YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME	**SUGGESTED ANWERS**
CG	
INDEX NO	

CHEMISTRY

9729/02

Paper 2 Structured Questions

1 September 2020

2 hours

Candidates answer on the Question Paper
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
A Data Booklet is provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Paper 1	
	/30
Paper 2	
1	**/14**
2	**/13**
3	**/15**
4	**/13**
5	**/20**
Penalty	
	/75
Paper 3	
	/80
Paper 4	
	/55
Overall Percentage (%)	

This document consists of **24** printed pages and **4** blank pages.

Answer **all** the questions in this section in the spaces provided.

1 Sodium chlorate(I), NaC*l*O, found in household bleach produces chlorine upon addition of acidified dilute hydrochloric acid according to the equation below.

$$ClO^-(aq) + 2H^+(aq) + Cl^-(aq) \rightarrow Cl_2(aq) + H_2O(l)$$

A 15.0 cm^3 sample of a household bleach is diluted to 100 cm^3. 25.0 cm^3 of this solution is then pipetted out into a conical flask containing dilute hydrochloric acid. Excess potassium iodide solution is added which will react with the chlorine present in the sample according to the equation below.

$$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

This resultant solution is then titrated against 0.150 mol dm^{-3} sodium thiosulfate solution and required 17.20 cm^3 for complete reaction. Sodium thiosulfate reacts with iodine according to the following equation.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

(a) (i) Calculate the amount of iodine produced in this reaction.

Amount of $S_2O_3^{2-}$ = 0.150 × 0.0172 = 2.58 × 10^{-3} mol
Amount of I_2 = 0.5 × (2.58 × 10^{-3}) = **1.29 × 10^{-3} mol**

[1]

(ii) Calculate the amount of sodium chlorate(I) present in the 15.0 cm^3 sample.

Amount of I_2 = 1.29 × 10^{-3} mol = Amount of Cl_2
Amount of NaC*l*O in 25.0 cm^3 of the diluted solution = 1.29 × 10^{-3} mol
Amount of NaC*l*O in 15.0 cm^3 of the undiluted solution = (1.29 × 10^{-3}) × (100/25) = **5.16 × 10^{-3} mol**

[1]

(iii) Calculate the concentration of the sodium chlorate(I) in the household bleach in g dm^{-3}.

Mass of NaC*l*O in 15.0 cm^3 of the undiluted solution = 0.0516 × (23.0 + 35.5 +16.0) = **0.38442 g**
Concentration of NaC*l*O = 0.38442 ÷ 0.015 = **25.6 g dm^{-3}**

[2]

(b) In a thiosulfate–acid reaction, a pale yellow precipitate of sulfur is formed slowly.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(g) + H_2O(l)$$

The rate of the reaction can be studied by following the time taken for the reaction mixture to turn opaque.

Outline a suitable experiment for determining the order of reaction with respect to $S_2O_3^{2-}$.

You may assume that you are provided with:

- 100 cm^3 of 0.100 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$ and
- 100 cm^3 of 2.0 mol dm^{-3} hydrochloric acid, HC*l*

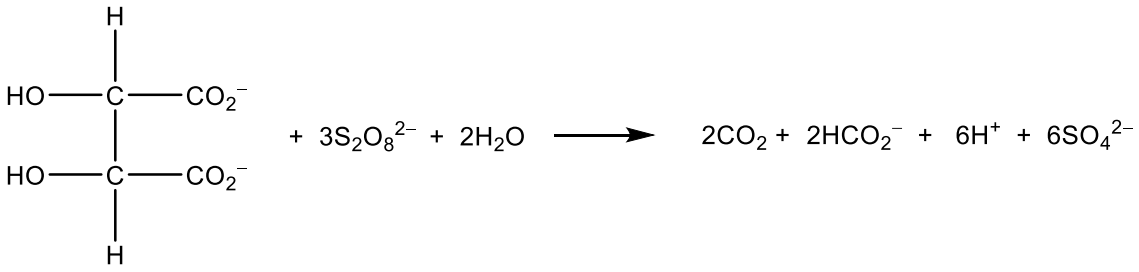
No details regarding the use of specific glassware are required.

1. Prepare a conical flask of 20.0 cm^3 of 0.100 mol dm^{-3} $Na_2S_2O_3$.
2. Prepare a second conical flask of 5.0 cm^3 of 2.0 mol dm^{-3} HC*l*.
3. Pour the hydrochloric acid rapidly into the first conical flask. Start the stopwatch during this addition.
4. Mix the contents thoroughly by swirling the flask and place the conical flask on top of a piece of page with a printed logo.
5. Stop the stopwatch when the solution first becomes opaque and note the time, t_1.
6. Repeat Steps 1 to 5 with 10.0 cm^3 of $Na_2S_2O_3$, 10.0 cm^3 of deionised H_2O and 5.0 cm^3 HC*l*.
7. Compare the volume of $Na_2S_2O_3$ against time.
   - If t_2 is the same as t_1, order with respect to thiosulfate is 0
   - If t_2 is twice that of t_1, order with respect to thiosulfate is 1.
   - If t_2 is four times that of t_1, order with respect to thiosulfate is 2.

