Surname	Centre Number	Candidate Number
Other Names		

GCSE

CHEMISTRY

UNIT 2: CHEMICAL BONDING, APPLICATION OF CHEMICAL REACTIONS AND ORGANIC CHEMISTRY HIGHER TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**10**	
3.	**7**	
4.	**12**	
5.	**11**	
6.	**8**	
7.	**8**	
8.	**6**	
9.	**8**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets at the end of each question or part-question.
Question **8** is a quality of extended response (QER) question where your writing skills will be assessed.

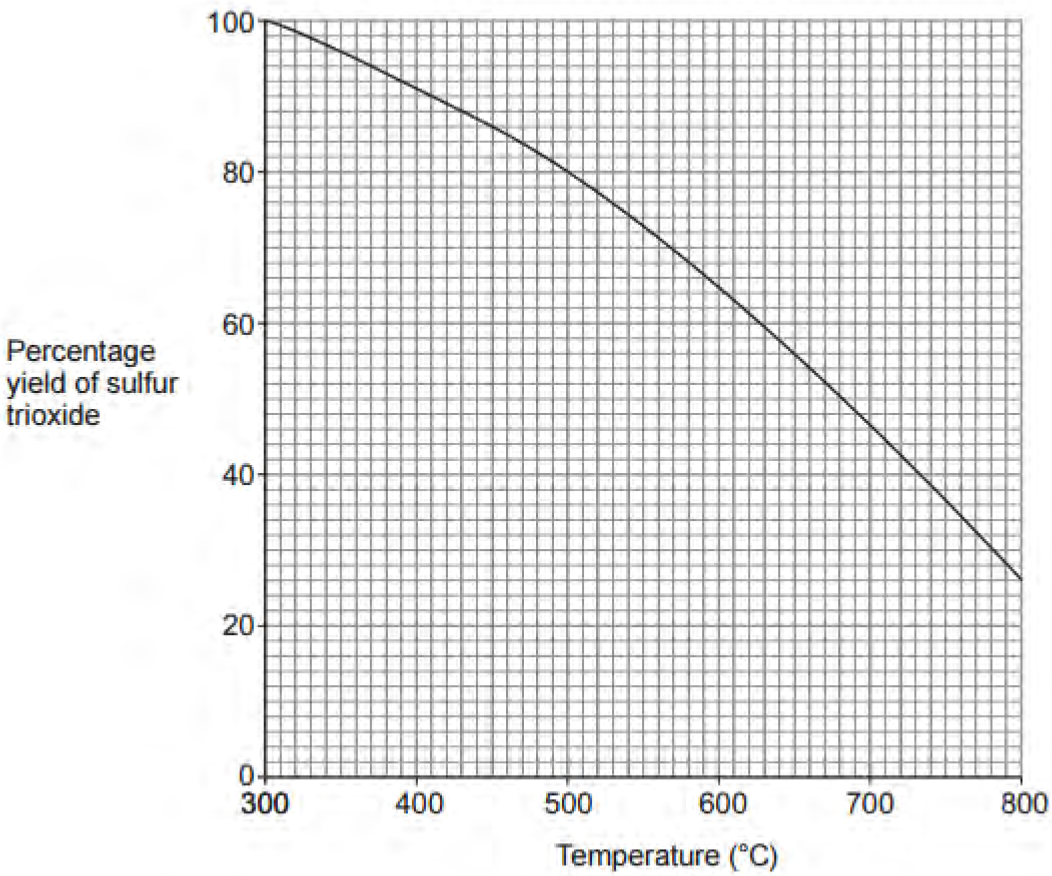
*Answer **all** questions.*

1. (a) One of the main stages in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to form sulfur trioxide.

(i) Write the balanced **symbol** equation which represents this reaction.[3]

.... + ... ⇋ ....

(ii) The graph below shows how the percentage yield of sulfur trioxide changes with temperature between 300°C and 800°C.



