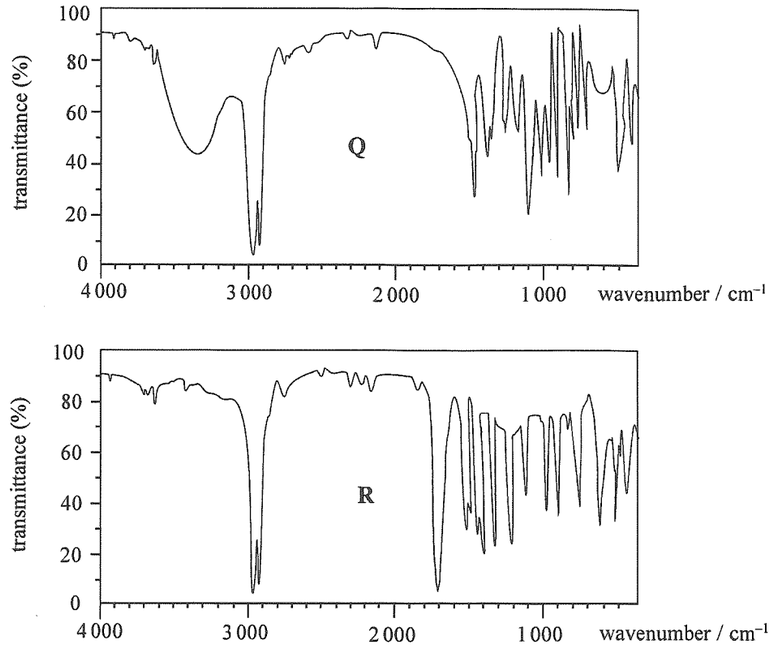
(i) Draw a labelled diagram to show the set-up for the titration. (2 marks)

(ii) Calculate a reasonable average of the volume of $AgNO_3(aq)$ used in the titration. (1 mark)

(iii) Calculate the concentration of $Cl^-(aq)$ ions, in g cm^{-3}, in the impure water sample.
(Relative atomic mass : Cl = 35.5) (3 marks)

(iv) It was then found that the impure water sample also contained $Br^-(aq)$ ions. Explain whether the concentration of $Cl^-(aq)$ ions in the sample calculated in (b)(iii) would be higher or lower than the actual value. (1 mark)

3. (c) A cyclic organic compound **Q** ($C_xH_yO_z$) contains 72.0% carbon and 12.0% hydrogen by mass. Its relative molecular mass is 100, and it is optically inactive. When **Q** is heated under reflux with excess acidified potassium dichromate solution, compound **R** is formed. The infra-red spectra of **Q** and **R** are shown below :



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 (hydrogen-bonded)	3230 to 3670
N–H	Amines	3350 to 3500

(i) Deduce the molecular formula of **Q**.
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0) (2 marks)

(ii) (1) State the principle in producing absorption peaks in an infra-red spectrum. (1 mark)

(2) Based on the infra-red spectra of **Q** and **R** and the information given in the above table, deduce one respective functional group that may be present in **Q** and **R**. (2 marks)

(iii) With reference to the information provided, deduce and draw a possible structure of **Q**. (3 marks)

END OF SECTION C
END OF PAPER