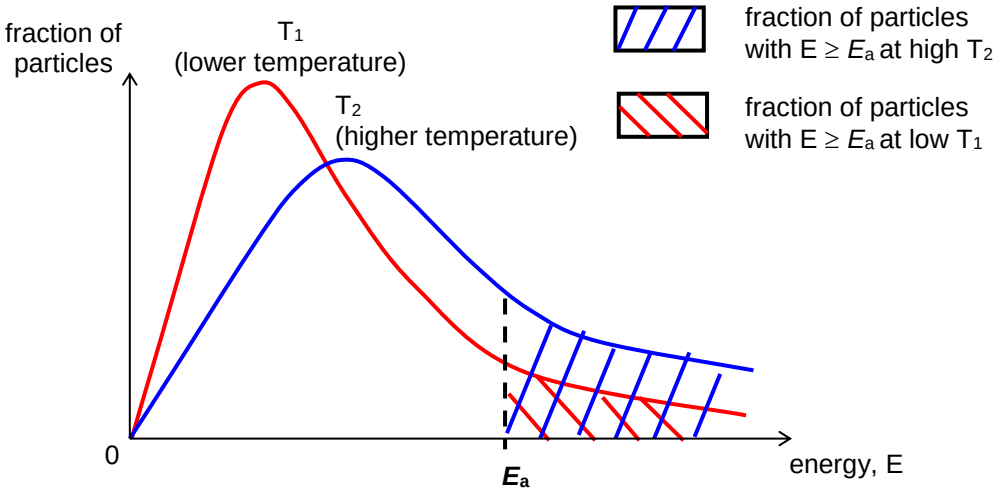
[3]

(c) Thiosulfate, $S_2O_3^{2-}$ and tetrathionate, $S_4O_6^{2-}$ are oxoanions of sulfur.

Peroxodisulfate(VI), $S_2O_8^{2-}$, is another oxonaion of sulfur. $S_2O_8^{2-}$ is able to oxidise the tartrate ion, $[CH(OH)(CO_2^-)]_2$ in the following reaction.



(i) With the aid of a Boltzmann distribution diagram, explain how an increase in temperature will lead to an increase in the rate of the reaction.



When the temperature is increased from T_2 to T_1,

- The **average kinetic energy** of the particles **increases.**
- There is an **increase** in the **fraction of particles with energy equal to or greater than the activation energy, E_a.**
- This result in an **increase in the frequency of effective collisions**, hence the reaction **increases**.
- A higher temperature also results in a **larger rate constant** and hence an increase in reaction rate.

[4]

(ii) The reaction between $S_2O_8^{2-}$ and $[CH(OH)(CO_2^-)]_2$ is very slow, even at elevated temperature.

Suggest an explanation for this observation.

Repulsion between two negatively charged ions caused the **activation energy to be high**.

[1]

(iii) Steps 1 and 2 represent a possible mechanism for the reaction between $S_2O_8^{2-}$ and the tartrate ion, $[CH(OH)(CO_2^-)]_2$ involving Mn^{3+} cations.

step 1: $6Mn^{3+} + [CH(OH)CO_2^-]_2 + 2H_2O \rightarrow 6Mn^{2+} + 2CO_2 + 2HCO_2^- + 6H^+$

step 2: $6Mn^{2+} + 3S_2O_8^{2-} \rightarrow 6Mn^{3+} + 6SO_4^{2-}$

Explain the role of the Mn^{3+} ions in this reaction with reference to the mechanism given.

Mn^{3+} functions as a **catalyst**.
It is **used in step 1** and **regenerated in the second step**.

[2]

[Total: 14]

2 Nitrosyl chloride, NO*Cl*, is a yellow gas that is most commonly encountered as a decomposition product of *aqua regia*, a mixture of hydrochloric acid and nitric acid.

At 250 ^{o}C, NO*Cl* readily dissociates into NO and Cl_2.

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$$

(a) (i) In NO*Cl*, the central atom is nitrogen.

Draw a dot-and-cross diagram to show the bonding present within a NO*Cl* molecule. You should distinguish carefully between electrons originating from the central atom and those from the other atoms.

[1]

(ii) State and explain, with reference to the Valence Shell Electron Pair Repulsion theory, the shape of the nitrosyl chloride molecule.

There are **3 electron pairs around the central atom**, N.
To minimise repulsion, the basic shape for the 3 electron pairs are arranged in a **trigonal planar arrangement**.
The 3 electron pairs consists of **2 bond pairs and 1 lone pair** and the molecule has a final shape of **bent** shape.

