OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL A-LEVEL

CHEMISTRY (9620)

Unit 5 Practical and synoptic

Monday 18 June 2018 07:00 GMT Time allowed: 1 hour 25 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

For Examiner's Use	
Question	Mark
1	
2	
3	
4–33	
TOTAL	

Do not write outside the box

Section A

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

0 1 . 1 A student has samples of three organic compounds. The samples are not labelled but are known to be propanoic acid, butanal and pentan-1-ol.

Describe **three** test-tube reactions that can be used to identify the three organic compounds. Use a **different** test-tube reaction for each compound.

Your answer should include the reagent(s) used and the expected observation for each test.

[6 marks]

Propanoic acid

Butanal

Pentan-1-ol

Do not write outside the box

0 1 . 2 The student mixed together samples of pentan-1-ol and propanoic acid and added a few drops of concentrated sulfuric acid.
The mixture was left in a warm place for a reaction to occur.

Write an equation for the reaction that occurs.
State an observation that would be made at the end of the reaction.
Give the IUPAC name of the organic product.

[3 marks]

Equation

Observation _____

_____

IUPAC name _____

_____

9

Turn over for the next question

Do not write outside the box

0 2 An alcohol, ROH, reacts with hydrochloric acid according to the equation

$$ROH + HCl \rightarrow RCl + H_2O$$

The kinetics of this reaction were investigated using this method.

- An aqueous mixture was prepared containing equal volumes of alcohol and hydrochloric acid.
- The concentration of HCl in the mixture, [HCl], was monitored by removing 5.00 cm^3 samples at known times. The samples were diluted and titrated with aqueous sodium hydroxide.
- A graph was plotted of [HCl] against time.

0 2 . 1 A 5.00 cm^3 sample was removed from the reaction mixture. This sample was then diluted to a volume of 25.0 cm^3 using deionised water.

This diluted sample needed 11.50 cm^3 of 0.255 mol dm^{-3} aqueous sodium hydroxide for complete neutralisation.

Calculate [HCl] in the sample removed from the reaction mixture.
Give your answer to the appropriate number of significant figures.

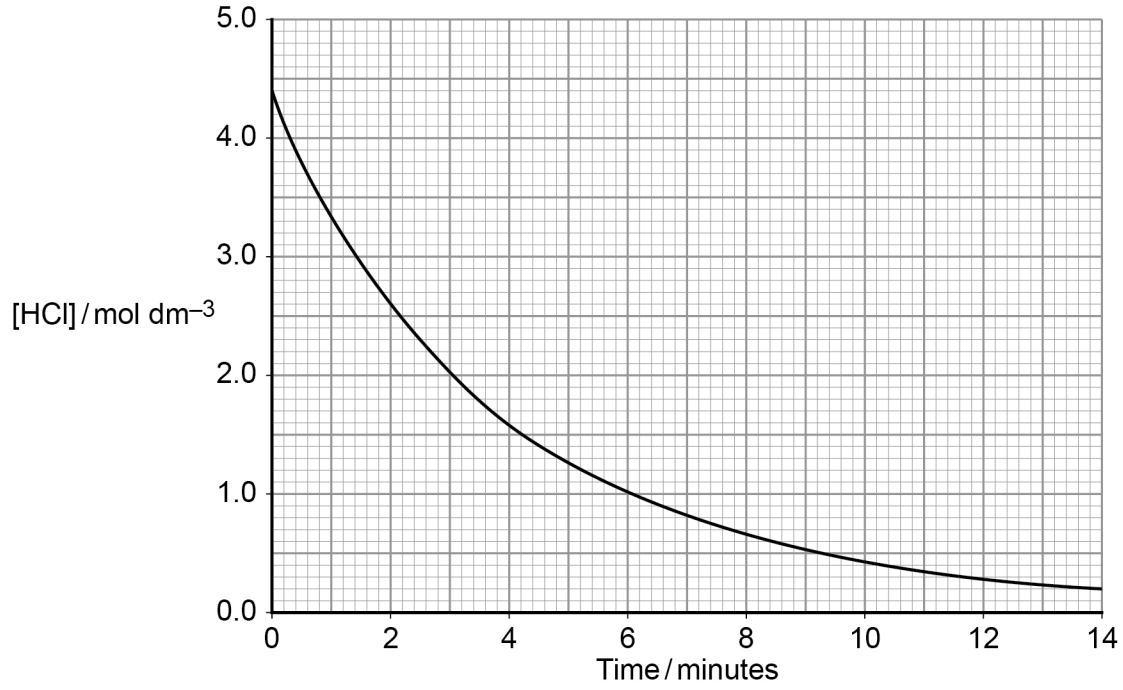
[3 marks]

[HCl] _____ mol dm^{-3}

Do not write outside the box

0 2 . 2 **Figure 1** shows how [HCl] varies with time during the reaction.