Use the graph to find the increase in percentage yield if the temperature is reduced from 650 °C to 450 °C. [2]

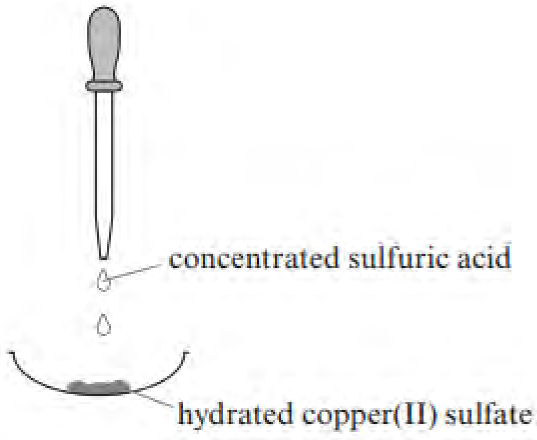
increase in percentage yield =......................... %

(iii) One molecule of sulfur trioxide reacts with one molecule of sulfuric acid to form one molecule of oleum as the **only** product.

Write a balanced **symbol** equation for this reaction. [2]

.... + ... → ....

(b) A few drops of concentrated sulfuric acid were added to some crystals of hydrated copper(II) sulfate, $CuSO_4.5H_2O$



Describe **two** changes that would be seen in the appearance of the copper(II) sulfate and state the property that the concentrated sulfuric acid displaying.

[3]

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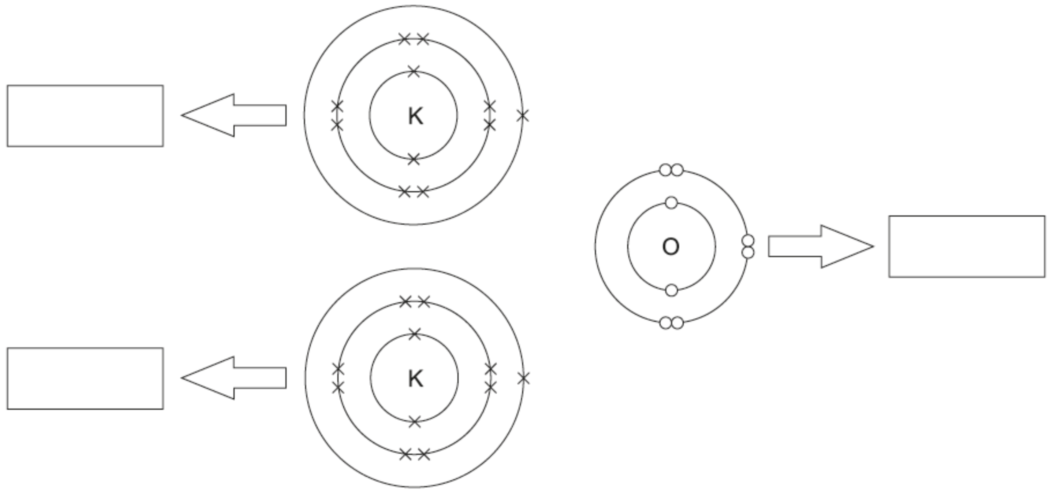
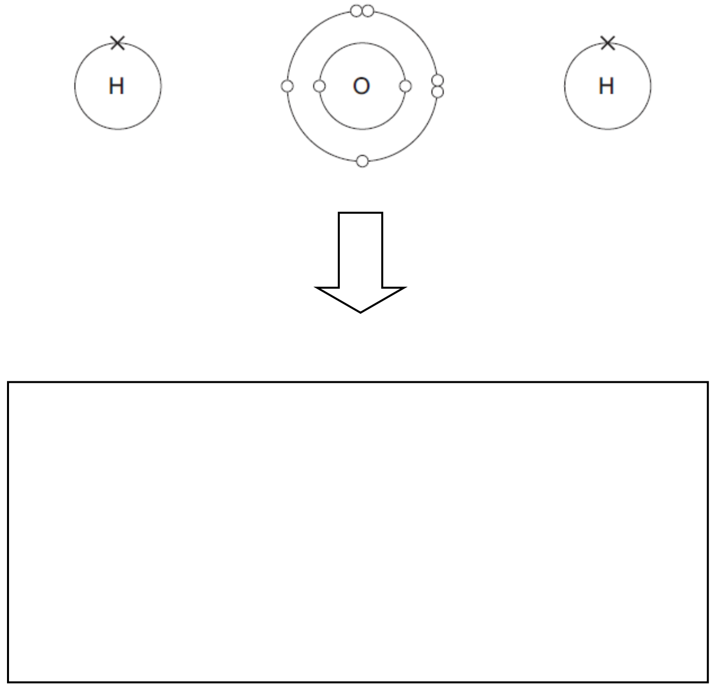
2. (a) Potassium reacts with oxygen to form potassium oxide. The diagram below can be used to show the electronic changes that take place as potassium oxide is formed.



