INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

8872/01

Paper 1 Multiple Choice Questions

15 September 2017

50 minutes

Additional Materials: *Data Booklet*
Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

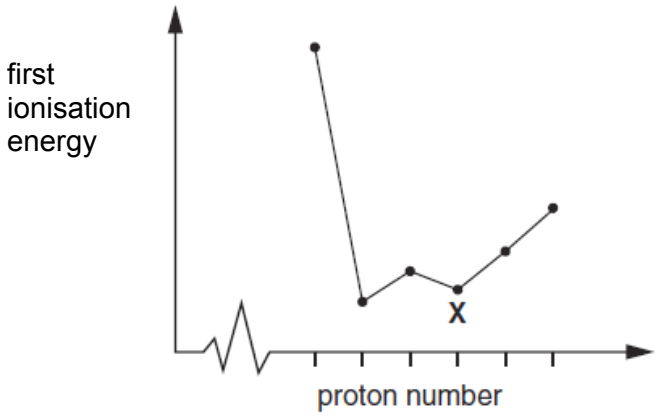
1 How many neutrons are present in 0.13 g of ^{13}C?
[L = the Avogadro constant]

A 0.06L
B 0.07L
C 0.13L
D 0.91L

2 Which factor helps to explain why the first ionisation energies of the Group 1 elements decrease from lithium to rubidium?

A The nuclear charge of the elements increases.
B The outer electron is in an 's' subshell.
C The repulsion between spin-paired electrons increases.
D The distance between the nucleus and the valence electron increases.

3 The sketch below shows the variation of first ionisation energy with proton number for six elements of consecutive proton numbers between 1 and 18 (H to Ar).



What is the identity of the element **X**?

A Mg
B A*l*
C Si
D P

4 Which orbital must an electron with the principal quantum n = 2 occupy?

A a spherically-shaped orbital
B either an s or p orbital
C the orbital closest to the nucleus
D a dumb-bell shaped orbital

5 Which of the following statements describes a phenomenon which **cannot** be explained by hydrogen bonding?

A Ice floats on water.

B The boiling point of carboxylic acids increase with increasing relative molecular mass.

C 2-nitrophenol is more volatile than 4-nitrophenol.

D Ethanoic acid molecules forms dimers when dissolved in benzene.

6 Ammonia, NH_3 reacts with boron trifluoride, BF_3 to give an addition product. Which of the following statements about the addition product is **not** true?

A The boron atom is electron deficient.

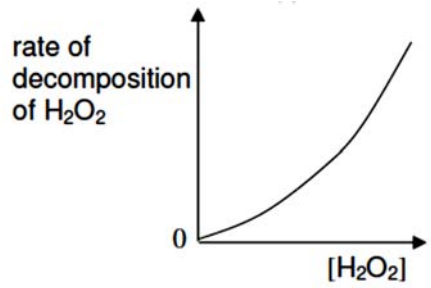
B It contains a dative covalent bond.

C It is polar.

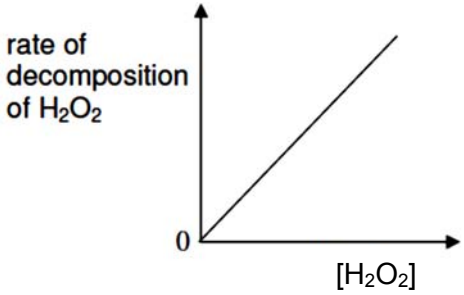
D There are seven sigma bonds.

7 Which graph would confirm that the rate of decomposition of hydrogen peroxide is first order with respect to the concentration of hydrogen peroxide?

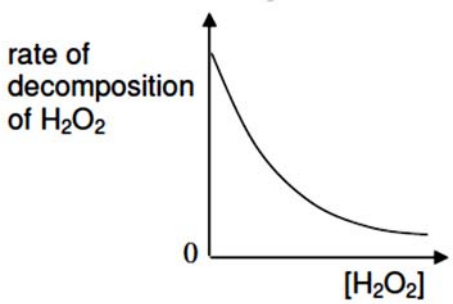
A



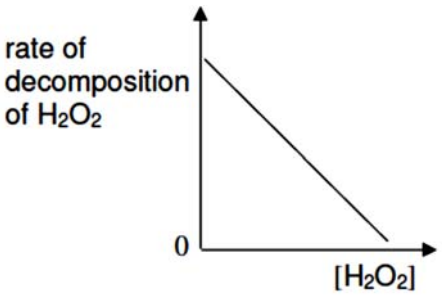
B



C



D



8 The reaction of a compound **RS** is shown below.

$$\mathbf{RS}(g) \longrightarrow \mathbf{R}(g) + \mathbf{S}(g)$$

The rate equation for the reaction is rate = k[**RS**] and the rate constant is found to be 3.6×10^{-3} s^{-1}. If the initial concentration of **RS** is 2.0×10^{-2} mol dm^{-3}, what will be the concentration of **RS** after 385 seconds?

A 1.0×10^{-2} mol dm^{-3}

B 5.0×10^{-3} mol dm^{-3}

C 2.5×10^{-3} mol dm^{-3}

D 2.0×10^{-3} mol dm^{-3}

9 Which one of the following is a correct statement about the effect of a catalyst on a reaction at equilibrium?

A It provides an alternative route with a lower E_a for the reaction to take place.

B It increases the equilibrium constant for the forward reaction.

C It increases the yield of product in equilibrium.

D It increases the rate of the forward reaction only.

10 Which of the following statements does **not** describe a reaction at equilibrium?

A Forward and backward reactions occur at equal rate.

B The reaction takes place in a closed system.

C K_c increases as the reaction progresses.

D Concentrations of reactants and products are constant.

11 Which of the following enthalpy changes is positive?

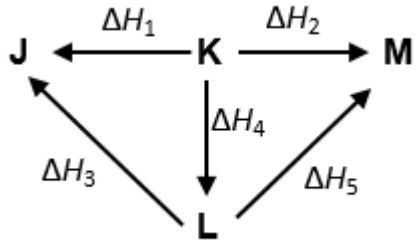
A $H_2O(l) \longrightarrow H_2O(s)$

B $2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l)$

C $2Br(g) \longrightarrow Br_2(g)$

D $Na(g) \longrightarrow Na^+(g) + e^-$

12 The energy cycle below shows the reaction pathways between Compounds **J** – **M**.



What is the enthalpy change for the following reaction?

Compound **J** ⟶ Compound **M**

A $\Delta H_1 + \Delta H_2$

B $\Delta H_2 - \Delta H_3 + \Delta H_4$

C $-\Delta H_3 - \Delta H_5$

D $\Delta H_4 + \Delta H_5 - \Delta H_1$

13 What is the enthalpy change for the following process equivalent to?

$$Al(g) \longrightarrow Al^{2+}(g) + 2e^-$$

A the second ionisation energy of aluminium

B the enthalpy change of vapourisation of aluminium

C the sum of the first ionisation energy and second ionisation energy of aluminium

D the sum of the enthalpy change of vaporisation, first ionisation energy and second ionisation energy of aluminium

14 A mixture was made by adding 20 cm^3 of a solution of pH 2.5 to 30 cm^3 of another solution of pH 4.5. What is the final pH of the mixture?

A 1.2 **C** 3.5

B 2.9 **D** 3.7

15 Which of the following pairs of solutions will produce an alkaline buffer solution upon mixing equal volumes of each solution?

A 1.50 mol dm^{-3} of HCl and 1.00 mol dm^{-3} of NaOH

B 1.00 mol dm^{-3} of NH_3 and 2.00 mol dm^{-3} of HCl

C 0.50 mol dm^{-3} of H_2SO_4 and 2.00 mol dm^{-3} of NH_3

D 1.00 mol dm^{-3} of $C_6H_5CO_2H$ and 0.50 mol dm^{-3} of KOH

16 A student isolated an organic compound with the molecular formula C_4H_8. How many possible isomers (including structural and geometrical isomers) can be deduced from the molecular formula?

A 3 **C** 5

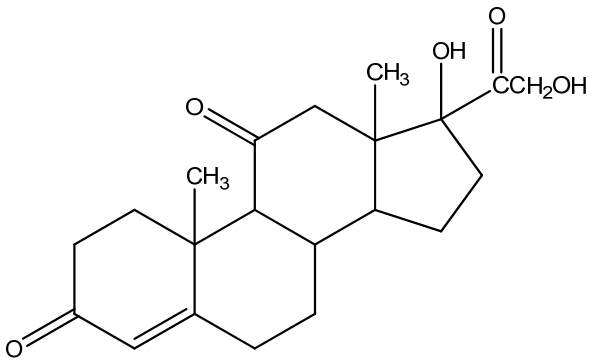
B 4 **D** 6

17 3-methylpentane was reacted with chlorine gas in the presence of ultraviolet light. What is the total number of possible structural isomers formed, assuming only mono-substitution took place?

A 4 **C** 6

B 5 **D** 14

18 Cortisone is an anti-inflammatory hormone.



cortisone

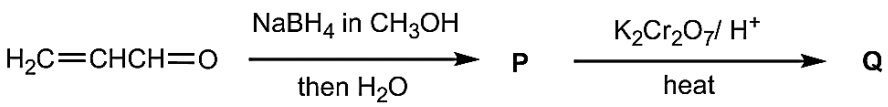
Cortisone is first reacted with hydrogen in the presence of a platinum catalyst, and the product is then oxidised by warming with acidified $KMnO_4$.

Given that no carbon-carbon σ bond is broken in this process, how many C=O double bonds will there be in the structure of the final product?

A 3 **C** 5

B 4 **D** 6

19 What will be the final product **Q** in this sequence of reactions?



A $CH_2CHCOOH$

B CH_3CH_2COOH

C $HOCH_2CH(OH)CH_2OH$

D HO_2CCOCO_2H

20 The table shows the results of simple chemical tests on a compound **U**.

Reagents	Observations
2,4-dinitrophenylhydrazine	Orange ppt
Fehling's reagent	Brick red ppt
Alkaline aqueous iodine	Yellow ppt

What could compound **U** be?

A CH_3CHO

B CH_3CH_2CHO

C $CH_3CH(OH)CH_3$

D CH_3COCH_3

21 Which of the following options shows the correct reagents and conditions for step 1 and 2?

$$CH_2(C\mathit{l})CH{=}CH_2 \xrightarrow{\textbf{step 1}} \textbf{E} \xrightarrow{\textbf{step 2}} CH_2(CH_2NH_2)CH{=}CH_2$$

	Step 1	Step 2
A	KCN in ethanol, heat	H_2, Pt
B	KCN in ethanol, heat	$LiAlH_4$
C	HCN, trace NaOH(aq), cold	$LiAlH_4$
D	NH_3 in ethanol, heat	H_2, Pt

22 Which alcohol is used to manufacture the ester, $CH_3CH_2CH(OH)CO_2CH(CH_3)_2$?

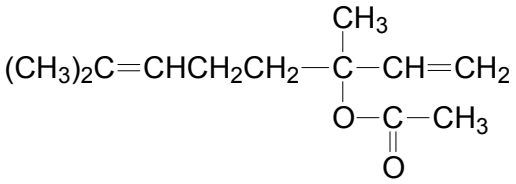
A CH_3CO_2H

B $CH_3CH(OH)CH_3$

C $CH_3CH_2CH_2OH$

D CH_3OH

23 Linalyl acetate is a naturally-occurring compound and it is a principal component of the essential oils of lavender.



Linalyl acetate

Which of the following statements about linalyl acetate is not true?

A It exhibits cis-trans isomerism.

B It does not react with 2,4-dinitrophenylhydrazine.

C It decolourises bromine water.

D It reacts with hot acidified potassium dichromate(VI) to give CH_3COOH as one of the products.

24 Which of the following forms an oxide that is soluble in both water and aqueous sodium hydroxide?

A magnesium

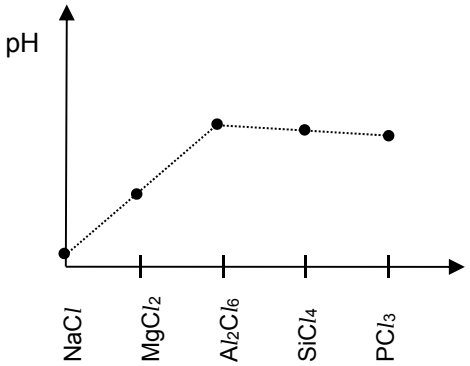
B silicon

C aluminium

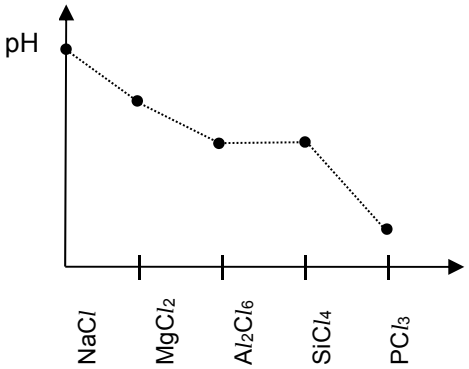
D phosphorus

25 The chlorides of the elements sodium to phosphorus are separately added to water. Which of the following diagrams best represents the pH of the solutions produced?

A



B



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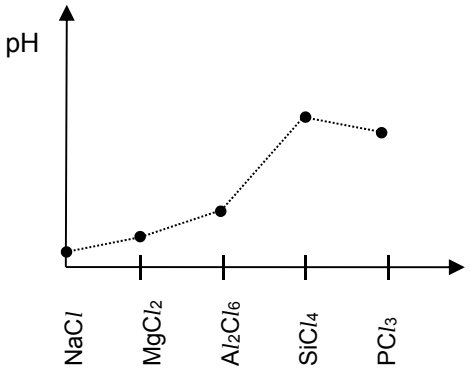
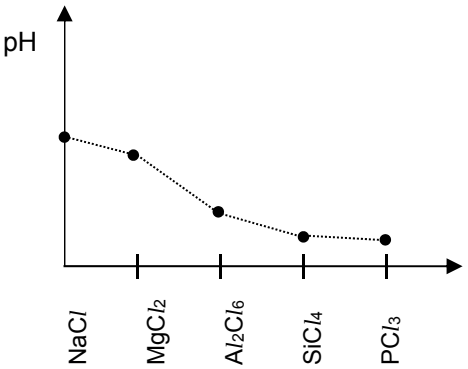


D



Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** are correct	**2** and **3** are correct	**1** only is correct

26 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

$$NO_3^-(aq) \xrightarrow{\mathbf{W}} NO_2^-(aq) \xrightarrow{\mathbf{X}} NO(g) \xrightarrow{\mathbf{Y}} N_2O(g) \xrightarrow{\mathbf{Z}} N_2(g)$$

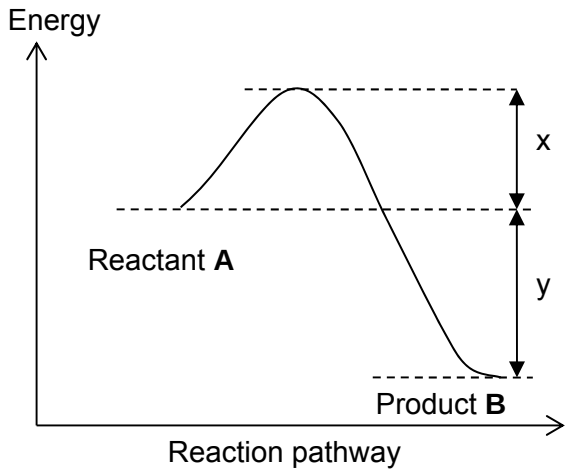
Which of the following steps involve a reduction in the oxidation number of nitrogen by 1?

