2013-DSE
CHEM
PAPER 2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013

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.

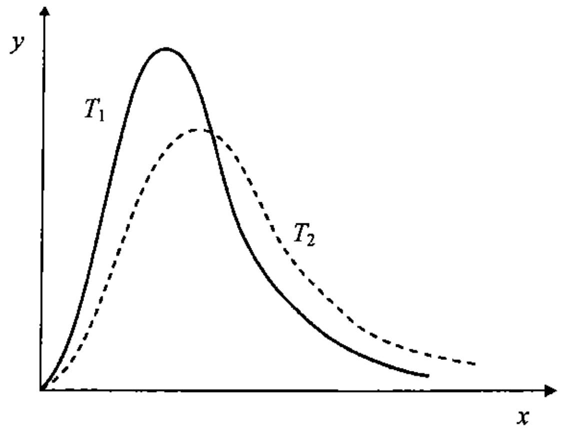
Not to be taken away before the end of the examination session

Section A Industrial Chemistry

Answer **ALL** parts of the question.

1. (a) For gaseous reactions, an increase in temperature leads to an increase in reaction rate.

(i) The graph below shows the Maxwell-Boltzmann distribution curves of molecular kinetic energies of a gas at two temperatures T_1 and T_2.



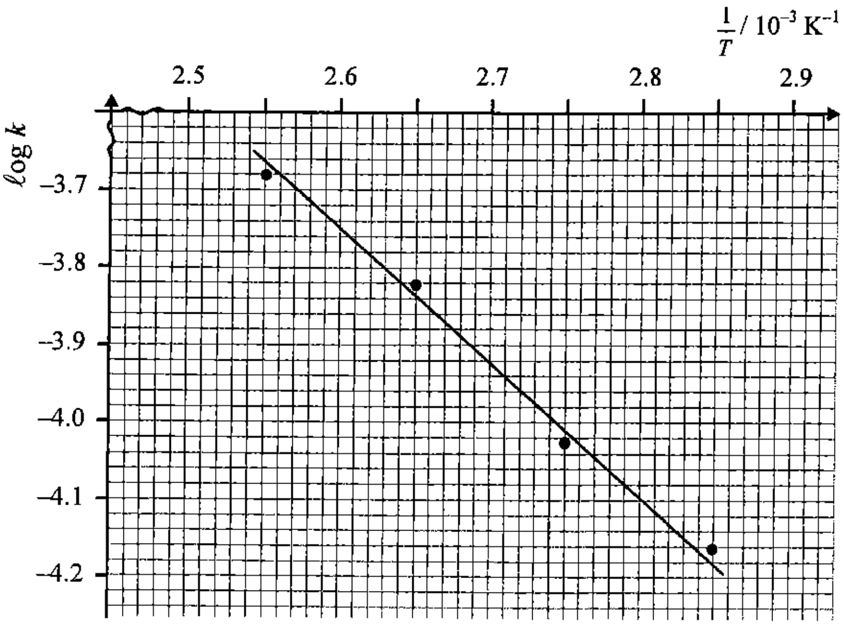
(1) What do the axes, x and y, in the above graph respectively represent ?

(2) With reference to the above graph, suggest why an increase in temperature can lead to an increase in the reaction rate of a gaseous reaction.

(5 marks)

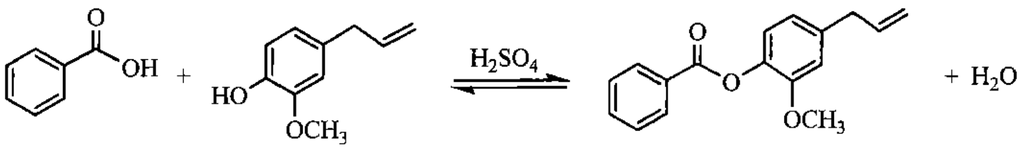
(ii) In a chemical kinetics experiment, the rate constants (k) of a reaction at various temperatures (T) were determined. The graph below shows the plot of $\ell og\ k$ against $\frac{1}{T}$. Calculate the activation energy of this reaction.