[2]

(iii) Table 2.1 shows the electronegativity values of the atoms in nitrosyl chloride.

Table 2.1

atom	electronegativity / Pauling units
nitrogen	3.04
oxygen	3.44
chlorine	3.16

Predict whether nitrosyl chloride is a polar molecule. Explain your reasoning.

Nitrosyl chloride is a **polar molecule**.

As the N-O bond and N-C*l* bond are **polar with different dipole moments** and there is a **net dipole moment** as the dipole moments do not cancel out exactly.

[2]

(b) The graph of *p*V/RT against *p* for 1 mole of O_2 at various pressures are plotted below in Fig 2.1.

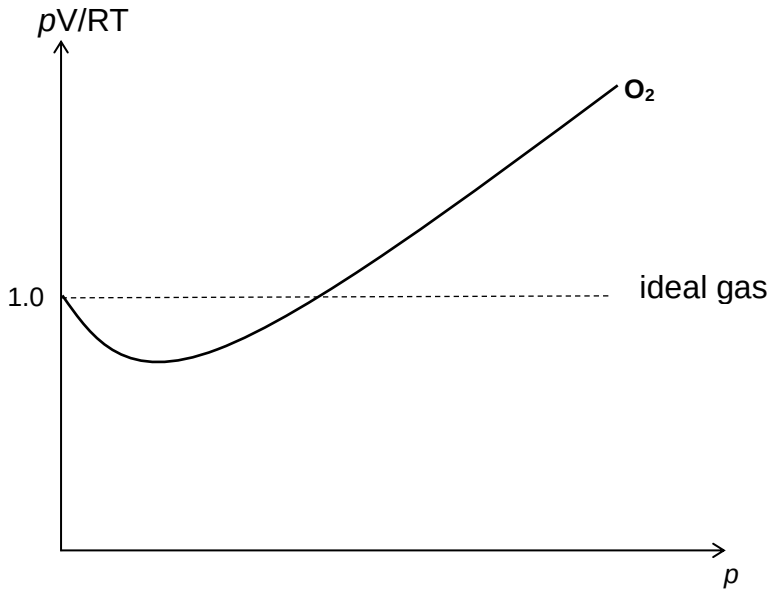
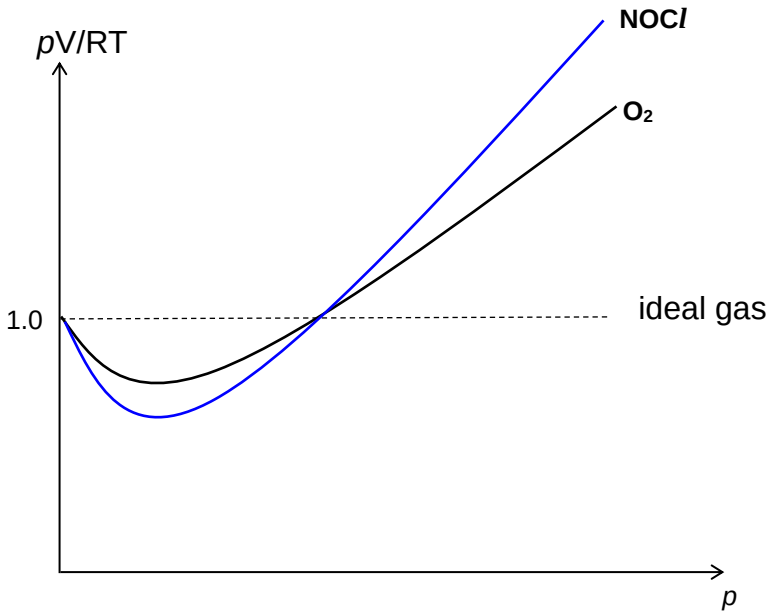


Fig. 2.1

Sketch the pV/RT graph for NOC*l* in Figure 2.1and explain your reasoning.



Graph needs to show **greater deviation** as compared to the graph for O_2.

NOC*l* will show a greater deviation from ideality as the **permanent dipole – permanent dipole interactions between the NOC*l* molecules is more significant than the instantaneous dipole – induced dipole interactions between the O_2 molecules**. The assumption that the **intermolecular forces are negligible between the molecules is now less valid** for NOC*l*.

[2]

(c) The dissociation was investigated by adding 5 moles of NOCl into a 5.0 dm^3 sealed vessel, and equilibrium was established at 250 °C under a pressure of 5.80×10^6 Pa.

(i) Assuming ideal gas behaviour, determine the total amount of gas in moles, at equilibrium.

Total amount of gas = $\dfrac{(5.80 \times 10^6) \times (5.0 \times 10^{-3})}{8.31 \times (250 + 273)}$ = **6.67 mol**

[1]

(ii) Write the expression for the equilibrium constant, K_p, for the dissociation of NOCl, giving its units.