Figure 1



Determine the rate of reaction at t = 4.0 minutes by drawing a tangent to the curve in **Figure 1**.

[3 marks]

rate of reaction _____ mol dm^{-3} min^{-1}

Turn over ►

Do not write outside the box

0 2 . 3 A graph of rate of reaction against [HCl] was plotted. The graph was a straight line through the origin.

The reaction between ROH and HCl is first order with respect to ROH

Deduce the rate equation for the reaction between ROH and HCl

[1 mark]

0 2 . 4 In one calculation of [HCl] the volume of the sample removed was recorded as 5.00 cm^3 but 10.00 cm^3 were incorrectly removed.

Deduce the effect, if any, of this mistake on the calculated value of [HCl]

[1 mark]

0 2 . 5 The kinetics of the reverse reaction ($RCl + H_2O \rightarrow ROH + HCl$) were also investigated.
The reaction was found to be first order with respect to RCl and zero order with respect to H_2O

In one experiment, the results obtained were

[RCl] = 0.107 mol dm^{-3}
rate = 0.562 mol dm^{-3} min^{-1}

Calculate the value of the rate constant, *k*, for this reverse reaction.
Deduce its units.

[2 marks]

k _____

units _____

Do not write outside the box

0 2 . 6 Hydrolysis reactions such as that between RCl and H_2O occur by different mechanisms that can be represented as shown.

Mechanism **1** $RCl + H_2O \rightarrow ROH + HCl$ (slow)

Mechanism **2** $RCl \rightarrow R^+ + Cl^-$ (slow)
$R^+ + H_2O \rightarrow ROH + H^+$ (fast)

Deduce which mechanism (**1** or **2**) is supported by the information given in Question **02.5**

Explain your choice.

[2 marks]

12

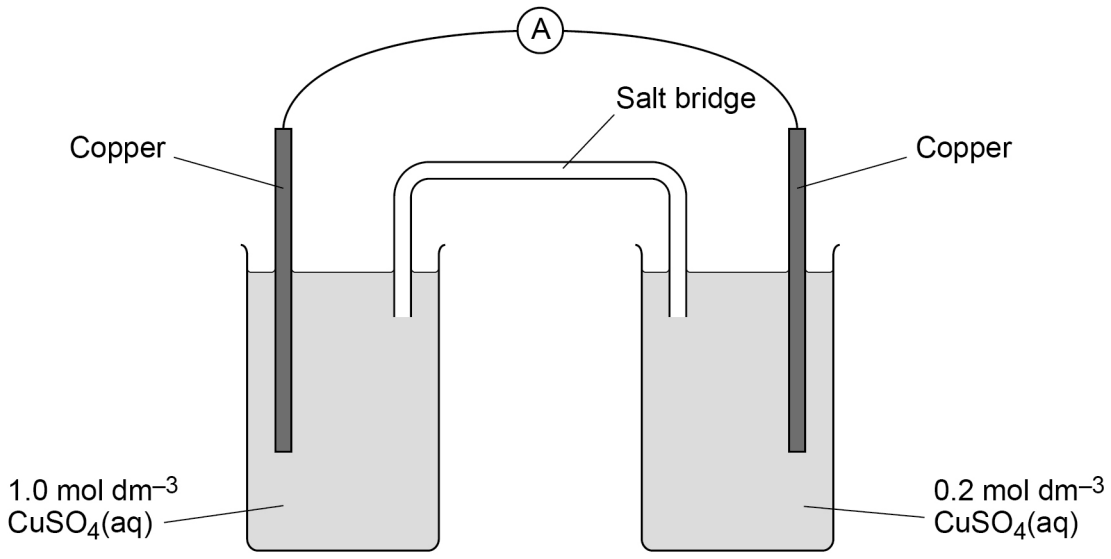
Turn over for the next question

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0 3 This question is about electrochemical cells.

