

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2015

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.

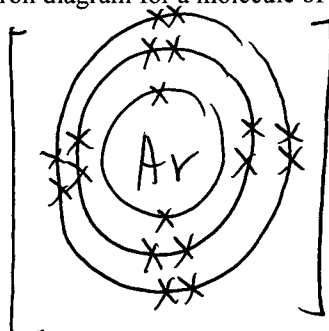


PART I

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

1. Argon and chlorine are elements in the same period of the Periodic Table.

(a) Draw the electron diagram for a molecule of argon, showing *electrons in all shells*.



(1 mark)

(b) What is the type of intermolecular force in chlorine gas ?

Van der Waals' force

(1 mark)

(c) Complete the table below by stating the natural source and the method of extraction from the source for each element.

Element	Natural source	Method of extraction
Argon	Atmospheric air	Fractional distillation of liquefied air
Chlorine	Sea water	Chloroalkali industry (membrane cell)

(4 marks)

Answers written in the margins will not be marked.

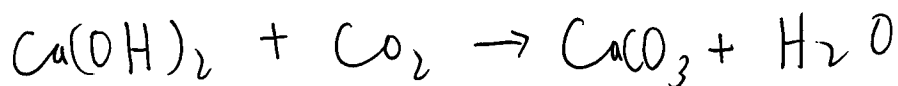
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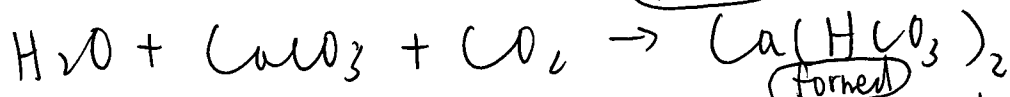
2. For each of the following experiments, state the expected observation, and write the chemical equation(s) for the reaction(s) involved.

- (a) passing carbon dioxide gas into limewater until in excess

The limewater turns milky
then colorless



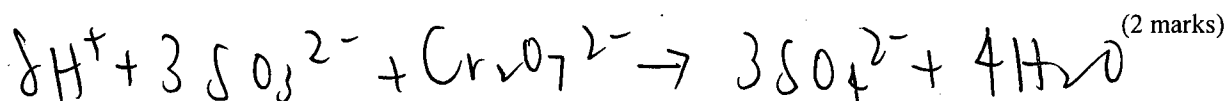
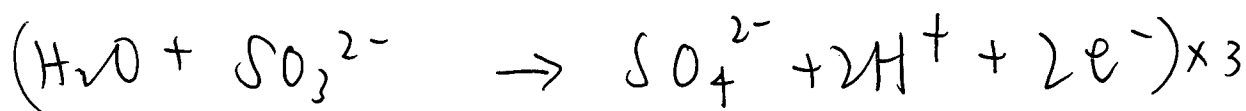
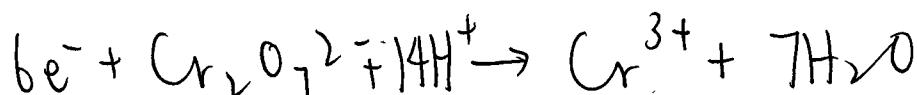
Calcium carbonate is insoluble
(formed) (milky)



Calcium hydrogencarbonate is soluble
(formed) (colorless) (3 marks)

- (b) adding sodium sulphite solution to acidified potassium dichromate solution until in excess

The orange solution turns green



Orange dichromate ions are reduced by
sulphite ions to form green
chromium (III) ions

Answers written in the margins will not be marked.

3. Aluminium and iron are commonly used construction materials.

(a) Suggest why iron was used earlier than aluminium in history.

Iron is less reactive than Aluminium.
It requires less advanced technology to
extract from ore than aluminium
(Iron: Blast furnace
Aluminium: Electrolysis)

(1 mark)

(b) A compound contains iron and oxygen only. In an experiment for determining the empirical formula of this compound, 2.31 g of the compound was heated with carbon monoxide. Upon complete reaction, carbon dioxide and 1.67 g of iron were formed.

(i) Calculate the empirical formula of this compound.

No of mol of Iron: $\frac{1.67}{55.8} = 0.0299283$
Let the empirical formula be Fe_xO_y
 $x = 0.029928315$

$$55.8(0.029928315) + 16y = 2.31$$

$$y = 0.04$$

$$\therefore x : y = 3 : 4$$

Empirical formula is Fe_3O_4

(ii) Write the chemical equation for the reaction involved in the experiment.



(iii) As carbon monoxide is poisonous, suggest one necessary safety precaution in carrying out the experiment.

Carry out the experiment in fume
cupboard.

(4 marks)

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3. (c) Explain why a galvanised iron object does not easily rust even if the zinc layer is broken.

