

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9701/21

May/June 2021

1 hour 15 minutes

You must answer on the question paper.

You will need: Data booklet

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working, use appropriate units and use an appropriate number of significant figures.

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [].

This document has **12** pages. Any blank pages are indicated.

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

1 Ethanedioic acid, $\text{HO}_2\text{CCO}_2\text{H}$, has a relative molecular mass of 90.0.

(a) (i) Explain what is meant by the term *relative molecular mass*.

.....

 [2]

(ii) State the empirical formula of ethanedioic acid.

..... [1]

(iii) Calculate how many atoms of carbon are present in 0.18 g of ethanedioic acid, $\text{HO}_2\text{CCO}_2\text{H}$.

Show your working.

atoms of carbon present = ... [3]

(b) Solid ethanedioic acid reacts with aqueous calcium ions to make a precipitate of calcium ethanedioate, CaC_2O_4 .

CaC_2O_4 breaks down when heated to form calcium oxide, carbon dioxide and carbon monoxide.

(i) Construct an equation to represent the reaction of CaC_2O_4 when heated. Include state symbols.

..... [2]

(ii) Identify the type of reaction which occurs when CaC_2O_4 is heated.

..... [1]

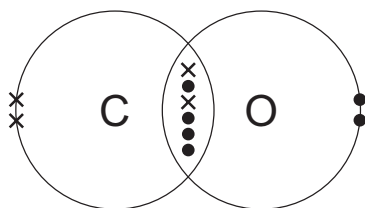
(iii) Identify another compound containing calcium ions which will also produce carbon dioxide and calcium oxide when it is heated.

..... [1]

[Total: 10]

2 Carbon monoxide gas, CO(g) , and nitrogen gas, $\text{N}_2\text{(g)}$, are both diatomic molecules.

(a) The diagram shows the arrangement of outer electrons in a molecule of CO(g) .



(i) State **one** similarity and **one** difference in the way the atoms in a carbon monoxide molecule are bonded together compared to the atoms in a nitrogen molecule.

.....

 [2]

(ii) The table states the electronegativity values of carbon, nitrogen and oxygen atoms.

	C	N	O
electronegativity	2.5	3.0	3.5

Use the electronegativity values and relevant details from the *Data Booklet* to complete the table below.

	N_2	CO
number of electrons per molecule		
type(s) of intermolecular (van der Waals') force		

[2]

(b) $\text{N}_2\text{(g)}$ is less reactive than CO(g) even though $\text{N}_2\text{(g)}$ has a lower bond energy than CO(g) .

Suggest why CO(g) is more reactive than $\text{N}_2\text{(g)}$.

.....
 [1]

- (c) Both carbon monoxide and nitrogen are gases at room temperature and pressure.

They both behave like ideal gases under certain conditions.

- (i) State the **two** conditions necessary for these two gases to approach ideal gas behaviour.

.....
 [1]

- (ii) Explain why $\text{N}_2(\text{g})$ behaves more like an ideal gas than $\text{CO}(\text{g})$ does at 20.0°C and 101 kPa .

.....

 [2]

- (d) Calculate the amount, in mol, of pure nitrogen gas which occupies 100 cm^3 at 101 kPa and 20.0°C .

Use relevant information from the *Data Booklet*. Show your working.

Assume nitrogen behaves as an ideal gas.

..... mol
 [3]

[Total: 11]

3 Sodium halide salts react with concentrated sulfuric acid at room temperature.

(a) (i) Write an equation to represent the reaction of NaCl(s) with concentrated sulfuric acid.

..... [1]

(ii) Name this type of reaction.

..... [1]

(b) NaI(s) reacts with concentrated sulfuric acid, at room temperature, to form steamy fumes.

(i) Identify the chemical responsible for the steamy fumes.

..... [1]

(ii) The reaction of NaI(s) with concentrated sulfuric acid continues, forming several other products, including a dark grey solid.

Identify the chemical responsible for the dark grey solid and **one** other product of this further reaction.

dark grey solid

other product [2]

(c) Explain the differences in observations, at room temperature, when NaI(s) reacts with concentrated sulfuric acid compared to those for NaCl(s) .

.....

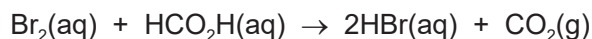
 [2]

(d) Complete the equation for the reaction of Br^- with excess concentrated H_2SO_4 at room temperature.