Figure 2 shows a diagram of an electrochemical cell.

Figure 2



0 3 . 1 Explain how the salt bridge provides an electrical connection between the two half-cells.

[1 mark]

0 3 . 2 Suggest why potassium chloride would **not** be a suitable salt for the salt bridge in this cell.

[1 mark]

0 3 . 3 Suggest why the current in the external circuit of this cell falls to zero after the cell has operated for some time.

[1 mark]

Do not write outside the box

0 3 . 4 A different electrochemical cell was made from a copper half-cell and a manganese half-cell.

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $\quad E^\ominus = +0.34$ V
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$ $\quad E^\ominus = -1.18$ V

Give the conventional representation for this cell.

Calculate the EMF of this cell.

[2 marks]

Cell representation _____

_____

_____

EMF _____ V

Question 3 continues on the next page

Do not write outside the box

Table 1 shows some standard electrode potential data.

Table 1

Electrode half-equation	$E^{\ominus}$ / V
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44
$Zn^{2+} + 2e^- \rightarrow Zn$	–0.76

Use these data to answer the following questions.

0 3 . 5 Iron filings are added to a solution that contains the ions Cu^{2+}, Fe^{3+} and Zn^{2+}, all with concentration 1.00 mol dm^{-3}

Give the formula of the metal ion in the solution that does **not** react when iron filings are added.

Give a reason for your answer.

[2 marks]

0 3 . 6 Deduce the equation for each of the two reactions that occur.

[2 marks]

9

Do not write outside the box

Section B

Each Question is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.
For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked.

0 4 Which element is in the p block of the Periodic Table?

[1 mark]

A Technetium

B Terbium

C Thallium

D Thorium

0 5 Which statement about sulfur dioxide is correct?

[1 mark]

A It is an ionic compound.

B It is insoluble in water.

C It reacts with calcium hydroxide solution.

D It reacts with hydrochloric acid.

Turn over ►

Do not write outside the box

0 6 Which molecule contains the smallest bond angle?

[1 mark]

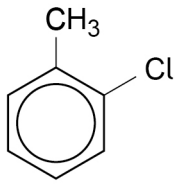
A H_2S ⬭

B BH_3 ⬭

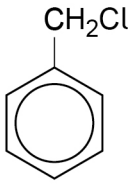
C CF_4 ⬭

D PCl_5 ⬭

0 7 The structures of two aromatic compounds are shown.



2-chloromethylbenzene



phenylchloromethane

2-Chloromethylbenzene is less reactive towards nucleophiles than phenylchloromethane.

This is because in 2-chloromethylbenzene

[1 mark]

A the C – Cl bond is less polar. ⬭

B the ring of delocalised electrons would be broken. ⬭

C the chlorine atom withdraws electrons from the benzene ring. ⬭

D the C – Cl bond is stronger. ⬭

Do not write outside the box

0 8 Which of the following is **not** able to act as a ligand?

[1 mark]

A Cl^- ⬭

B $CH_3CH_2CH_3$ ⬭

C H_2O ⬭

D $H_2NCH_2CH_2NH_2$ ⬭

0 9 Which equation represents the reaction for which the energy change is the standard enthalpy of formation of sodium hydroxide?

[1 mark]

A $Na(s) + H_2O(l) \rightarrow NaOH(s) + \frac{1}{2}H_2(g)$ ⬭

B $Na(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g) \rightarrow NaOH(s)$ ⬭

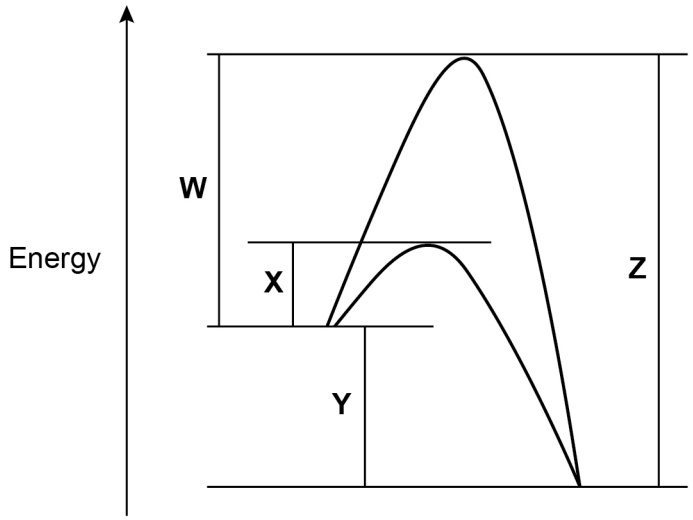
C $Na(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g) \rightarrow NaOH(aq)$ ⬭