(Gas constant, $R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$)



(3 marks)

1. (b) Eugenol benzoate is a commonly used food flavouring agent. Eugenol benzoate can be synthesised from the reaction of eugenol with benzoic acid in the presence of sulphuric acid as a homogeneous catalyst.



benzoic acid eugenol eugenol benzoate

(i) Suggest why a catalyst can speed up a reaction.

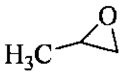
(1 mark)

(ii) For the above reaction, would the use of concentrated sulphuric acid or that of dilute sulphuric acid give a better yield of eugenol benzoate ? Explain your answer.

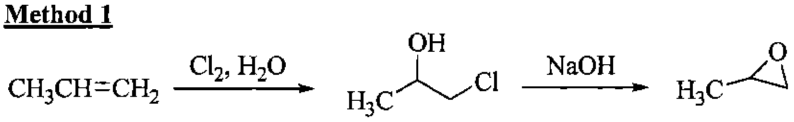
(1 mark)

(iii) Eugenol benzoate can also be synthesised from the reaction of eugenol with benzoic acid in the presence of a solid acid as a heterogeneous catalyst. With reference to the synthesis of eugenol benzoate, state ONE advantage of using a homogeneous catalyst and ONE advantage of using a heterogeneous catalyst.

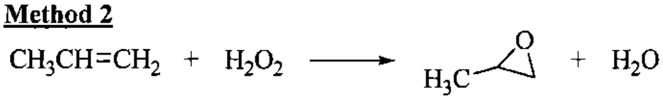
(2 marks)

(c) Propylene oxide () is a chemical commonly used in the plastics industry. Two methods for producing propylene oxide are shown below:

Method 1



Method 2



(i) The Cl_2 and NaOH used in Method 1 are products of the chloroalkali industry. Briefly describe how these two chemicals are produced.

(3 marks)

(ii) The atom economy of Method 1 is 29.7%. Calculate the atom economy of Method 2.

(1 mark)

(iii) Discuss, from TWO different perspectives, whether Method 1 or Method 2 is greener.

(2 marks)

(iv) Comment on the following statement, and explain your answer:

'A reaction with a high atom economy should also have a high yield.'

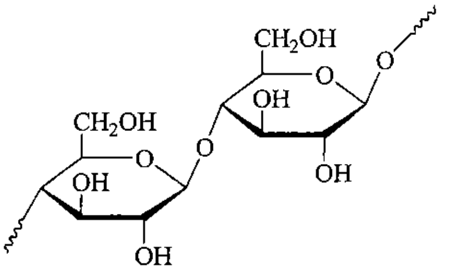
(2 marks)

END OF SECTION A

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) A part of the structure of cellulose is shown below:



(i) Cellulose is a condensation polymer of glucose.

(1) What is the meaning of the term 'condensation polymer' ?

(2) Draw the structure of a molecule of glucose.

(2 marks)

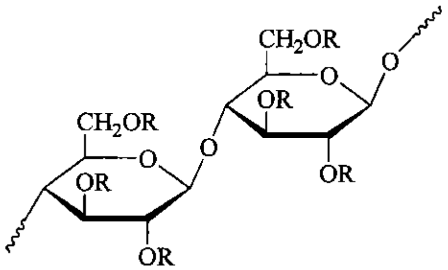
(ii) The relative molecular mass of cellulose generally ranges from 2.5×10^5 to 1.0×10^6. Suggest why the relative molecular mass of cellulose falls into a wide range.

(1 mark)

(iii) Explain why there is a significant difference in the solubility of glucose and cellulose in water.

(3 marks)

(b) (i) Methyl cellulose is a polymer synthesised from cellulose. It is commonly used as the active ingredient of wallpaper glue. A part of the structure of methyl cellulose is shown below:

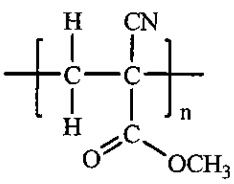


(In the structure, R can be H or CH_3.)