1 **X**, **Y** and **Z**

2 **W** and **Y**

3 **W** and **X**

27 The energy profile for a reversible reaction is shown below.



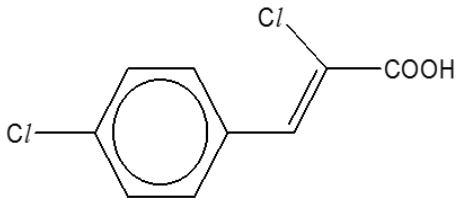
Which of the following statements are correct?

1 The reaction from **B** to **A** is endothermic.

2 The activation energy of the reaction **A** to **B** is *x*.

3 The activation energy of the reaction **B** to **A** is *x* + *y*.

28 Compound **A** is used as a starting material for a class of anti-bacterial drugs known as quinolones. Which of the following statements about compound **A** are correct?



compound **A**

1 1 mole of **A** reacts with CH_3OH to give 1 mole of H_2O.

2 1 mole of **A** reacts with Na metal to give 0.5 mole of H_2.

3 1 mole of **A** reacts with $CaCO_3$ to give 1 mole of CO_2.

29 For which types of compound are **all** of the following statements correct?

- They are unreactive towards mild oxidising agents.
- They form esters.
- They react with sodium.

1 aldehydes

2 carboxylic acids

3 tertiary alcohols

30 Which of the following trends concerning Period 3 elements from Na to C*l* are true?

1 There is a change from metallic behaviour to non-metallic behaviour.

2 Their compounds show an increase in the maximum oxidation number across the period.

3 The melting points of the elements decrease across the period.

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Answers

1	B	6	A	11	D	16	D	21	B	26	D
2	D	7	B	12	D	17	A	22	B	27	A
3	B	8	B	13	C	18	B	23	A	28	B
4	B	9	A	14	B	19	A	24	D	29	C
5	B	10	C	15	D	20	A	25	D	30	B

This document consists of **18** printed pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 How many neutrons are present in 0.13g of ^{13}C?
[L = the Avogadro constant]

A 0.06L
B 0.07L
C 0.13L
D 0.91L

Answer is **B**

No. of mol of ^{13}C = 0.13/13 = 0.01
No. of atoms of ^{13}C = 0.01 L
No. of neutrons per ^{13}C atom = 7
No. of neutrons in 0.01L of ^{13}C = 0.07L

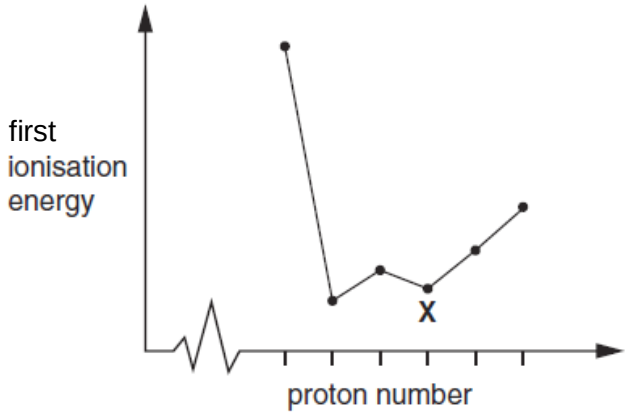
2 Which factor helps to explain why the first ionisation energies of the Group I elements decrease from lithium to rubidium?

A The nuclear charge of the elements increases.
B The outer electron is in an 's' subshell.
C The repulsion between spin-paired electrons increases.
D The distance between the nucleus and the valence electron increases.

Answer is **D**

The valence electron is further away from the nucleus as you go down the group due to an increase in the number of principal quantum shells.

3 The sketch below shows the variation of first ionisation energy with proton number for six elements of consecutive proton numbers between 1 and 18 (H to Ar).



What is the identity of the element **X**?

A Mg
B A*l*
C Si
D P

Answer is **B**

The lowest first IE represent group **1** element, as when going across the period the increase in nuclear charge outweighs the negligible increase in shielding effect (due to ineffective shielding of electrons added to the same outermost shell).

Hence X is A*l*. Moreover, A*l* first IE is lower than Mg as its electron is removed from 3p orbital which is further away from nucleus as compare to 3s orbital.

4 Which orbital must an electron with the principal quantum n = 2 occupy?

A a spherically-shaped orbital
B either an s or p orbital
C the orbital closest to the nucleus
D a dumb-bell shaped orbital

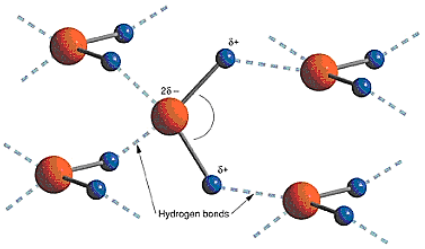
Answer is **B**

Orbitals available at principal quantum *n* = 2 are 2s (spherically-shaped) and 2p (dumb-bell-shaped) orbital

5 Which of the following statements describes a phenomenon which **cannot** be explained by hydrogen bonding?

A Ice floats on water.
B The boiling point of carboxylic acids increase with increasing relative molecular mass.
C 2-nitrophenol is more volatile than 4-nitrophenol.
D Ethanoic acid molecules forms dimers when dissolved in benzene.

Answer is **B**



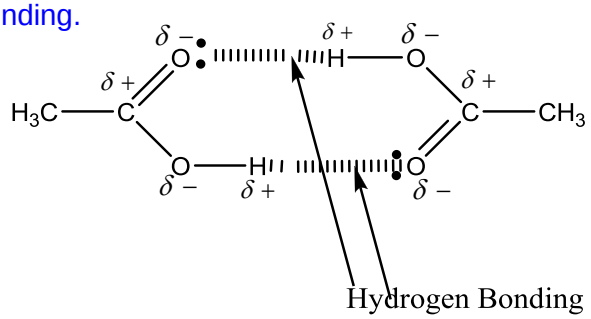
H-bonding in ice

Option **A** is incorrect as it is the hydrogen bonding between H_2O that caused the molecules to be more spaced out and less dense. Hence, ice float on water.

Option **B** is correct as carboxylic acid relative molecular mass increases when the carbon chain increases. However, this will result in the instantaneous dipole-induced dipole forces of attraction to increase which results in an increase in boiling point. The hydrogen bond does not affect the boiling point.

Option **C** is incorrect as 2-nitrophenol can form an intramolecular hydrogen bond due to the proximity of the OH and NO_2 groups so less intermolecular hydrogen bond occurs. Hence, 2-nitrophenol has a lower boiling point and is more volatile.

Option **D** is incorrect as ethanoic acid does form dimers in benzene via hydrogen bonding.



6 Ammonia, NH_3 reacts with boron trifluoride, BF_3 to give an addition product. Which of the following statements about the addition product is **not** true?

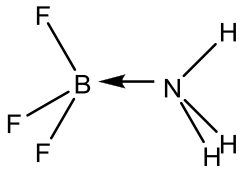
A The B atom is electron deficient.

B It contains a dative covalent bond.

C It is polar.

D There are seven sigma bonds.

Answer is **A**



Addition product

Option **A** is correct as with the dative bond formed from N to B in the product, B is no longer electron deficient.

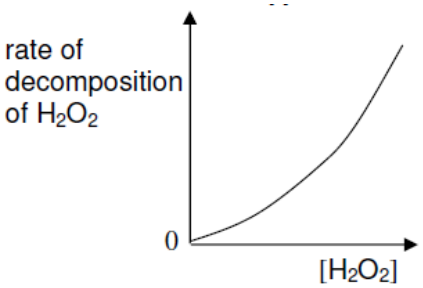
Option **B** is incorrect as the dative bond is between N and B.

Option **C** is incorrect as it is polar as the sum of all the dipole moments do not cancel out.

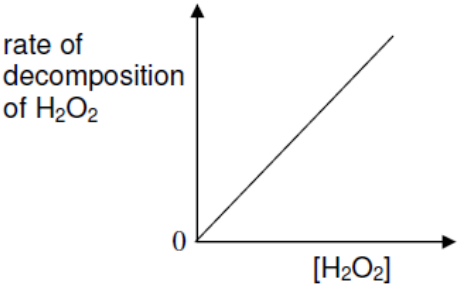
Option **D** is correct as there are 7 sigma bonds in the product after counting all the single bonds in the diagram above.

7 Which graph would confirm that the rate of decomposition of hydrogen peroxide is first order with respect to the concentration of hydrogen peroxide?

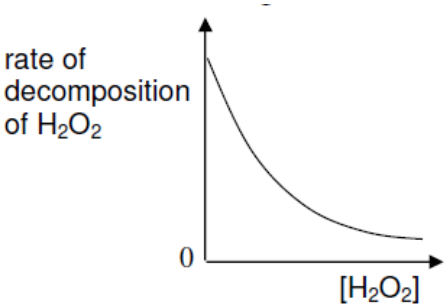
A



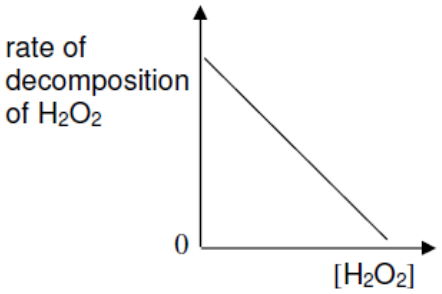
B



C



D



Answer is **B**.

Rate = k $[H_2O_2]$
|| ||
y-axis x-axis

So it is a y=mx +c graph, a straight line that passes through the origin.

8 The reaction of a compound **RS** is shown below.

$$\mathbf{RS}(g) \longrightarrow \mathbf{R}(g) + \mathbf{S}(g)$$

The rate equation for the reaction is rate = k[**RS**] and the rate constant is found to be 3.6×10^{-3} s^{-1}. If the initial concentration of **RS** is 2.0×10^{-2} mol dm^{-3}, what will be the concentration of **RS** after 385 seconds?

A 1.0×10^{-2} mol dm^{-3}

B 5.0×10^{-3} mol dm^{-3}

C 2.5×10^{-3} mol dm^{-3}

D 2.0×10^{-3} mol dm^{-3}

Answer is **B**

Using $t_{1/2} = \ln 2/k$

$t_{1/2} = \ln 2 / (3.6 \times 10^{-3})$

$= 192.5s$

385 seconds = 2 half lives

$2.0 \times 10^{-2} \rightarrow 1.0 \times 10^{-2} \rightarrow 0.5 \times 10^{-2} (= 5.0 \times 10^{-3})$

9 Which one of the following is a correct statement about the effect of a catalyst on a reaction at equilibrium?

A It provides an alternative route for the reaction to take place.

B It increases the equilibrium constant for the forward reaction.

C It increases the yield of product in equilibrium.

D It increases the rate of the forward reaction only.

Answer is **A**

Option **A** is correct as a catalyst will lower the activation energy of a reaction by providing an **alternative pathway** for the reaction to occur.

Option **B** is wrong as the equilibrium constant is only affected by **temperature**.

Option **C** and **D** are wrong as a catalyst will only speed up **both forward and backward reaction** but It will **not** increase the yield of reaction.

10 Which of the following statements does **not** describe a reaction at equilibrium?

A Forward and backward reactions occur at equal rate.

B The reaction takes place in a closed system.

C K_c increases as the reaction progresses.

D Concentrations of reactants and products are constant.

Answer is **C**

Option **A** and **D** are wrong as based on the definition of dynamic equilibrium, a system at equilibrium is when the rate of forward reaction is the same as the backward reaction and the concentration of both reactants and products are constant.

Option **B** is wrong as an equilibrium system must take place in a closed system.

Option **C** is correct as if Kc is increasing, it means that either the reactants concentration is dropping or the product concentration is increasing. So equilibrium position is still shifting, hence the reaction has not reached equilibrium yet.

11 Which of the following enthalpy changes is positive?

A $H_2O(l) \longrightarrow H_2O(s)$

B $2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l)$

C $2Br(g) \longrightarrow Br_2(g)$

D $Na(g) \longrightarrow Na^+(g) + e^-$

Answer is **D**

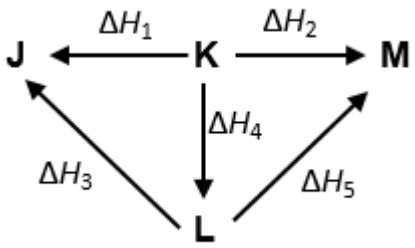
Option **A** is wrong as the equation represents the freezing of water and freezing is exothermic as more H-bonds are formed during freezing.

Option **B** is wrong as the equation represents the combustion of ethane. All combustion reactions are exothermic.

Option **C** is wrong as the equation represents the formation of the Br-Br bond. It is exothermic as bond formation is always exothermic.

Option **D** is correct as the equation represents the first ionisation energy of sodium. The first ionisation energy is always endothermic as energy is needed to remove the most loosely held electron.

12 The energy cycle below shows the reaction pathways between Compounds **J** – **M**.



What is the enthalpy change for the following reaction?

Compound **J** ⟶ Compound **M**

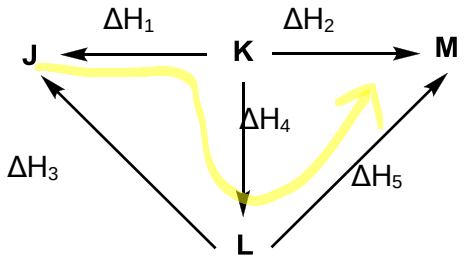
A $\Delta H_1 + \Delta H_2$

B $\Delta H_2 - \Delta H_3 + \Delta H_4$

C $-\Delta H_3 - \Delta H_5$

D $\Delta H_4 + \Delta H_5 - \Delta H_1$

Answer is **D**



By Hess's law, following the yellow arrow:

enthalpy change from **J** to **M** = $-\Delta H_1 + \Delta H_4 + \Delta H_5$

= $\Delta H_4 + \Delta H_5 - \Delta H_1$ (option **D**).