D $2Na(s) + H_2(g) + O_2(g) \rightarrow 2NaOH(s)$ ⬭

Turn over for the next question

Do not write outside the box

1 0 The diagram shows the energy profiles for a reaction, with and without using a catalyst.



Which letter represents the activation energy for the catalysed reaction?

[1 mark]

A W ⬭

B X ⬭

C Y ⬭

D Z ⬭

1 1 What is the expression for the dissociation constant (K_a) for the weak acid HX?

[1 mark]

A $\frac{[H^+]+[X^-]}{[HX]}$ ⬭

B $\frac{[HX]}{[H^+]+[X^-]}$ ⬭

C $\frac{[HX]}{[H^+][X^-]}$ ⬭

D $\frac{[H^+][X^-]}{[HX]}$ ⬭

Do not write outside the box

1 2 The equation for a displacement reaction is

$$Br_2 + 2KI \rightarrow 2KBr + I_2$$

Which statement explains why bromine displaces iodine from potassium iodide?

[1 mark]

A Bromine has a higher electronegativity than iodine. ⬭

B Bromine has a lower boiling point than iodine. ⬭

C Bromine has a lower relative molecular mass than iodine. ⬭

D Bromine is a better oxidising agent than iodine. ⬭

1 3 Which equation represents a redox reaction?

[1 mark]

A $[Co(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CoCl_4]^{2-} + 6H_2O$ ⬭

B $[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow [Fe(H_2O)_4(OH)_2] + 2H_2O$ ⬭

C $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$ ⬭

D $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$ ⬭

1 4 What is the oxidation state of N in N_2O_4?

[1 mark]

A –4 ⬭

B –2 ⬭

C +2 ⬭

D +4 ⬭

Do not write outside the box

1 5 Which compound does **not** form a racemic mixture when reacted with KCN, followed by dilute acid?

[1 mark]

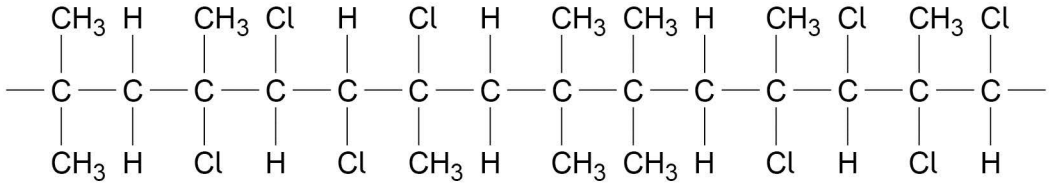
A Ethanal ⬭

B Propanone ⬭

C Butanone ⬭

D Pentan-2-one ⬭

1 6 The structure shows a section of a polymer chain formed from the random polymerisation of two different monomers.



Which pair of monomers could produce this polymer?

[1 mark]

A $CH_2=C(CH_3)Cl$ and $CHCl=CHCl$ ⬭

B $CH_2=C(CH_3)Cl$ and $(CH_3)_2C=C(CH_3)_2$ ⬭

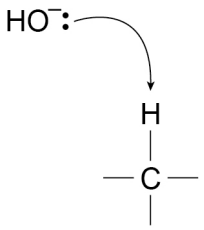
C $(CH_3)_2C=CH_2$ and $CH_2=C(CH_3)Cl$ ⬭

D $(CH_3)_2C=CH_2$ and $CHCl=C(CH_3)Cl$ ⬭

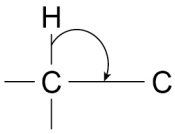
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1 7 Which of the following curly arrows does **not** show the formation of a new covalent bond? **[1 mark]**

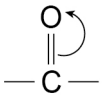
A



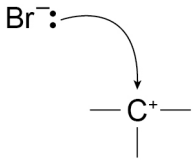
B



C



D



Turn over for the next question

Do not write outside the box

1 8 The equation for the complete hydrogenation of buta-1,3-diene is

$$CH_2=CH-CH=CH_2 + 2H_2 \rightarrow CH_3-CH_2-CH_2-CH_3$$

The table shows some mean bond enthalpies.