..... Br^- + ... H^+ + ... $\text{H}_2\text{SO}_4 \rightarrow$ [1]

[Total: 8]

- 4 Aqueous bromine reacts with methanoic acid to form hydrogen bromide and carbon dioxide gas.



The table shows the oxidation numbers of bromine and carbon in the species involved in this reaction.

	Br in Br_2	C in HCO_2H	Br in HBr	C in CO_2
oxidation number	0	+2	-1	+4

- (a) Identify the oxidising agent in this reaction. Explain your reasoning with reference to oxidation numbers.

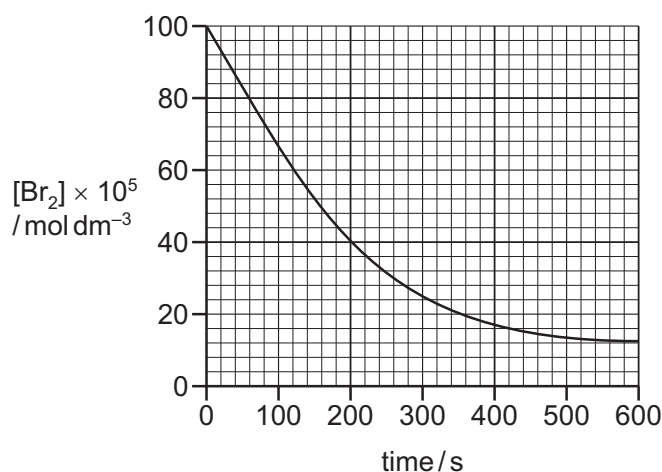
.....
 [1]

- (b) Suggest one change you would observe, ignoring temperature changes, when bromine reacts with methanoic acid.

..... [1]

- (c) This reaction can be followed by measuring the concentration of bromine present in the mixture at regular time intervals.

The graph shows the change in concentration of bromine against time in a reaction carried out at 20°C.



- (i) Use the graph to calculate the average rate of reaction at 20°C during the first 600 s. State the units of this rate of reaction.

average rate of reaction units [2]

The experiment is repeated at a temperature of 40°C. This relatively small increase in temperature produces a large increase in reaction rate.

- (ii) Sketch a graph, on the same axes, to show the expected results when repeating the experiment at 40°C. [1]
- (iii) The rate of reaction increases when the frequency of successful collisions between reactant particles increases.

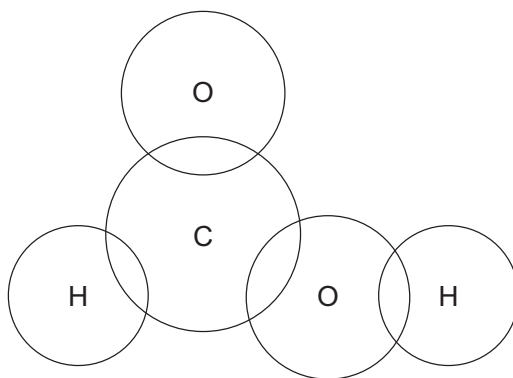
Explain why an increase in temperature produces this effect.

.....

.....

..... [2]

- (d) Complete the 'dot-and-cross' diagram, showing outer electrons only, to show the bonding in methanoic acid, HCO_2H .



[2]

[Total: 9]

5 (a) Naphtha is a mixture which contains only hydrocarbon molecules.

(i) What is meant by the term *hydrocarbon*?

.....
 [1]

(ii) Name the raw material that is used to produce a sample of naphtha.

..... [1]

(b) Compound **V** is found in naphtha. It has a molecular formula $C_{10}H_{22}$.

When **V** is heated at high pressure in the absence of air, an equal number of moles of ethene, propene and **W** are made. **W** is a compound made of straight chain, saturated molecules.

(i) Name the process that describes this reaction.

..... [1]

(ii) Deduce the structure of **W**. Draw its structure below.

[1]

(c) Propene is separated from the mixture and heated in air in the presence of a catalyst. Propene is oxidised to **X**, which contains two functional groups.

(i) Effervescence is seen when $Na_2CO_3(aq)$ is added to **X**.

Identify the functional group present in **X** which is responsible for this observation.