Zinc loses electrons more readily than iron.

Zinc carries out sacrificial protection to prevent iron from rusting.

(2 marks)

- (d) Explain why anodisation can prevent aluminium objects from corrosion.

Anodisation increases the thickness of oxide layer on the surface of anodized aluminium.

The aluminium oxide layer is impermeable to oxygen and

(2 marks)

water vapour in air, thus prevent aluminium in contact with oxygen and water vapour and prevent it from corrosion.

Corrosion of metals require water and oxygen.

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4. Lead-acid accumulator is a secondary cell containing sulphuric acid. It is commonly used in starting up motor vehicle engines.

(a) What is meant by the term 'secondary cell'?

The cell is rechargeable

(1 mark)

(b) Suggest why a lead-acid accumulator is suitable for starting up motor vehicle engines.

It has a high voltage.

(1 mark)

(c) State one environmental impact that would be imposed from the disposal of lead-acid accumulators.

Toxic lead would pollute rivers
and kill aquatic animals.

(1 mark)

(d) A student diluted a sample of concentrated sulphuric acid for making a lead-acid accumulator.

(i) Describe how concentrated sulphuric acid can be diluted in a laboratory. State a safety precaution needed during the dilution process.

Add concentrated sulphuric acid
to a large amount of water.

Wear protective gloves during
dilution process

(ii) 5.00 cm^3 of the solution in the lead-acid accumulator made contains 2.48 g of sulphuric acid. Calculate the molarity of the sulphuric acid in the solution.
(Molar mass of sulphuric acid = 98.1 g)

$$\text{No. of mol of } \text{H}_2\text{SO}_4 = \frac{2.48}{98.1}$$

$$= 0.025280326$$

$$\text{Molarity} = \frac{0.025280326}{0.005}$$

$$= 5.06 \text{ M}$$

(5 marks)

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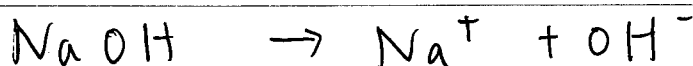
*5.

Explain, with the aid of a chemical equation, why $\text{NH}_3(\text{aq})$ is regarded as a weak alkali. Suggest how you would show that $\text{NH}_3(\text{aq})$ is a weaker alkali than $\text{NaOH}(\text{aq})$ through an experiment.

(6 marks)

The strength of an alkali refers to the degree of ionization of OH^- per alkaline molecule. (hydroxide ions)

For NaOH , it is a strong alkali, as it ionizes completely to form OH^- as the only negatively charged ion



For NH_3 , it requires water molecules to form OH^- in the equation, thus the process is reversible. NH_3 molecules is not

$$\text{H}_2\text{O} + \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$$

To compare the strength of completely ionized $\text{NaOH}(\text{aq})$ and $\text{NH}_3(\text{aq})$ (NH3 is less ionized than NaOH. Weaker than NaOH (aq))

1. Firstly, obtain 50cm^3 $\text{NH}_3(\text{aq})$ and $\text{NaOH}(\text{aq})$ of same molarity (i.e. 2M), place 2 solutions in 2 beakers.
2. Connect each of the beaker of solution with electrical wires to a light bulb.

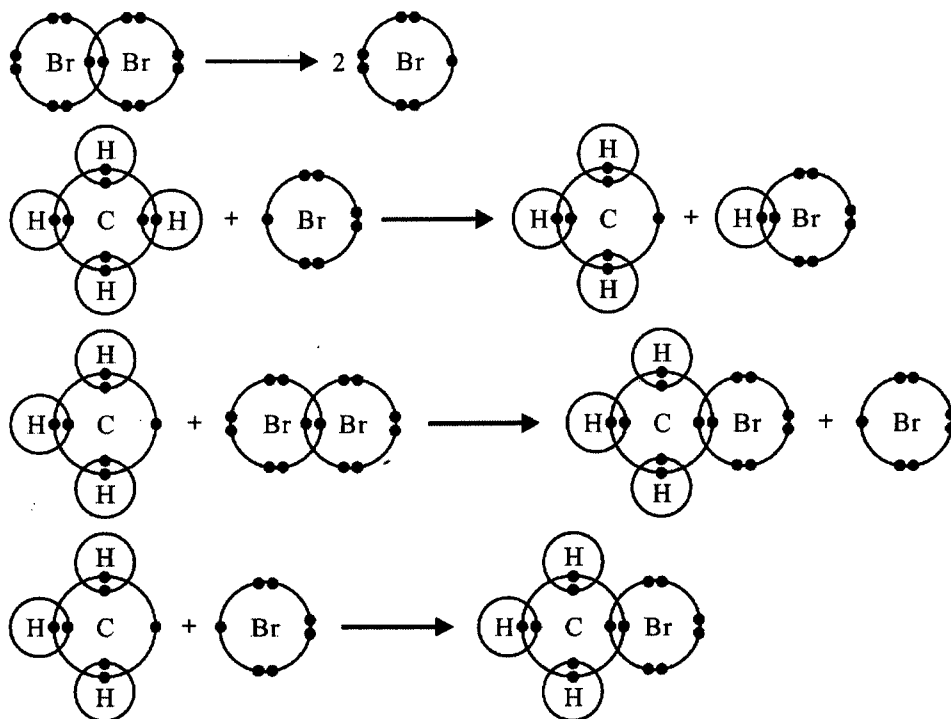
The brightness of the bulb passing the $\text{NaOH}(\text{aq})$ is brighter than that of $\text{NH}_3(\text{aq})$, showing that the electrical conductivity of $\text{NaOH}(\text{aq})$ better than NH_3 . More number of mobile ions in NaOH than NH_3 .