(i) **Draw arrows on the diagram** to show the movement of electrons that leads to the formation of ions. [1]

(ii) **Write in the boxes**, the electronic configurations of the potassium and oxide **ions** formed. Include the charges on these ions. [2]

(b) Using the electronic structures shown, complete the diagram to show the covalent bonding in a molecule of water, H_2O. [2]



(c) **Table 1** shows some properties associated with three different types of structure.

Structure	Particle model	Melting point and boiling point	Electrical conductivity
giant ionic	consists of charged ions	high	only when molten or in solution
giant covalent	single molecules consisting of very many atoms	high	poor
simple covalent	small molecules, each consisting of a few atoms	low	poor

Table 1

Table 2 lists some properties of four substances, **A**, **B**, **C** and **D**.

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity
A	–182	–161	poor
B	3550	4827	poor
C	1085	2562	good
D	801	1413	good when dissolved

Table 2

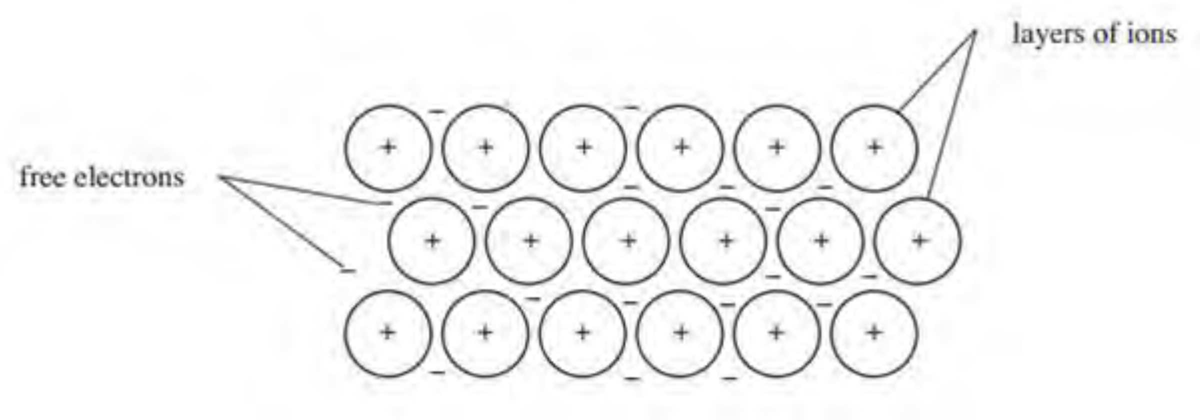
Give the letter of the substance, **A**, **B**, **C** or **D** that does not have a structure listed in **Table 1**. Give the reason for your answer. [2]

Substance ....

Reason ....

....

(d) The diagram shows a model that can be used to represent the structure of a metal.



Use this model to explain **three** properties that are typical of metals. [3]

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10

3. The following passage gives some information about how wine makers convert grapes into wine:

"Grapes contain sugar. When picked at the right time, the grapes are crushed and the juices are collected. They are covered with a layer of yeast solution and a chemical reaction takes place. During the reaction, the yeast transforms the sugars from the grapes into carbon dioxide and alcohol. This way of making alcohol has been used for thousands of years and is known as fermentation."

(a) During the fermentation reaction, frothy bubbles form. Why does this happen? Tick (✓) the correct answer. [1]

