HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2018

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) Write TWO half equations for the electrolysis of brine using membrane electrolytic cell in chloroalkali industry.

(2 marks)

(ii) Sketch a labelled diagram for a Maxwell-Boltzmann distribution curve.

(2 marks)

(iii) Which one of the following species can be a raw material for manufacturing vitamin C in industry ?

acetic acid, acetone, formaldehyde, glucose

(1 mark)

(b) Reaction (I) below shows a process of producing methanol using catalyst at 100 atm and 250°C in industry :

Reaction (I) : $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

(i) (1) Suggest a suitable catalyst for the reaction.

(2) Suggest why the reaction would proceed slowly in the absence of a catalyst.

(3) Explain why the operation pressure in industry for the reaction is set at 100 atm but not at atmospheric pressure.

(4 marks)

(ii) Methanol can also be produced from carbon dioxide, a side product of some industrial processes, using another catalyst as shown in Reaction (II) below :

Reaction (II) : $CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g)$

Based on the given information :

(1) Suggest one reason why Reaction (II) can be considered as greener than Reaction (I).

(2) Suggest a potential benefit of Reaction (II) to the environment.

(2 marks)

(iii) One of the industrial applications of methanol is to produce ethanoic acid. Write a chemical equation for the reaction involved.

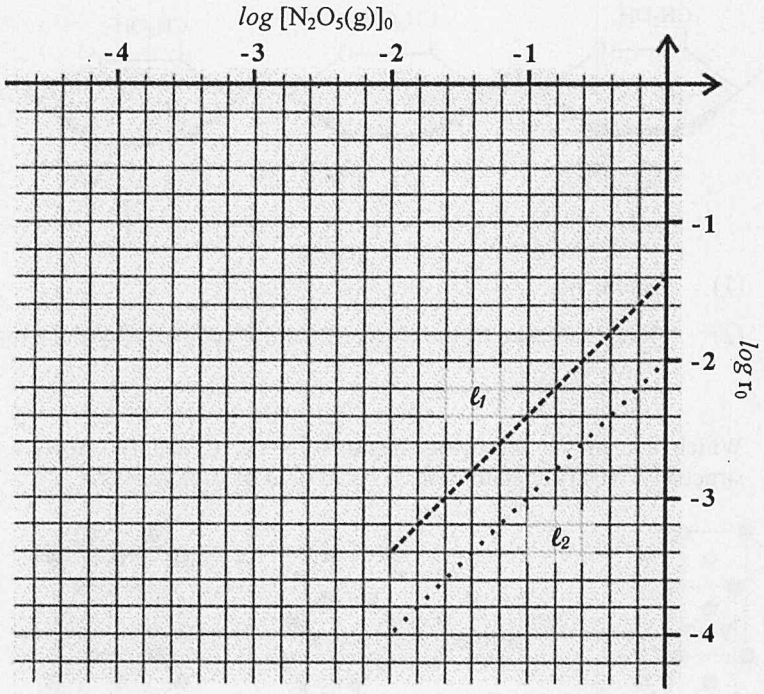
(1 mark)

1. (c) Two sets of experiments (one at 360 K ; another at 345 K) were performed to study the chemical kinetics of the decomposition of $N_2O_5(g)$:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

For each set of the experiments, the variation of *log* r_0 with *log* $[N_2O_5(g)]_0$ was plotted and both of them got a straight line as shown in the graph below :

	Representing	Unit
$[N_2O_5(g)]_0$	initial concentration of $N_2O_5(g)$	mol dm^{-3}
r_0	initial rate of decomposition of $N_2O_5(g)$	mol dm^{-3} s^{-1}
ℓ_1	straight line obtained at 360 K	
ℓ_2	straight line obtained at 345 K	



It is given that *log* r_0 = *log* k + n *log* $[N_2O_5(g)]_0$, where k is the rate constant and n is the order of reaction with respect to $N_2O_5(g)$.

(i) Given that ℓ_1 and ℓ_2 have the same slope, what can you deduce in terms of chemical kinetics ?

(1 mark)

(ii) From ℓ_1, deduce the order of reaction with respect to $N_2O_5(g)$.

(2 marks)

(iii) From ℓ_2, deduce the rate constant for the reaction at 345 K.

(2 marks)

(iv) According to the relevant information of the graph, calculate the activation energy of the reaction.
(Gas constant, $R = 8.31$ J K^{-1} mol^{-1})

(3 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 :

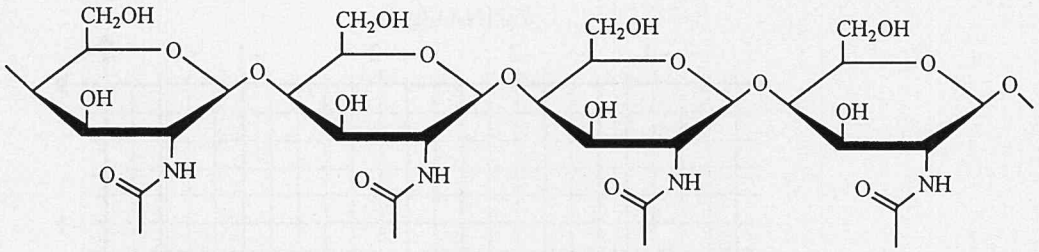
(i) The following chemical equation shows how vinyl acetate can be obtained.

$$2CH_3COOH + 2CH_2{=}CH_2 + O_2 \xrightarrow{Pd} \underset{\text{vinyl acetate}}{2CH_3COOCH{=}CH_2} + 2H_2O$$

Give TWO reasons why this reaction can be considered as green.