13 What is the enthalpy change for the following process equivalent to?

$$Al(g) \longrightarrow Al^{2+}(g) + 2e^-$$

A the second ionisation energy of aluminium

B the enthalpy change of vaporisation of aluminium

C the sum of the first ionisation energy and second ionisation energy of aluminium

D the sum of the enthalpy change of vaporisation, first ionisation energy and second ionisation energy of aluminium

Answer is **C**

Option **A** is wrong as the second ionisation energy of aluminium is

$$Al^{+}(g) \longrightarrow Al^{2+}(g) + e^{-}$$

Option **B** is wrong as the enthalpy change of vaporisation of aluminium is

$$Al(s) \longrightarrow Al(g)$$

Option **C** is correct as the equation is the sum of the first ionisation energy and second ionisation energy of aluminium

$$Al(g) \longrightarrow Al^{+}(g) + e^{-} \quad (1^{st}\ \text{I.E.})$$
$$Al^{+}(g) \longrightarrow Al^{2+}(g) + e^{-} \quad (2^{nd}\ \text{I.E.})$$

Option **D** is wrong as the equation shows $Al(g)$ forming $Al^{2+}(g)$ and not $Al(s)$ forming $Al^{2+}(g)$.

14 A mixture was made by adding 20 cm^3 of a solution of pH 2.5 to 30 cm^3 of another solution of pH 4.5. What is the final pH of the mixture?

A 1.2 **C** 3.5

B 2.9 **D** 3.7

Answer is **B**

$[H^+]$ in first solution = $10^{-2.5}$ mol dm^{-3}

$[H^+]$ in second solution = $10^{-4.5}$ mol dm^{-3}

$[H^+]$ in mixture = $\frac{0.020 \times 10^{-2.5} + 0.030 \times 10^{-4.5}}{0.050}$ = 1.284 x 10^{-3} mol dm^{-3}

pH of mixture = - $\log_{10}(1.284 \times 10^{-3})$ = 2.89 = 2.9 (1d.p.)

15 Which of the following pairs of solutions will produce an alkaline buffer solution upon mixing equal volumes of each solution?

A 1.50 mol dm^{-3} of HCl and 1.00 mol dm^{-3} of NaOH

B 1.00 mol dm^{-3} of NH_3 and 2.00 mol dm^{-3} of HCl

C 0.50 mol dm^{-3} of H_2SO_4 and 2.00 mol dm^{-3} of NH_3

D 1.00 mol dm^{-3} of $C_6H_5CO_2H$ and 0.50 mol dm^{-3} of KOH

Answer is **C**

Assume that the volumes of each solution is 1 dm^3

Option **A** contains 1.5 mol of HCl reacting with 1 mol of NaOH, the resulting solution will contain 0.5 mol of HCl.

Option **B** contains 1 mol of NH_3, a weak base, reacting with 2 mol of HCl, the resulting solution will contain 1 mol of HCl.

Option **C** contains 2 x 0.5 = 1 mol of H^+ from 0.5 mol of H_2SO_4 reacting with 2 mol of NH_3. The resulting solution will contain 1 mol of NH_3 and 1 mol of NH_4^+, an alkaline buffer.

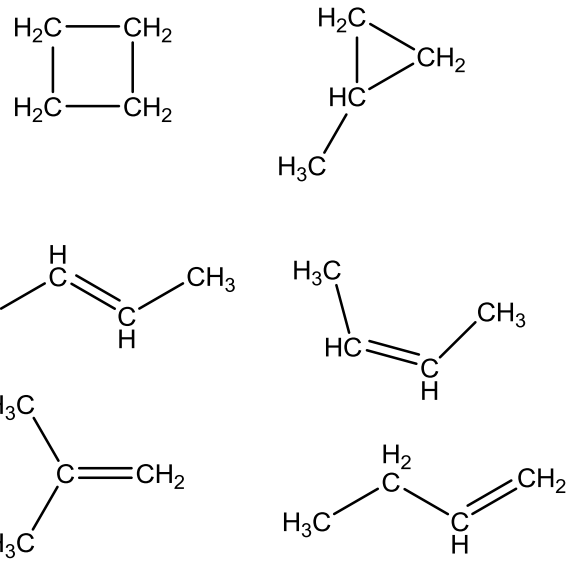
Option **D** contains 1 mol of $C_6H_5CO_2H$ reacting with 0.5 mol of KOH. The resulting solution will contain 0.5 mol of $C_6H_5CO_2H$ and 0.5 mol of $C_6H_5CO_2^-$, an acidic buffer.

16 A student isolated an organic compound with the molecular formula C_4H_8. How many possible isomers (including structural and geometrical isomers) can be deduced from the molecular formula?

A 3
B 4
C 5
D 6

Answer is **D**

There are 6 possible isomers that can be formed for C_4H_8

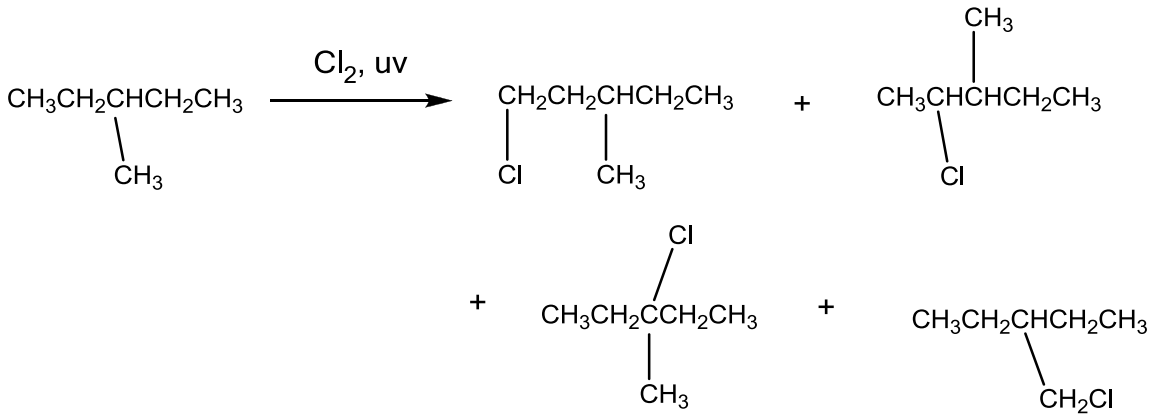


17 3-methylpentane was reacted with chlorine gas in the presence of ultraviolet light. What is the total number of possible structural isomers formed, assuming only mono-substitution took place?

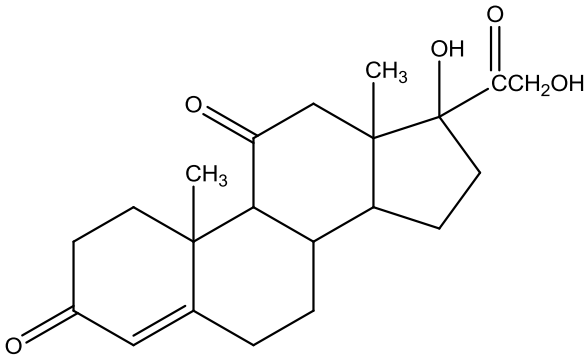
A 4
B 5
C 6
D 14

Answer is **A**

The four possible structural isomers formed are:



18 Cortisone is an anti-inflammatory hormone.



cortisone

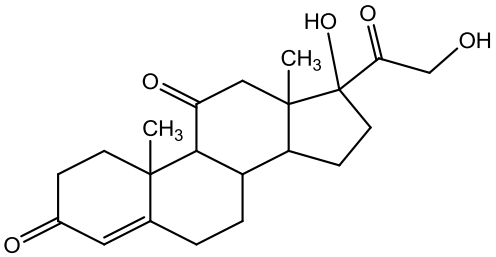
Cortisone is first reacted with hydrogen in the presence of a platinum catalyst, and the product is then oxidised by warming with acidified $KMnO_4$.

Given that no carbon-carbon σ bond is broken in this process, how many C=O double bonds will there be in the structure of the final product?

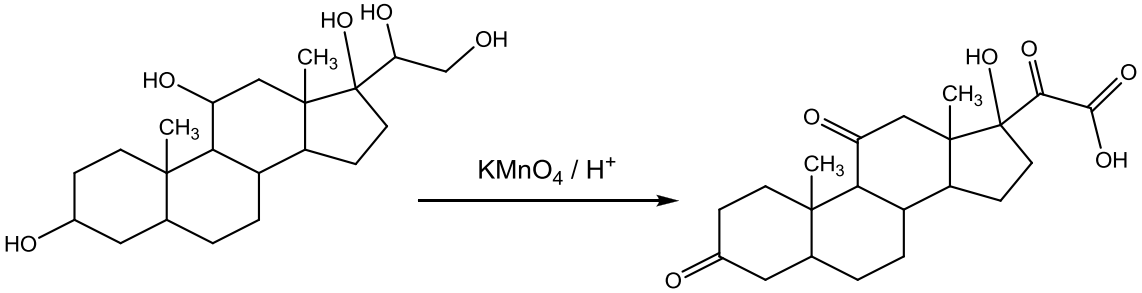
A 3 **C** 5

B 4 **D** 6

Answer is **B**

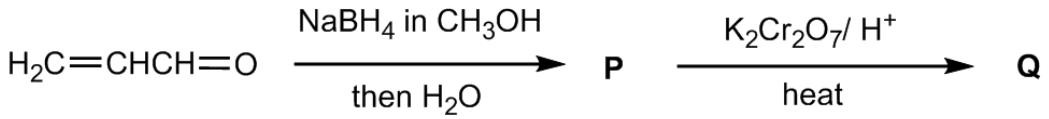


cortisone



No. of double bonds = 4

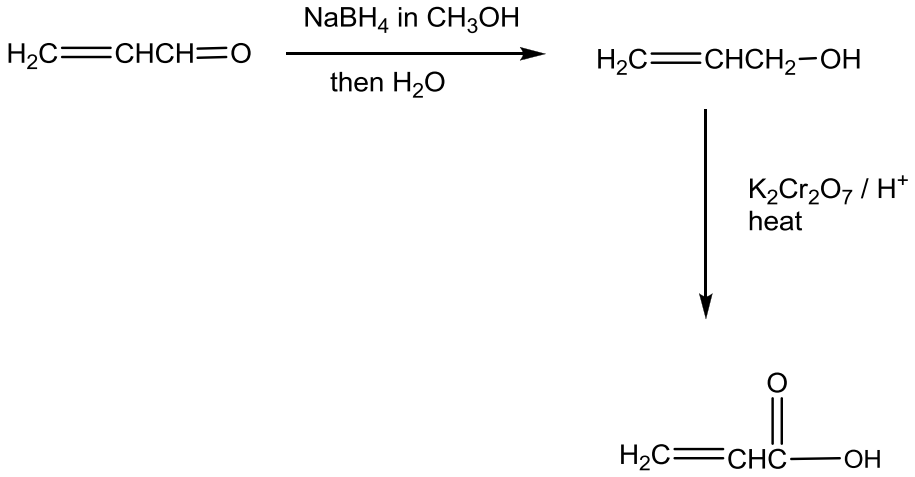
19 What will be the final product **Q** in this sequence of reactions?



A $CH_2CHCOOH$
B CH_3CH_2COOH
C $HOCH_2CH(OH)CH_2OH$
D HO_2CCOCO_2H

Answer is **A**

$NaBH_4$ can also reduce carbonyl group but it cannot reduce alkene. $K_2Cr_2O_7$ will only oxidise alcohol in P but it cannot oxidise alkene.



20 The table shows the results of simple chemical tests on a compound **U**.

Reagents	Observations
2,4-dinitrophenylhydrazine	Orange ppt
Fehling's reagent	Brick red ppt
Alkaline aqueous iodine	Yellow ppt

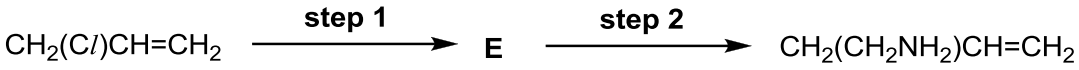
What could compound **U** be?

A CH_3CHO
B CH_3CH_2CHO
C $CH_3CH(OH)CH_3$
D CH_3COCH_3

Answer is **A**

Based on the three tests, compound U should be a carbonyl compound as it gives an orange ppt. with 2,4-DNPH. It is also an aldehyde as it gives a brick red ppt. with Fehling's reagent and it has a CH_3CO group as it forms a yellow ppt. with alkaline aqueous iodine.

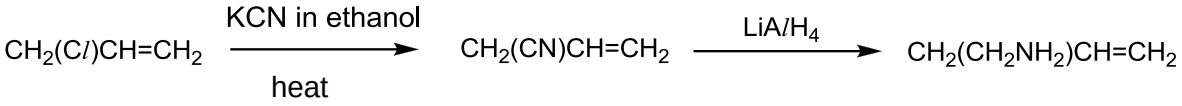
21 Which of the following options shows the correct reagents and conditions for step 1 and 2?



	Step 1	Step 2
A	KCN in ethanol, heat	H_2, Pt
B	KCN in ethanol, heat	$LiAlH_4$
C	HCN, trace NaOH(aq), cold	$LiAlH_4$
D	NH_3 in ethanol, heat	H_2, Pt

Answer is **B**

The reaction will proceed in this manner:



22 Which alcohol is used to manufacture the ester, $CH_3CH_2CH(OH)CO_2CH(CH_3)_2$?

A	CH_3CO_2H	**C**	$CH_3CH_2CH_2OH$
B	$CH_3CH(OH)CH_3$	**D**	CH_3OH

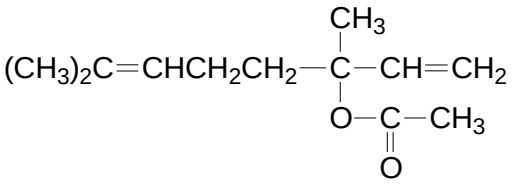
Answer is **B**

$CH_3CH_2CH(OH)CO_2CH(CH_3)_2$ is made from:

$CH_3CH_2CH(OH)COOH$ and $HOCH(CH_3)_2$

$HOCH(CH_3)_2$ can be rewritten as $CH_3CH(OH)CH_3$ (Option B).

23 Linalyl acetate is a naturally-occurring compound and it is a principal component of the essential oils of lavender.



Linalyl acetate

Which of the following statements about linalyl acetate is not true?