bubbles form because alcohol is produced and turns into a gas ☐

bubbles form because of the yeast reproducing ☐

bubbles form because a gas, carbon dioxide, is produced ☐

bubbles form because the grape juice turns into a vapour ☐

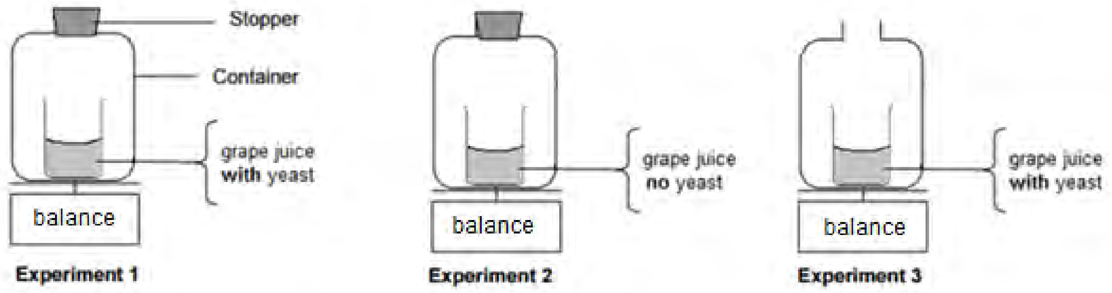
(b) During the reaction, the yeast transforms the sugar in the grapes into carbon dioxide and alcohol.

Where do the carbon atoms that are present in the carbon dioxide and alcohol come from? Complete the following table. [3]

Suggested explanation of where the carbon atoms come from	Is this correct? Yes/No
some carbon atoms come from the sugars	....
some carbon atoms come from the yeast	....
some carbon atoms come from the solution	....

(c) During the fermentation process, carbon dioxide gas is produced.

Three separate fermentation experiments were set up as shown below and left for 1 hour. State and explain what you would expect to happen to the mass of each experiment after one hour. [3]



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7

4. (a) On Anglesey, there is a large copper mine called Parys Mountain. Unwanted rock from the mining process has been dumped forming waste tips. As rainwater passes through the waste tips it dissolves copper salts. One of the salts is copper(II) sulfate.

During the 18^{th} century, large shallow pits were dug all over the mountain. These filled with rainwater. Scrap iron was placed into the water and after a few months the pits were drained and copper-rich sludge was collected.

Explain the reaction taking place in the pits. Give the names of the products formed. [3]

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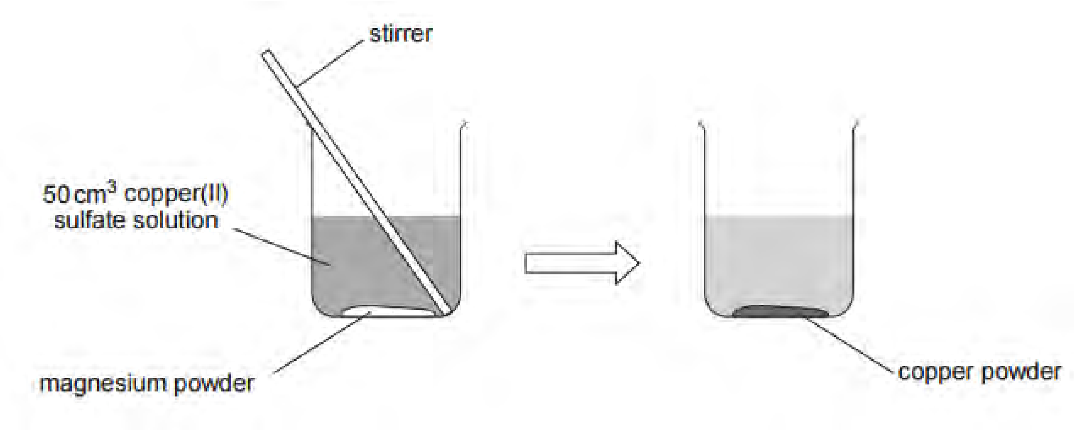
(b) A similar reaction takes place between copper and silver nitrate. One of the products formed is copper(II) nitrate, $Cu(NO_3)_2$.

Write the balanced **symbol** equation for this reaction. [2]

……………………… + ……………………… → ……………………… + ………………………

(c) Three students individually investigated the mass of copper formed when increasing amounts of magnesium powder were added to 50 cm^3 of copper(II) sulfate solution.



- Each pupil added 0.1 g of magnesium to 50 cm^3 of copper(II) sulfate solution and stirred the mixture until no more magnesium remained.
- They filtered, dried and weighed the copper formed.
- They repeated the experiment using 0.15, 0.20 and 0.25 g of magnesium powder and a new 50 cm^3 of copper(II) sulfate solution each time.

The results they obtained, as well as the theoretical results are shown in the following table.