(2 marks)

(ii) Substance **W** is the component of the exoskeleton of crabs. Part of the structure of **W** is shown below :

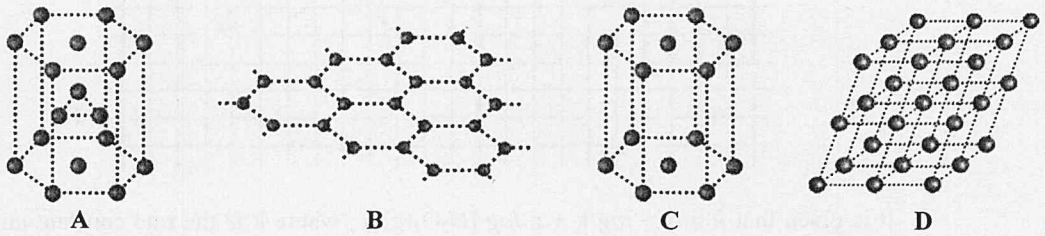


(1) Name **W**.

(2) With reference to the above structure, suggest why the exoskeleton of crabs is very hard.

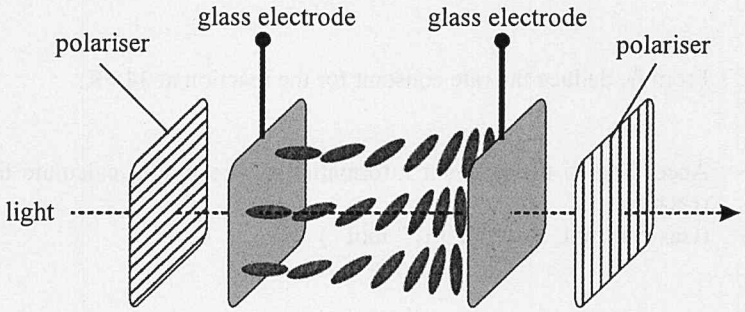
(2 marks)

(iii) Which one of the following diagrams, **A**, **B**, **C** and **D**, shows a hexagonal close-packed structure ? (Only need to write **A**, **B**, **C** or **D** in your answer.)



(1 mark)

(b) The following diagram shows the arrangement of certain liquid crystal molecules between the glass electrodes of one pixel in a liquid crystal display when no voltage is applied.



2. (b) (i) Name the relevant liquid crystal phase. Explain your answer.

(2 marks)

(ii) A voltage is applied to the liquid crystal layer.

(1) Draw a diagram to show the expected arrangement of the liquid crystal molecules.

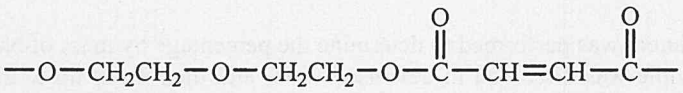
(2) Would the pixel appear bright or dark? Explain your answer.

(4 marks)

(iii) Explain why the liquid crystal display could not operate beyond a certain high temperature.

(1 mark)

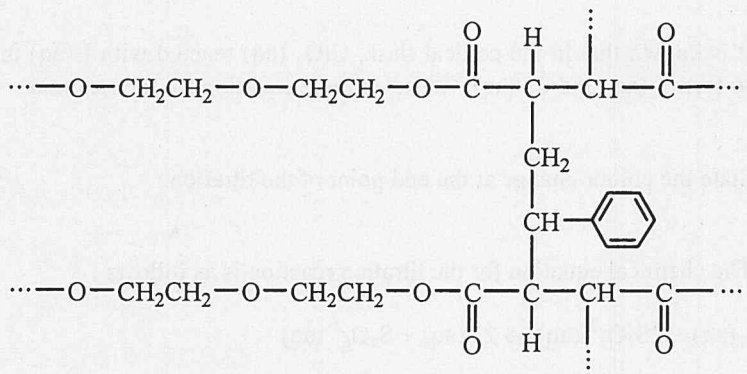
(c) The repeating unit of a polymer **X** is shown below :



(i) Draw the structures of the monomers of **X**.

(2 marks)

(ii) Compound **A** joins molecules of **X** together to form **Y**. Part of the structure of **Y** is shown below :



(1) Draw the structure of **A**.

(2) Comment on the thermal property of **Y**.

(3) Suggest one way to control the rigidity of **Y**. Explain your answer.

(4 marks)

(iii) **Y** is used to make the body of a boat.

(1) Suggest a moulding method for making the body of the boat.

(2) Suggest one advantage of using **Y** over iron in making the body of a boat.

(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) An ionic compound gives a brick red flame in a flame test. Suggest one cation the compound may contain.