$K_p = \dfrac{p_{NO}^{\,2} \times p_{Cl_2}}{p_{NOCl}^{\,2}}$ Units = **Pa**

[2]

(iii) The equilibrium amounts of NO and Cl_2 was found to be 3.346 mol and 1.673 mol respectively.

Calculate the partial pressures of the gases in the equilibrium mixture and hence calculate a value for K_p under the stated conditions.

Amount of NOCl at equilibrium = 6.673 − 3.346 – 1.673 = **1.654 mol**

At equilibrium,

gas	amount / mol	mole fraction	partial pressure / Pa
NOCl	1.654	1.654 ÷ 6.673 = 0.248	$0.248 \times 5.80 \times 10^6$ = **1.4384×10^6**
NO	3.346	3.346 ÷ 6.673 = 0.501	$0.501 \times 5.80 \times 10^6$ = **2.9058×10^6**
Cl_2	1.673	1.673 ÷ 6.673 = 0.251	$0.251 \times 5.80 \times 10^6$ = **1.4558×10^6**

$K_p = \dfrac{(2.9058 \times 10^6)^2 \times (1.4558 \times 10^6)}{(1.4384 \times 10^6)^2}$ = **5.94 10^6** Pa

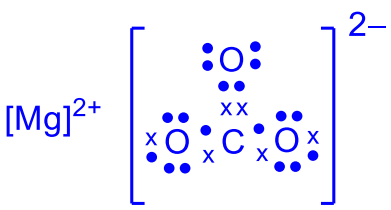
[Total: 13]

3 Group 2 carbonates undergo thermal decomposition to form the corresponding metal oxide and carbon dioxide according to the equation below.

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

Magnesium carbonate decomposes at 350°C whereas barium carbonate decomposes at 1100°C.

(a) Draw a dot-and-cross diagram of magnesium carbonate.



[2]

(b) Explain the difference in the decomposition temperature of magnesium carbonate and barium carbonate.

- Both Ba^{2+} and Mg^{2+} have the same charge but the **ionic radii of Ba^{2+} is larger than that of Mg^{2+}**
- Ba^{2+} has a **lower charge density** and thus **lower polarising power** compared to Mg^{2+}
- Hence the **electron cloud of the large CO_3^{2-} anion is distorted (or polarised) to a lesser extent and a smaller weakening effect on the C–O bonds** within the CO_3^{2-} by Ba^{2+}
- Thermal decomposition becomes increasingly difficult and a higher temperature is required for the decomposition of barium carbonate to occur.

[2]

(c) In an experiment, a sample containing 20.0 g of a mixture of magnesium carbonate and barium carbonate was heated at 350°C until no further change occurred. The remaining solid weighed 10.9 g. Calculate the percentage composition by mass of magnesium carbonate in the sample.

Let mass of $MgCO_3 = x$
Mass of $MgCO_3 = x$ g and
Mass of $BaCO_3 = (20 - x)$ g

At 350 °C, only $MgCO_3$ decomposes.
Mass of MgO formed = $[10.9 - (20 - x)] = (x - 9.1)$ g

Amount of $MgCO_3 = \frac{x}{84.3}$ mol

Amount of MgO = $\frac{x - 9.1}{40.3}$ mol

Since the mole ratio of $MgCO_3$: MgO = 1:1

$\frac{x}{84.3} = \frac{x - 9.1}{40.3}$
$x = 17.434$ g

Percentage composition by mass = $\frac{17.434}{20.0} \times 100\% =$ **87.2 %**

Alternative working

Mass of carbon dioxide = 20.0 – 10.9 = 9.1 g

Amount of carbon dioxide = $\frac{9.1}{44.0} = 0.20681\ mol$

Since the mole ratio of $MgCO_3$: CO_2 = 1:1

Mass of $MgCO_3$ = 0.20681 x 84.3 = 17.434 g

Percentage composition by mass = $\frac{17.434}{20.0} \times 100\% =$ **87.2 %**

[3]

(d) Table 3.1 lists the pK_a values for some weak acids.

Table 3.1

compound	formula	pK_a
benzoic acid	$C_6H_5CO_2H$	4.20
ethanoic acid	CH_3CO_2H	4.75
phenol	C_6H_5OH	9.80

(i) Calculate the pH of 0.10 mol dm^{-3} benzoic acid.

K_a (C_6H_5COOH) = $10^{-4.20}$ = 6.3095×10^{-5} mol dm^{-3}

$[H_3O^+] = \sqrt{6.3095 \times 10^{-5} \times 0.10} = 2.5118 \times 10^{-3}$ mol dm^{-3}

pH = 2.60

[2]

(ii) Suggest the difference in the pK_a values between benzoic acid and phenol.

Benzoic acid is a stronger acid than phenol since it has a smaller p*K*a value.