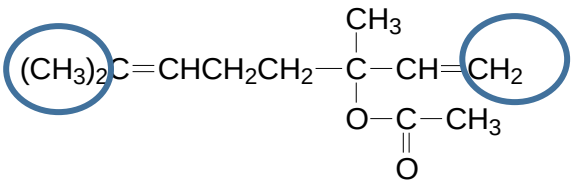
A It exhibits *cis-trans* isomerism.

B It does not react with 2,4-dinitrophenylhydrazine.

C It decolourises bromine water.

D It reacts with hot acidified potassium dichromate(VI) to give CH_3COOH as one of the products.

Answer is **A**



Answer **A** is correct as the groups attached to one side of each C=C bond are identical (circled in the diagram). So there are no cis-trans isomers.

24 Which of the following forms an oxide that is soluble in both water and aqueous sodium hydroxide?

A magnesium

B silicon

C aluminium

D phosphorus

Answer is **D**

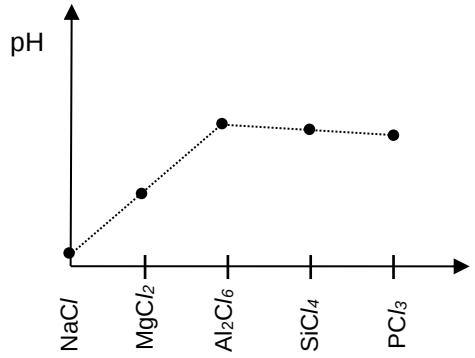
Phosphorus trioxide P_4O_6 is a non-metallic acidic oxide that reacts with water an aqueous sodium hydroxide in the following manner:

$P_4O_6(s) + 6H_2O(l) \longrightarrow 4H_3PO_3(aq)$

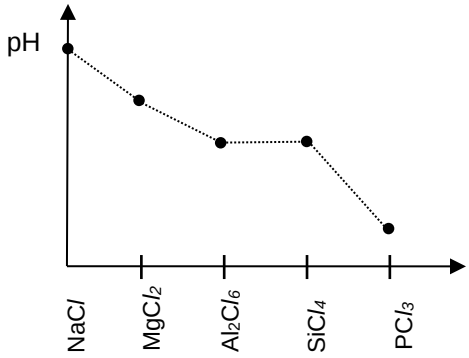
$P_4O_6(s) + 8NaOH(aq) \longrightarrow 4Na_2HPO_3(aq) + 2H_2O(l)$

25 The chlorides of the elements sodium to phosphorous are separately added to water. Which of the following diagrams best represents the pH of the solutions produced?

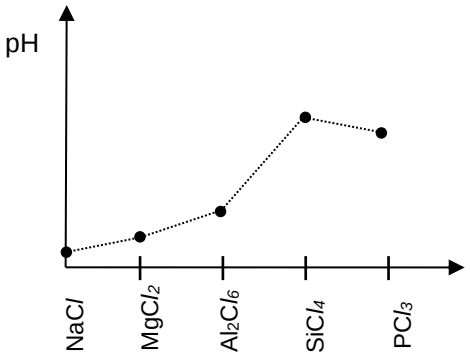
A



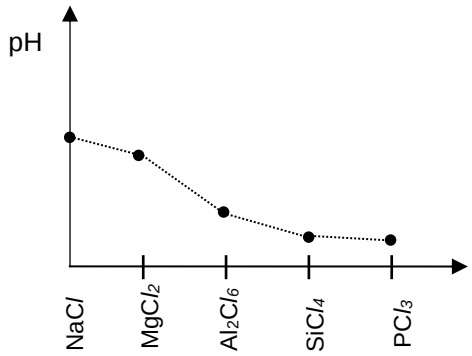
B



C



D



Answer is **D**

Across the Period 3, when the chlorides become more covalent, its tendency to undergo hydrolysis increases. Hence the pH of the resulting solution drops steadily across the period.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** are correct	**2** and **3** are correct	**1** only is correct.

26 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

$$NO_3^-(aq) \xrightarrow{\textbf{W}} NO_2^-(aq) \xrightarrow{\textbf{X}} NO(g) \xrightarrow{\textbf{Y}} N_2O(g) \xrightarrow{\textbf{Z}} N_2(g)$$

Which of the following steps involve a reduction in the oxidation number of nitrogen by 1?

1 **X**, **Y** and **Z**

2 **W** and **Y**

3 **W** and **X**

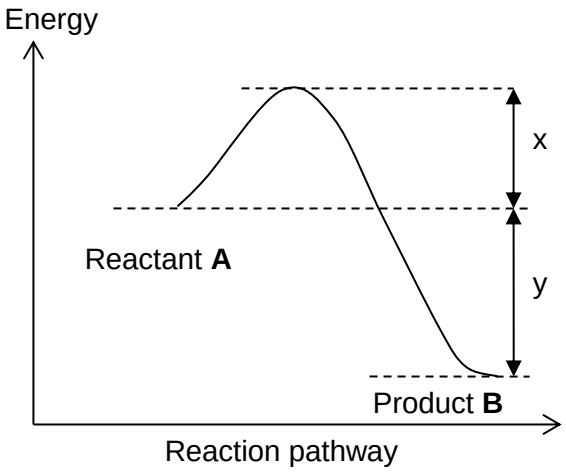
Answer is **D**

Oxidation number (oxidation state) of nitrogen:
+5 in NO_3^-
+3 in NO_2^-
+2 in NO
+1 in N_2O
0 in N_2

In **W** change in oxidation number = +2
In **X** change in oxidation number = +1
In **Y** change in oxidation number = +1
In **Z** change in oxidation number = +1

So option **1** is the correct.

27 The energy profile for a reversible reaction is shown below.



Which of the following statements are correct?

1 The reaction from **B** to **A** is endothermic.

2 The activation energy of the reaction **A** to **B** is *x*.

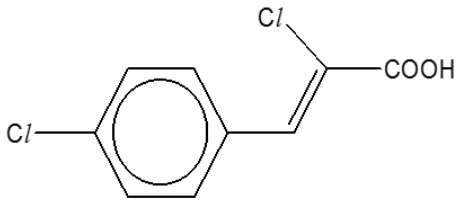
3 The activation energy of the reaction **B** to **A** is *x* + *y*.

Answer is **A**

Reactant **B** has lower energy than the product **A**, hence reaction is endothermic

Activation energy, E_a is the minimum amount of energy that molecular collisions must possess in order for a chemical reaction to occur. It is measured from the reactant to the transition state.

28 Compound **A** is used as a starting material for a class of anti-bacterial drugs known as quinolones. Which of the following statements about compound **A** are correct?



compound **A**

1 1 mole of **A** reacts with CH_3OH to give 1 mole of H_2O.

2 1 mole of **A** reacts with Na metal to give 0.5 mole of H_2.

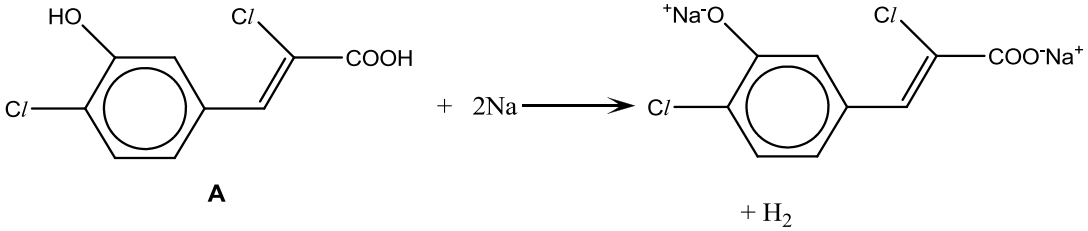
3 1 mole of **A** reacts with $CaCO_3$ to give 1 mole of CO_2.

Answer is **B**

Option **1** is correct as only carboxylic acid group in A reacts with PCl_5:

$$RCOOH + PCl_5 \longrightarrow RCOCl + POCl_3 + HCl$$

Option **2** is correct as both phenol and carboxylic acid group in A reacts with Na metal:



Option **3** is wrong as **2** moles of A reacts with $CaCO_3$ to form 1 mole of CO_2

$$2ROOH + CaCO_3 \longrightarrow Ca(RCOO^-)_2 + CO_2 + H_2O$$

29 For which types of compound are **all** of the following statements correct?

- They are unreactive towards mild oxidising agents.
- They form esters.
- They react with sodium.

1 aldehydes

2 carboxylic acids

3 tertiary alcohols

Answer is **C**

Option **1** is wrong because aldehydes can be oxidised but it cannot react with sodium and cannot form esters.

Option **2** and **3** are correct as both carboxylic acid and tertiary alcohols cannot be oxidised, they both react with sodium and they both can form esters.

30 Which of the following trends concerning Period 3 elements from Na to C*l* are true?

1 There is a change from metallic behaviour to non-metallic behaviour.

2 Their compounds show an increase in the maximum oxidation number across the period.

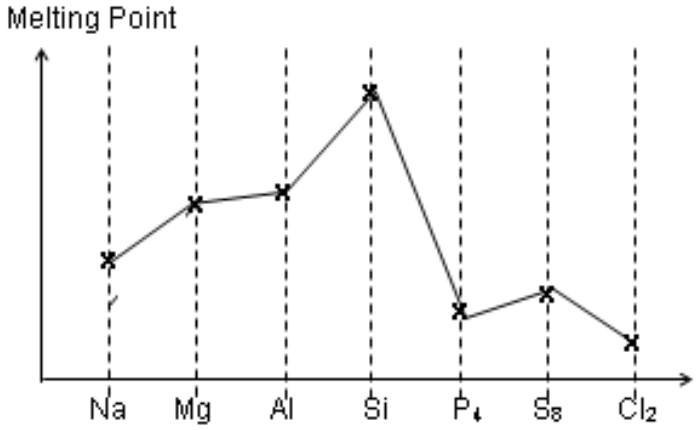
3 The melting points of the elements decrease across the period.

Answer is **B**

Option **1** is correct as the covalent character of the elements increase from Na to C*l*.

Option **2** is correct as the number of valence electrons increase Na to C*l* hence the maximum oxidation state of the element increases.

Option **3** is wrong as the melting point of the elements increase across the period and reaches a maximum at Si before decreasing across the period.



INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

8872/02

24 Aug 2017

2 hours

Paper 2 Structured Questions

Candidates answer on the question paper.

Additional Materials: *Data Booklet*
Writing paper

READ THESE INSTRUCTIONS FIRST

Write your index number, name and civics group on all the work you hand in.
Write in dark blue or black pen.
You may use pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the space provided.

Section B
Answer **2 out of 3** questions on writing paper provided.

You are advised to show all working in calculations.
You are reminded of the need for good English and clear presentation in your answers.
You are reminded of the need for good handwriting.
Your final answers should be in 3 significant figures.

You may use a calculator.

The number of marks is given in brackets [ ] at the end of each question or part question.

At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
1	/15
2	/9
3	/16
Section B	
4	/20
5	/20
6	/20
Significant Figures and Units	
Handwriting and Presentation	
Total	/80

This document consists of **15** printed pages and **1** blank page.

For Examiner's Use

Answer ALL questions on the space provided.

1 **(a)** The element potassium can exist as a number of isotopic species.

Complete the table below for two isotopic species of potassium.

isotopic species	protons	neutrons	electrons	electronic configuration
$^{39}_{19}K$	19			$1s^2$ ……...
		21	18	$1s^2$ ……...

[4]

(b) The structure of an alkene can be determined by identifying the products formed when it undergoes a type of reaction that involves the breakage of the C=C double bond.

In **(i)** and **(ii)** use the products shown to determine the structure of the original alkene.

(i) products: CO_2 and $(CH_3)_2CO$

(ii) products: CH_3CO_2H and $CH_3CH_2CO_2H$

[2]

(c) State the reagent(s) and condition(s) required for the reactions in **(b)(i)** and **b(ii)**.

……...

[1]

(d) State the type of reaction in **(b)(i)** and **b(ii)**.

……...

[1]

For Examiner's Use

(e) Alkenes can be prepared in the laboratory by heating alcohols with excess concentrated sulfuric acid. The set up shown below can be used to prepare a sample of ethene.

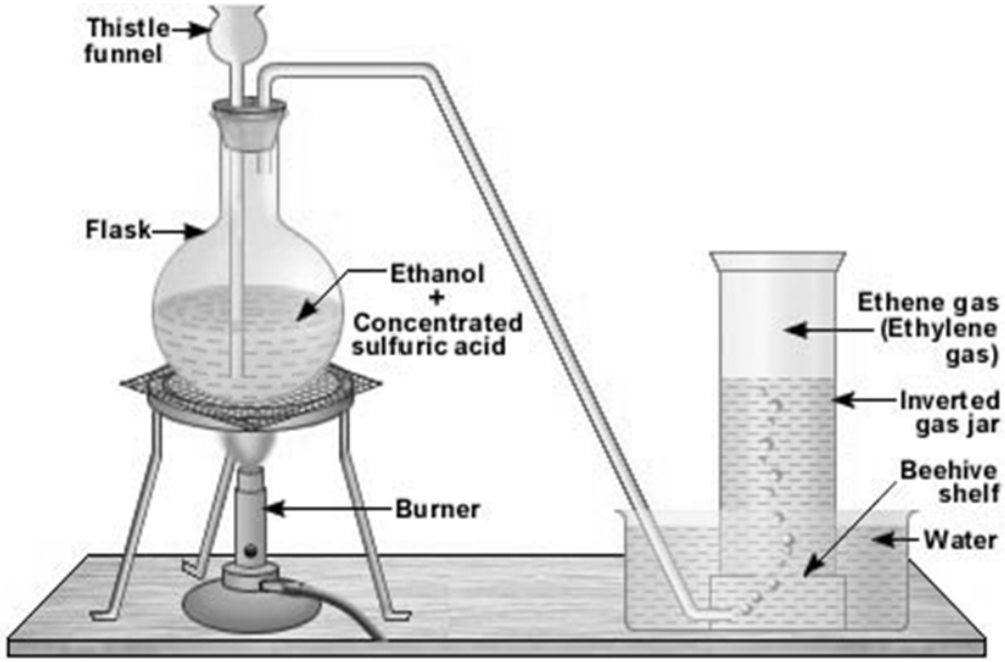


Figure 1.1

From the set up in **Figure 1.1**, the ethene gas collected in the inverted gas jar can be further purified by first bubbling it through another solution **A** and then passing it through a test tube containing anhydrous calcium chloride.

(i) Suggest an identity for solution **A** and explain its purpose.

……...

……...

[2]

(ii) Suggest why anhydrous calcium chloride is required to obtain pure ethene.