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6. The steps involved in the reaction of methane with bromine forming CH_3Br can be shown by the following diagram. Only electrons in the outermost shells are shown.



- (a) Name the type of the reaction for the formation of CH_3Br from methane and bromine.

Substitution

(1 mark)

- (b) State the condition needed for the reaction to occur.

UV light
(ultra-violet light)

(1 mark)

- (c) State the expected observation for the reaction.

The bromine turns from
brown to colourless.

(1 mark)

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6. (d) With reference to its electronic structure, explain why the species  has a high reactivity.

It has a charge of +1

It does not attain a stable octet rule

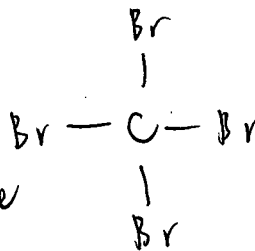
Thus has high tendency to gain electrons

(1 mark)

Thus has high reactivity

- (e) The reaction of methane with bromine can also form other single-carbon-containing organic compounds.

- (i) Suggest one such compound.



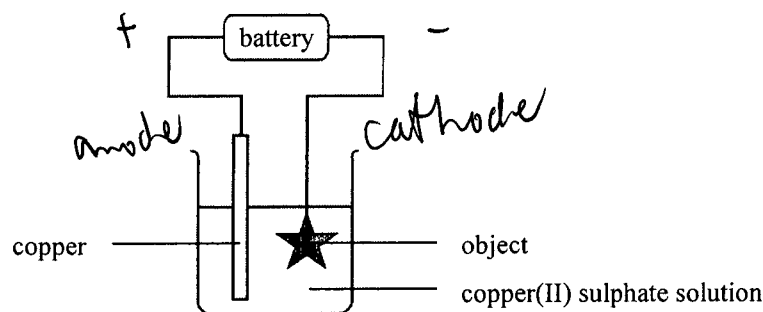
Tetrabromomethane

- (ii) Suggest a condition so that the reaction of methane with bromine can form more CH_3Br but less other organic compounds.

Add excess methane

(2 marks)

7. Refer to the set-up for electroplating an object shown in the diagram below.



- (a) Explain why oily dirt on the object should be removed before electroplating.

To attain even plating of metal on the object.

(1 mark)

- (b) Copper(II) sulphate is an electrolyte. What is meant by the term 'electrolyte'?

A substance that can conduct electricity in molten or aqueous state

(1 mark)

- (c) List ALL the ions existing in the solution.

Cu^{2+} SO_4^{2-} H^+ OH^-
copper(II) ions sulphate ions hydrogen ions hydroxide ions

(1 mark)

- (d) Explain why copper(II) ions are preferentially discharged during the electroplating process.

Copper occupies a lower position than hydrogen in the electrochemical series.

(1 mark)

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7. (e) Write the half equation of the change that occurs at the anode.



(1 mark)

- (f) State the observable change, if any, in the solution during the electroplating process.

The copper electrode dissolves

(1 mark)

- (g) It is known that 2.28×10^{22} electrons have passed through the external circuit during the electroplating process. Calculate the mass of copper that would theoretically be plated on the object.

(Relative atomic mass: Cu = 63.5; Avogadro's constant = $6.02 \times 10^{23} \text{ mol}^{-1}$)

$$\begin{aligned} \text{No. of electrons lost per mol of Cu} &= 6.02 \times 10^{23} \times 2 \\ &= 12.04 \times 10^{23} \end{aligned}$$

$$\text{No. of mol of copper plated} = \frac{2.28 \times 10^{22}}{12.04 \times 10^{23}}$$

$$= 0.018936877$$

$$\begin{aligned} \text{Mass of copper plated} &= 0.018936877 \times 63.5 \\ &= 1.20 \text{ g} \end{aligned}$$

(2 marks)

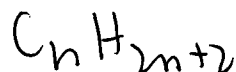
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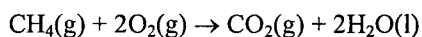
8. Natural gas is an important energy source for electricity generation. It contains mainly methane (CH_4).