Methyl cellulose glue, when dried, is a white solid. State and explain the behaviour of the white solid when it is gradually heated up to a very high temperature.

(3 marks)

(ii) Poly(methyl 2-cyanoacrylate) is commonly used as the active ingredient of superglue. The structure of poly(methyl 2-cyanoacrylate) is shown below:



2. (b) (ii) (1) Draw the structure of the monomer of poly(methyl 2-cyanoacrylate).

(2) Propanone (CH_3COCH_3) is a commonly used solvent for removing hardened superglue. Explain why propanone can dissolve poly(methyl 2-cyanoacrylate).

(3 marks)

(iii) Which of methyl cellulose or poly(methyl 2-cyanoacrylate) degrades more readily in the environment ? Explain your answer.

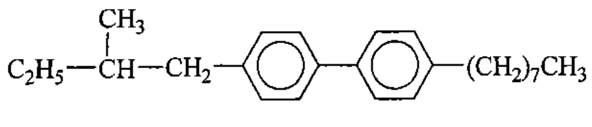
(2 marks)

(c) Liquid crystals are widely used in making visual displays. Liquid crystals can have various phases in their structures.

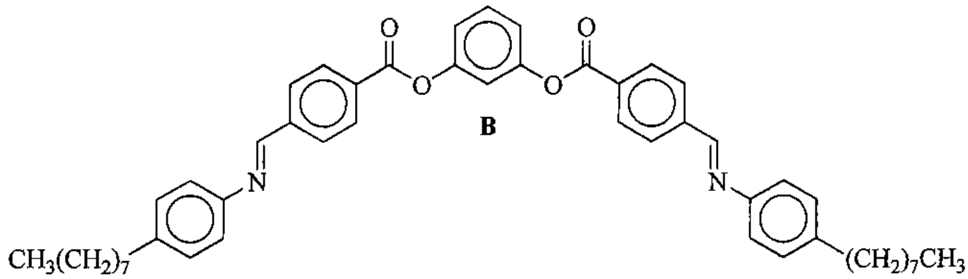
(i) Compare the nematic phase and the smectic phase of liquid crystals.

(2 marks)

(ii) Explain which of the following compounds, **A** or **B**, would form cholesteric phase liquid crystals.



A



B

(1 mark)

(iii) Suggest why liquid crystals would lose the liquid crystal properties at very low temperatures.

(1 mark)

(iv) Organic Light Emitting Diode (OLED) can emit light when an electric current passes through. OLED can also be used in making visual displays. Explain why the power efficiency of liquid crystal displays is considered to be lower than that of OLED displays.

(2 marks)

END OF SECTION B

Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) Outline how hex-1-ene can be obtained from a mixture of hex-1-ene, octane and water by physical methods.
(Boiling points: hex-1-ene = 63°C, octane = 125°C, water = 100°C)

(4 marks)

(b) Both white wine and red wine contain SO_2 preservative which is fixed in different forms. A volumetric analysis experiment was performed to determine the total concentration of SO_2 in a sample of white wine. In the experiment, 25.00 cm^3 of the wine sample was transferred to a conical flask. Following certain stipulated procedures, $NaOH(aq)$ and $H_2SO_4(aq)$ were successively added to the flask to liberate all SO_2 from the wine. The resultant solution was immediately titrated with 0.00412 mol dm^{-3} $I_2(aq)$ using freshly prepared starch solution as indicator. The experiment was repeated several times, and the mean volume of $I_2(aq)$ required to reach the end point was 10.50 cm^3.

(i) A reaction must fulfill certain conditions in order that it can be used in volumetric analysis. State ONE such condition.

(1 mark)

(ii) Explain why the resultant solution needed to be titrated immediately.

(1 mark)

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

(1 mark)

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

$$SO_2(aq) + I_2(aq) + 2H_2O(l) \rightarrow 2HI(aq) + H_2SO_4(aq)$$

Calculate the total concentration of SO_2, in mg dm^{-3}, in the white wine sample.