..... [1]

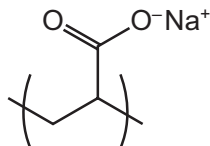
(ii) Identify a reagent which could be used to show that **X** contains a $C=C$. Include relevant observations.

.....
 [2]

(d) **X** reacts with another reagent to form **Y**.

Molecules of **Y** react together to form addition polymer **Z**. The diagram shows the repeat unit of polymer **Z**.

repeat unit of polymer **Z**



Draw the structural formula of monomer **Y**.

[1]

(e) Polymer **Z** is useful because it absorbs large amounts of water. However, there are problems associated with the disposal of products containing polymer **Z**.

Combustion is not an appropriate method to dispose of pure **Z** because the process releases harmful gases. Some of these gases contribute to the enhanced greenhouse effect.

(i) Identify a gas released during the combustion of **Z** which contributes to the enhanced greenhouse effect.

..... [1]

(ii) Identify another gas which could be produced during the combustion of pure **Z**. Describe a consequence, other than the enhanced greenhouse effect, of its release into the atmosphere.

gas

consequence

[1]

[Total: 10]

- 6 Propene, C_3H_6 , reacts with H_2O in the presence of an acid catalyst to form an alcohol with molecular formula $\text{C}_3\text{H}_8\text{O}$.

(a) Name this type of reaction.

..... [1]

(b) Name the catalyst used and state the conditions needed for this reaction to occur.

catalyst

conditions [2]

(c) Complete the table to show the numbers of sigma (σ) bonds and pi (π) bonds present in propene, C_3H_6 , and $\text{C}_3\text{H}_8\text{O}$.

	σ	π
C_3H_6		
$\text{C}_3\text{H}_8\text{O}$		

[2]

(d) The reaction of propene, C_3H_6 , with H_2O occurs in a two-step mechanism. In step 1 C_3H_6 reacts with the catalyst, H^+ , to form a carbocation.

(i) Draw structures to identify the more stable and less stable carbocations which can form in step 1. Explain your answer.

more stable carbocation	less stable carbocation

explanation

.....

[3]

- (ii) Name the major organic product formed from the reaction of propene, C_3H_6 , with H_2O .

..... [1]

- (e) 2-bromopropane reacts to form propene, hydrogen bromide and water under certain conditions.

- (i) Name this type of reaction.

..... [1]

- (ii) Describe the reagents and conditions needed to favour this reaction.

reagents

conditions [2]

[Total: 12]

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- 1 A Group 2 metal combines with bromine to form a crystalline solid, MBr_2 .

Excess aqueous AgNO_3 is added to a solution of MBr_2 and a precipitate forms. The mixture is filtered. The precipitate is dried and the mass of the precipitate is recorded.

- (a) State the formula and colour of the precipitate.

..... [2]

- (b) Complete the equation to represent the reaction between MBr_2 and AgNO_3 .

..... MBr_2 + ... $\text{AgNO}_3 \rightarrow$ [1]

- (c) A 0.250 g sample of pure MBr_2 contains 8.415×10^{-4} mol MBr_2 .

Calculate the relative formula mass, M_r , of MBr_2 . Use this to identify **M**.

Show your working.

$M_r =$

M = ... [3]

- (d) A sample of MBr_2 is dissolved in water. Chlorine gas is then bubbled into the solution.

- (i) Describe the observations for this reaction.

.....
..... [1]

- (ii) Name the type of reaction that occurs when MBr_2 reacts with chlorine gas.

..... [1]

- (e) Compound **Y** is a pure **insoluble** solid which contains halide ions.

A single reagent is added directly to compound **Y** to determine the halide ion present.

Identify the reagent added. State the observation which would confirm that **Y** contains bromide ions.

reagent

observation

[2]

- (f) Separate 1.0g samples of three different magnesium salts are tested in order to identify the anion present in each sample.

- (i) Explain how the action of heat is used to identify which sample is:

- MgCO_3
- $\text{Mg}(\text{NO}_3)_2$
- MgO .

.....

.....

.....

.....

..... [3]

- (ii) Complete the electron configuration of the magnesium cation present in these salts.

$1s^2$ [1]

- (g) A sample of $\text{MgCO}_3(\text{s})$ is distinguished from a sample of $\text{Mg}(\text{OH})_2(\text{s})$ by adding a small amount of each solid to $\text{HCl}(\text{aq})$.