- (a) Write the general formula of the molecules in the homologous series that methane belongs to.



(1 mark)

- (b) The combustion of methane is an exothermic reaction. Its chemical equation is shown below :



- (i) Complete the table below by stating all the covalent bond(s) that are broken and formed during the combustion of methane.

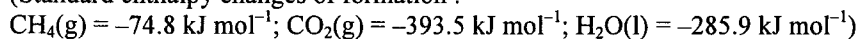
Covalent bond(s) broken	1. bonds between O atoms of O_2 2. bonds between C and H atoms of CH_4
Covalent bond(s) formed	1. bonds of C and O atoms of CO_2 2. bonds of H and O atoms of H_2O

- (ii) Suggest why the combustion is exothermic in terms of the breaking and forming of covalent bonds.

The energy required for breaking covalent bonds is higher than that of forming covalent bonds.

- (iii) Calculate the standard enthalpy change of combustion of methane.

(Standard enthalpy changes of formation :



$$\Delta H_c^\circ = -(-74.8) - (-393.5) - 2(-285.9)$$

$$= -890.5 \text{ kJ mol}^{-1}$$

(5 marks)

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8. (c) Some regions tend to generate electricity more by natural gas but less by coal. Give TWO reasons from environmental protection consideration.

Natural gas is a cleaner fuel as it produces less pollutants such as suspended particles and produces less soot

Natural gas is more readily to undergo complete combustion than coal. (2 marks)

The present amount of natural gas is more than coal. Using natural gas is a more sustainable way to consume natural resources.

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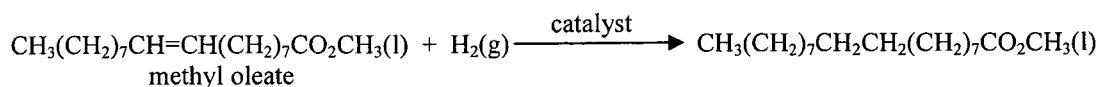
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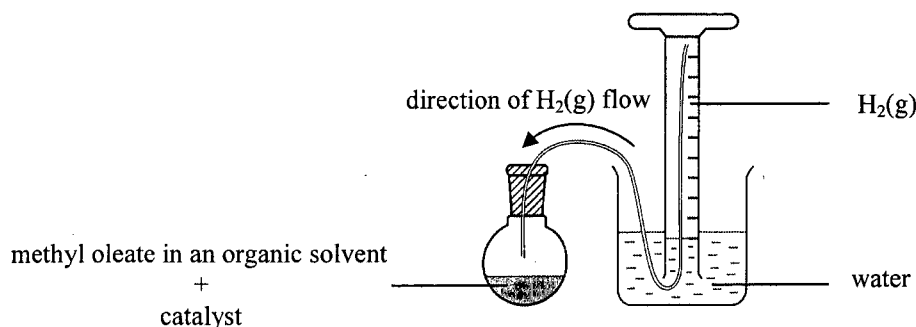
PART II

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

9. Consider the reaction below :



At room temperature and pressure, a micro-scale experiment was performed using the set-up shown below in which 0.080 g of methyl oleate in an organic solvent was allowed to react with excess $\text{H}_2(\text{g})$. The $\text{H}_2(\text{g})$ flowed from the inverted measuring cylinder to the reacting flask through the tubing.



- (a) State one advantage of conducting this reaction in a micro-scale experiment.

It can save chemicals.

(1 mark)

- (b) Explain why the right end of the tubing was placed at the uppermost position of the inverted measuring cylinder.

To prevent water from entering the reaction mixture.

(1 mark)

- (c) State an expected observation in the inverted measuring cylinder during the reaction.

The meniscus of water moves upwards

(1 mark)

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$$\frac{24}{1} \quad m \quad 24 \quad \frac{mol}{dm^3} \quad \checkmark \quad \frac{dm^3}{mol}$$

9. (d) Calculate the theoretical volume of $H_2(g)$ needed for the reaction to complete at room temperature and pressure.