……

……

[1]

Ethane-1,2-diol, $CH_2(OH)CH_2(OH)$ may be formed instead of ethene if the water in **Figure 1.1** is replaced with reagent **B**.

(iii) Suggest an identity of reagent **B** and state the condition to be used.

……...

……...

[1]

For Examiner's Use

(iv) What changes do you expect to observe to reagent **B**?

……...

……...
[1]

(v) Suggest one simple chemical test that could be used to distinguish between ethane-1,2-diol and ethanol, and state the observation expected for each compound.

……...

……...

……...

……...

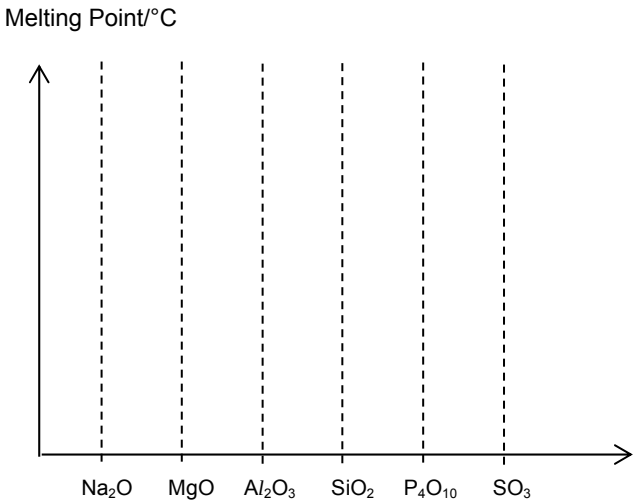
……...

……...
[2]

[Total: 15]

2 (a) (i) The oxides Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10} and SO_3 differ considerably in their physical properties.

In the space provided below, sketch a graph of the melting point of these oxides.



[2]

For Examiner's Use

(ii) Explain, as fully as you can, why the melting point varies across the oxides of Period 3 elements.

……

……

……

……

……

……

……

……

……

……

……

……

……

[4]

(b) Both aluminium and phosphorus can form chlorides.

PCl_5 hydrolyses in water to produce hydrochloric acid and phosphoric acid, $H_3PO_4(aq)$.

$AlCl_3$ also hydrolyses in water to produce an acidic solution.

(i) Write a balanced equation to show the reaction between PCl_5 and water.

……

[1]

(ii) Explain using equation(s) why $AlCl_3$ undergoes hydrolysis with water to produce an acidic solution.

……

……

……

[2]

[Total: 9]

For Examiner's Use

3 Carbonic acid-bicarbonate buffer is the most important buffer for maintaining acid-base balance in our blood. The equilibrium reactions involved are as follows.

$$H^+(aq) + HCO_3^-(aq) \overset{K_1}{\rightleftharpoons} H_2CO_3(aq)$$

$$H_2CO_3(aq) \overset{K_2}{\rightleftharpoons} H_2O(l) + CO_2(g)$$

(a) Carbonic acid-bicarbonate can act as a buffer because they are *conjugate acid-base pair.*

(i) Using H_2CO_3 as an example, what do you understand by the term *conjugate acid-base pair*.

……

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……

……

[1]

(ii) Define the term *buffer*.

……

……

……

[1]

(iii) Explain how carbonic acid-bicarbonate acts as buffer using relevant equations.

……

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……

……

[3]

For Examiner's Use

(b) During exercise, our body expends the energy in glucose and produces large amounts of CO_2 and H^+. This causes the pH of our blood to drop and may lead to a medical condition known as acidosis. Increased breathing during exercise will help to reverse this drop in pH.

Describe how increased breathing alters the carbonic acid-bicarbonate buffer equilibrium leading to the removal H^+ from the blood.

……

……

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……

……

……

[3]

(c) With reference to the equilibrium below, answer the following questions.

$$H^+(aq) + HCO_3^-(aq) \overset{K_1}{\rightleftharpoons} H_2CO_3(aq)$$

(i) Write an expression for the equilibrium constant of this reaction, K_1, stating clearly its units.

[2]

(ii) In our kidney, HCO_3^- is removed from the body. Predict what will happen to the value of K_1.

……

……

……

……

[1]

For Examiner's Use

(d) pH of blood is carefully maintained at 7.4 for our body to function optimally. pH of a carbonic acid-bicarbonate buffer solution can be calculated using modified Henderson-Hasselbalch equation.

$$pH = pK - \log_{10}\left(\frac{[HCO_3^-]}{[CO_2]}\right)$$

where pK is the negative logarithm of K (where $K = K_1.K_2$).

(i) Given the value of pK is 6.1, calculate the ratio of $[CO_2]$ and $[HCO_3^-]$ in our blood.

[1]

(ii) The desired concentration of HCO_3^- in the blood is 12 millimole per litre. Using your answer in **(d)(i)**, what is the corresponding concentration of CO_2 in mol dm^{-3}?

[1]

(iii) Calculate the mass of $NaHCO_3$ that needs to be dissolved in 1 dm^3 of water to obtain the desired concentration of HCO_3^- in a lab setting.

[1]

For Examiner's Use

(e) Besides exercise, alcohol beverage consumption can also lead to acidosis. This occurs when lactic acid, 2-hydroxypropanoic acid, is formed when ethanol is metabolised in the body.

The main component in alcohol beverages is ethanol.

(i) Ethanol can be converted to ethanoic acid. State the reagent(s) and condition(s) for this reaction in a lab setting.

Reagent(s) and condition(s)

……

……
[1]

(ii) Explain why lactic acid cannot be formed using its corresponding alcohol in the lab setting.

……

……

……

……
[1]

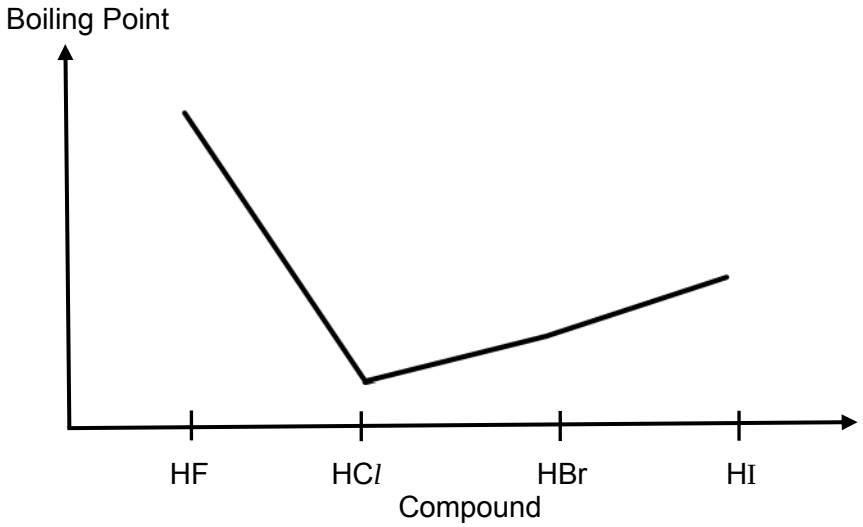
[Total:16]

SECTION B (Free Response Questions)

Answer **two** questions from this section on separate answer paper.

4 Hydrogen halides are diatomic inorganic compounds with the formula HX where X is one of the halogen atoms: fluorine, chlorine, bromine, iodine or astatine. They exist as gases that dissolve in water to give acids which are commonly known as hydrohalic acids.

The boiling points of hydrogen halides are shown in the graph below.



(a) **(i)** Explain why the boiling point of HF is the highest.

[2]

(ii) Explain why the boiling points of hydrogen halides increase from HC*l* to HI.

[2]

(b) With the aid of a diagram, draw the type of bonding present between HF molecules.

[2]

(c) Explain if hydrohalic acids are able to conduct electricity when dissolved in water.

[1]

At high temperature, hydrogen iodide partially dissociates into hydrogen and iodine according to the equation:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \quad \Delta H > 0$$

At 500K, the equilibrium constant, K_c, for the dissociation reaction is 6.25×10^{-3}. Some pure HI is placed into an evacuated glass tube and heated to 500K. In the equilibrium sample, the concentration of I_2 is 3.10×10^{-5} mol dm^{-3}.

(d) **(i)** Determine the concentrations of HI(g) in this equilibrium mixture at 500K.

[1]

(ii) Hence, calculate the initial concentration of HI added originally.

[1]

(iii) Suggest and explain how the value of K_c would change if the temperature of the glass tube was raised.

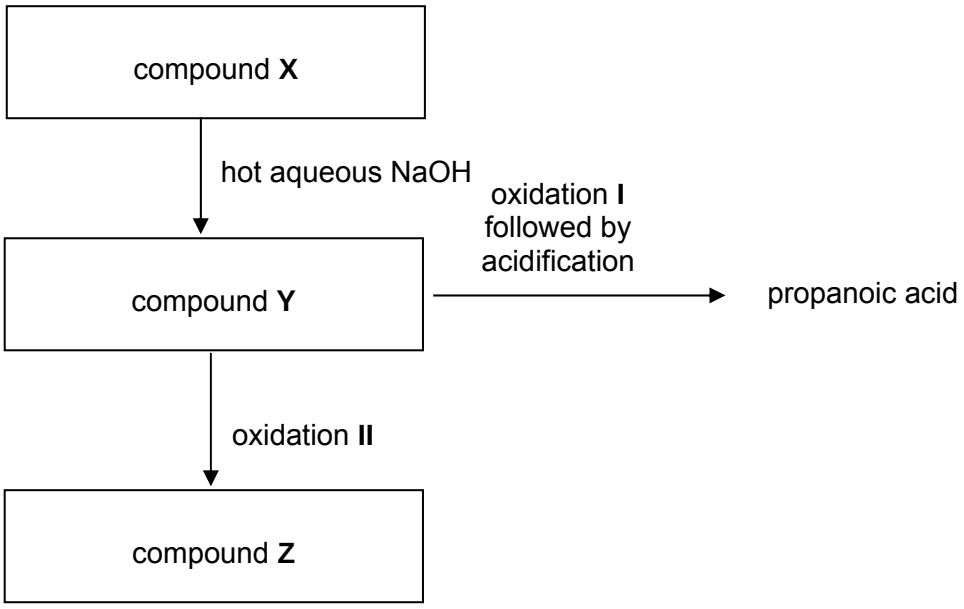
[2]

(e) Compound **X** is a halogenoalkane with molecular formula C_4H_9Cl. When heated under reflux with aqueous NaOH, compound **Y** is formed.

Compound **Y** is able to undergo oxidation with two different sets of reagents and conditions. Using the first set of reagents and conditions, followed by acidification, propanoic acid is formed. However, when compound **Y** is oxidised using the second set of reagents and conditions, product **Z** is formed. Compound **Z** reacts with 2,4 -dinitrophenylhydrazine but not with Tollens' reagent.

(i) Using the information given above and the flow chart below, deduce and draw the structures of compounds **X**, **Y** and **Z** in your writing paper.

[3]



(ii) State the reagents and conditions for oxidation **I** and oxidation **II**.

[2]

(iii) Predict the shape and bond angle about Cl – C – H in compound **X**, C_4H_9Cl.

[2]

(iv) State and explain whether compound **X**, C_4H_9Cl is polar or non-polar.

[2]

[Total: 20]

5 This question is about chlorine.

(a) Due to its toxic nature, chlorine was used as an offensive weapon in World War I in Flanders. It was first deployed in 1915 when the German army released the gas from hundreds of cylinders. The threat of causing many men dying in agony was eventually countered by issuing gas masks, termed the "hypo helmet", which was a hood that was dipped in aqueous sodium thiosulfate, $Na_2S_2O_3$.

(i) When chlorine gas was absorbed by sodium thiosulfate found in the "hypo helmet", chlorine was reduced to chloride while thiosulfate ions, $S_2O_3^{2-}$ was oxidised to sulfate ions, SO_4^{2-}.

Write a balanced equation for the reaction between chlorine and thiosulfate ions in an acidic medium.

[1]

(ii) Assuming that each treated "hypo helmet" effectively absorbed 500 cm^3 of chlorine gas during a battle at room temperature and pressure, and the production of each "hypo helmet" required 700 cm^3 of aqueous sodium thiosulfate, calculate the concentration in mol dm^{-3} of sodium thiosulfate required. [You may assume the mole ratio between Cl_2 and $S_2O_3^{2-}$ to be 2 : 3 if you are not able to write the equation between Cl_2 and $S_2O_3^{2-}$]

[3]

(b) Chlorine reacts with the Period 3 elements magnesium to phosphorus to form their chlorides. The melting point of these chlorides are given in the table below.

compound	magnesium chloride	aluminium chloride	phosphorus pentachloride
melting point/^oC	714	178	161

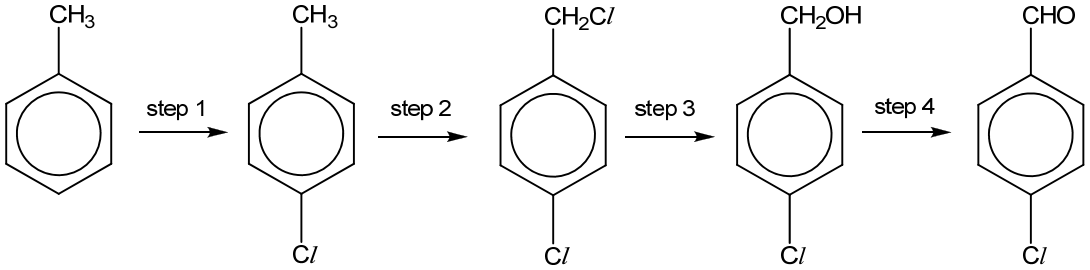
(i) Draw the Lewis structure of phosphorus pentachloride.

[1]

(ii) $AlCl_3$ can undergo dimerisation to form Al_2Cl_6. Draw the dot-and-cross diagram for $AlCl_3$ and Al_2Cl_6. Hence, or otherwise, deduce, with reasoning, whether the dimerisation reaction is endothermic or exothermic.

[3]

(c) Chlorine has landed its use in Organic Chemistry as shown in the reaction scheme below.



(i) Suggest suitable reagents and conditions for steps 1, 2 and 4.

[3]

(ii) State the type of reaction for step 3.

[1]

(d) The following results were obtained when chloroalkane, RC*l* reacted with aqueous sodium hydroxide.

Expt	Initial [NaOH] / mol dm^{-3}	Initial [RC*l*] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.02	0.0150	4.0×10^{-4}
2	0.02	0.0225	6.0×10^{-4}
3	0.03	0.0225	9.0×10^{-4}

(i) Deduce the orders of reaction with respect to each of the reactants. Hence, write the rate equation for the reaction.

