2016-DSE
CHEM
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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. Refer to the following information of phosphorus (P) and chlorine (Cl).

	P	Cl
Atomic number	15	17
Relative atomic mass	31.0	35.5

(a) State the electronic arrangement of a phosphorus atom.

(1 mark)

(b) All chlorine atoms have the same atomic number. Explain why some chlorine atoms have different mass numbers.

(1 mark)

(c) A compound of phosphorus and chlorine has a relative molecular mass smaller than 250. It contains 22.6% of phosphorus by mass.

(i) Deduce the molecular formula of the compound.

(ii) Draw the electron diagram for the compound, *showing electrons in the outermost shells only.*

(3 marks)

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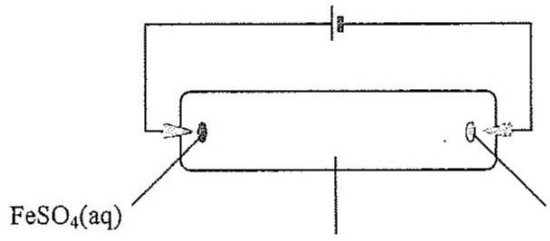
2. The set-up of an experiment for studying the movement of ions is shown below.



(a) Explain why the filter paper is soaked with $K_2SO_4(aq)$ instead of water.

(1 mark)

(b) State the colour of $FeSO_4(aq)$.

(1 mark)

(c) Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

(d) The experiment is repeated, but the two poles of the cell have been reversed at the very beginning. Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

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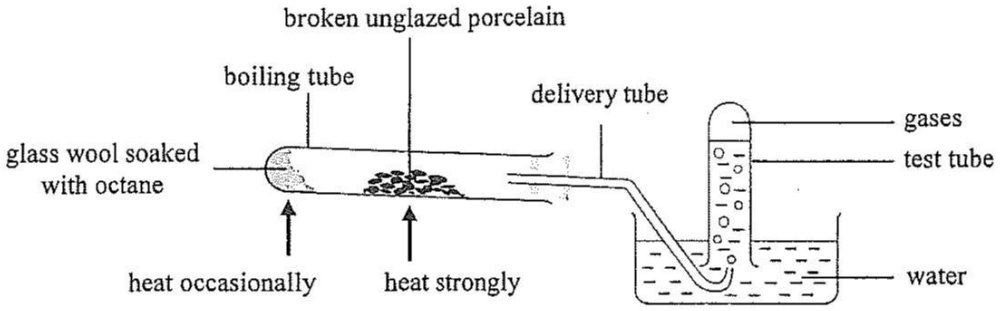
3. The diagram below shows an experimental set-up in which the glass wool soaked with octane is heated occasionally and the broken unglazed porcelain is heated strongly. Some gases are collected in the test tube over water.



(a) Name the type of reaction that occurs in the boiling tube. Suggest one importance of this type of reaction in industry.

(2 marks)

(b) Explain why, instead of a large piece of unglazed porcelain, broken unglazed porcelain is used in this experiment.

(1 mark)

(c) Suppose that during the experiment, octane changes to ethane gas and propene gas only and they can be collected in the test tube.

(i) Write the balanced equation for the reaction of changing octane to ethane and propene.

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3. (c) (ii) The gases collected in the test tube are shaken thoroughly with a few drops of Br_2(in CH_3CCl_3) solution.

(1) State the expected observation.

(2) Draw the structure of the product formed from the reaction between propene and Br_2.

(3 marks)

(d) When no more gas can be collected, what should be done to end the experiment for safety consideration ? Explain your answer.

(2 marks)

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4. Consider the molecules CO_2, CS_2 and CH_2Br_2.

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

(i) CS_2

(ii) CH_2Br_2

(2 marks)

(b) Identify, with explanation, the polar bond(s) in CH_2Br_2.

(2 marks)

(c) Suggest why, under room temperature and pressure, CO_2 is a gas but CS_2 is a liquid.

(2 marks)

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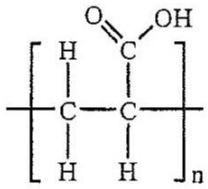
5. Polymer **B** shown below can be used as water absorbing material in diapers. It can be formed from the polymerisation of compound **A**.



polymer **B**

(a) Draw the structure of compound **A** and state its systematic name.

(2 marks)

(b) State the type of polymerisation for the formation of **B** from **A**.

(1 mark)

(c) Suggest why the relative molecular mass of **B** is expressed using a range of values instead of a single fixed value.

(1 mark)

(d) It is known that the reaction of polymer **B** with NaOH(aq) forms polymer **C** which can absorb water better. Draw the structure of **C**.

