2013-DSE
CHEM
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2013

Candidate Number

CHEMISTRY PAPER 1

SECTION B : Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) This section consists of TWO parts, Parts I and II.

(4) Answer ALL questions in both Parts I and II. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) An asterisk (*) has been put next to the questions where one mark will be awarded for effective communication.

(6) Supplementary answer sheets will be provided on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string INSIDE this Question-Answer Book.

(7) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

* A 1 4 0 E 0 1 B *

PART I

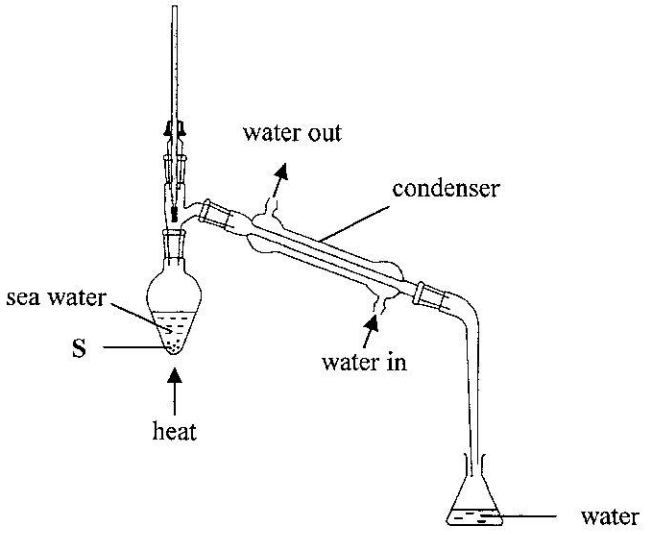
Answer **ALL** questions. Write your answers in the spaces provided.

1. Water is the most abundant compound on the Earth's surface. It is very important to life on Earth.

(a) Draw the electron diagram for a water molecule, showing *electrons in the outermost shells* only.

(1 mark)

(b) Nearly 98% of the water on Earth is sea water, which is not fit for human consumption. The diagram below shows the set-up used in a simple distillation experiment for obtaining water from sea water.



(i) Outline the underlying principle of this simple distillation experiment.

(ii) Insoluble solid **S** was placed into the flask before heating. Why ?

(3 marks)

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1. (c) Explain, from molecular level, why the density of ice is lower than that of water.

(3 marks)

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2. Both BF_3 and NH_3 exist as simple molecules.

(a) For each of these molecules, draw its three-dimensional structure.

BF_3

NH_3

(2 marks)

(b) For each of these molecules, explain whether or not it is polar.

(2 marks)

(c) BF_3 reacts with NH_3 to give F_3BNH_3. Describe the bond formation between BF_3 and NH_3.

(2 marks)

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3. Compound **W** contains carbon, hydrogen and oxygen only. The relative molecular mass of **W** is 88.0. Complete combustion of 1.32 g of **W** gives 2.64 g of carbon dioxide and 1.08 g of water.

(a) Deduce the molecular formula of **W**.
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(3 marks)

(b) Given that **W** has only one functional group, draw TWO possible structures of **W**.

(2 marks)

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4. The structure of a dibasic acid with chemical formula $H_2C_2O_4$ is shown below:

(a) Give the systematic name of this dibasic acid.

(1 mark)

(b) A student expected a 0.0500 mol dm^{-3} standard $H_2C_2O_4(aq)$ to have a pH of 1.0. However, the pH of the solution, when measured with a calibrated pH meter, was found to be greater than 1. Explain this observation with the aid of a chemical equation.

(2 marks)

(c) Solid sodium hydroxide is available in school laboratories. However, standard NaOH(aq) CANNOT be directly prepared by weighing NaOH(s) and then dissolving it in water. Explain why.

(1 mark)

(d) In a titration experiment, 25.00 cm^3 of a 0.0500 mol dm^{-3} standard $H_2C_2O_4(aq)$ and a few drops of phenolphthalein indicator were placed in a conical flask. NaOH(aq) of unknown concentration was then added from a burette into the flask. 17.20 cm^3 of the NaOH(aq) was required to reach the titration end point.

