

CHEMISTRY PAPER 2

(Sample Paper)

Time allowed: 1 hour

This paper must be answered in English.

INSTRUCTIONS

- (1) Answer **TWO** questions in this paper.
- (2) Each question carries 20 marks.
- (3) Answers are to be written in the Answer Book provided.
- (4) A Periodic Table is printed on the back of this Question Book. 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

Answer any **TWO** questions.

(1) Industrial Chemistry

- (a) In acid solution, chlorate ions (ClO_3^-) slowly oxidize chloride ions to chlorine. The following kinetic data are obtained at 25°C :

$[\text{ClO}_3^-(\text{aq})]$ /mol dm ⁻³	$[\text{Cl}^-(\text{aq})]$ /mol dm ⁻³	$[\text{H}^+(\text{aq})]$ /mol dm ⁻³	Initial rate /mol dm ⁻³ s ⁻¹
0.08	0.15	0.20	1.0×10^{-5}
0.08	0.15	0.40	4.0×10^{-5}
0.16	0.15	0.40	8.0×10^{-5}
0.08	0.30	0.20	2.0×10^{-5}

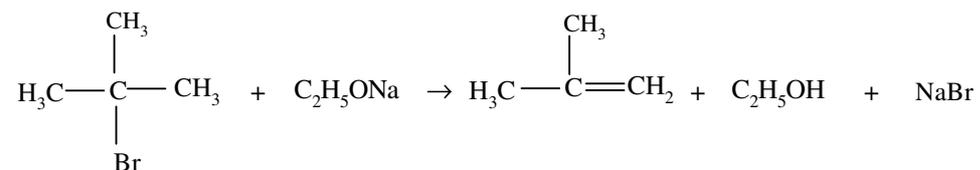
- (i) Write the balanced equation for this reaction.
- (ii) Determine the order of the reaction with respect to each reactant.
- (iii) Determine the rate constant at this temperature.
- (iv) If the rate of the reaction is found to be doubled when the temperature is raised by 10°C , deduce the activation energy of the reaction.
(Gas constant $R = 8.31 \text{ JK}^{-1}\text{mol}^{-1}$)

(10 marks)

- (b) For the industrial preparation of nitric acid from nitrogen, give the chemical reactions and the conditions under which they take place.

(6 marks)

- (c) The reaction for the production of methylpropene from 2-bromo-2-methylpropane is represented by the following equation :

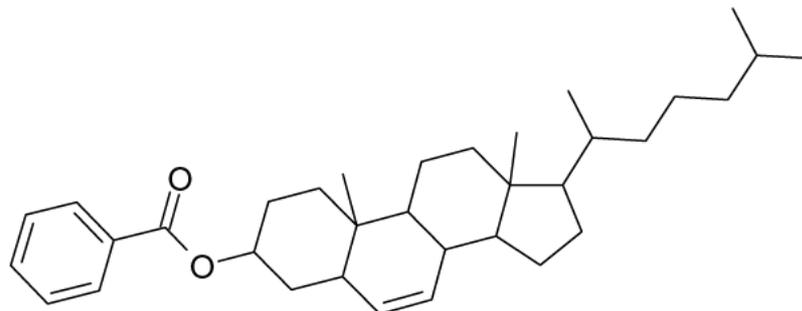


- (i) With reference to green chemistry, calculate the atom economy of the reaction.
- (ii) Apart from atom economy, suggest TWO other factors that scientists should consider in order to conduct a green production process.

(4 marks)

(2) **Materials Chemistry**

(a) The structure of compound A, which exhibits liquid-crystalline behaviour, is shown below :



- (i) Compound A can be formed by condensation of benzoic acid with cholesterol. Draw the structure of cholesterol.
- (ii) What is the difference between 'true liquid' and 'liquid crystal' ?
- (iii) Describe briefly the arrangement of the molecules in cholesteric phase liquid crystals.
- (iv) Outline the working principle of cholesteric phase liquid crystals in Liquid Crystal Display (LCD).

(10 marks)

(b) Plastics can be classified into thermoplastics and thermosetting plastics according to their thermal properties.