State **one** similarity and **one** difference in these two reactions.

similarity

.....

difference

.....

[2]

[Total: 16]

2 The strength of interaction between particles determines whether the substance is a solid, liquid or gas at room temperature.

(a) Lithium sulfide, Li_2S , is a crystalline solid with a melting point of 938°C . It conducts electricity when it is molten.

(i) Give the formulae of the particles present in solid lithium sulfide.

..... [1]

(ii) Explain, in terms of the structure of the crystalline solid, why lithium sulfide has a high melting point.

.....

..... [2]

(b) Carbon monoxide, CO , is a gas at room temperature and pressure. It contains a coordinate bond.

(i) Explain what is meant by *coordinate bond*.

.....

..... [1]

(ii) Draw a 'dot-and-cross' diagram to show the arrangement of outer electrons in CO .

Show the electrons belonging to the C atom as $\times$.

Show the electrons belonging to the O atom as $\bullet$.

[2]

(c) Nitrogen, N_2 , is also a gas at room temperature and pressure. Neither CO nor N_2 is an ideal gas.

(i) State two assumptions that are made about the behaviour of particles in an ideal gas.

1

.....

2

.....

[2]

(ii) Explain why N_2 does not behave as an ideal gas at very high pressures.

.....

.....

.....

..... [2]

(iii) Complete the table by naming **all** the types of intermolecular forces (van der Waals') in separate samples of $N_2(g)$ and $CO(g)$.

	$N_2(g)$	$CO(g)$
number of electrons per molecule	14	14
presence of a dipole moment	$\times$	$\checkmark$
boiling point/ $^{\circ}C$	-195.8	-191.5
intermolecular forces (van der Waals')		

[2]

(iv) Suggest why the bond in a molecule of CO contains a dipole moment.

..... [1]

[Total: 13]

- 3 A large excess of 2-bromo-2-methylpropane is added to 0.0010 mol of NaOH(aq), which contains a few drops of phenolphthalein indicator. A stopwatch is started as soon as the substances are mixed. The time taken for the pink colour to disappear is recorded.

The experiment is repeated at different temperatures, keeping all concentrations and volumes of reagents constant.

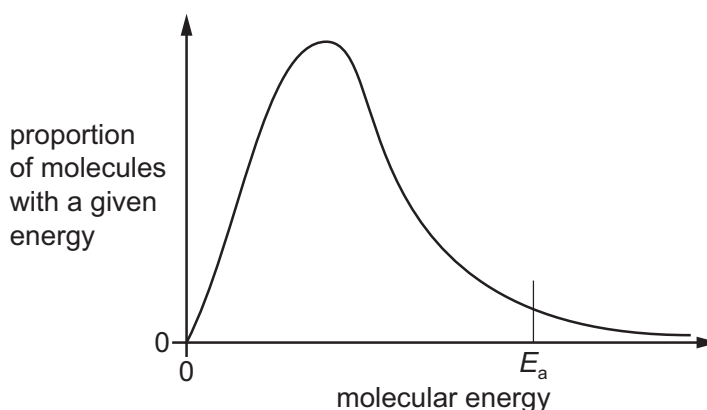
temperature / °C	time taken for pink colour to disappear / s
20	300
25	65
35	20

- (a) Explain what is meant by the term *rate of reaction*.

.....
 [1]

- (b) The graph shows the energy distribution of molecules in a sample of 2-bromo-2-methylpropane at 25 °C.

E_a represents the activation energy for the reaction.

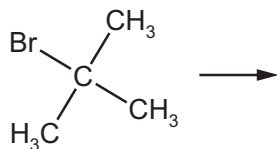


- (i) Label the graph to show the proportion of 2-bromo-2-methylpropane molecules which have sufficient energy to react. [1]
- (ii) Use the same axes to sketch the distribution of energies of molecules in a sample of 2-bromo-2-methylpropane at 50 °C. [2]
- (iii) State the effect of an increase in temperature on E_a for this reaction.

..... [1]

- (c) (i) Draw the mechanism to show the reaction of 2-bromo-2-methylpropane with $\text{OH}^-(\text{aq})$. Show the intermediate formed in this reaction.

Include all charges, partial charges, lone pairs and curly arrows as appropriate.



[3]

- (ii) Name the mechanism for this reaction.