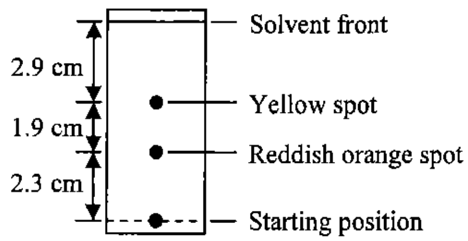
(4 marks)

(v) Explain whether the total concentration of SO_2 in a sample of red wine can be determined in such an experiment.

(1 mark)

(c) The main pigments in a certain brand of tomato paste are lycopene (reddish orange) and β-carotene (yellow). In order to isolate lycopene from the tomato paste, an experiment involving solvent extraction, thin-layer chromatography (TLC) and column chromatography was performed.

(i) The result of TLC is shown below:



Calculate the R_f value for the lycopene spot.

(1 mark)

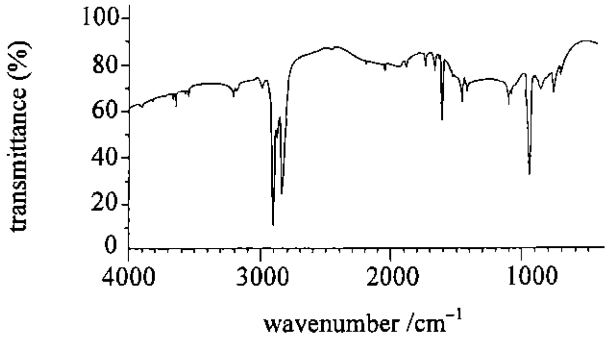
(ii) With reference to the result of TLC, explain whether the first-collected coloured fraction in the column chromatography is lycopene or β-carotene, if the same stationary phase and mobile phase are used.

(1 mark)

3. (c) (iii) Suggest an instrumental method that can be used to determine the concentration of lycopene in the collected lycopene fraction. State the physical property of the lycopene fraction that needs to be measured.

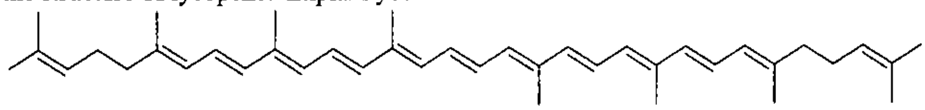
(2 marks)

(iv) The infra-red spectrum of lycopene is shown below:

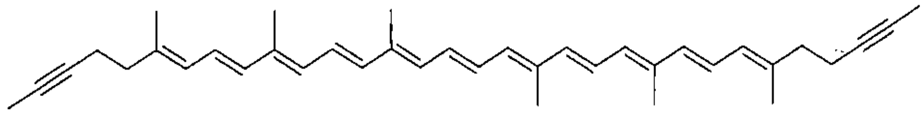


By referring to the Characteristic Infra-red Absorption Wavenumber Ranges (Stretching modes) given in the table below, suggest which of the following structures (**W**, **X**, **Y** or **Z**) may be the structure of lycopene. Explain your answer.

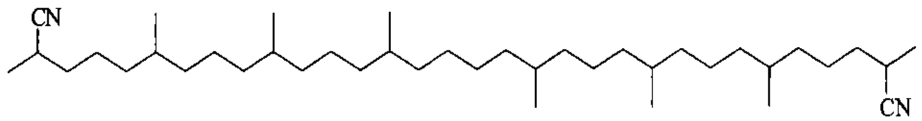
W:



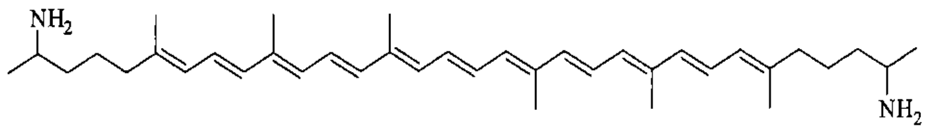
X:



Y:



Z:



(4 marks)

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

END OF SECTION C
END OF PAPER

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

1 **H** 1.0

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)