(i) State the colour change at the titration end point.

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4. (d) (ii) From the titration results, calculate the concentration of the NaOH(aq), in mol dm^{-3}.

(3 marks)

(e) The following were considered as INAPPROPRIATE practices when carrying out the experiment in (d). For each of them, explain why it would lead to inaccurate titration results:

(i) rinsing the conical flask with the standard $H_2C_2O_4(aq)$ before transferring 25.00 cm^3 of the acid solution to it

(ii) carrying out the titration with the filter funnel remained on top of the burette after using it to fill the burette with the NaOH(aq)

(2 marks)

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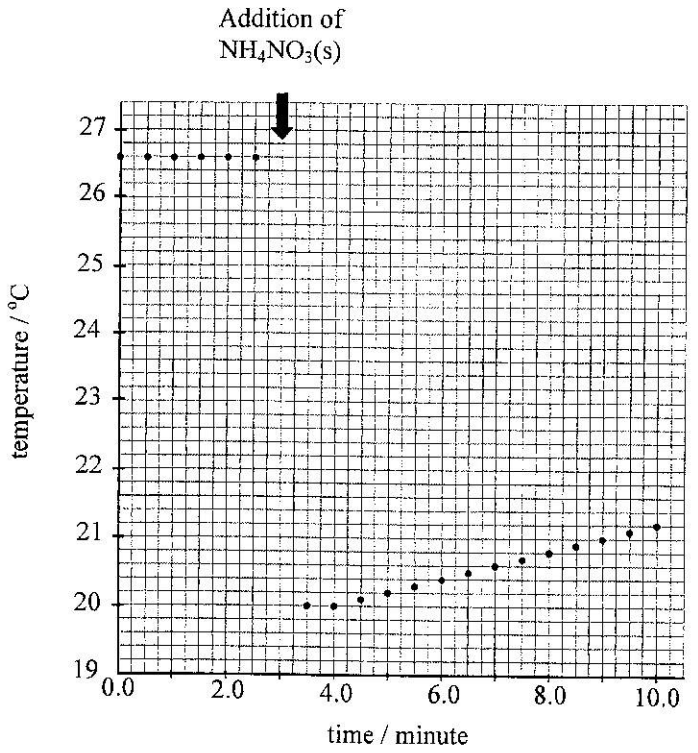
5. The following experiment was carried out to determine the enthalpy change of solution of ammonium nitrate:

$$NH_4NO_3(s) \xrightarrow{H_2O(l)} NH_4NO_3(aq)$$

A certain volume of water was placed in an expanded polystyrene cup. The temperature of the water in the cup was measured with a thermometer at half-minute intervals. Right at the third minute, 2.0 g of $NH_4NO_3(s)$ was added to the cup. The solution in the cup was then stirred thoroughly and its temperature was measured for an additional 7 minutes.

The recordings of temperature are shown in the graph below:



(a) (i) From the graph, estimate the greatest temperature drop of the solution in the cup.

(ii) The mass of the $NH_4NO_3(aq)$ obtained was found to be 21.8 g. Calculate the enthalpy change of solution of ammonium nitrate, in kJ mol^{-1}, under the experimental conditions. (Assume that the heat capacity of the expanded polystyrene cup is negligible, and the specific heat capacity of the $NH_4NO_3(aq)$ obtained is 4.3 J g^{-1} K^{-1}.)

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5.

(4 marks)

(b) Suggest ONE way of keeping $NH_4NO_3(s)$ dry during storage.

(1 mark)

*6. Briefly describe how polypropene can be produced from naphtha.

(4 marks)

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7. Thermite reactions broadly refer to exothermic oxidation-reduction reactions between a metal powder and a metal oxide. One example is the reaction of finely divided iron(III) oxide with aluminium powder. This reaction results in a very high temperature, and is commonly used in the welding of rail tracks for trains. At this very high temperature, the molten iron formed joins the rail tracks together.

(a) (i) Complete and balance the chemical equation for the following thermite reaction.

____ $Fe_2O_3(s)$ + ____ Al(s) ⟶ +

(ii) Sketch a labelled enthalpy level diagram for this reaction.