Bond	Mean bond enthalpy / kJ mol^{-1}
C–C	348
C=C	612
C–H	412
H–H	436

What is the enthalpy change, in kJ, for this reaction?

[1 mark]

A –684 ⬭

B –248 ⬭

C +140 ⬭

D +576 ⬭

1 9 Which Group 7 anion would give a white precipitate when dilute nitric acid is added, followed by a few drops of silver nitrate solution?

[1 mark]

A F^- ⬭

B Cl^- ⬭

C Br^- ⬭

D I^- ⬭

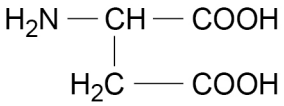
Do not write outside the box

2 0 Which element could be sulfur?

[1 mark]

	Melting point of element	Solution of oxide	
A	high	acidic	⬭
B	high	alkaline	⬭
C	low	acidic	⬭
D	low	alkaline	⬭

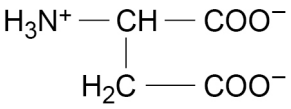
2 1 The structure of aspartic acid is



Which structure is formed by aspartic acid in solution at pH 14?

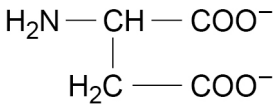
[1 mark]

A



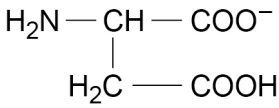
⬭

B



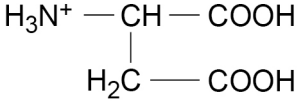
⬭

C



⬭

D



⬭

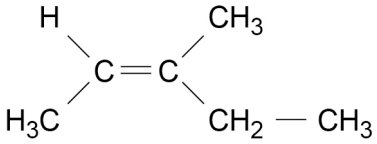
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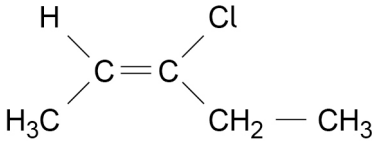
2 2 Which structure shows an *E*- isomer?

[1 mark]

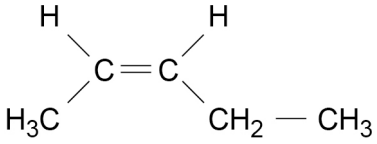
A



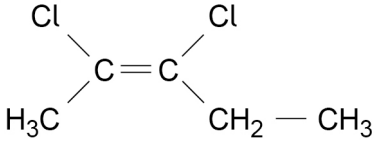
B



C



D



Do not write outside the box

2 3 Benzene reacts with propanoyl chloride in the presence of an aluminium chloride catalyst.

Which compound is formed in this reaction?

[1 mark]

A $C_6H_5CH_2CH_3$ ⬭

B $C_6H_5COCH_3$ ⬭

C $C_6H_5COCH_2CH_3$ ⬭

D $C_6H_5CH_2COCH_3$ ⬭

2 4 Which is a correct equation for a propagation step in the reaction of butane with chlorine to form dichlorobutane?

[1 mark]

A $C_4H_{10} + Cl\bullet \rightarrow C_4H_9Cl + H\bullet$ ⬭

B $C_4H_9Cl + Cl\bullet \rightarrow C_4H_9\bullet + Cl_2$ ⬭

C $C_4H_9Cl + Cl\bullet \rightarrow C_4H_8Cl\bullet + HCl$ ⬭

D $C_4H_8Cl_2 + Cl\bullet \rightarrow C_4H_7Cl_2\bullet + HCl$ ⬭

Turn over for the next question

Do not write outside the box

2 5 The overall equation for the manufacture of sodium carbonate is

$$CaCO_3 + 2NaCl \rightarrow Na_2CO_3 + CaCl_2$$

The relative formula masses of the reactants and products are

$CaCO_3 = 100.1$ $NaCl = 58.5$ $Na_2CO_3 = 106.0$ $CaCl_2 = 111.1$

What is the percentage atom economy of this process?

