2012-DSE
CHEM
PAPER 2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2012

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) Ammonia can be produced by the Haber process through the reaction of nitrogen and hydrogen at about 500°C and 200 atm in the presence of a catalyst. The chemical equation for the reaction is shown below :

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

(i) (1) What is the catalyst used in the Haber process ?

(2) Explain the effect of a catalyst on a chemical reaction.

(3 marks)

(ii) Suggest how hydrogen can be obtained for the Haber process, and give a chemical equation involved.

(2 marks)

(iii) You are given that for the formation of $NH_3(g)$ from $N_2(g)$ and $H_2(g)$ at 300°C and 1000 atm, the yield of $NH_3(g)$ at equilibrium is about 98 %. However, the operation conditions of the Haber process in industry are set at about 500°C and 200 atm with the yield of $NH_3(g)$ at equilibrium of about 20 %. With reference to the given information, explain why such operation conditions are chosen in industry.

(2 marks)

(iv) In the Haber process, the product mixture is removed from the reaction chamber before reaching the yield of about 20 %. Explain why this is so.

(2 marks)

(b) Methanol is an important compound in the chemical industry. Methanol can be produced from syngas made from methane.

(i) Why is methanol an important compound in the chemical industry ?

(1 mark)

(ii) Write the chemical equation for the reaction in the production of methanol from syngas, and state the conditions required.

(3 marks)

(iii) State an advancement of the methanol production technology. Explain why it is considered as an advancement.

(2 marks)

1. (c) Three trials of an experiment were performed at the same temperature for the study of the kinetics of the following reaction.

$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

The table below shows the data obtained :

Trial	Initial concentration of NO(g) / mol dm^{-3}	Initial concentration of H_2(g) / mol dm^{-3}	Initial rate with respect to N_2(g) / mol dm^{-3} s^{-1}
1	2.50×10^{-2}	5.00×10^{-3}	1.20×10^{-6}
2	2.50×10^{-2}	1.00×10^{-2}	2.40×10^{-6}
3	1.25×10^{-2}	1.00×10^{-2}	6.00×10^{-7}

(i) Explain why 'initial rate' is commonly used in the study of the kinetics of a reaction.

(1 mark)

(ii) Deduce the order of reaction with respect to NO(g) and that to H_2(g).

(2 marks)

(iii) State the rate equation for the reaction, and calculate its rate constant at the temperature of the experiment.

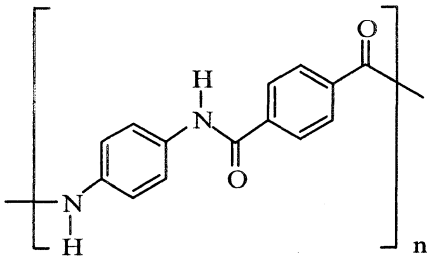
(2 marks)

END OF SECTION A

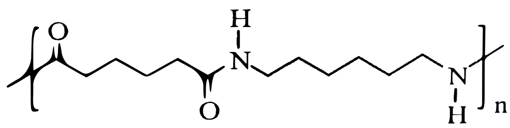
Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) The structures of Kevlar and nylon-6,6 are shown below :



Kevlar



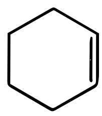
Nylon-6,6

(i) (1) Draw the structures of the monomers for making Kevlar.

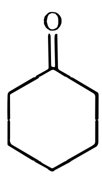
(2) Name the type of reaction for the formation of Kevlar from its monomers.

(3 marks)

(ii) Compound **A** is one of the monomers for making nylon-6,6 in industry. The following equations show two reactions that can produce **A** :



$\xrightarrow{H_2O_2,\ \text{catalyst}}$ **A** + H_2O Reaction (1)



$\xrightarrow{\text{conc. } HNO_3}$ **A** + N_2O Reaction (2)

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

(2) Reaction (1) is considered to be greener than Reaction (2). Suggest THREE reasons.

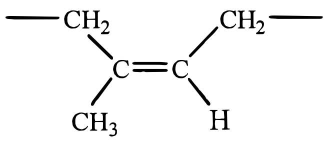
(3) In what aspect are both reactions considered as NOT green ?

(5 marks)

(iii) With reference to the structures of Kevlar and nylon-6,6, account for their difference in mechanical strength.