(1 mark)

(ii) Suggest a chemical test to distinguish between $K_2SO_3(aq)$ and $K_2SO_4(aq)$.

(2 marks)

(iii) What is meant by the 'R_f value' of a substance in a paper chromatogram ?

(2 marks)

(b) An experiment was performed to determine the percentage by mass of $NaClO_3(s)$ in a sample. 1.63 g of the sample was dissolved in deionised water and then made up to 250.0 cm^3. 10.00 cm^3 of the solution was transferred to a conical flask. Then 10 cm^3 of 1 M KI(aq) and 20 cm^3 of 6 M HCl(aq) were added in the flask. The resulting mixture was titrated with 0.112 M $Na_2S_2O_3(aq)$, adding starch solution as an indicator at appropriate time. The titration was repeated several times, and the mean volume of $Na_2S_2O_3(aq)$ required to reach the end point was 27.88 cm^3.

(i) Describe how the sample dissolved in deionised water can be made up to 250.0 cm^3.

(2 marks)

(ii) It is known that in the conical flask, $ClO_3^-(aq)$ reacted with $I^-(aq)$ in the presence of $H^+(aq)$ to form $I_2(aq)$ and $Cl^-(aq)$. Write an ionic equation for the reaction.

(1 mark)

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

(1 mark)

(iv) The chemical equation for the titration reaction is as follows :

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

Assuming that no other species in the sample would react with $I^-(aq)$, calculate the percentage by mass of $NaClO_3(s)$ in the sample.
(Relative atomic masses: O = 16.0, Na = 23.0, Cl = 35.5)

(3 marks)

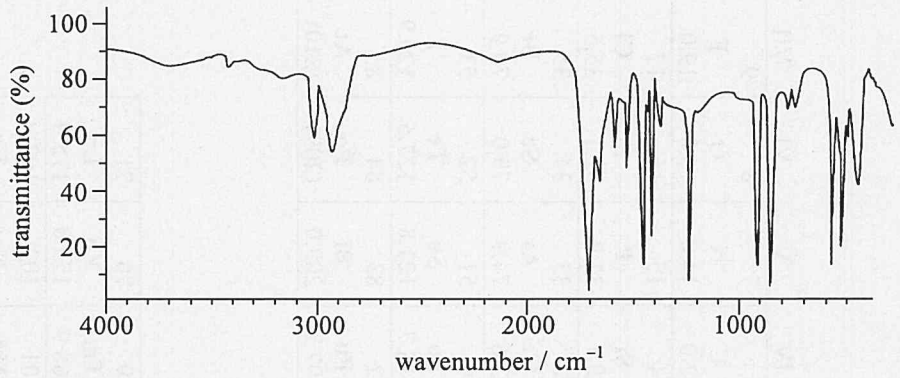
(c) A liquid mixture consists of two organic compounds **X** and **Y** :

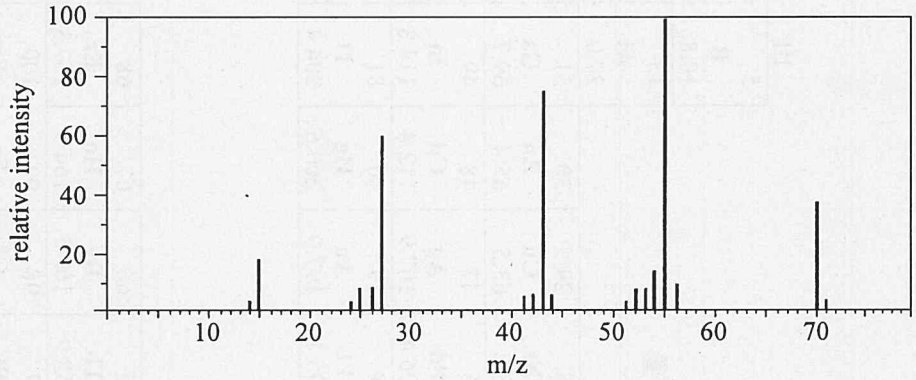
	X	**Y**
molecular formula	C_4H_6O	C_4H_8O
boiling point / °C	81.4	79.6

(i) Explain why fractional distillation is NOT a suitable method to separate **X** from the mixture.

(1 mark)

3. (c) (ii) **X** gives the following infra-red spectrum and mass spectrum :





(1) By referring to the infra-red spectrum and the information given in the table below, deduce one functional group that may be present in **X**.

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

(2) By referring to the mass spectrum, suggest one chemical species corresponding to each of the signals at m/z = 43 and 55.

(3) According to (1) and (2) above, draw a possible structure of **X**.

(4 marks)

(iii) Compound **Y** shows a positive result in 2,4-dinitrophenylhydrazine test, and a negative result in Tollens' reagent test. Deduce what **Y** may be.

(3 marks)

END OF SECTION C
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PERIODIC TABLE 周期表

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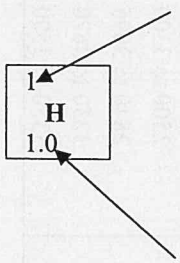

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar**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