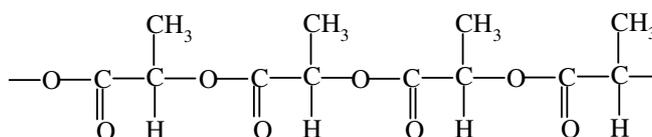
(i) Explain, in terms of bonding and structure, why thermoplastics and thermosetting plastics behave differently upon heating.

(ii) Polyethene (PE) is a thermoplastic commonly used in making shopping bags.

(I) Write the chemical equation for the formation of PE from its monomer.

(II) State the repeating unit of PE.

(iii) Some scientists suggested using polylactic acid (PLA) instead of PE to make shopping bags as this can help reduce environmental problems. Part of the structure of PLA is shown below:



(I) Draw the structure of the monomer used to make PLA.

(II) Give the systematic name of the monomer.

(III) Name the type of polymerisation for making PLA.

(IV) Explain, in chemical terms, why the disposal of PLA poses less harm to the environment than that of PE.

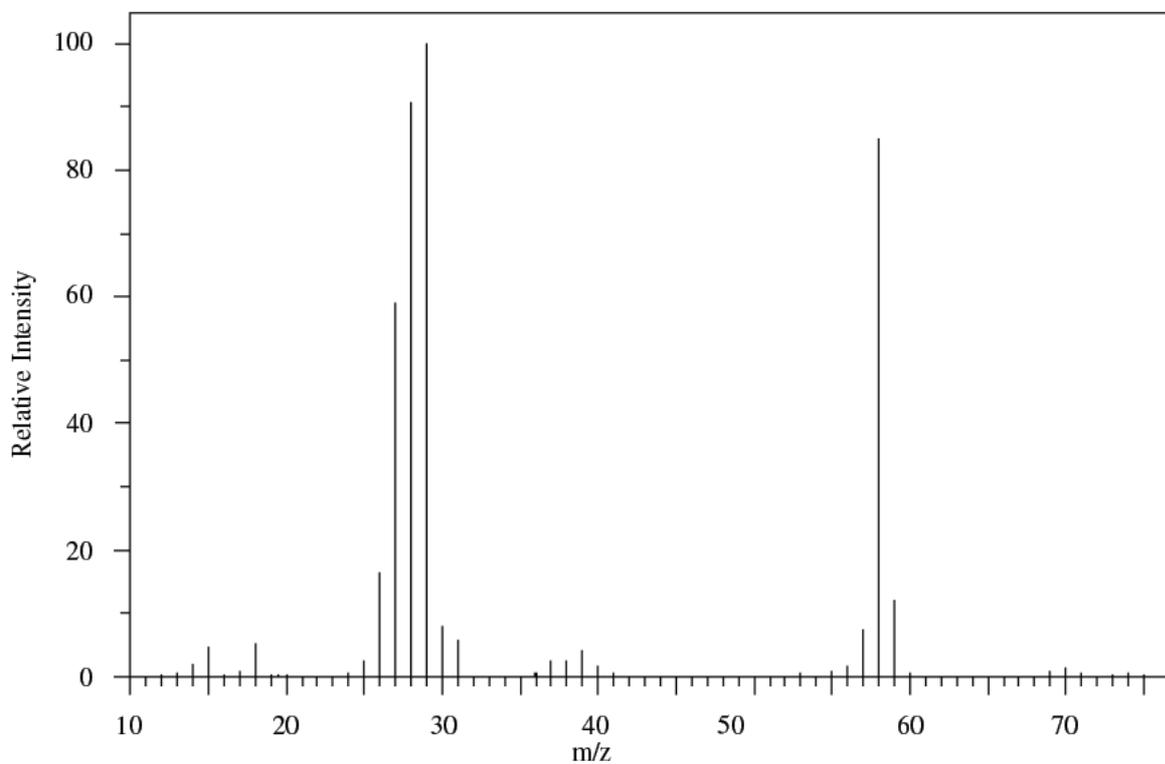
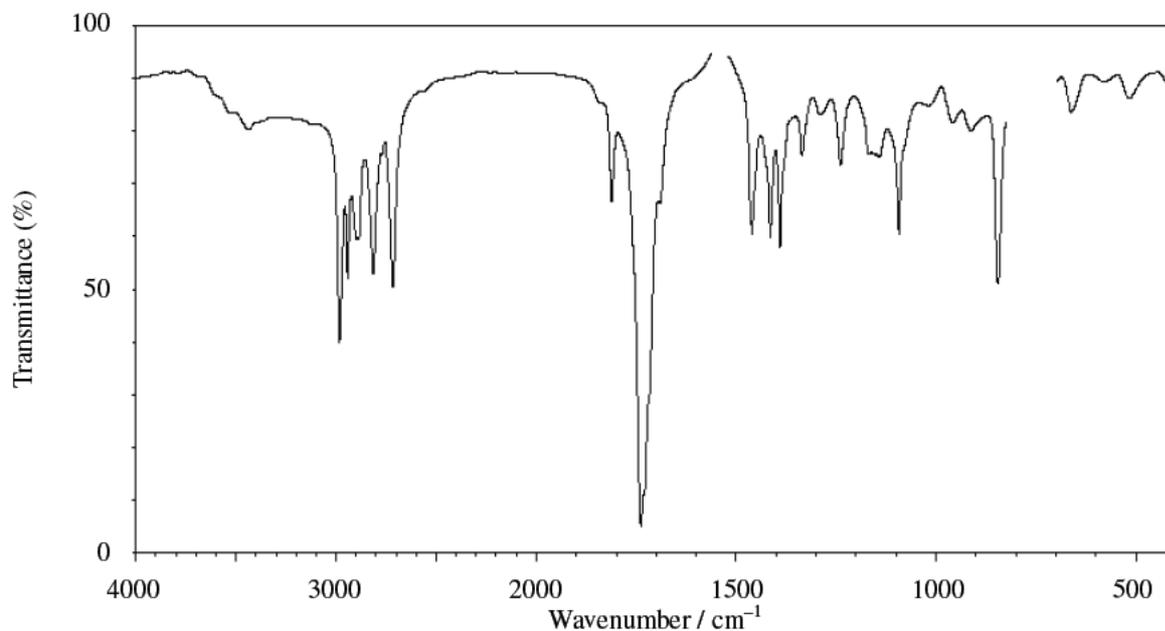
(10 marks)