[3]

(ii) In Expt 4, the initial concentrations of NaOH and RC*l* are 0.06 mol dm^{-3} and 0.03 mol dm^{-3} respectively. Calculate the initial rate for Expt 4.

[1]

(iii) Describe and explain, with an appropriate diagram, how the rate of this reaction is affected when the experiment is repeated at a higher temperature.

[4]

[Total: 20]

6 **(a)** Carbonates, CO_3^{2-} and hydrogencarbonates, HCO_3^{2-} react with acids in the following manner.

Reaction **A** $CO_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$
Reaction **B** $HCO_3^-(aq) + H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$

A student mixed 40.0 cm^3 of 1.0 mol dm^{-3} of an unknown solution and 40.0 cm^3 of 1.0 mol dm^{-3} of nitric acid, $HNO_3(aq)$. The temperature fell by 1.5 ºC.

The unknown solution is either sodium carbonate, Na_2CO_3 or sodium hydrogencarbonate, $NaHCO_3$.

(i) Use the standard enthalpy change of formation values in the table below to calculate the standard enthalpy change for reactions **A** and **B**.

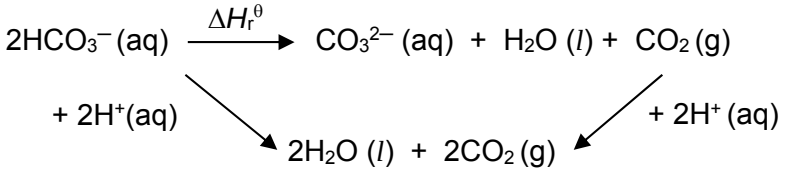
	ΔH_f^θ / kJ mol^{-1}
$H_2O(l)$	– 285.8
$CO_2(g)$	– 393.5
$HCO_3^-(aq)$	– 692
$CO_3^{2-}(aq)$	– 677
$H^+(aq)$	0.0

[2]

(ii) Use your answer in **(a)(i)** to determine which of the two equations, **A** or **B**, represents the reaction that has occurred. Explain your answer.

[3]

(b) Using the energy cycle provided, calculate the enthalpy change, ΔH_r^θ for the following reaction.



[2]

(c) Propanoic acid, CH_3CH_2COOH, can also react with carbonates and hydrogencarbonates.

(i) Explain in terms of its structure why 2-chloropropanoic, $CH_3CH(Cl)COOH$ acid is more acidic than propanoic acid.

[2]

(ii) Describe how you would convert propanoic acid to propan-1-ol, $CH_3CH_2CH_2OH$. Include the reagents and equation in your answer.

[2]

(d) How will propanal, CH_3CH_2CHO react with the following reagents?

In each case, write an equation to illustrate your answer and state what type of reaction is taking place.

(i) hydrogen cyanide, HCN, in the presence of sodium hydroxide,

[2]

(ii) 2,4-dintirophenylhydrazine reagent,

[2]

(ii) sodium borohydride, $NaBH_4$

[2]

(e) Describe one simple chemical test that could distinguish between propanoic acid and propan-1-ol.

[3]

[Total: 20]

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INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME

CLASS | INDEX NUMBER

CHEMISTRY

8872/02

Paper 2 Structured Questions

24 Aug 2017

Candidates answer on the question paper.

2 hours

Additional Materials: *Data Booklet*

READ THESE INSTRUCTIONS FIRST

Write your index number, name and civics group on all the work you hand in.
Write in dark blue or black pen.
You may use pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the space provided.

Section B
Answer **2 out of 3** questions on writing paper provided.

You are advised to show all working in calculations.
You are reminded of the need for good English and clear presentation in your answers.
You are reminded of the need for good handwriting.
Your final answers should be in 3 significant figures.

You may use a calculator.

The number of marks is given in brackets [ ] at the end of each question or part question.

At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
1	/15
2	/9
3	/16
Section B	
4	/20
5	/20
6	/20
Significant Figures and Units	
Handwriting and Presentation	
Total	/80

This document consists of **18** printed pages and **1** blank page.

Answer ALL questions on the space provided.

1 **(a)** The element potassium can exist as a number of isotopic species

Complete the table below for two isotopic species of potassium.

Isotopic species	protons	neutrons	electrons	electronic configuration
$^{39}_{19}K$	19	20	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
$^{40}_{19}K^+$	19	21	18	$1s^2 2s^2 2p^6 3s^2 3p^6$

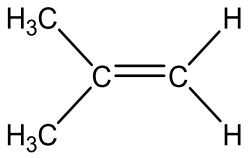
[4]

(b) The structure of an alkene can be determined by identifying the products formed when it undergoes a type of reaction that involves the breakage of the C=C double bond.

In **(i)** and **(ii)** use the products shown to determine the structure of the original alkene.

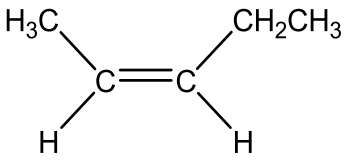
(i) products: CO_2 and $(CH_3)_2CO$

Original alkene:



(ii) products: CH_3CO_2H and $CH_3CH_2CO_2H$

Original alkene (accept cis-isomer)



[2]

(c) State the reagent(s) and condition(s) required for the reactions in **(b)(i)** and **b(ii)**.

$KMnO_4$, dilute H_2SO_4 heat with reflux (Accept heat)

[1]

(d) State the type of reaction in **(b)(i)** and **b(ii)**.

Oxidative cleavage (Accept Oxidation)

[1]

(e) Alkenes can be prepared in the laboratory by heating alcohols with **excess** concentrated sulfuric acid. The set up shown below can be used to prepare a sample of ethene.

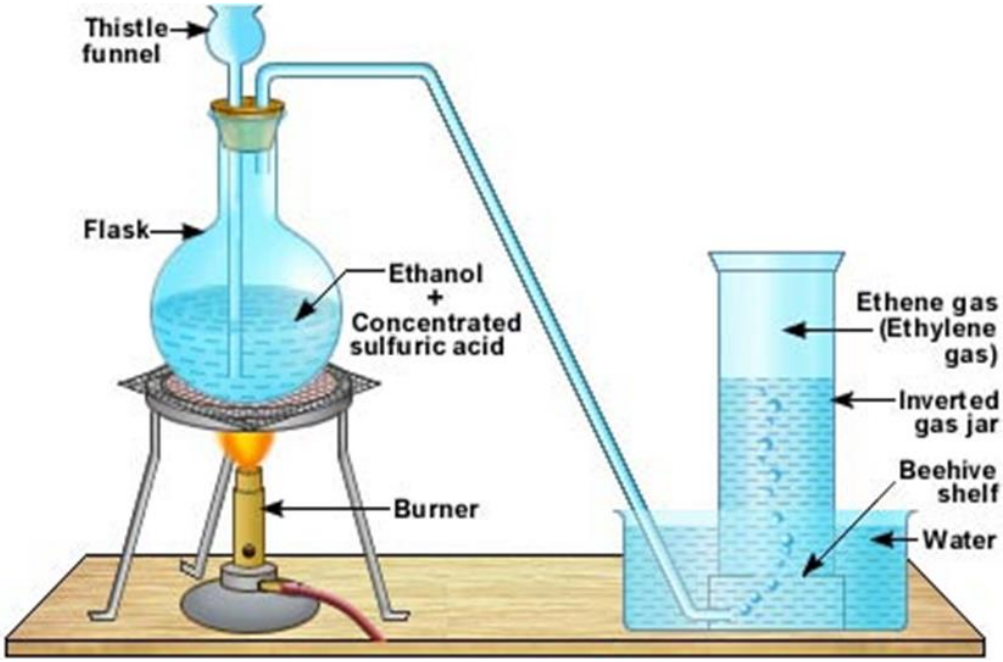


Figure 1.1

From the set up in **Figure 1.1**, the ethene gas collected in the inverted gas jar can be further purified by first bubbling it through another solution **A** and then passing it through a test tube containing anhydrous calcium chloride.

(i) Suggest an identity for solution **A** and explain its purpose.
Aqueous NaOH or Na_2CO_3.
To neutralize any sulfuric acid that remains

[2]

(ii) Suggest why anhydrous calcium chloride is required to obtain pure ethene
To remove water

[1]

Ethane-1,2-diol, $CH_2(OH)CH_2(OH)$ may be formed instead of ethene if the water in **Figure 1.1** is replaced with reagent **B**.

(iii) Suggest an identity of reagent **B** and state the condition to be used.
Cold $KMnO_4$, in dilute H_2SO_4(aq) or NaOH(aq)

[1]

(iv) What changes do you expect to observe to reagent **B**?
Purple $KMnO_4$ solution turns colourless
and a brown precipitate is observed (if alkaline medium is used)

[1]

(v) Suggest one simple chemical test that could be used to distinguish between ethane–1,2–diol and ethanol, and state the observation expected for each compound.

Add I_2, NaOH(aq) to each compound, warm
(Accept aqueous alkaline iodine)
Ethanol: yellow precipitate.
Ethane-1,2-diol: no precipitate.
OR
Add $KMnO_4$(aq), dil H_2SO_4(aq) to each compound, heat
Ethanol: Purple $KMnO_4$ turns colourless

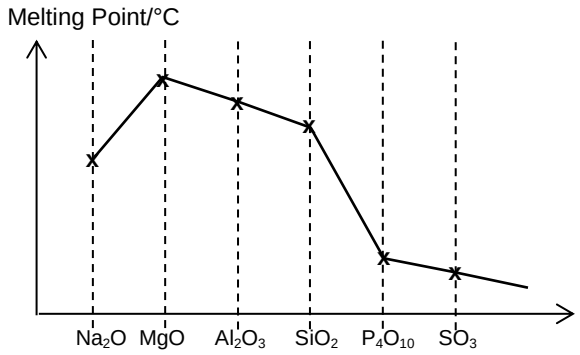
Ethane-1,2-diol: Purple $KMnO_4$ turns colourless. Effervescence is observed, when evolved gas is reacted with aqueous $Ca(OH)_2$, a white precipitate is observed.

[2]

[Total: 15]

2 **(a)** **(i)** The oxides Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10} and SO_3 differ considerably in their physical properties.

In the space provided below, sketch a graph of the **melting point** of these oxides.



*Axes will be given in question paper

- Graph should peak at MgO
- Increase from Na_2O to MgO then starts to drop
- Na_2O should be lower in m.p. than SiO_2
- P_4O_{10}/P_4O_6 and SO_3/SO_2 should have low m.p. with a decreasing trend

[2]

(ii) Explain, as fully as you can, why the melting point varies in the way shown.

Na_2O, MgO and Al_2O_3 has high melting point as it exists as giant ionic structure with strong electrostatic forces of attraction between the oppositely charged ions. Increase melting point from Na_2O to MgO is due to the increasing ionic bond stength of the compound. Al_2O_3 has ionic bond with covalent character hence the decrease in melting point.

SiO_2 has high melting point as it exists as giant covalent structure. Large amount of energy is required to break the strong and extensive covalent bonds between carbon atoms.

P_4O_{10} and SO_3 exist as simple molecular structure with instantaneous dipole induced dipole forces of attraction between molecules, hence less energy is required to overcome it. P_4O_{10} has a larger electron cloud size which is more easily polarised as compared to SO_3 hence a higher melting point.

[4]

(b) Both aluminium and phosphorus can form chlorides.

PCl_5 hydrolyses in water to produce hydrochloric acid and phosphoric acid, H_3PO_4(aq).

$AlCl_3$ also hydrolyses in water to produce an acidic solution.

(i) Write a balanced equation to show the reaction between PCl_5 and water.

$PCl_5 + 4H_2O \longrightarrow 5HCl + H_3PO_4$

[1]

(ii) Explain using equation(s) why $AlCl_3$ undergoes hydrolysis with water to produce an acidic solution.

Al^{3+} has high polarising power due to its high charge density. The O –H bond in the water molecule is polarised and broken to produce H^+ ions.

$[Al(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons [Al(H_2O)_5(OH)]^{2+}(aq) + H_3O^+(aq)$

[2]

[Total: 9]

3 Carbonic acid-bicarbonate buffer is the most important buffer for maintaining acid-base balance in our blood. The equilibrium reactions involved are as follows.

$$H^+(aq) + HCO_3^-(aq) \overset{K_1}{\rightleftharpoons} H_2CO_3(aq)$$

$$H_2CO_3(aq) \overset{K_2}{\rightleftharpoons} H_2O(l) + CO_2(g)$$

(a) Carbonic acid-bicarbonate can acts as a buffer because they are ***conjugate acid-base pair.***

(i) Using H_2CO_3 as an example, what do you understand by do you understand by the term ***conjugate acid-base pair***.

When H_2CO_3 loses its proton, its conjugate base HCO_3^- is formed. Hence, H_2CO_3 and HCO_3^- are conjugate acid-base pair.
OR
H_2CO_3 and HCO_3^- differs only by the addition/removal of H^+

[1]

(ii) Define the term *buffer*.

A buffer solution is one which resist changes in pH when small amounts of acid and base is added.

[1]

(iii) Explain how carbonic acid-bicarbonate acts as buffer using relevant equations.

When small amount of H^+ is added, H^+ reacts with the conjugate base HCO_3^-.

$$HCO_3^- + H^+ \longrightarrow H_2CO_3$$

$[H^+]$ remains relatively constant/ pH remains fairly constant.

When base amount of OH^- is added, OH^- reacts with the acid H_2CO_3.

$$H_2CO_3 + OH^- \longrightarrow HCO_3^- + H_2O$$

$[OH^-]$ remains relatively constant/ pH remains fairly constant.

[3]

(b) During exercise, our body expends the energy in glucose and produces large amounts of CO_2 and H^+. This causes the pH of our blood to drop and may lead to a medical condition known as acidosis. Increased breathing during exercise will help to reverse this drop in pH.

(i) Describe how increase breathing alters the carbonic acid-bicarbonate buffer equilibrium leading to the removal H^+ from the blood.

When breathing, CO_2 is removed (from the lung and reduced $[CO_2]$ in the blood) By Le Chatelier's Principle, equilibrium position of this $H_2CO_3(aq) \rightleftharpoons H_2O(l) + CO_2(g)$ to shift to the right to increase the concentration of CO_2. This decreases the concentration of H_2CO_3 will then cause the equilibrium position of $H^+(aq) + HCO_3^-(aq) \rightleftharpoons H_2CO_3(aq)$ to the right to increase in conceration of H_2CO_3.and decrease concentration of H^+ (from the blood).