..... [1]

- (d) The original experiment is repeated at 25°C with 2-chloro-2-methylpropane instead of 2-bromo-2-methylpropane. All other variables remain constant.

Predict the effect of using 2-chloro-2-methylpropane compared to 2-bromo-2-methylpropane on the time taken for the pink colour to disappear. Explain your answer.

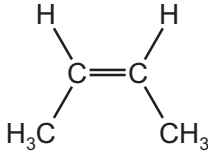
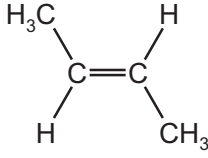
.....

 [2]

[Total: 11]

- 4 (a) The table shows the structural formulae of four compounds, **A**, **B**, **C** and **D**, with molecular formula C_4H_8 .

(i) Complete the table by giving the systematic name of **A**, **B**, **C** and **D**.

	structural formula	name
A	$CH_3CH_2CH=CH_2$	
B		
C		
D	$CH_2=C(CH_3)_2$	

[4]

(ii) Explain what is meant by *stereoisomerism*.

.....
 [1]

- (b) **W** is an alkene with formula C_4H_8 . It reacts with HBr to form two possible carbocations, $CH_3C^+(H)(CH_2CH_3)$ and $H_2C^+CH_2CH_2CH_3$.

(i) Identify **W** as compound **A**, **B**, **C** or **D**.

..... [1]

- (ii) Draw the skeletal formula of the major organic product formed when HBr reacts with **W**. Explain why this is the major organic product.

.....

.....

.....

[3]

- (c) A sample of propan-1-ol reacts with concentrated sulfuric acid to form propene.

Identify the role of concentrated sulfuric acid in this reaction.

..... [1]

- (d) Alcohol **Y** reacts completely when warmed with acidified $\text{Cr}_2\text{O}_7^{2-}$ to form **Z**.

Z is distilled from the reaction mixture as soon as it is made.

Tollens' reagent is added to a sample of **Z** and warmed. A silver mirror forms.

- (i) Name the type of reaction that occurs when **Y** reacts to form **Z**.

..... [1]

- (ii) Identify with a tick (✓) the functional group(s) present in **Z**.

functional group	present in Z
aldehyde	
ketone	
carboxylic acid	

[1]

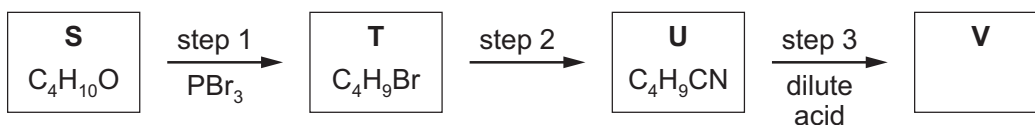
[Total: 12]

5 **S** is a secondary alcohol with molecular formula $C_4H_{10}O$.

(a) Draw the displayed formula of **S**.

[1]

(b) **S** is converted to **V** in a three-step reaction sequence.



In step 1, the secondary alcohol **S** reacts with PBr_3 to produce **T**, which has molecular formula C_4H_9Br .

(i) Give the systematic name of **T**.

..... [1]

(ii) Name the type of reaction that occurs in step 1.

..... [1]

(iii) State the reagent(s) and conditions for step 2.

.....
 [2]