(3) Analytical Chemistry

(a) Compound **G**, with relative molecular mass of 58, has the following composition by mass :

C : 62.1% H : 10.3% O : 27.6%

The infrared and mass spectra of compound **G** are given 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, phenols (hydrogen-bonded)	3230 to 3670
N-H	Amines	3350 to 3500

- (i) Deduce the molecular formula of compound **G**.
- (ii) From the given spectral information and the molecular formula obtained in (i), deduce the structural formula of compound **G**.
- (iii) Suggest an experiment, with detailed procedures, to support the structure of compound **G** you have deduced in (ii).

(10 marks)

- (b) In an experiment to determine the concentration of ethanol in a brand of spirit, 10.0 cm³ of a sample of the spirit was diluted to 250.0 cm³. 25.0 cm³ portions of the diluted spirit were withdrawn. To each portion, 25.0 cm³ of 0.156 M K₂Cr₂O₇(aq) and excess dilute H₂SO₄ were added. The mixtures obtained were allowed to stand at room temperature overnight. The excess K₂Cr₂O₇ in each mixture was then titrated against 0.118 M (NH₄)₂Fe(SO₄)₂(aq) with an appropriate indicator. The mean titre was 12.23 cm³.

- (i) Write an equation for the reaction of ethanol with dichromate ions under acidic condition.
- (ii) Give TWO properties of (NH₄)₂Fe(SO₄)₂ rendering it to be used as a primary standard in volumetric analysis.
- (iii) Suggest a method to test whether the oxidation of ethanol has been completed.
- (iv) Calculate the concentration of ethanol, in mol dm⁻³, in this brand of spirit.

(10 marks)

END OF PAPER

PERIODIC TABLE 週期表

GROUP 族

I		II												III	IV	V	VI	VII	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)															

atomic number 原子序

1
H
1.0

relative atomic mass 相對原子質量

*	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)