(2 marks)

(b) Copper powder CANNOT be used to replace aluminium powder in carrying out the thermite reaction with iron(III) oxide. Explain why.

(1 mark)

(c) The extraction of iron from its ores also involves the reduction of iron oxides.

(i) Suggest why aluminium is NOT used as the reducing agent in iron extraction.

(ii) Suggest ONE reducing agent commonly used in iron extraction.

(2 marks)

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8. Both caesium (Cs) and sodium (Na) are elements in Group I of the Periodic Table. Caesium reacts with chlorine to form caesium chloride.

(a) Write the chemical equation for the reaction of caesium with chlorine.

(1 mark)

(b) Solid caesium chloride has a giant ionic structure.

(i) Draw a diagram to show the structure of caesium chloride.

(ii) Explain why solid caesium chloride is brittle.

(3 marks)

(c) Predict, with ONE reason, whether sodium or caesium is more reactive towards chlorine.

(1 mark)

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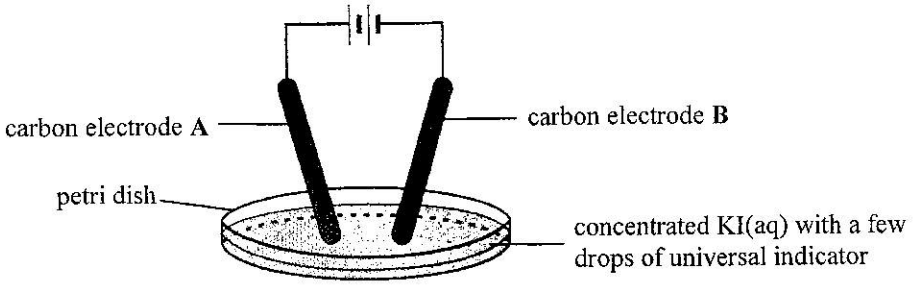
9. The diagram below shows the set-up used in an investigation on the electrolysis of concentrated potassium iodide solution:



(a) State and explain the expected observation around carbon electrode **A** during the electrolysis.

(2 marks)

(b) The solution near carbon electrode **B** gradually turned blue.

(i) Explain this observation.

(ii) Would there be any change in observation if carbon electrode **B** is replaced by a copper electrode in the investigation ? Explain.

(3 marks)

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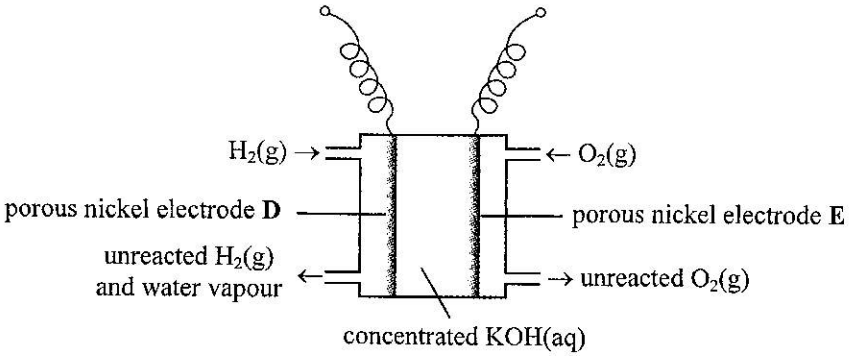
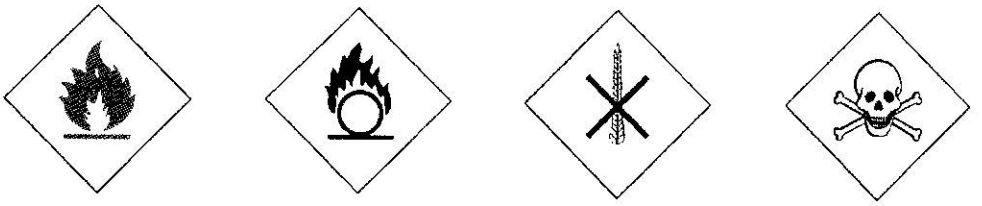
10. The diagram below shows the structure of a hydrogen-oxygen fuel cell using concentrated potassium hydroxide solution as the electrolyte.