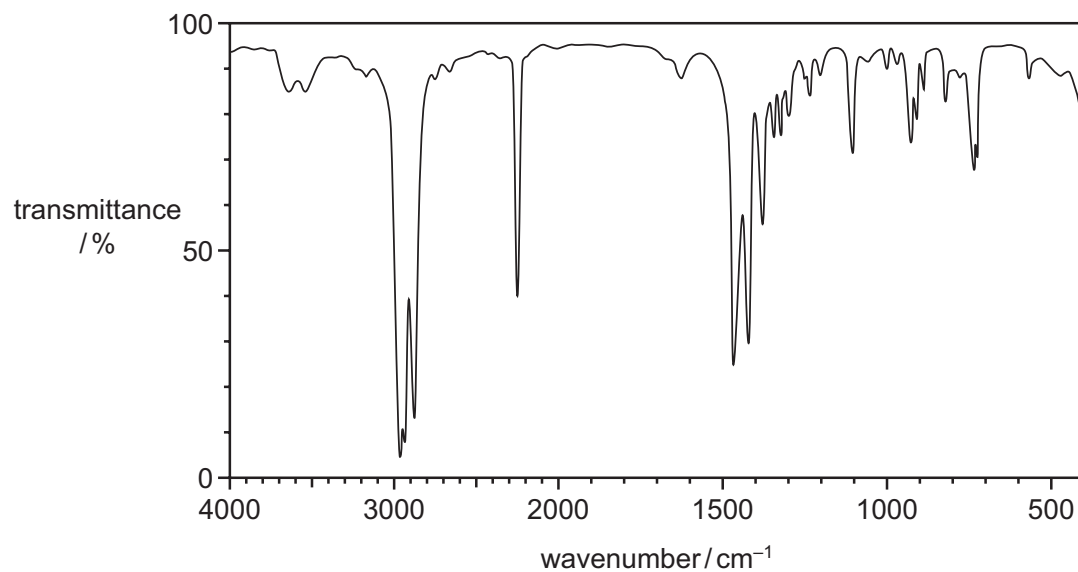
(iv) Step 3 involves heating C_4H_9CN with dilute acid to form **V**.

Complete the equation for this reaction.



- (v) An unlabelled sample contains either **S**, **T** or **U**.

The sample produces the infrared spectrum shown.



Explain how this spectrum confirms that the unknown sample contains **U**.

In your answer identify **one** relevant absorption in the infrared spectrum and the bond that corresponds to this absorption in the region above 1500 cm^{-1} .

.....
..... [1]

[Total: 8]

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Cambridge International AS & A Level

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CHEMISTRY

9701/23

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1 The elements in Group 17 are known as the halogens.

(a) Between the molecules of Group 17 elements van der Waals' forces exist.

(i) State the trend in the relative strength of van der Waals' forces down Group 17.

..... [1]

(ii) State the physical state of each of the halogens under room conditions.

chlorine

bromine

iodine [1]

(b) A solution of aqueous bromide ions, $\text{Br}^-(\text{aq})$, is added to separate samples of $\text{Cl}_2(\text{aq})$ and $\text{I}_2(\text{aq})$.

Describe what is observed in each reaction. Explain your answer in terms of the relative reactivity of these elements as oxidising agents.

observation on addition to $\text{Cl}_2(\text{aq})$

.....

observation on addition to $\text{I}_2(\text{aq})$

.....

explanation

.....

..... [3]

(c) Bleach is made by reacting Cl_2 with cold $\text{NaOH}(\text{aq})$.

Write an equation for the reaction of Cl_2 with cold NaOH .

..... [1]

(d) When $\text{ClO}^-(\text{aq})$ is added to water, it behaves as a Brønsted-Lowry base.

(i) Define the term *Brønsted-Lowry base*.

..... [1]

(ii) Write an ionic equation for the reaction between ClO^- and H_2O .

..... [1]

(e) The concentration of NaClO in bleach **S** is $x \text{ g dm}^{-3}$.

NaClO reacts with $\text{H}_2\text{O}_2(\text{aq})$ as shown.



A 5.00 cm^3 sample of **S** completely reacts with $\text{H}_2\text{O}_2(\text{aq})$. The volume of $\text{O}_2(\text{g})$ produced is 24.0 cm^3 under room conditions.

Assume that only the NaClO in **S** reacts with $\text{H}_2\text{O}_2(\text{aq})$.

Calculate x . Show your working.

$x = \dots\dots\dots \text{ g dm}^{-3}$
[3]

(f) Sodium chlorate(I), NaClO , oxidises dilute hydrochloric acid to form three products. The products which contain chlorine have chlorine species with oxidation number -1 or 0 .

No other species changes its oxidation number during the reaction.

Use this information to complete the ionic equation.



[Total: 13]

2 Methanol, CH_3OH , is soluble in water because it forms hydrogen bonds with water molecules.

- (a) Draw a fully labelled diagram to show how a hydrogen bond forms between a water molecule and a methanol molecule.

[3]

- (b) Methanol has a melting point of -97.6°C and a boiling point of 64.7°C .

A sample of pure liquid methanol is added to a flask and then sealed. The sealed flask is left for several days at constant temperature. The vapour pressure is then measured as 17 kPa.

- (i) Describe what is meant by the term *vapour pressure of methanol*.