Mass of magnesium added (g)	**Mass of copper formed (g)**				
	Student 1	**Student 2**	**Student 3**	**Mean result**	**Theoretical result**
0.10	0.15	0.13	0.14	0.14	0.26
0.15	0.25	0.21	0.23	0.23	0.40
0.20	0.35	0.37	0.28	0.36	0.54
0.25	0.41	0.45	0.39	0.40	0.68

(i) **Circle** the anomalous results **not** used in calculating the mean masses of copper. [1]

(ii) Using the information in the table, describe the relationship between the mass of magnesium added and the mass of copper formed. [1]

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(iii) Using the information in the table, state whether the evidence supporting your conclusion in part (ii) is strong or weak. Give a reason for your answer. [1]

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(iv) The mean values calculated are lower than the theoretical values. Suggest **two** possible reasons for this difference. [2]

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(v) Use the results to predict the **theoretical** mass of copper that would be deposited when a mass of 0.35 g of magnesium is added. Give a reason for your answer. [2]

Theoretical mass deposited = ... g

Reason ………………………………………………………………………...

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12

5. (a) Crude oil is a mixture of hydrocarbons.

(i) Describe briefly how crude oil was formed. [2]

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(ii) Explain how crude oil is separated into different fractions. [4]

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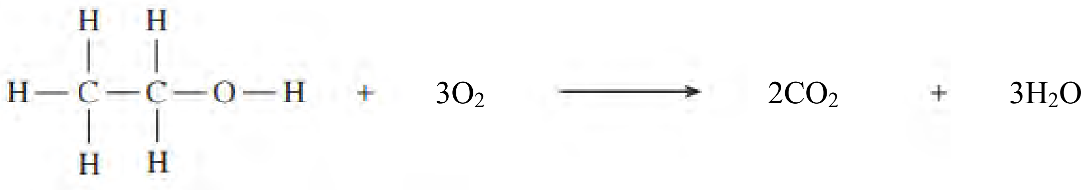
(b) Some countries use ethanol as a fuel for their cars instead of petrol. The following diagram shows the chemical changes that occur as ethanol burns.



Remember that CO_2 contains double bonds **only**

The bond energies relating to the bonds in the above diagram are shown in the table.

Bond	**Bond energy (kJ)**
O = O	496
C—H	413
C—C	347
C—O	358
O—H	464
C = O	743

Use this information to show that the reaction is exothermic and that the overall energy change is –1034 kJ. [5]

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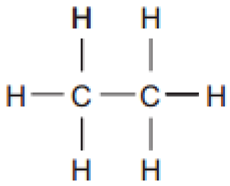
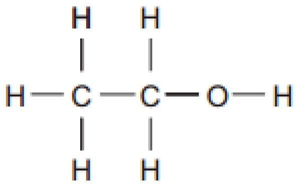
11

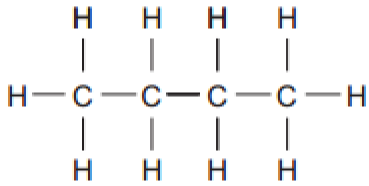
6. The following diagram shows the structures of six organic compounds.



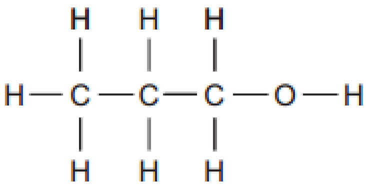
A



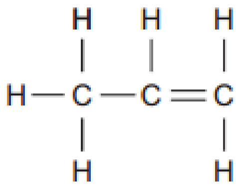
B



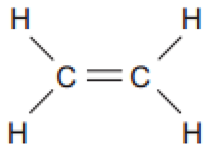
C



D



E



F

(a) Complete the table below by giving the name of the family to which each pair of compounds belongs and the general molecular formula for that family. [2]

Pair of compounds	**Family to which the pair of compounds belong**	**General molecular formula for the family**
A and **C**		
B and **D**		

(b) Describe a chemical test that could be carried out to distinguish between compounds **C** and **E** compounds. [2]

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(c) Compound **C** is one of two isomers that have the molecular formula C_4H_{10}.

(i) Give the meaning of the term *isomer.* [1]

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(ii) Draw the structure of the other isomer of C_4H_{10}. [1]

(d) Identify from compounds **A**-**F**, **one** compound other than **C** that has an isomer. Draw the structure of its isomer and give its systematic name. [2]

Compound ....

Structure

Name ....

8

7. (a) A student carries out a series of chemical tests on three unknown solutions, **A**, **B** and **C**. Her results are recorded in the table below.