[1 mark]

A $\dfrac{106.0 \times 100}{100.1 + 58.5}$ ⬭

B $\dfrac{106.0 \times 100}{106.0 + 111.1}$ ⬭

C $\dfrac{111.1 \times 100}{100.1 + 58.5}$ ⬭

D $\dfrac{111.1 \times 100}{100.1 + 106.0}$ ⬭

Do not write outside the box

2 6 Measurements made during an experiment in which compound **X** is dissolved in water are

mass of **X**	= 3.85 g
volume of solution formed	= 50.0 cm^3
initial temperature of water	= 18.7 °C
final temperature of solution	= 22.4 °C

The specific heat capacity of the solution = 4.18 J K^{-1} g^{-1}
You should assume that the density of the solution is 1.00 g cm^{-3}

What is the heat change, in joules, for this process?

[1 mark]

A $3.85 \times 4.18 \times (22.4 - 18.7)$ ⬭

B $\dfrac{3.85 \times 4.18 \times (22.4 - 18.7)}{1000}$ ⬭

C $50.0 \times 4.18 \times (22.4 - 18.7)$ ⬭

D $\dfrac{50.0 \times 4.18 \times (22.4 - 18.7)}{1000}$ ⬭

2 7 A student investigated the enthalpy change of the neutralisation reaction

$$KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$$

The student mixed 20.0 cm^3 of 1.85 mol dm^{-3} KOH(aq) with 30.0 cm^3 of 1.75 mol dm^{-3} HCl(aq).

The heat change calculated was 1656 J

What is the enthalpy change, in kJ mol^{-1}, for this reaction?

[1 mark]

A – 44.8 ⬭

B – 31.5 ⬭

C + 31.5 ⬭

D + 44.8 ⬭

Turn over ►

Do not write outside the box

2 8 The equation for the reaction between gaseous hydrogen and iodine is

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = -10 \text{ kJ mol}^{-1}$$

An equilibrium mixture of gaseous hydrogen, iodine and hydrogen iodide was prepared at 500 K

The pressure and temperature of the equilibrium mixture were both increased.

Which statements describe the effects of these changes on the value of K_p?

[1 mark]

	Effect of increase in pressure	Effect of increase in temperature	
A	K_p increases	K_p increases	⬭
B	K_p increases	K_p decreases	⬭
C	K_p unchanged	K_p increases	⬭
D	K_p unchanged	K_p decreases	⬭

2 9 The strengths of the weak acids 2-chloropropanoic acid and hydroxyethanoic acid are compared.

$$CH_3CHClCOOH \rightleftharpoons CH_3CHClCOO^- + H^+ \qquad K_a = 1.48 \times 10^{-3} \text{ mol dm}^{-3}$$

$$CH_2(OH)COOH \rightleftharpoons CH_2(OH)COO^- + H^+ \qquad pK_a = 3.83$$

Which statement is correct?

[1 mark]

A Hydroxyethanoic acid is a stronger acid than 2-chloropropanoic acid. ⬭

B The pH of a 0.100 mol dm^{-3} solution of hydroxyethanoic acid is 1.00 ⬭

C The pK_a value of 2-chloropropanoic acid is –2.83 ⬭

D The K_a value of hydroxyethanoic acid is 1.48×10^{-4} mol dm^{-3} ⬭

Do not write outside the box

3 0 Which compound is butanoic anhydride?

[1 mark]

A $CH_3COOCOCH_3$ ⬭

B $CH_3COOCH_2CH_3$ ⬭

C $CH_3CH_2CH_2COOCOCH_2CH_2CH_3$ ⬭

D $CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3$ ⬭

3 1 The equation for a reaction is

$$A(s) + B(l) \rightarrow C(g) + D(g)$$

The rate of this reaction could be studied by following the

[1 mark]

A decrease in partial pressure of A ⬭

B increase in concentration of B ⬭

C decrease in concentration of C ⬭

D increase in partial pressure of D ⬭

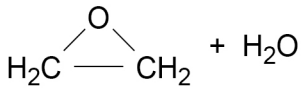
Turn over for the next question

Do not write outside the box

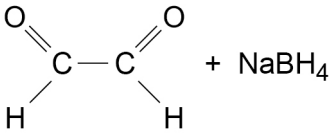
3 2 Which pair of reagents would **not** react to give ethane-1,2-diol as one of the products?