.....
.....
..... [2]

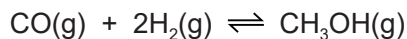
- (ii) Explain why some of the liquid becomes a vapour.

.....
.....
..... [1]

- (iii) Suggest and explain why the vapour pressure of water at room temperature is lower than the vapour pressure of methanol at room temperature. Refer to the correct intermolecular forces in your answer.

.....
.....
..... [2]

(c) Methanol is made by reacting carbon monoxide with hydrogen.



Carbon monoxide and hydrogen react at $1.0 \times 10^7 \text{ Pa}$ and 200°C . Eventually the reaction mixture reaches dynamic equilibrium.

The table shows the amounts of each species present in the mixture.

	CO(g)	H ₂ (g)	CH ₃ OH(g)
initial amount/mol	1.0	2.0	0
equilibrium amount/mol	0.030	0.060	0.97

(i) Explain what is meant by *dynamic equilibrium*.

.....

 [2]

(ii) Calculate the partial pressure of methanol vapour at equilibrium under these conditions. Show your working.

..... Pa [2]

(iii) Write an expression for the equilibrium constant, K_p , for this reaction. State the units in your answer.

$K_p =$

units = ... [2]

[Total: 14]

- 3 Separate samples of **R**, **S**, **T** and **U** are added to cold water. The identity of each sample is unknown. However, each sample is known to be pure and can only be one of $\text{Ba}(\text{OH})_2$, NaCl , P_4O_{10} or SiCl_4 .

- (a) (i) Use the observations in the table to identify each sample as one of $\text{Ba}(\text{OH})_2$, NaCl , P_4O_{10} and SiCl_4 . Write your answers in the table.

	state at room temperature	observations on addition of sample to water	identity of sample
R	solid	alkaline, colourless solution is produced, some white solid remains	
S	solid	white solid disappears, solution is neutral	
T	liquid	misty fumes produced, white solid is made in vigorous reaction	
U	solid	acidic, colourless solution produced in vigorous reaction	

[4]

- (ii) Identify the formula of the white solid made when sample **T** reacts with water.

..... [1]

- (iii) Name the solution formed when sample **U** reacts with water.

..... [1]

- (b) Magnesium oxide and aluminium oxide have properties typical of ceramic materials.

- (i) Name **one** physical property typical of ceramic materials.

..... [1]

- (ii) Give the formula of another Period 3 oxide which behaves as a ceramic material.

..... [1]

(c) Tungsten oxide, W_xO_y , is used to give colour to ceramic materials.

A sample of W_xO_y contains 79.29% tungsten by mass.

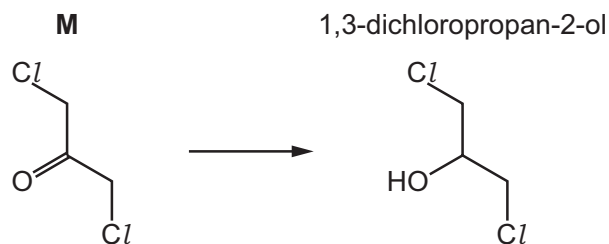
Calculate the empirical formula of W_xO_y .

Show your working.

empirical formula = ...
[3]

[Total: 11]

- 4 (a) 1,3-dichloropropan-2-ol can be made by reacting **M**.



- (i) Give the systematic name of **M**.

..... [1]

- (ii) Name the functional group present in **M** that changes during this reaction.

..... [1]

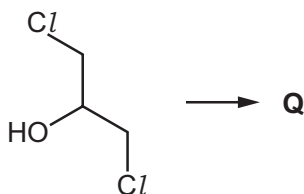
- (iii) State a suitable reagent for this reaction.

..... [1]

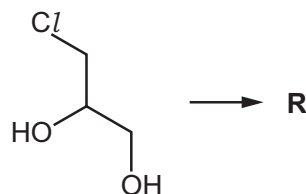
- (b) Separate samples of 1,3-dichloropropan-2-ol and 3-chloropropane-1,2-diol are heated with excess acidified $\text{Cr}_2\text{O}_7^{2-}$ until there is no further reaction.

In each reaction, a different organic product, **Q** or **R**, is made.

1,3-dichloropropan-2-ol



3-chloropropane-1,2-diol



Q and **R** are tested separately with 2,4-dinitrophenylhydrazine solution, 2,4-DNPH, and sodium carbonate solution, $\text{Na}_2\text{CO}_3(\text{aq})$.