Use all the information to identify reagents **X** and **Y** and solutions **A** and **B**. [4]

	Add dilute HCl	**Add $BaCl_2(aq)$**	**Add reagent X**	**Add reagent Y**
A	no reaction	white precipitate forms	pale green precipitate forms	no reaction
B	fizzes	no reaction	pungent smell given off	white precipitate forms
C	no reaction	no reaction	no reaction	yellow precipitate forms

Reagent **X** ....

Reagent **Y** ....

Solution **A** ....

Solution **B** ....

(b) Give the balanced **symbol** equation for the reaction that takes place between sodium carbonate and dilute nitric acid. [2]

Na_2CO_3 + ☐ HNO_3 → ☐ .... + ... + ...

(c) The equation below represents the reaction occurring between copper(II) chloride solution and sodium hydroxide solution.

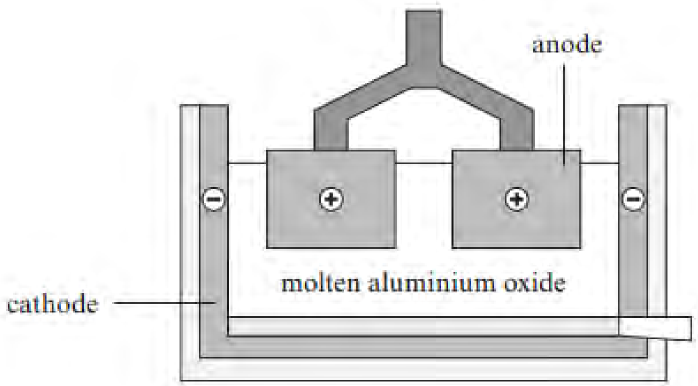
$$CuCl_2 + 2NaOH \rightarrow Cu(OH)_2 + 2NaCl$$

Write the **ionic** equation for this reaction. Include state symbols. [2]

.... + ... → ....

8

8. The diagram below shows an electrolysis cell used in the extraction of aluminium from aluminium oxide.



Describe and explain how this process works, including relevant equations. [6 QER]

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6

9. (a) Richard prepared a solution of sodium hydroxide, NaOH, by dissolving 2.40 g of sodium hydroxide pellets in 250 cm^3 of water.

Calculate the concentration of the sodium hydroxide solution in mol/dm^3. [2]

$M_r(NaOH) = 40$

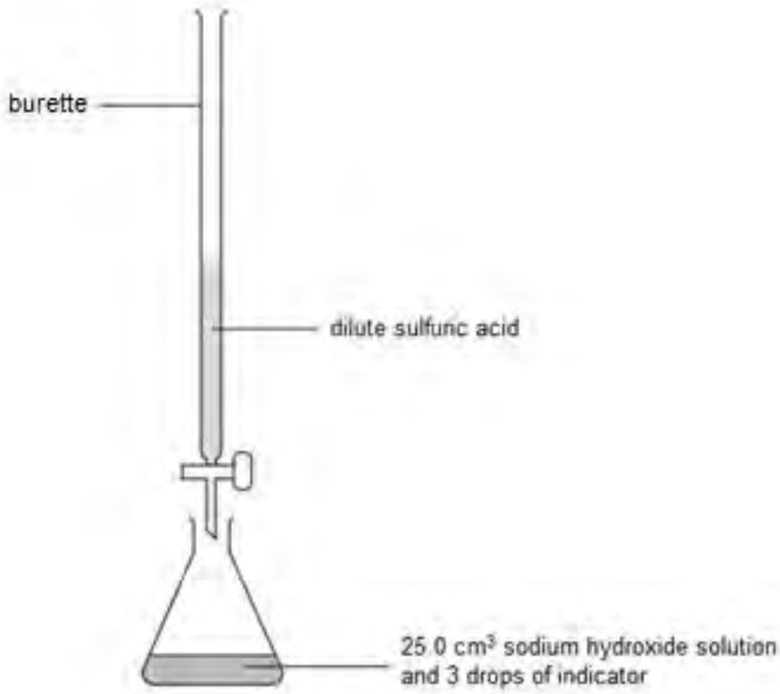
concentration = ... mol/dm^3

(b) Sulfuric acid reacts with sodium hydroxide according to the following equation.

$$H_2SO_4 \quad + \quad 2NaOH \quad \rightarrow \quad Na_2SO_4 \quad + \quad 2H_2O$$

Richard used his sodium hydroxide solution to determine the concentration of a sample of dilute sulfuric acid.