[3]

(c) With reference to the equilibrium below, answer the following questions.

$$H^+(aq) + HCO_3^-(aq) \overset{K_1}{\rightleftharpoons} H_2CO_3(aq)$$

.

(i) Write an expression for the equilibrium constant of this reaction, K_1, stating clearly its units.

$K_1 = \dfrac{[H_2CO_3]}{[HCO_3^-][H^+]}$

Units: $mol^{-1}\ dm^3$

[2]

(ii) In our kidney, HCO_3^- is removed from the body. Predict what will happen to the value of K_1.

K_1 remains constant (as equilibrium constant only changes with temperature).

[1]

(d) pH of blood is carefully maintained at 7.4 for our body to function optimally. pH of a carbonic acid-bicarbonate buffer solution can be calculated using modified Henderson-Hasselbalch equation.

$$pH = pK - \log_{10}\left(\frac{[HCO_3^-]}{[CO_2]}\right)$$

Where pK is the negative logarithm of K (where $K = K_1.K_2$).

(i) Given the value of pK is 6.1, calculate the ratio of $[CO_2]$ and $[HCO_3^-]$ in our blood.

$7.4 = 6.1 - \log\left(\dfrac{[HCO_3^-]}{[CO_2]}\right)$

$\log\left(\dfrac{[HCO_3^-]}{[CO_2]}\right) = -1.3$

$\left(\dfrac{[HCO_3^-]}{[CO_2]}\right) = 0.0501$

OR $\dfrac{[CO_2]}{[HCO_3^-]} = 19.95 = 20.0$

[1]

(ii) The desired concentration of HCO_3^- in the blood is 12 millimole per litre. Using your answer in **(d)(i)**, what is the corresponding concentration of CO_2 in mol dm^{-3}?

$[HCO_3^-]$ = 12 millimole per litre = 12 x 10^{-3} mol dm^{-3}

$[CO_2] = \frac{12 \times 10^{-3}}{0.0501}$

= 0.239 mol dm^{-3}

OR $[CO_2]$ = 19.95 x $[HCO_3^-]$

[1]

(iii) Calculate the mass of $NaHCO_3$ that needs to be dissolved in 1 dm^3 of water to obtain the desired concentration of HCO_3^- in a lab setting.

No. of mol. Of HCO_3^- needed = 12 x 10^{-3} mol
Mass of $NaHCO_3$ needed = 84.0 (Mr of $NaHCO_3$) x 12 x 10^{-3}
= 1.01 g

[1]

(e) Besides exercise, alcohol beverage consumption can also lead to acidosis. This occurs when lactic acid, 2-hydroxypropanoic acid, is formed when ethanol is metabolised in the body.

The main component in alcohol beverages is ethanol.

(i) Ethanol can be converted to ethanoic acid. State the reagent (s) and condition (s) for this reaction in a lab setting.

Reagent (s) and condition (s)

$K_2Cr_2O_7$, dilute H_2SO_4 and heat (with reflux).
OR
$KMnO_4$, dilute H_2SO_4 and heat (with reflux) [1]

(ii) Explain why lactic acid cannot be formed using its corresponding alcohol in the lab setting.

The corresponding alcohol of lactic acid is $CH_3CH(OH)CH_2OH$, when it is subjected to the reagent(s) and condition(s) in part (e)(i), both alcohol present in the molecule will be oxidised. [1]

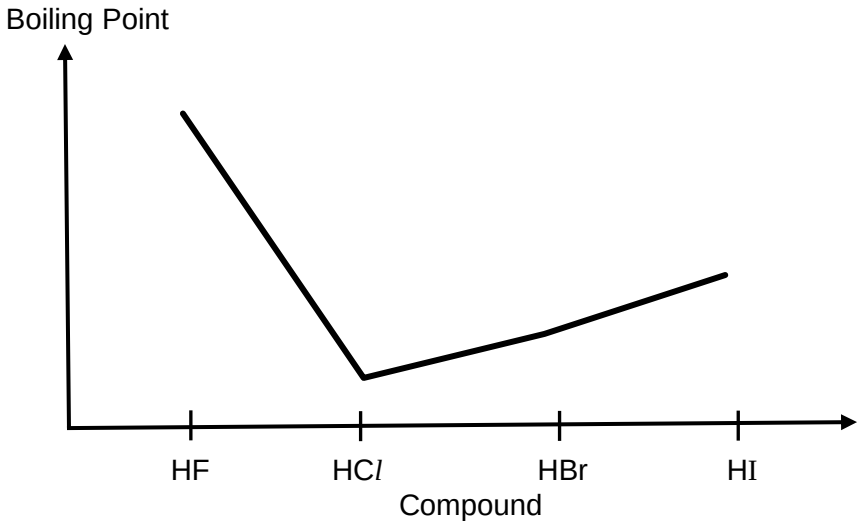
[Total:16]

SECTION B (Free Response Questions)

Answer **two** questions from this section on separate answer paper.

4 Hydrogen halides are diatomic inorganic compounds with the formula HX where X is one of the halogen atoms: fluorine, chlorine, bromine, iodine, or astatine. They exist as gases that dissolve in water to give acids which are commonly known as hydrohalic acids.

The boiling points of hydrogen halides are shown in the graph below.



(a) **(i)** Explain why the boiling point of HF is the highest.

[2]

The hydrogen halides have simple molecular structures.
The unusually high boiling point of HF is due to the intermolecular hydrogen bonds between HF molecules which are stronger than the permanent dipole permanent dipole OR instantaneous dipole induced dipole interactions between HC*l* HBr and HI molecules .

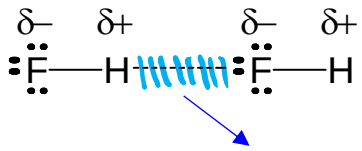
(ii) Explain why the boiling points of hydrogen halides increase from HC*l* to HI.

[2]

The size of electron cloud increases from HC*l* to HI. Polarisability of the electron cloud of the molecules increase and strength of instantaneous dipole–induced dipole between molecules also increases from HC*l* to HI. More energy is required to overcome the intermolecular attractions between HI.

(b) With the aid of a diagram, draw the type of bonding present between HF molecules.

[2]



Hydrogen bonding

- correct set of dipole on both molecules
- at least one lone pair of electrons on F used for bonding
- bonding from H to lone pair of electrons

- labelling of hydrogen bonding

(c) Explain if hydrohalic acids are able to conduct electricity when dissolved in water.

[1]

Hydrohalic acids are able to conduct electricity as the hydrogen halides dissociate/ ionise in water to form free moving / mobile H^+ and X^- ions which can conduct electricity.

At high temperature, hydrogen iodide partially dissociates into hydrogen and iodine according to the equation:

$$2HI\,(g) \rightleftharpoons H_2\,(g) + I_2\,(g) \qquad \Delta H > 0$$

At 500K, the equilibrium constant, K_c, for the dissociation reaction is 6.25×10^{-3}. Some pure HI is placed into an evacuated glass tube and heated to 500K. In the equilibrium sample, the concentration of I_2 is 3.10×10^{-5} mol dm^{-3}.

(d) **(i)** Determine the concentrations of HI (g) in this equilibrium mixture at 500K.

[1]

$[H_2] = [I_2] = 3.1 \times 10^{-5}$ mol dm^{-3}

$K_c = \frac{[H_2][I_2]}{\{HI\}^2}$

$[HI] = 3.92 \times 10^{-4}$ mol dm^{-3}

(ii) Hence, calculate the initial concentration of HI added originally.

[1]

	2HI (g)	H_2 (g)	I_2 (g)
Initial conc	?	0	0
Change in conc	$-2 \times (3.1 \times 10^{-5})$	$+ 3.1 \times 10^{-5}$	$+ 3.1 \times 10^{-5}$
Eqm conc	3.92×10^{-4}	3.1×10^{-5}	3.1×10^{-5}

$[HI]_{initial} = 3.92 \times 10^{-4} + 2(3.10 \times 10^{-5})$
$= 4.54 \times 10^{-4}$ mol dm^{-3}

(iii) Suggest and explain how the value of K_c would change if the temperature of the glass tube was raised.

[2]

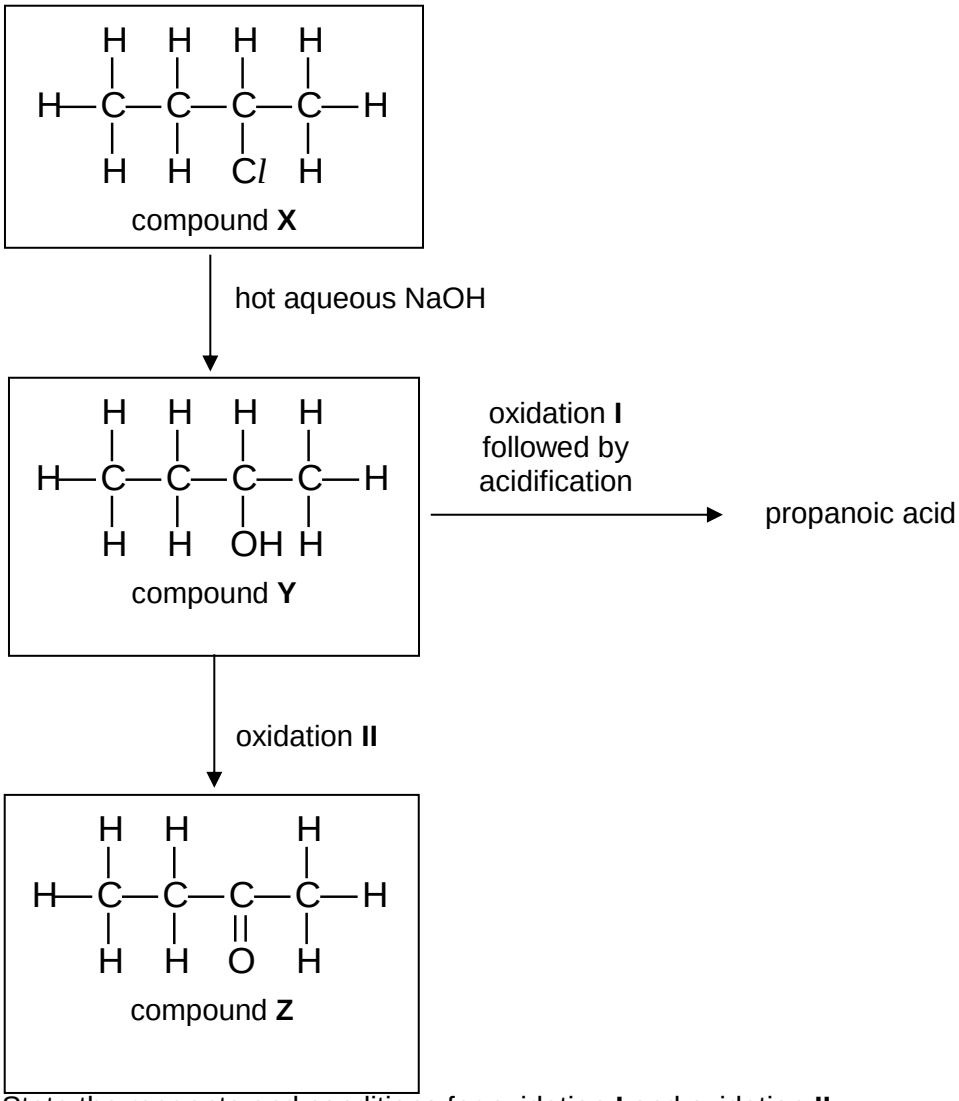
When the temperature was raised, the system will remove the additional heat by favouring the endothermic reaction which will shift the equilibrium to the right. This will increase the value of K_c.

(e) Compound **X** is a halogenoalkane with molecular formula C_4H_9Cl. When heated under reflux with aqueous NaOH, compound **Y** is formed.

Compound **Y** is able to undergo oxidation with two different sets of reagents and conditions. Using the first set of reagents and conditions, followed by acidification, propanoic acid is formed. However, when compound **Y** is oxidised using the second set of reagents and conditions, product **Z** is formed. Compound **Z** reacts with 2,4 - dinitrophenylhydrazine but not with Tollens' reagent.

(i) Using the information given above, deduce and draw the structures of compounds **X**, **Y** and **Z** in the flowchart below.

[3]



(ii) State the reagents and conditions for oxidation **I** and oxidation **II**.

[2]

Oxidation **I**: NaOH(aq), I_2(aq), warm
Oxidation **II**: $KMnO_4$ OR $K_2Cr_2O_7$, H_2SO_4(aq), heat

(iii) Predict the shape and bond angle about C*l* – C – H in compound **X**, C_4H_9Cl.

[2]

Shape : tetrahedral Bond angle : 109.5°

(iv) State and explain whether compound **X**, C_4H_9Cl is polar or non-polar.

[2]

C_4H_9Cl is polar/ C – C*l* bond is polar due to the difference in electronegativity between carbon and chlorine atoms. The dipole moments do not cancel each other out OR there is a net dipole moment.

[Total: 20m]

5 This question is about chlorine.

(a) Due to its toxic nature, chlorine was used as an offensive weapon in World War I in Flanders. It was first deployed in 1915 when the German army released the gas from hundreds of cylinders. The threat of causing many men dying in agony was eventually

countered by issuing gas masks, termed the "hypo helmet", which was a hood that was dipped in aqueous sodium thiosulfate, $Na_2S_2O_3$.

(i) When chlorine gas was absorbed by sodium thiosulfate found in the "hypo helmet", chlorine was reduced to chloride while thiosulfate ions, $S_2O_3^{2-}$ was oxidised to sulfate ions, SO_4^{2-}.

Write a balanced equation for the reaction between chlorine and thiosulfate ions in an acidic medium.

$4\ Cl_2\ (g) + S_2O_3^{2-}\ (aq) + 5\ H_2O\ (l) \rightarrow 8\ Cl^-\ (aq) + 2\ SO_4^{2-}\ (aq) + 10\ H^+\ (aq)$

Ignore state symbols

[1]

(ii) Assuming that each treated "hypo helmet" effectively absorbed 500 cm^3 of chlorine gas during a battle at room temperature and pressure, and the production of each "hypo helmet" required 700 cm^3 of aqueous sodium thiosulfate, calculate the concentration in mol dm^{-3} of sodium thiosulfate required.