The benzoate ion (or the conjugate base of benzoic acid) is **more stable** as the **negative charge on the O atom of benzoate ion is completely delocalised between the two electronegative oxygen atoms**
while the **negative charge on the O atom of phenoxide ion is partially delocalised into the benzene ring**.

Hence benzoic acid dissociates to a larger extent.

[2]

(iii) Although the average oxidation state of carbon in ethanoic acid is zero, the two carbon atoms have different oxidation states.

Suggest the oxidation number of the carbonyl carbon, C=O, in ethanoic acid.

oxidation state of carbonyl carbon +3 [1]

(iv) Ethanoic acid can be converted to N-methylethanamide via a two-step process.

Identify the reagents and conditions required for each step.

step 1 anhydrous PCl_5, room temperature

step 2 (anhydrous) CH_3NH_2, room temperature

[2]

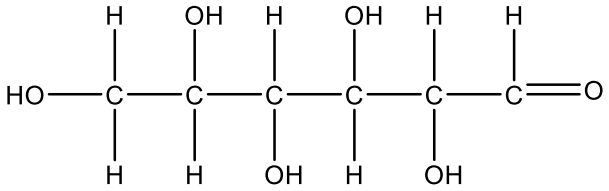
(v) Explain why N-methylethanamide cannot function as a Lewis base.

The **lone pair of electrons on N is delocalised into the C=O** hence it is not available for donation.

[1]

[Total: 15]

4 Glucose is a common alcohol and has the following structure.



glucose, $C_6H_{12}O_6$

The human body can derive energy from the metabolism of proteins, carbohydrates and fats. Athletes engaged in high intensity endurance races receive the bulk of their energy from carbohydrates, which are often stored in the form of glucose.

(a) The aerobic metabolism of glucose by the body to produce energy can be represented by the combustion of glucose in oxygen.

(i) Write an equation to represent the standard enthalpy change of combustion of glucose, $\Delta H^{\ominus}_c$.

$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

[1]

(ii) Using bond energy values from the *Data Booklet*, calculate the standard enthalpy change of combustion of glucose.

bonds broken	(endothermic)	bonds formed	(exothermic)
5 × C–C	5 × (+350)	12 × C=O	12 × (–805)
5 × C–O	5 × (+360)	12 × O–H	12 × (–460)
7 × C–H	7 × (+410)		
1 × C=O	+740		
5 × O–H	5 × (+460)		
6 × O=O	6 × (+496)		
total	+12436	total	−15180

$\Delta H_c^{\ominus}$ = +12436 + (−15180) = **−2744 kJ mol^{-1}**

[2]

(b) An alternative metabolic pathway which produces energy without oxygen is described as anaerobic. In this process, glucose is converted into lactic acid, $C_3H_6O_3$.

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 \qquad \Delta H = -77 \text{ kJ mol}^{-1}$$

The experimentally determined value of the standard enthalpy change of combustion of lactic acid is -1362 kJ mol^{-1}.

(i) Using this information, determine another value for the standard enthalpy change of combustion of glucose.

$\Delta H_c^{\ominus} = 2(-1362) + (-77) =$ **-2801 kJ mol^{-1}**

[1]

(ii) Suggest why your answer in **(b)(i)** is different from the value calculated in **(a)(ii)**.

Bond energy values from the *Data Booklet* are **average values**
or
The sublimation of glucose is not accounted for as it is in **solid/liquid state**.

[1]

(iii) Suggest why the combustion of lactic acid is spontaneous at all temperatures.

$C_3H_6O_3(s) + 3O_2(g) \rightarrow 3CO_2 + 3H_2O(l)$

$\Delta S = 0$ as there is **no change in the number of gaseous molecules**.

$\Delta G = \Delta H - T\Delta S$
Since **ΔH is negative and ΔS is zero**, **ΔG will be negative for all temperature**.

[2]

(c) Compound **C**, $C_9H_8O_3$, a phenolic ester can be made from compound **A** using appropriate organic and inorganic reagents as shown in Fig 4.1.

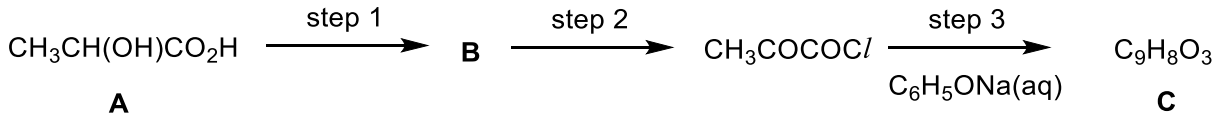
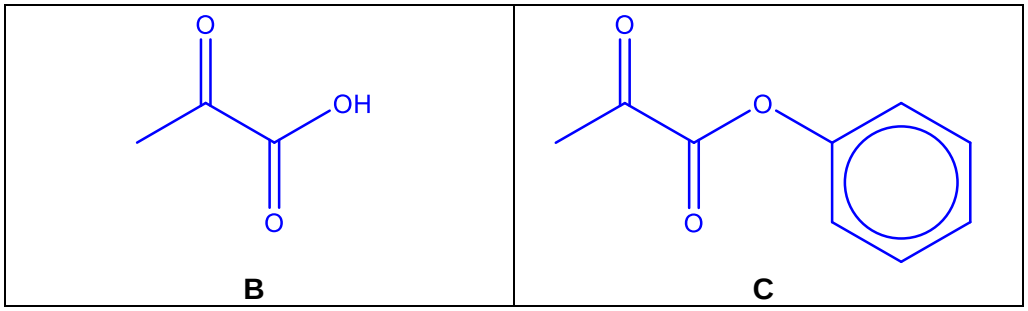