[1 mark]

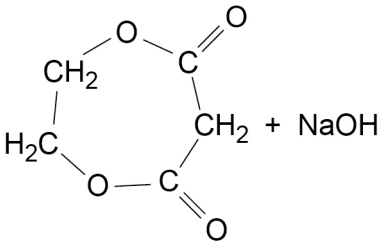
A



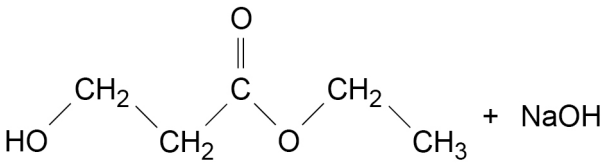
B



C



D

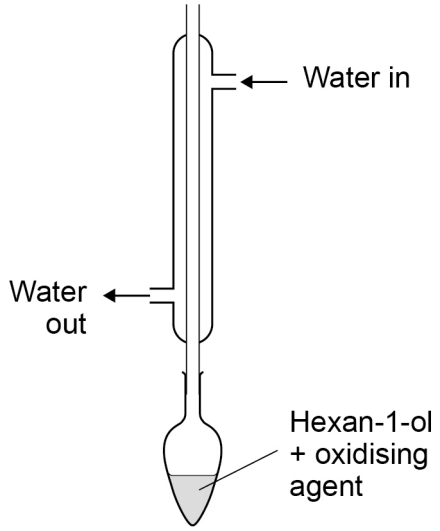


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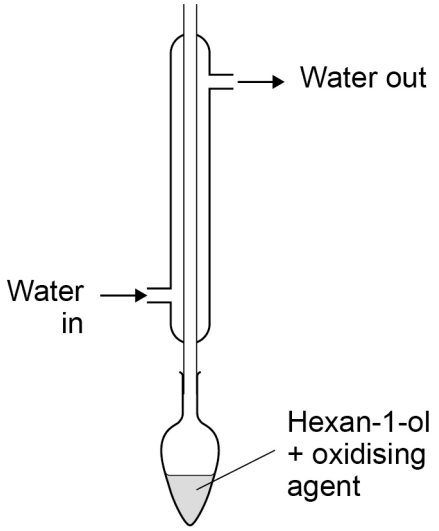
3 3 Which diagram shows the correct apparatus for the conversion of hexan-1-ol to hexanal?

[1 mark]

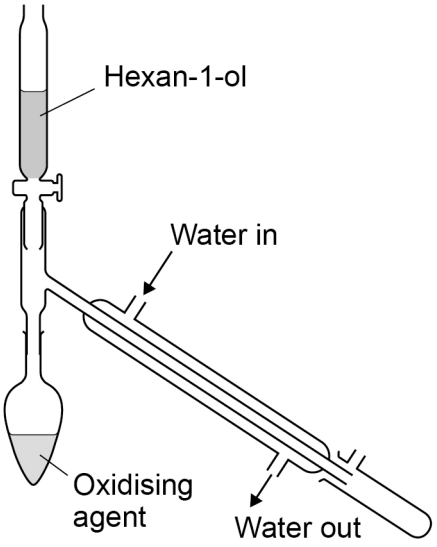
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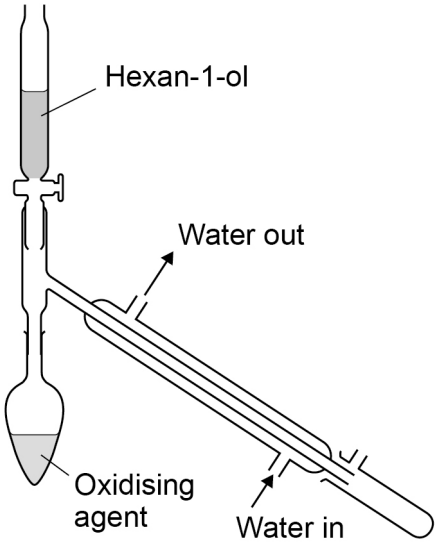
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

END OF QUESTIONS

30

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