(1 mark)

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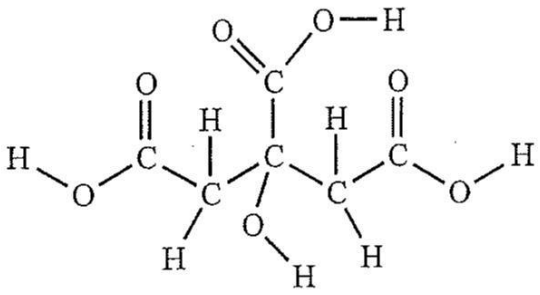
6. Citric acid is a tribasic acid found in lemon. It is a white solid and soluble in water.

(a) In the structure of citric acid shown below, circle ALL ionisable hydrogen atom(s) making it a tribasic acid.



(1 mark)

(b) A solid sample contained citric acid and other soluble inert substances. 1.65 g of the sample was dissolved in deionised water and diluted to 250.0 cm^3 in apparatus **X**. After that, 25.00 cm^3 of the diluted solution was withdrawn and titrated with 0.123 M NaOH(aq) using phenolphthalein as an indicator. 18.45 cm^3 of the NaOH(aq) was required to reach the end point.
(Molar mass of citric acid = 192.0 g)

(i) What is apparatus **X** ?

(ii) Calculate the percentage by mass of citric acid in the solid sample.

(4 marks)

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6. (c) A few drops of lemon juice are added to sodium hydrogencarbonate powder.

(i) State the expected observation.

(ii) Write the ionic equation for the reaction involved.

(2 marks)

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7. The enthalpy change of formation of $MgCO_3(s)$ can be obtained using an indirect method. Firstly, the enthalpy change for the reaction of $MgCO_3(s)$ with $H_2SO_4(aq)$, and that of $Mg(s)$ with $H_2SO_4(aq)$ are respectively determined experimentally. After that, the enthalpy change of formation of $MgCO_3(s)$ can be obtained through calculation with given enthalpy changes of formation of $CO_2(g)$ and $H_2O(l)$.

(a) According to definition, under which condition could the 'heat change' of a reaction be regarded as the 'enthalpy change' ?

(1 mark)

(b) Explain why, instead of a direct method, an indirect method is used to obtain the enthalpy change of formation of $MgCO_3(s)$.

(1 mark)

(c) In order to determine experimentally the enthalpy change for the reaction of $MgCO_3(s)$ with $H_2SO_4(aq)$, an accurate mass of $MgCO_3(s)$ was firstly allowed to react with excess $H_2SO_4(aq)$ in a polystyrene foam cup. The maximum rise in temperature of the mixture was then found. After calculation, the enthalpy change for the reaction can be obtained.

(i) Suggest one possible error for the above experimental procedure.

(ii) Explain whether the enthalpy change for the reaction of $CaCO_3(s)$ with $H_2SO_4(aq)$ can be obtained using a similar experimental procedure.

(2 marks)

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7. (d) Using the information given below, calculate the standard enthalpy change of formation of $MgCO_3(s)$.

Standard enthalpy change for the reaction of $MgCO_3(s)$ with $H_2SO_4(aq)$	$= -50$ kJ mol^{-1}
Standard enthalpy change for the reaction of $Mg(s)$ with $H_2SO_4(aq)$	$= -467$ kJ mol^{-1}
Standard enthalpy change of formation of $CO_2(g)$	$= -394$ kJ mol^{-1}
Standard enthalpy change of formation of $H_2O(l)$	$= -286$ kJ mol^{-1}

(3 marks)

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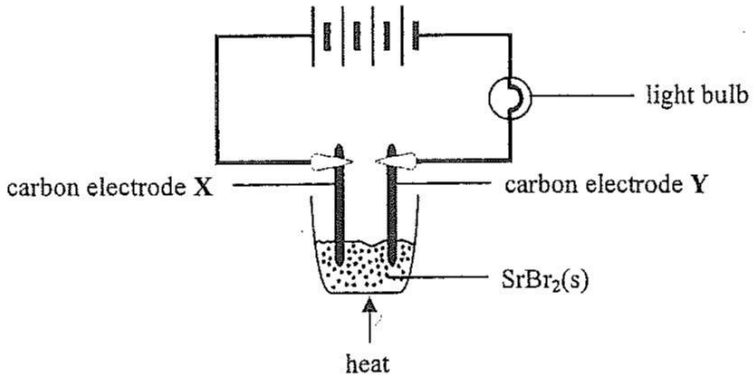
8. Consider the experimental set-up shown below :



(a) In the above experiment, the bulb lights up when the $SrBr_2(s)$ becomes molten. (Atomic number of Sr = 38)

(i) State the observation at carbon electrode **X**.

(ii) Write a half equation for the change that occurs at carbon electrode **Y**.