(Molar volume of gas at room temperature and pressure = 24 dm^3 ;

Relative molecular mass: methyl oleate = 296.0)

$$\text{No of mol of methyl oleate} = \frac{0.08}{296} = 2.702702703 \times 10^{-4}$$

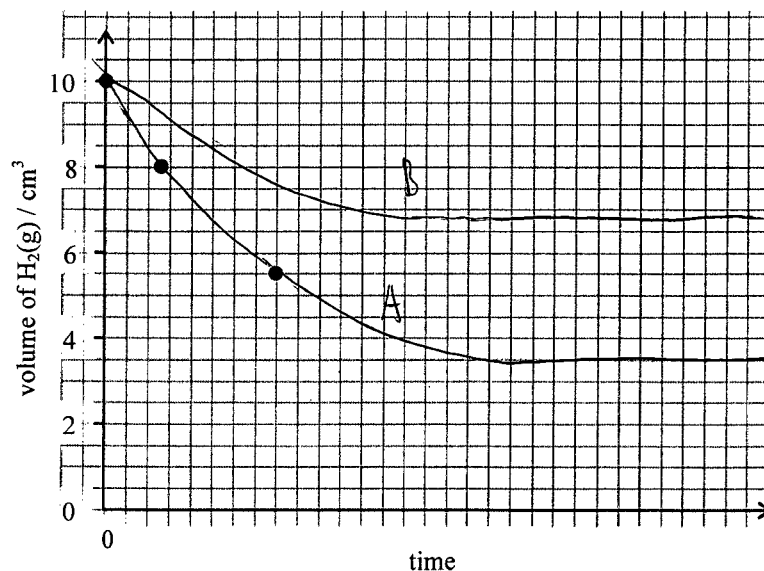
$$\text{Volume of } H_2 \text{ needed} = 2.702702703 \times 10^{-4} \times 24$$

$$= 6.49 \times 10^{-3} \text{ dm}^3$$

$$= 6.49 \text{ cm}^3$$

(3 marks)

- (e) (i) Sketch, in the graph below, the variation of the volume of $H_2(g)$ in the measuring cylinder with time from start until the completion of the reaction. You should label this sketch as 'A'. (The measuring cylinder initially contained 10.0 cm^3 of $H_2(g)$. The first few points have been given in the graph to facilitate the sketch.)



- (ii) In the same graph above, give another sketch as required in (i) but only using 0.040 g of methyl oleate for the reaction while the other conditions remain unchanged. You should label this sketch as 'B'.

(2 marks)

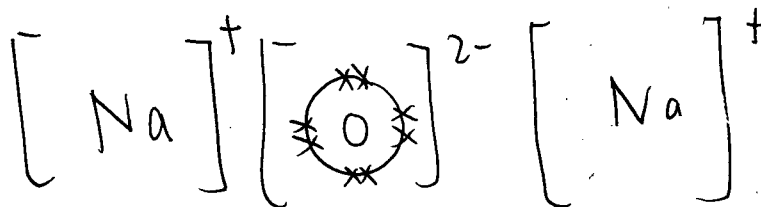
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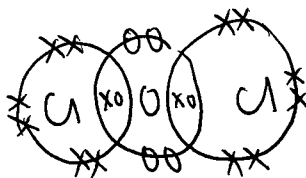
Answers written in the margins will not be marked.

10. (a) For each of the oxides below, draw its electron diagram (showing electrons in the outermost shells only), and state its behaviour in water.

(i) Na_2O



(ii) Cl_2O



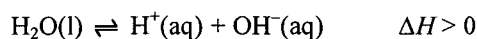
(4 marks)

- (b) Using iron as an example, illustrate TWO characteristics of transition metals.

1. Iron can exist in various oxidation state
e.g. Fe^{2+} , Fe^{3+}
2. Iron's ions have various colours
e.g. Fe^{2+} is green
 Fe^{3+} is yellow

(2 marks)

11. Refer to the following chemical equation :



Under fixed conditions, $[\text{H}_2\text{O(l)}]$ is considered as a constant. In consideration of the definition of K_c , $[\text{H}^+(\text{aq})][\text{OH}^-(\text{aq})]$ would also be a constant.

- (a) The pH of an aqueous solution is defined as $-\log[\text{H}^+(\text{aq})]$. The pH of water equals 7.0 at 298 K. Find, at this temperature, the :

- (i) $[\text{H}^+(\text{aq})]$

$$-\log [\text{H}^+(\text{aq})] = 7$$

$$[\text{H}^+(\text{aq})] = 1 \times 10^{-7} \text{ M}$$

- (ii) $[\text{H}^+(\text{aq})][\text{OH}^-(\text{aq})]$

$$\text{pH} = 7 \text{ (neutral)}$$

$$[\text{H}^+(\text{aq})] = [\text{OH}^-(\text{aq})]$$

$$[\text{H}^+(\text{aq})][\text{OH}^-(\text{aq})] = (1 \times 10^{-7})^2$$

$$= 1 \times 10^{-14} \text{ M}$$

(3 marks)

- (b) $[\text{H}_2\text{O(l)}]$ equals 55.6 mol dm^{-3} at 298 K. Suggest why $[\text{H}_2\text{O(l)}]$ is considered as a constant with reference to the values of $[\text{H}^+(\text{aq})]$ and $[\text{OH}^-(\text{aq})]$.