(2 marks)

2. (b) A part of the structure of natural rubber is shown below :



(i) Natural rubber needs to be treated with sulphur before it can be used in making tyres. Name this treatment process, state its purpose, and explain the principle behind.

(3 marks)

(ii) A technician wore a pair of gloves made with natural rubber and performed an experiment involving bromine. Bromine was spilt onto the gloves and then the gloves became brittle. Explain the phenomenon.

(2 marks)

(c) (i) Consider the body-centred cubic structure of solid iron.

(1) Draw a unit cell of iron.

(2) Deduce the number of iron atoms in the unit cell.

(2 marks)

(ii) With reference to the elements introduced into iron for forming stainless steel, explain why stainless steel is suitable for making knives.

(3 marks)

END OF SECTION B

Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) Compound **X** (molar mass < 118 g) contains a $-C_6H_5$ group. Two chemical tests are performed on **X** and the results are as follows :

Test (1) : **X** turns acidified potassium dichromate solution green.

Test (2) : **X** gives a negative result when tested with 2,4-dinitrophenylhydrazine.

(i) With reference to the result of Test (1) only, suggest TWO functional groups that **X** may have.

(2 marks)

(ii) (1) What is the purpose of using 2,4-dinitrophenylhydrazine in Test (2) ?

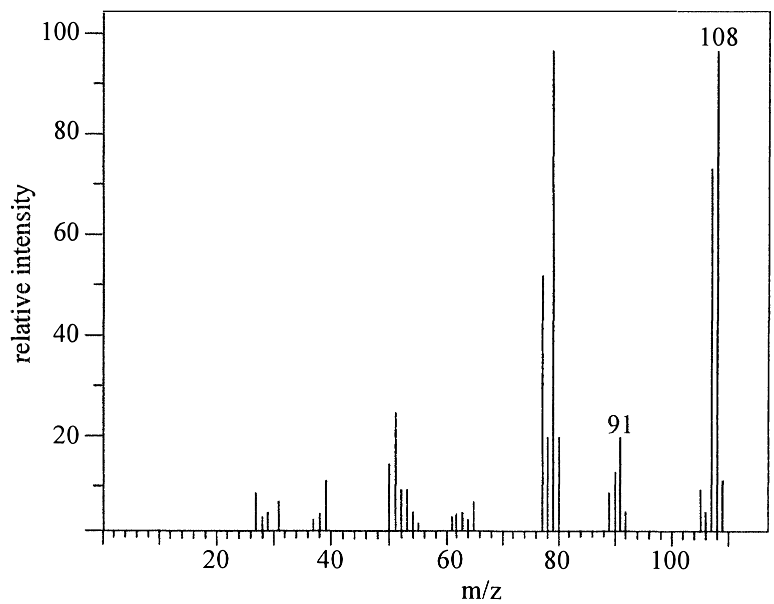
(2) State the expected observation if **X** gives a positive result in Test (2).

(2 marks)

(iii) With reference to the results of both Test (1) and Test (2), suggest one functional group that may be present in **X**.

(1 mark)

(iv) The mass spectrum of **X** is shown below :



Suggest one chemical species corresponding to each of the signals at m/z = 91 and 108.

(2 marks)

(v) Draw a possible structure of **X**.

(1 mark)

3. (b) The dioxin levels in air are generally measured through instrumental analysis but not gravimetric analysis or volumetric analysis.

(i) Suggest a source of dioxins in air.

(1 mark)

(ii) Explain why there is a need to measure the dioxin levels in air.

(1 mark)

(iii) Suggest an instrumental analytical method for measuring the dioxin levels in air, and state why this method, rather than methods based on gravimetric analysis or volumetric analysis, is to be used.

(2 marks)

(c) An aqueous solution only contains HCl(aq) and HI(aq). Based on the fact that AgCl(s), but not AgI(s), can dissolve in excess NH_3(aq), you are required to plan a gravimetric analysis to determine the mole ratio of Cl^-(aq) to I^-(aq) in the solution.

(i) Suggest TWO reagents, other than deionised water, that should be used in the analysis.

(2 marks)

(ii) Outline the experimental steps involved in the analysis.

(4 marks)

(iii) Outline the steps in the calculation of the mole ratio of Cl^-(aq) to I^-(aq) in the solution using the data obtained from (ii) above.

(2 marks)

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)