(2 marks)

(b) Explain why the experiment should be performed in a fume cupboard.

(1 mark)

(c) Zinc-carbon cells are used in the above experiment. The equation below shows the reaction that occurs in the zinc-carbon cells when the bulb lights up.

$$2MnO_2(s) + 2NH_4Cl(aq) + Zn(s) \rightarrow Mn_2O_3(s) + 2NH_3(aq) + H_2O(l) + ZnCl_2(aq)$$

(i) Deduce, in terms of change in oxidation number, the oxidising agent in a zinc-carbon cell.

(ii) Write a half equation for the change that occurs at the cathode in a zinc-carbon cell.

(3 marks)

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*9. Three unlabelled reagent bottles each contains one of the white solids listed below :

$ZnSO_4$ $MgSO_4$ $MgSO_4 \cdot 7H_2O$

Outline how you would carry out tests to distinguish these three solids.

(6 marks)

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PART II

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

10. In an experiment, 2.0 mol of $SO_2(g)$ and 2.0 mol of $O_2(g)$ are allowed to react in a closed container maintained at 950 K. The chemical equation for the reaction is shown below :

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -198 \text{ kJ mol}^{-1}$$

When the reaction attains dynamic equilibrium, 1.8 mol of $SO_3(g)$ is obtained.

(a) What is meant by the term 'dynamic equilibrium' ?

(1 mark)

(b) At 950 K, the equilibrium constant K_c for the above reaction is 878 $dm^3\ mol^{-1}$. Calculate the volume of the container.

(3 marks)

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10. (c) If the above equilibrium mixture is subjected to each of the following changes, will the number of moles of $SO_3(g)$ obtained increase, decrease or remain unchanged ? Explain your answer in each case.

(i) increasing the temperature

(ii) adding a suitable catalyst

(2 marks)

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11. Under certain conditions, a pink compound **X** reacts with NaOH(aq) to give a colourless product. Three trials of an experiment were conducted to study the kinetics of the reaction. Firstly, three NaOH(aq) solutions were prepared by mixing different volumes of 2.0 M NaOH(aq) and $H_2O(l)$ at 25°C. After that, one drop of **X** was added to each of them and the time needed for the pink colour to disappear was recorded. The relevant data is shown below :

	Volume of 2.0 M NaOH(aq) used / cm^3	Volume of $H_2O(l)$ used / cm^3	Time needed for the pink colour to disappear / s
Trial 1	5.0	0	61
Trial 2	4.0	1.0	76
Trial 3	3.0	2.0	101

(a) Why is it necessary to make the total volume of the reaction mixtures the same for the trials ?

(1 mark)

(b) Given that at 25°C, $[H^+(aq)]\,[OH^-(aq)] = 1.0 \times 10^{-14}\ mol^2\ dm^{-6}$, calculate the pH of the NaOH(aq) solution prepared in Trial 2.

(3 marks)

(c) Based on the information provided, deduce one factor which affects the rate of this reaction.

(2 marks)

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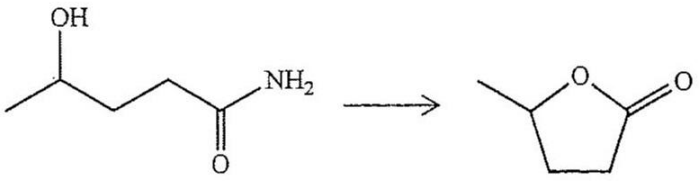
11. (d) Detection of colour change using naked eye is not accurate enough. Suggest an instrumental method that can be used to more accurately detect the colour change.

(1 mark)

12. Outline a synthetic route, with *no more than three steps*, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



(3 marks)

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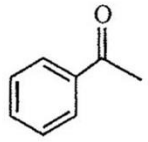
13. The structure of acetophenone is shown below :



Heating a mixture of acetophenone and $NaBH_4$ in methanol solvent under reflux can give two isomeric compounds **P** and **Q**. **P** and **Q** have the same melting point and same solubility in methanol.

(a) Draw a labelled diagram of the set-up for heating the mixture under reflux.

(2 marks)

(b) Suggest another reagent that can also react with acetophenone in a suitable solvent to give **P** and **Q**.

(1 mark)

(c) What kind of isomers are **P** and **Q** ?

(1 mark)

(d) State one different physical property between **P** and **Q**.

(1 mark)

(e) Suggest a chemical test to show how acetophenone and **P** can be distinguished.

(2 marks)

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*14. Arrange sodium, aluminium, silicon and sulphur in decreasing order of electrical conductivity at room conditions, and explain your answer in terms of bonding and structure.

(5 marks)

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PERIODIC TABLE　周期表

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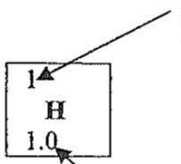

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar**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