$\text{H}_2\text{O(l)}$ is a pure liquid

It is in large excess, only small portion of H_2O is consumed.

(1 mark)

- (c) Explain whether the pH of water at 328 K would be less than 7.0, equal to 7.0, or greater than 7.0.

pH depends on the $[\text{H}^+]$ and $[\text{OH}^-]$

The reaction is endothermic
Increase in temperature shifts equilibrium position to the right (product side)

pH of water would equal to 7 as same amt of H^+ and OH^- is produced per ionization of molecule of H_2O

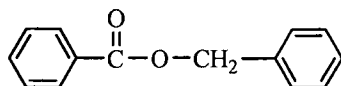
(2 marks)

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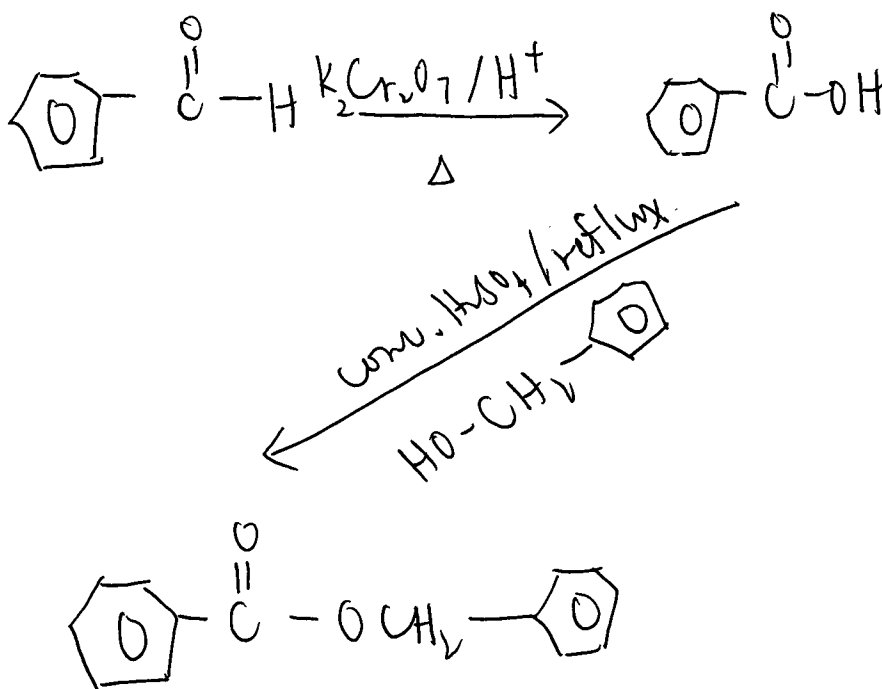
12.

You are provided with c1ccccc1C=O, inorganic reagents and organic solvents.

Outline a synthetic route, with no more than three steps, to obtain the following compound :



For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



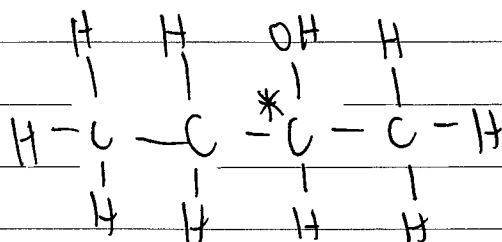
(3 marks)

Answers written in the margins will not be marked.

- *13. Using $\text{C}_2\text{H}_5\text{CH}(\text{OH})\text{CH}_3$ as an example, write a paragraph to illustrate 'enantiomerism'. Suitable diagram(s) should be included in your answer.

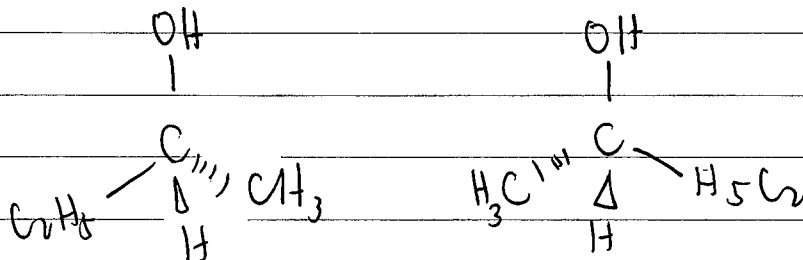
(5 marks)

Enantiomerism is only applicable to compound with chiral carbon



The carbon marked with '*' is chiral
A chiral carbon refers to a carbon atom bonded to four different groups

$\text{C}_2\text{H}_5\text{CH}(\text{OH})\text{CH}_3$ has two enantiomers.



A pair of enantiomers are mirror images of each other.