[You may assume the mole ratio between Cl_2 and $S_2O_3^{2-}$ to be 2 : 3 if you are not able to write the equation between Cl_2 and $S_2O_3^{2-}$]

No. of moles of chlorine in 500 cm^3 = $(500 \times 10^{-3})/ 24 = 0.0208$ mol

No. of moles of thiosulfate needed = $0.0208 / 4 = 5.208 \times 10^{-3}$ mol [ECF from wrong mole ratio]

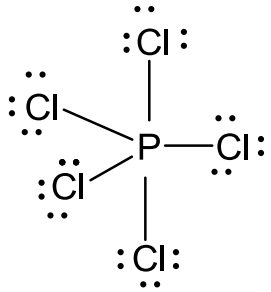
Conc of thiosulfate = mole/vol = $(5.208 \times 10^{-3}) / (700 \times 10^{-3})$
= 7.44×10^{-3} mol dm^{-3}

[3]

(b) Chlorine reacts with the Period 3 elements magnesium to phosphorus to form their chlorides. The melting point of these chlorides are given in the table below.

compound	magnesium chloride	aluminium chloride	phosphorus pentachloride
melting point/^oC	714	178	161

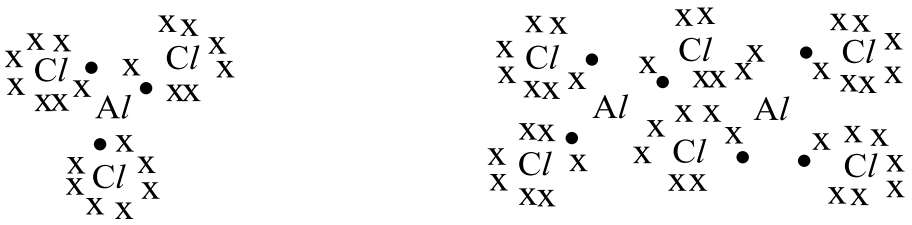
(i) Draw the Lewis structure of phosphorus pentachloride.



Must show correct axial and equatorial position
Must show lone pair of electrons on chlorine

[1]

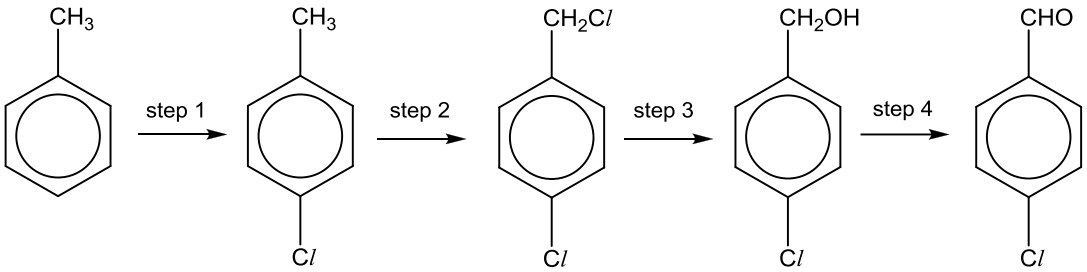
(ii) $AlCl_3$ can undergo dimerisation to form Al_2Cl_6. Draw the dot-and-cross diagram for $AlCl_3$ and Al_2Cl_6. Hence, or otherwise, deduce, with reasoning, whether the dimerisation reaction is endothermic or exothermic.



The dimerization involves forming bond between two $AlCl_3$ molecules. Hence, the reaction is exothermic.

[3]

(c) Chlorine has landed its use in Organic Chemistry as shown in the reaction scheme below.



(i) Suggest suitable reagents and conditions for steps 1, 2 and 4.
Step 1: Cl_2(g), or Cl_2 in CCl_4, anhydrous $FeCl_3$ catalyst, room temp in the dark (to prevent FRS) (For catalyst, can use Fe or $AlClX_3$)

Step 2: Cl_2(g), or Cl_2 in CCl_4, uv light

Step 4: $K_2Cr_2O_7$, dil H_2SO_4, heat with immediate distillation

[3]

(ii) State the type of reaction for step 3.
Substitution

Do not accept hydrolysis.

[1]

(d) The following results were obtained when chloroalkane, RCl reacted with aqueous sodium hydroxide.

Expt	Initial [NaOH] / mol dm^{-3}	Initial [RCl] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.02	0.0150	4.0×10^{-4}
2	0.02	0.0225	6.0×10^{-4}
3	0.03	0.0225	9.0×10^{-4}

(i) Deduce the orders of reaction with respect to each of the reactants. Hence, write the rate equation for the reaction.
Comparing expt 2 & 3

When [NaOH] increases by 1.5 times, keeping [RC*l*] constant, rate increases by 1.5 time. Order wrt NaOH is 1.

Comparing expt 1 & 2
When [RC*l*] increases by 1.5 times, keeping [NaOH] constant, rate increases by 1.5 time. Order wrt RC*l* is 1.

Rate = k [NaOH][RC*l*] [ECF based on order]

[3]

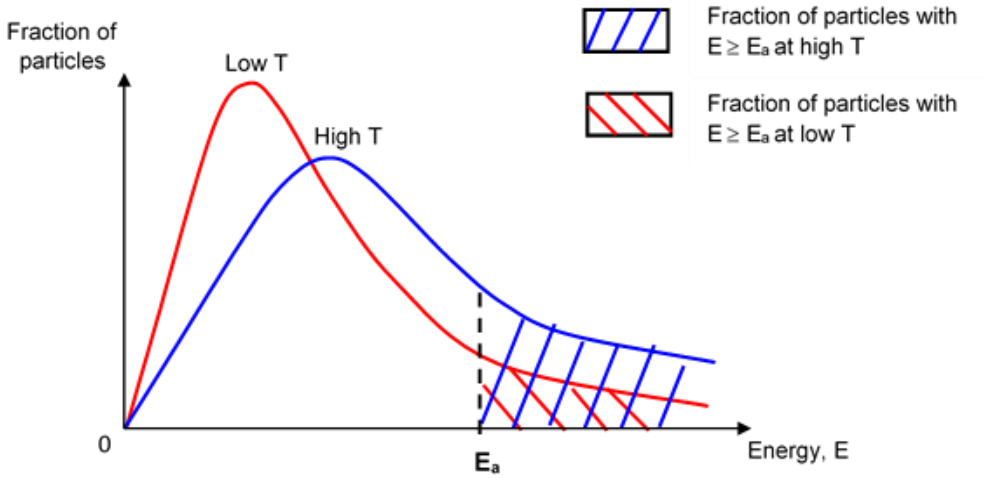
(ii) In Expt 4, the initial concentrations of NaOH and RC*l* are 0.06 mol dm^{-3} and 0.03 mol dm^{-3} respectively. Calculate the initial rate for Expt 4.

Comparing expt 1 & 4
[NaOH] increases by 3 and [RCl] increases by 2
Therefore rate increases by 6

$x = (3 \times 2 \times 4.0 \times 10^{-4})$
$= 2.4 \times 10^{-3}$ mol dm^{-3} s^{-1}

[1]

(iii) Describe and explain, with an appropriate diagram, how the rate of this reaction is affected when the experiment is repeated at a higher temperature.



- ✓ Correct axes & origin
- ✓ Correct shape of both graphs with correct label & start at origin
- ✓ Ea & correct shading
- ✓ Correct legend & corresponding shading

At a higher temperature, 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 as rate of reaction is proportional to frequency of effective collision.

[4]

[Total: 20m]

(a) Carbonates, CO_3^{2-} and hydrogencarbonates, HCO_3^{2-} react with acids in the following manner.

Reaction A $CO_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$
Reaction B $HCO_3^{-}(aq) + H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$

A student mixed 40.0 cm^3 of 1.0 mol dm^{-3} of an unknown solution and 40.0 cm^3 of 1.0 mol dm^{-3} of nitric acid, $HNO_3(aq)$. The temperature fell by 1.5 °C.

The unknown solution is either sodium carbonate, Na_2CO_3 or sodium hydrogencarbonate, $NaHCO_3$.

(i) Use the standard enthalpy change of formation values in the table below to calculate the standard enthalpy change for reactions **A** and **B**.

	ΔH_f^θ / kJ mol^{-1}
$H_2O(l)$	– 285.8
$CO_2(g)$	– 393.5
$HCO_3^-(aq)$	– 692
$CO_3^{2-}(aq)$	– 677
$H^+(aq)$	0.0

[2]

Using the ΔH_f^θ values (theoretical data):

ΔH_{rxn}^θ of **A** = $\sum n\Delta H_f^\theta$ **(products)** – $\sum m\Delta H_f^\theta$ **(reactants)**

= (-285.8 -393.5) – (-677)

= (-679.3) + 677 = – 2.30 kJ mol^{-1}

ΔH_{rxn}^θ of **B** = $\sum n\Delta H_f^\theta$ **(products)** – $\sum m\Delta H_f^\theta$ **(reactants)**

= (– 679.3) – (– 692) = – 679.3 + 692 = +12.7 kJ mol^{-1}

(ii) Use your answer in **(a)(i)** to determine which of the two equations, **A** or **B**, represents the reaction that has occurred. Explain your answer.

[3]

Using the ΔH_f^θ values (theoretical data):

ΔH_{rxn}^θ of **A** = – 2.30 kJ mol^{-1}

ΔH_{rxn}^θ of **B** = +12.7 kJ mol^{-1}

Heat absorbed = mcΔT = (80)(4.18)(1.5) = 501.6 J

Moles of $H^+ = \frac{40}{1000} \times 1.0 = 0.04$ mol

Moles of CO_3^{2-} or $HCO_3^- = \frac{40}{1000} \times 1.0 = 0.04$ mol

In both cases, H^+ is the limiting reagent. (Note that this is not a marking point)

ΔH^{θ}_{rxn} of A = $+\frac{501.6}{0.02}$ = +25080 J mol^{-1} = +25.1 kJ mol^{-1}

ΔH^{θ}_{rxn} of B =$+\frac{501.6}{0.04}$ = +12540 J mol^{-1} = +12.5 kJ mol^{-1}

Since the experimental value of the ΔH^{θ}_{rxn} of B is similar to the theoretical value, equation **B** has occurred.

2 – 1mark

Alternative answer

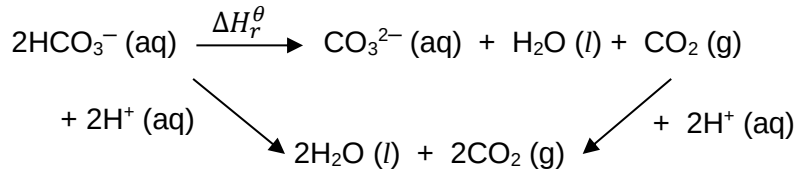
Using the ΔH^{θ}_{f} values (theoretical data):

ΔH^{θ}_{rxn} of **A** = – 2.30 kJ mol^{-1}

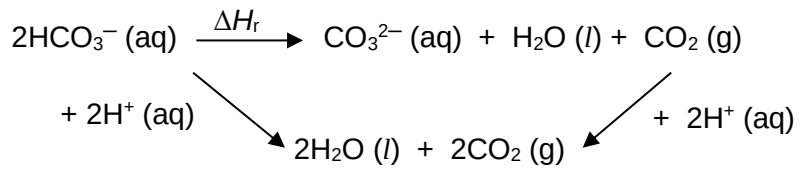
ΔH^{θ}_{rxn} of **B** = +12.7 kJ mol^{-1}

Since the enthalpy change of reaction of **B** is **positive** and the reaction is observed to be an **endothermic** one where **temperature has dropped**, equation **B** has occurred.

(b) Using the energy cycle provided, calculate the enthalpy change, ΔH^{θ}_{r} for the following reaction.



[2]



ΔH^{θ}_{rxn} of A = -2.3 kJ mol^{-1}

ΔH^{θ}_{rxn} of B = +12.7 kJ mol^{-1}

From the energy cycle, using Hess' law,

ΔH^{θ}_{rxn} = 2 x ΔH^{θ}_{rxn} of B - ΔH^{θ}_{rxn} of A

= 2 x + 12.7 – (– 2.3) = +27.7 kJ mol^{-1}

Sign must be seen for answer.

ECF if the student's calculation for ΔH^{θ}_{rxn} of A and ΔH^{θ}_{rxn} of B are wrong in part (a).

(c) Propanoic acid, CH_3CH_2COOH, can also react with carbonates and hydrogencarbonates.

(i) Explain in terms of its structure why 2-chloropropanoic, $CH_3CH(Cl)COOH$ acid is more acidic than propanoic acid. [2]

Compare $CH_3CH(Cl)COOH$ vs CH_3CH_2COOH

$CH_3C(Cl)HCOOH$ is more acidic than CH_3CH_2COOH because the electron withdrawing Cl atom is present. The negative charge on O atom of anion is more dispersed and hence the anion $CH_3CH(Cl)COO^-$ is more stabilised than the $CH_3CH_2COO^-$ anion.

(ii) Describe how you would convert propanoic acid to propan-1-ol, $CH_3CH_2CH_2OH$. Include the reagents and equation in your answer. [2]

React propanoic acid with $LiAlH_4$ with dry ether at room temperature.

Equation: $CH_3CH_2COOH + 4[H] \longrightarrow CH_3CH_2CH_2OH + H_2O$

(d) How will propanal, CH_3CH_2CHO react with the following reagents?

In each case, write an equation to illustrate your answer and state what type of reaction is taking place.

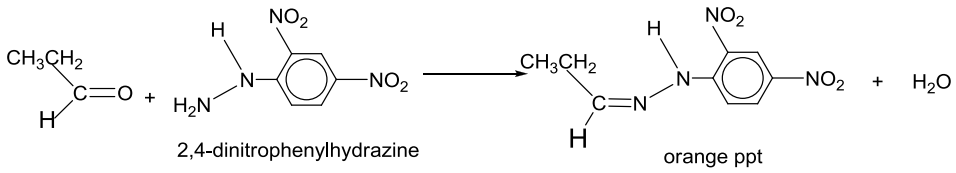
(i) hydrogen cyanide, HCN, in the presence of sodium hydroxide, [2]

Type of reaction: addition

$CH_3CH_2CHO + HCN \longrightarrow CH_3CH_2CH(CN)OH$

(ii) 2,4-dintirophenylhydrazine reagent, [2]

Type of reaction: condensation



(ii) Sodium borohydride, $NaBH_4$ [2]

Type of reaction: reduction

$CH_3CH_2CHO + 2[H] \longrightarrow CH_3CH_2CH_2OH$

(e) Describe one simple chemical test that could distinguish between propanoic acid and propan-1-ol.

[3]

Test: add Na_2CO_3(aq) to each sample at room temp

Observation:
For propanoic acid, effervescence seen & gas evolved gives white ppt with $Ca(OH)_2$ (aq) but no effervescence is seen for propanol.

OR

Test: add $KMnO_4$ followed by dilute H_2SO_4 into each sample & heat.

Observation:
For propanol, purple $KMnO_4$ is decolourised but purple $KMnO_4$ remains for ethanoic acid.

[Total: 20]

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