Fig. 4.1

(i) Suggest the structures of compound **B** and **C**.



[2]

(ii) State the reagent and conditions for step 1.

$KMnO_4$ or $K_2Cr_2O_7$ with dilute H_2SO_4, heat

[1]

(iii) State the type of reaction in step 3.

condensation or nucleophilic acyl substitution

[1]

(iv) Explain why sodium phenoxide, C_6H_5ONa, is used instead of phenol in step 3 to produce compound **C**.

Phenol is a **weak nucleophile** due to the **delocalisation of the lone pair on the O atom into the benzene ring** and hence it must be converted into a stronger nucleophile, sodium phenoxide.

[2]

[Total: 13]

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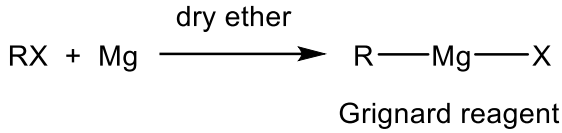
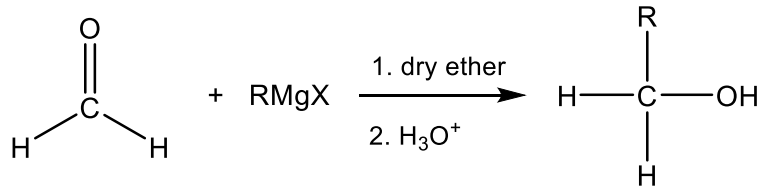
5 Magnesium reacts with halogenoalkanes, RX in dry ether, forming Grignard reagents which are important intermediates used to produce many organic compounds.

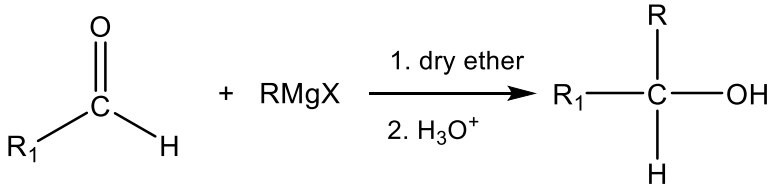


RMgX is called an organometallic compound, where R is an alkyl group and X is chlorine, bromine or iodine. The R in RMgX behaves like an anion R^-, and is strongly basic and nucleophilic.

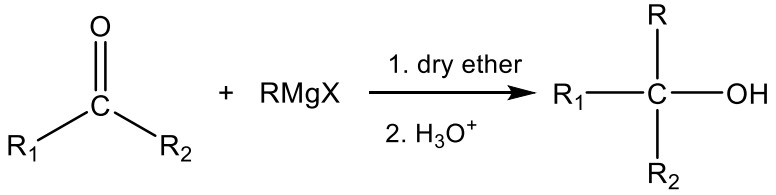
RMgX undergoes addition reactions with carbonyl compounds forming various classes of alcohols.



methanal — primary alcohols

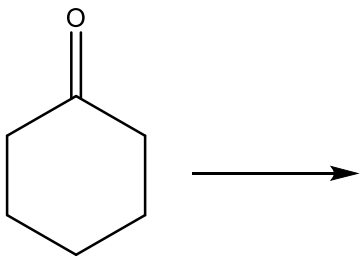


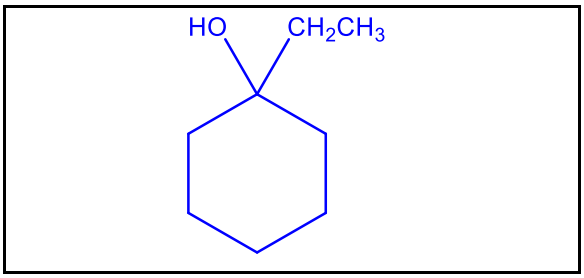
aldehydes, other than methanal — secondary alcohols



ketones — tertiary alcohols

(a) Draw the structures of the organic compounds formed when CH_3CH_2MgBr is reacted with the following compounds in the similar process.