Difference in physical properties

They rotate a beam of plane polarized light in opposite directions.

END OF SECTION B

END OF PAPER

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序																	0																
1 H 1.0																																	

2015 DSE (D)

香港考試及評核局
HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

香港中學文憑考試
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION

答題簿 ANSWER BOOK

考生須知

- (一) 宣布開考後，考生須首先在第 1 頁之適當位置填寫考生編號，並在第 1 及 3 頁之適當位置貼上電腦條碼。
- (二) 每題(非指分題)必須另起新頁作答，並須在每一頁的相應試題編號方格填畫「X」號，以表示選答的題號(見下例)。
- (三) 紙張兩面均應使用，並應每行書寫。不可在各頁邊界以外位置書寫。寫於邊界以外的答案，將不予評閱。
- (四) 如有需要，可要求派發方格紙及補充答題紙。每一紙張均須填寫考生編號、填畫試題編號方格、貼上電腦條碼，並用繩縛於簿內。
- (五) 試場主任宣布停筆後，考生不會獲得額外時間貼上電腦條碼及填畫試題編號方格。

INSTRUCTIONS

- (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 and 3.
- (2) Start each question (not part of a question) on a new page. Put 'X' in the corresponding question number box on each page to indicate the appropriate question number (see the example below).
- (3) Write on both sides using each line. Do not write in the margins. Answers written in the margins will not be marked.
- (4) Graph paper and supplementary answer sheets will be supplied 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 book.
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例 Example:

試題編號 Question No. = 3

試題編號 Question No.												
1	2	3	4	5	6	7	8	9	10	11	12	
☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	
13	14	15	16	17	18	19	20	21	22	23	24	≥25

Level 5 Exemplar Paper 2

由考生填寫 To be filled in by the candidate	由閱卷員填寫 Marker's Use Only	由試卷主席填寫 Examiner's Use Only
	閱卷員編號 Marker No.	試卷主席編號 Examiner No.

試題編號 Question No.	各頁積分 Marks	積分 Marks	積分 Marks
	+ + =		
	+ + =		
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1.(w)(i)(1) The concentration of $I_{2(aq)}$ does not change the reaction rate.

The order w.r.t. $I_{2(aq)}$ is zero.

The reaction rate does not depend on the concentration of $I_{2(aq)}$

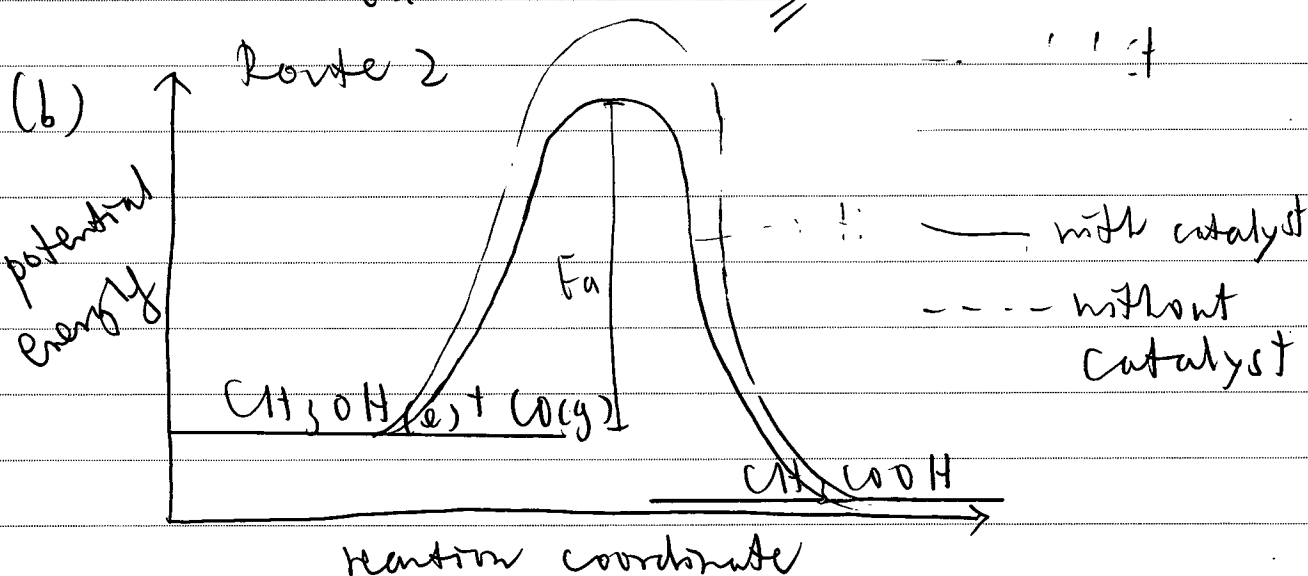
$$(2) \text{ Rate} = k [CH_3COOH_{(aq)}] [H^+_{(aq)}]$$



$$(iii) \log\left(\frac{1}{2}\right) = -\frac{E_a}{2.3R} \left(\frac{1}{298} - \frac{1}{308}\right)$$

$$E_a = 52808 \text{ J}$$

$$E_a = 52.808 \text{ kJ}$$



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~~(b)(i)(v) The catalyst might be poisoned and lost its function after prolonged use~~

(b)(i)(2) Biological catalyst have a limited span of life and will die after a period of time (e.g. yeast)

Catalyst might be poisoned after prolonged use.