(a) An oxygen cylinder can be used to provide oxygen for the above fuel cell. From the hazard warning labels shown below, circle the label that should be displayed on the oxygen cylinder.



(1 mark)

(b) Write the half equation for the change occurring at each of the following electrodes when this fuel cell is producing a current.

electrode **D**

electrode **E**

(2 marks)

(c) Some people have the view that cars powered by hydrogen-oxygen fuel cells are more environmentally friendly than those powered by petrol.

Comment on this view from each of the following aspects:

(i) source of fuel

(ii) the car emissions

(2 marks)

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PART II

Answer **ALL** questions. Write your answers in the spaces provided.

11. Safety airbags are important devices installed in vehicles. During a serious car crash, the chemicals in the airbag immediately react to release a large amount of gas. An airbag hence inflates instantly, protecting the passenger. The main chemicals in safety airbags are sodium azide (NaN_3) and potassium nitrate (KNO_3). The equations below show the reactions involved when an airbag is inflated:

$2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$

$10Na(s) + 2KNO_3(s) \rightarrow K_2O(s) + 5Na_2O(s) + N_2(g)$

(a) Explain why the $NaN_3(s)$ and $KNO_3(s)$ used in the airbags are in the form of fine powder.

(1 mark)

(b) An airbag contains 100.0 g of $NaN_3(s)$ and 200.0 g of $KNO_3(s)$. Calculate the theoretical volume, measured at room temperature and pressure, of the gas produced when the bag is inflated.
(Formula masses: $NaN_3 = 65.0$, $KNO_3 = 101.1$;
molar volume of gas at room temperature and pressure = 24 dm^3)

(3 marks)

(c) The main function of $NaN_3(s)$ is to produce $N_2(g)$ for inflating the airbags. Suggest why it is necessary to include $KNO_3(s)$ in the airbags.

(1 mark)

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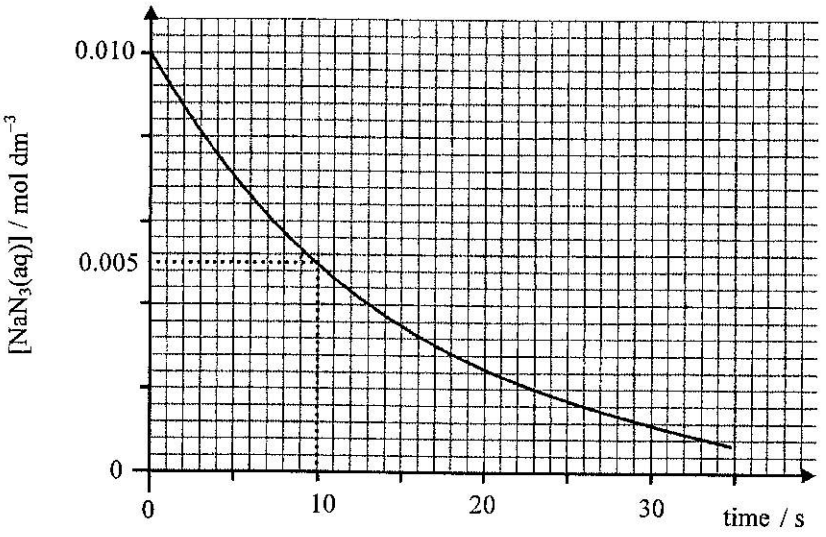
11. (d) Sodium azide is a toxic chemical. Thus any NaN_3 waste remained during the manufacture of safety airbags needs special treatment before disposal. The treatment involves first dissolving NaN_3 in water, and then reacting the solution formed with excess nitrous acid, $HNO_2(aq)$. The graph below shows the variation of the concentration of $NaN_3(aq)$ in the reaction mixture with time in one such process:



(i) Calculate the average rate of consumption of $NaN_3(aq)$ in the first 10 seconds.

(ii) Suggest how the instantaneous rate of consumption of $NaN_3(aq)$ at the 10th second can be determined from the graph.