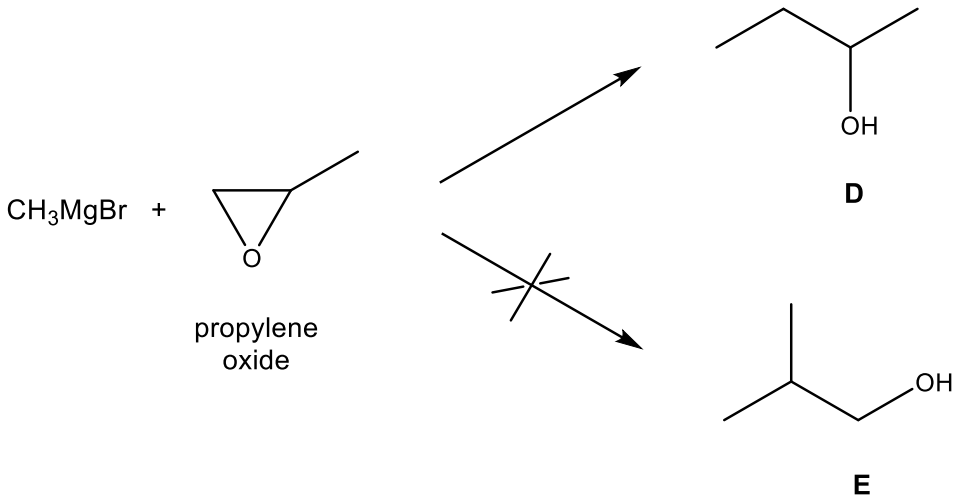
CO_2 →

$CH_3CH_2CO_2H$

[2]

(b) Grignard reagents also undergo nucleophilic addition reactions with epoxides, which are cyclic ethers with a three-atom ring.

Another Grignard reagent CH_3MgBr reacts with propylene oxide and isomer **D** is produced rather than isomer **E**.



(i) Suggest why isomer **D** is preferentially produced.

The Grignard reagent attacks the **least sterically hindered end** to form isomer **D**.

[1]

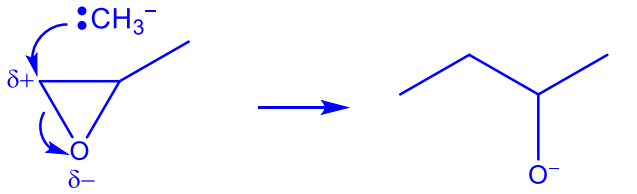
(ii) The nucleophilic addition reaction occurs via a two-step mechanism.

In the first step, the nucleophile **:**CH_3^- from the Grignard reagent reacts with propylene oxide to form an alkoxide ion.

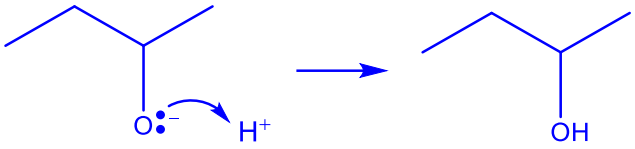
The second step involves the protonation of the alkoxide by an acid, which is added after adding the Grignard reagent.

Use the information provided to suggest a mechanism for this reaction.

step 1



step 2



[3]

The following procedure details the conversion of pentanone to its corresponding alcohol, which involves the initial preparation of a Grignard reagent RMgX, where R is an alkyl group and X is chlorine, bromine or iodine.

$$RX + Mg \rightarrow RMgX$$

$$RMgX + \text{ketone} \rightarrow \text{alcohol} + Mg(OH)X$$

The table below shows some of the physical properties of the substances used in the experimental procedure. These data is repeated on page 24.

Table 5.1

substance	formula	M_r	density / g cm^{-3}	boiling point / °C
iodoethane	C_2H_5I	156.0	1.93	72
diethyl ether	$C_2H_5OC_2H_5$	74.0	0.713	35
magnesium	Mg	24.3	1.74	1110
pentanone	$C_5H_{10}O$	86.0	0.814	102
product alcohol	–	–	0.823	143
water	H_2O	18.0	1.00	100

The Grignard reagent is highly reactive and has to be carefully prepared in an anhydrous environment.

Preparation of the Grignard reagent

1. To a round bottom flask, add 1.50 g of magnesium turnings followed by an equimolar quantity of iodoethane and 20 cm^3 of diethyl ether.

2. Add a small crystal of iodine to the mixture and heat under reflux for 30 minutes.

Reaction of the Grignard reagent with pentanone

3. Cool the mixture and add 6.0 cm^3 of pentanone in a dropwise manner. Gently reflux the mixture for another 10 minutes.

4. Cool the mixture using an ice-water bath and slowly add 25 cm^3 of 4 mol dm^{-3} hydrochloric acid.

(c) Suggest the role of diethyl ether in step 1.

Acts as a **solvent**

[1]

(d) (i) The reaction mixture is heated under reflux for 30 minutes (step 2).
Why is this process necessary for the preparation of many covalent organic compounds?
Explain your answer.