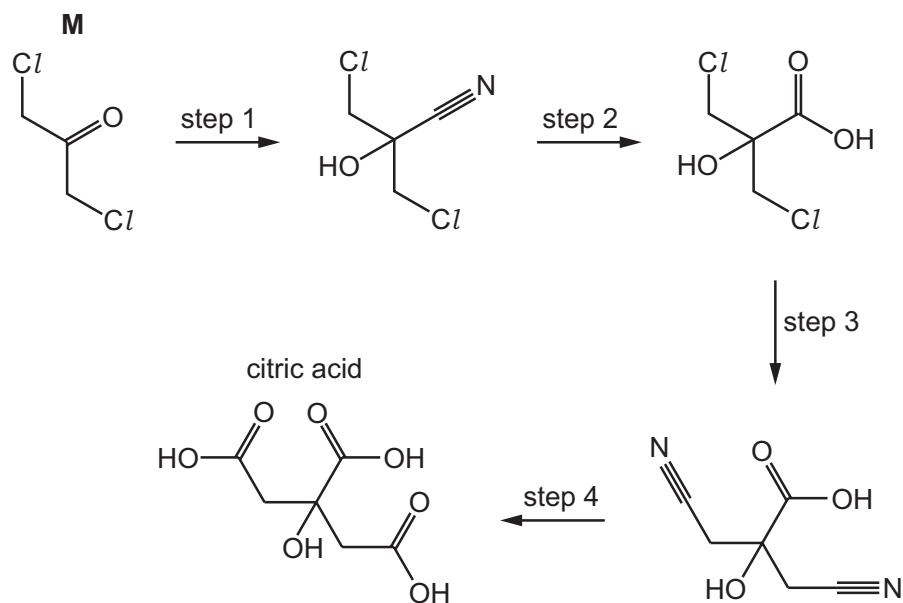
Complete the table to give any relevant observations.

If no reaction occurs, write 'no visible change'.

reagent	observation with Q	observation with R
2,4-DNPH		
$\text{Na}_2\text{CO}_3(\text{aq})$		

[4]

(c) Citric acid can be made from **M** in a four-step reaction.



Complete the table for each step of the reaction sequence to identify:

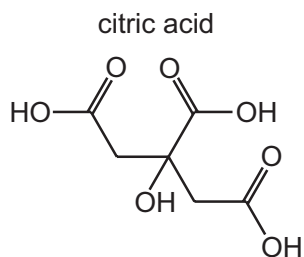
- the reagents and conditions required
- the type of reaction.

step	reagent and conditions	type of reaction
1		
2	dilute sulfuric acid	
3		
4	dilute sulfuric acid	

[5]

[Total: 12]

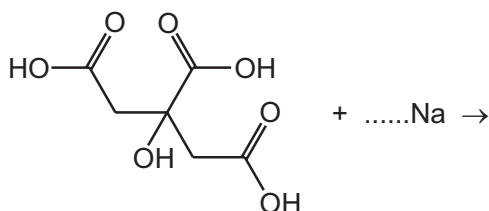
- 5 Compound **X** contains the same functional groups as citric acid.



The table describes some of the similarities and differences between citric acid and compound **X**.

	citric acid	X
chiral centre	no	yes
reaction with Na	fizzing	fizzing
reaction with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$	remains orange	orange to green

- (a) Complete the equation to show the reaction of excess sodium with citric acid. Show the skeletal structure of the product.



[3]

- (b) (i) Use the information in the table to deduce the skeletal formula of **X**, $\text{C}_3\text{H}_6\text{O}_3$. Draw the skeletal formula of **X** in the box. Label the chiral centre of compound **X** with an asterisk (*).



[2]

- (ii) Explain why compound **X** reacts with acidified $\text{Cr}_2\text{O}_7^{2-}$ but citric acid does not.

.....

.....

..... [2]

(c) Compound **X** is one of a pair of stereoisomers.

Stereoisomerism occurs when a molecule has at least one of two key features.

State the two key features that give rise to stereoisomerism.

1

.....

2

.....

[2]

(d) A structural isomer of compound **X** does not fizz when added to sodium.

Explain what is meant by *structural isomer*.

.....

..... [1]

[Total: 10]

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