(2 marks)

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12. At 250°C, the equilibrium constant K_c for the following reaction is 25 $mol^{-1}dm^3$.

$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$

A 10.0 dm^3 sealed container, which is maintained at 250°C, initially contains 0.50 mol of $PCl_3(g)$, 0.20 mol of $Cl_2(g)$ and 0.40 mol of $PCl_5(g)$.

(a) For this system under the initial conditions, calculate its reaction quotient. Predict and explain, under the initial conditions, whether the forward reaction rate or the backward reaction rate would be greater.

(2 marks)

(b) Calculate the concentration of $Cl_2(g)$ when the system attains equilibrium at 250°C.

(2 marks)

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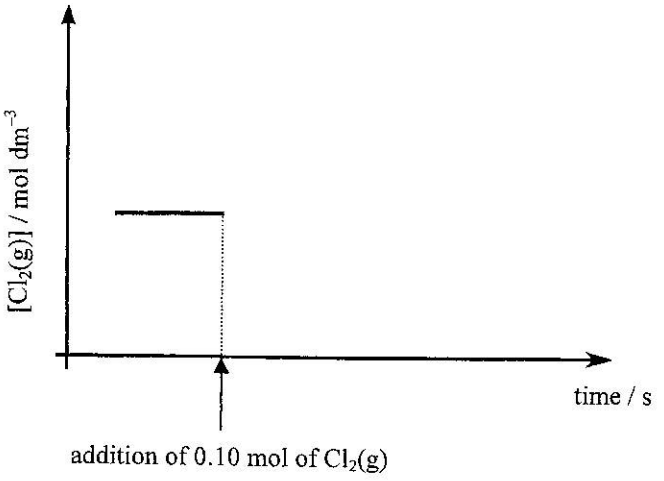
12. (c) 0.10 mol of $Cl_2(g)$ is added to the equilibrium mixture in (b). Sketch, in the graph below, the variation of the concentration of $Cl_2(g)$ with time until a new equilibrium is attained. (Assume that the temperature of the system remains at 250°C throughout the whole process.)



(1 mark)

*13. Lithium, beryllium, carbon (graphite) and nitrogen are elements of the second period of the Periodic Table. Arrange them in increasing order of melting point, and explain the order in terms of structure and bonding.

(5 marks)

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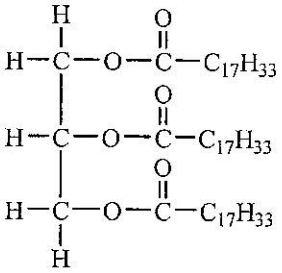
14. An unsaturated fat **F** is a component of a vegetable oil. The structure of **F** is shown below:



(a) State the reagents needed for converting **F** to a saturated fat.

(1 mark)

(b) Vegetable oils can be used to make soap.

(i) Write the chemical equation involved for the formation of soap from **F**.

(ii) In the presence of an acid, the soap formed in (i) can react with methanol to give compound **G**, which can be used as a biodiesel. Draw the structure of **G**.

(2 marks)

(c) With reference to their relative molecular masses and physical properties, explain why **G** can be used as a fuel for cars, but **F** cannot.

(2 marks)

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15. Consider the conversions of organic compounds shown below:

$$\underset{\mathbf{X}}{CH_3CH_2COCH_2CH_3} \xrightarrow{\mathbf{R}} \underset{\mathbf{Y}}{CH_3CH_2CH(OH)CH_2CH_3} \xrightarrow{\text{dehydrating agent}} \underset{\mathbf{Z}}{\text{a mixture of alkenes}}$$

(a) Suggest a chemical test to distinguish between **X** and **Y**.

(2 marks)

(b) Suggest what reagent **R** might be.

(1 mark)

(c) The mixture **Z** contains two alkenes with the same structural formula. Draw the respective structures of these two alkenes, and state their isomeric relationship.

(2 marks)

(d) The alkenes in (c) can react with HCl to form an optically active chloroalkane. Write the structural formula of this chloroalkane.

(1 mark)

END OF SECTION B

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