Organic reactions have **high activation energy** because of the numerous strong covalent bonds that need to be broken. Thus heating is required to **provide the heat energy to overcome the strong covalent bonds** in organic molecules.

[2]

(ii) By using the amounts given in the procedure, one of the reagents, pentanone or the Grignard reagent formed in step 3, will be present in an excess.
Use the data above to determine, by calculation, which reagent is in an excess.

You may assume the reaction in step 1 goes to completion.

Amount of pentanone = $\frac{0.814}{86.0} \times 6 = 0.05679$ mol

Amount of Grignard reagent = Amount of Mg = $\frac{1.50}{24.3} = 0.0617$ mol

Since the mole ratio of pentanone: Grignard reagent = 1:1,
the **Grignard reagent** is in excess.

[2]

(e) An ice-water bath is used in step 4. Suggest a reason why cooling is required.

The addition of hydrochloric acid to the mixture is highly exothermic.

[1]

The preparation of organic compounds usually produces a mixture of the required compound and other impurities. Obtaining the required compound in a pure state involves the application of chemical knowledge and principles.

The purification of the crude product alcohol is described below. These data are repeated from page 22.

Table 5.1

substance	formula	M_r	density / g cm^{-3}	boiling point / °C
iodoethane	C_2H_5I	156.0	1.93	72
diethyl ether	$C_2H_5OC_2H_5$	74.0	0.713	35
magnesium	Mg	24.3	1.74	1110
pentanone	$C_5H_{10}O$	86.0	0.814	102
product alcohol	–	–	0.823	143
water	H_2O	18.0	1.00	100

Purification of the product alcohol

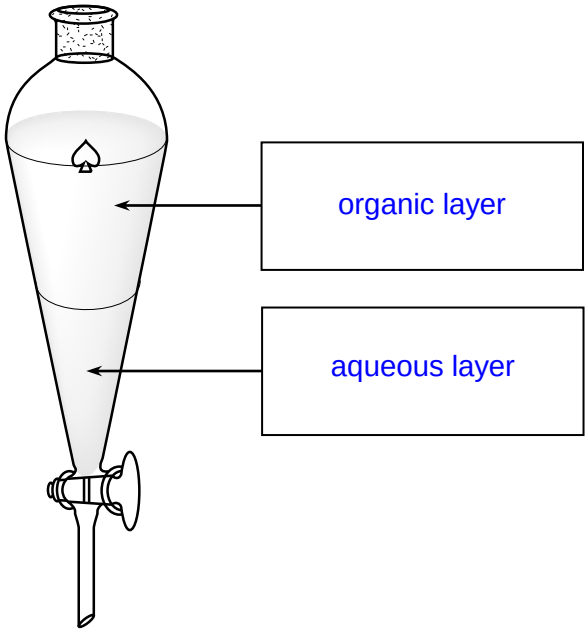
5. Transfer the two-layer mixture to a separating funnel and shake vigorously to extract the product alcohol into the diethyl ether (organic) layer.

6. Isolate the organic layer and extract the aqueous layer again with two further portions of 10 cm^3 of diethyl ether. Combine the organic layers.

7. Wash the combined organic layer with water, followed by aqueous sodium hydrogen carbonate and finally aqueous sodium thiosulfate.

8. Add anhydrous calcium chloride to the organic layer followed by a filtration.

(f) The diagram of a separating funnel containing the aqueous and organic layer in step 5 is shown below.



Using the data from Table 5.1, indicate the relative position of the two layers in the boxes provided. [1]

(g) The impurities in the organic layer are removed in steps 7 and 8, either by dissolving or by a chemical reaction.

Suggest the impurity that is removed by each of the following substances.

(i) H_2O Mg(OH)I or $MgCl_2$ or MgI_2

(ii) $NaHCO_3$ HCl

(iii) $Na_2S_2O_3$ I_2

(iv) $CaCl_2$ H_2O

[3]

(h) After step 8, further separation and purification has to be carried out in order to collect the product alcohol.

Using the data from Table 5.1, briefly describe how you would obtain a pure sample of the product alcohol.

Carry out a **distillation** and collect the pure alcohol product at a temperature range of **141°C to 145°C** as the distillate.

[2]

(i) Suggest a simple chemical test to distinguish the reagent pentanone from the product alcohol. State what you would observe.

reagent and condition	pentanone	alcohol
2,4-DNPH, room temperature	orange precipitate	no orange precipitate
Na, room temperature	no effervescence	effervescence and gas evolved gives a 'pop' with a lighted splint
anhydrous PCl_5 or $SOCl_2$	no white fumes	white fumes of HCl

Note: cannot use $KMnO_4$ or $K_2Cr_2O_7$ as the alcohol formed will be a tertiary alcohol

[2]

[Total: 20]