He measured exactly 25.0 cm^3 of the sodium hydroxide solution and titrated it against the sulfuric acid using the following apparatus.



(i) Explain why a burette is used to add the sulfuric acid. [2]

....

....

(ii) The results of the titration are shown in the following table.

Titration	1	2	3	4
Volume of sulfuric acid used (cm^3)	17.3	15.9	16.1	16.0

Use the results of the titrations to calculate the concentration of the dilute sulfuric acid in mol/dm^3. [4]

concentration = ... mol/dm^3

8

END OF PAPER

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		
Zinc	Zn^{2+}		

Avogadro's number, $L = 6 \times 10^{23}$

PERIODIC TABLE OF ELEMENTS

1	2	Group										3	4	5	6	7	0
								$^{1}_{1}$H Hydrogen									$^{4}_{2}$He Helium
$^{7}_{3}$Li Lithium	$^{9}_{4}$Be Beryllium											$^{11}_{5}$B Boron	$^{12}_{6}$C Carbon	$^{14}_{7}$N Nitrogen	$^{16}_{8}$O Oxygen	$^{19}_{9}$F Fluorine	$^{20}_{10}$Ne Neon
$^{23}_{11}$Na Sodium	$^{24}_{12}$Mg Magnesium											$^{27}_{13}$Al Aluminium	$^{28}_{14}$Si Silicon	$^{31}_{15}$P Phosphorus	$^{32}_{16}$S Sulfur	$^{35}_{17}$Cl Chlorine	$^{40}_{18}$Ar Argon
$^{39}_{19}$K Potassium	$^{40}_{20}$Ca Calcium	$^{45}_{21}$Sc Scandium	$^{48}_{22}$Ti Titanium	$^{51}_{23}$V Vanadium	$^{52}_{24}$Cr Chromium	$^{55}_{25}$Mn Manganese	$^{56}_{26}$Fe Iron	$^{59}_{27}$Co Cobalt	$^{59}_{28}$Ni Nickel	$^{64}_{29}$Cu Copper	$^{65}_{30}$Zn Zinc	$^{70}_{31}$Ga Gallium	$^{73}_{32}$Ge Germanium	$^{75}_{33}$As Arsenic	$^{79}_{34}$Se Selenium	$^{80}_{35}$Br Bromine	$^{84}_{36}$Kr Krypton
$^{86}_{37}$Rb Rubidium	$^{88}_{38}$Sr Strontium	$^{89}_{39}$Y Yttrium	$^{91}_{40}$Zr Zirconium	$^{93}_{41}$Nb Niobium	$^{96}_{42}$Mo Molybdenum	$^{99}_{43}$Tc Technetium	$^{101}_{44}$Ru Ruthenium	$^{103}_{45}$Rh Rhodium	$^{106}_{46}$Pd Palladium	$^{108}_{47}$Ag Silver	$^{112}_{48}$Cd Cadmium	$^{115}_{49}$In Indium	$^{119}_{50}$Sn Tin	$^{122}_{51}$Sb Antimony	$^{128}_{52}$Te Tellurium	$^{127}_{53}$I Iodine	$^{131}_{54}$Xe Xenon
$^{133}_{55}$Cs Caesium	$^{137}_{56}$Ba Barium	$^{139}_{57}$La Lanthanum	$^{179}_{72}$Hf Hafnium	$^{181}_{73}$Ta Tantalum	$^{184}_{74}$W Tungsten	$^{186}_{75}$Re Rhenium	$^{190}_{76}$Os Osmium	$^{192}_{77}$Ir Iridium	$^{195}_{78}$Pt Platinum	$^{197}_{79}$Au Gold	$^{201}_{80}$Hg Mercury	$^{204}_{81}$Tl Thallium	$^{207}_{82}$Pb Lead	$^{209}_{83}$Bi Bismuth	$^{210}_{84}$Po Polonium	$^{210}_{85}$At Astatine	$^{222}_{86}$Rn Radon
$^{223}_{87}$Fr Francium	$^{226}_{88}$Ra Radium	$^{227}_{89}$Ac Actinium															

Key:

Mass number → A

X ← Element Symbol

Atomic number → Z

Name