(ii) 1. Route 1 do not require high temperature but Route 2 does (180°C) route 1 do not require high pressure but Route 2 does (30 atm)

Route 1 uses less energy.

2. The catalyst Route 1 use is a biological catalyst by natural fermentation (yeast)

(iii) Ethanol and produced in route 2 is of higher purity

Ethanol and is produced faster in Route 2.

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(c)(i) Brine

(ii) The availability of electricity to support the operation of chemical plant.

(iii) $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{Cl}_2 + \text{H}_2$

(iv) Mercury is toxic and harmful to environment and other living organisms.

(v) Membrane cell can produce sodium hydroxide of high purity while diaphragm cell cannot.

(vi) $\text{OCl}^- + \text{HCl} \rightarrow \text{Cl}_2 + \text{OH}^-$

Toxic chlorine gas would be evolved

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3(a)(i) Add acidified silver nitrate solution
Creamy precipitate would be formed in the presence
of $\text{Br}^- (\text{aq})$.

(ii) Gas chromatography - mass spectrometry

(iii) Add $\text{HCl} (\text{aq})$ to the sample
 Cu remains as solid while soluble FeCl_3 is
formed

Filter the mixture to obtain copper powder
as residue

Wash the copper powder with large amount
of distilled water to remove soluble impurities
such as FeCl_3

Dry the powder in an oven.

(b)(i) Orange precipitate formed.

(ii) Use Tollen's reagent
No observable change for X
Silver mirror formed in Y

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(iii) In the mass spectrum, X would appear to have peak at $m/z = 77$ and $m/z = 15$; correspond to $[C_6H_5]^+$ and $[CH_3]^+$ respectively, but not for Y.

In mass spectrum, Y would appear to have peak at $m/z = 91$ due to $[C_6H_5CH_3]^+$ but not for X.

(iv) No.

The functional group present in X and Y that can be detected are phenol and C=O group. Both of them would have absorption peak at around 1680 to 1800 cm^{-1} and 3230 to 3670 cm^{-1} . Therefore unable to distinguish them as infra-red spectroscopy cannot show difference in carbonyl group in aldehydes and ketones.

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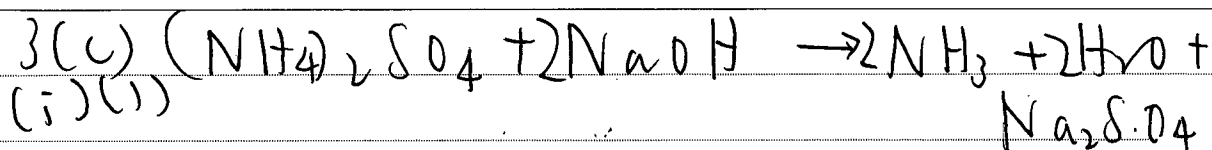
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(ii) From red to yellow

$$\begin{aligned} (iii) \text{ No of mol of KOH} &= 0.1 \times 0.01355 \\ &= 1.355 \times 10^{-3} \end{aligned}$$

$$\begin{aligned} \text{No of mol of HCl reacted with } NH_3 \\ 1 \times 0.05 - 1.355 \times 10^{-3} \times 10 &= 0.03645 \end{aligned}$$

$$\text{No. of mol of } NH_3 = 0.03645$$

$$\begin{aligned} \text{No. of mol of } (NH_4)_2SO_4 &= 0.03645 \div 2 \\ &= 0.018225 \end{aligned}$$

$$\begin{aligned} \text{Mass of N} &= 0.018225 \times 2 \times 14 \\ &= 0.5103 \text{ g} \end{aligned}$$

$$\begin{aligned} \% \text{ by mass of N} \\ \frac{0.5103}{3} \times 100\% &= 17.01\% \end{aligned}$$

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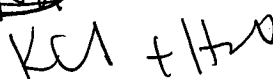
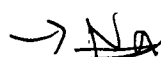
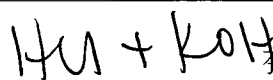
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(iv) The nitrogen the milk powder contained may not come from protein molecule.

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