Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Sample assessment material for first teaching 2024

Time 1 hour 40 minutes

Paper reference **4WCH2/1C**

Chemistry (Modular)
UNIT 2

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this unit is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 This question is about gases in the atmosphere.

The box gives the name of some gases.

argon	carbon dioxide	hydrogen
nitrogen	oxygen	water vapour

(a) Choose gases from the box to answer the questions.

(i) Identify the least reactive gas in the atmosphere.

(1)

(ii) Identify the most abundant gas in the atmosphere.

(1)

(iii) Identify the gas that is not normally found in the atmosphere.

(1)

(b) State an environmental problem caused by increasing amounts of carbon dioxide in the atmosphere.

(1)

(c) Describe the test for carbon dioxide.

(2)

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(d) A student does an experiment to find the percentage by volume of oxygen in a sample of air.

These are the results.

volume of air	90 cm^3
volume of air after removing oxygen	73 cm^3

Calculate the percentage by volume of oxygen in the sample of air.

(2)

(Total for Question 1 = 8 marks)

2 This question is about ammonia and ammonium compounds.

(a) (i) Give the electronic configuration of nitrogen, N

(1)

.....

(ii) State why the compound PH_3 has similar chemical properties to NH_3

(1)

.....

(b) The table shows the names and formulae of some ammonium compounds.

Name	ammonium sulfate		ammonium carbonate
Formula	$(NH_4)_2SO_4$	NH_4Cl	

(i) Complete the table by giving the missing information.

(2)

(ii) When ammonia reacts with sulfuric acid, ammonium sulfate is formed.

Write a chemical equation for this reaction.

(1)

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(iii) Describe a test for ammonium ions.

(3)

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(c) The table gives some information about ammonia and ammonium compounds.

Name	Formula	Percentage of nitrogen (%)
ammonia	$NH_3(g)$	82
ammonium nitrate	$NH_4NO_3(s)$	
ammonium sulfate	$(NH_4)_2SO_4(s)$	21

Calculate the percentage of nitrogen in ammonium nitrate.

[M_r of NH_4NO_3 = 80]

(2)

percentage of nitrogen = ... %

(Total for Question 2 = 10 marks)

3 This question is about rates of reaction.

(a) A student uses this method to investigate the rate of reaction between iron(III) nitrate solution and sodium thiosulfate solution.

- pour 50 cm^3 of iron(III) nitrate solution into a conical flask
- add one drop of catalyst solution
- add 50 cm^3 of sodium thiosulfate solution to the conical flask
- record the time for the mixture to become colourless

The student repeats the method using different catalysts and also with no catalyst.

The table shows the student's results.

Catalyst	Time for mixture to become colourless in s
no catalyst	55
cobalt(II) choloride solution	32
copper(II) sulfate solution	8
iron(II) sulfate solution	27
zinc nitrate solution	75

(i) Explain which is the best catalyst for reaction.

(2)

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(ii) Explain how a catalyst increases the rate of a reaction.

(2)

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(b) The rate of a reaction can also be altered by changing the temperature or by changing the concentration of solutions.

(i) Explain, using the particle collision theory, how increasing the temperature affects the rate of a reaction.

(4)

(ii) Explain why using a solution of a lower concentration decreases the rate of reaction.

(2)

(Total for Question 3 = 10 marks)

4 A student investigates how the electrical conductivity changes as dilute sulfuric acid is added to barium hydroxide solution.

This is the student's method.

Step 1 add 50.0 cm^3 of barium hydroxide solution to a beaker

Step 2 measure the electrical conductivity of the solution

Step 3 add 10.0 cm^3 of dilute sulfuric acid to the beaker

Step 4 stir the mixture

Step 5 measure the electrical conductivity of the mixture

Step 6 repeat steps 3 to 5 until a total of 100 cm^3 of dilute sulfuric acid has been added

The table shows the student's results.

Total volume of acid added in cm^3	Electrical conductivity in arbitrary units
0.0	10.0
10.0	8.0
20.0	7.2
30.0	4.0
40.0	2.0
50.0	0.0
60.0	1.4
70.0	2.8
80.0	4.2
90.0	5.6
100.0	7.0

(a) (i) Which piece of apparatus is the most suitable for measuring the volume of dilute sulfuric acid in Step 3?

(1)

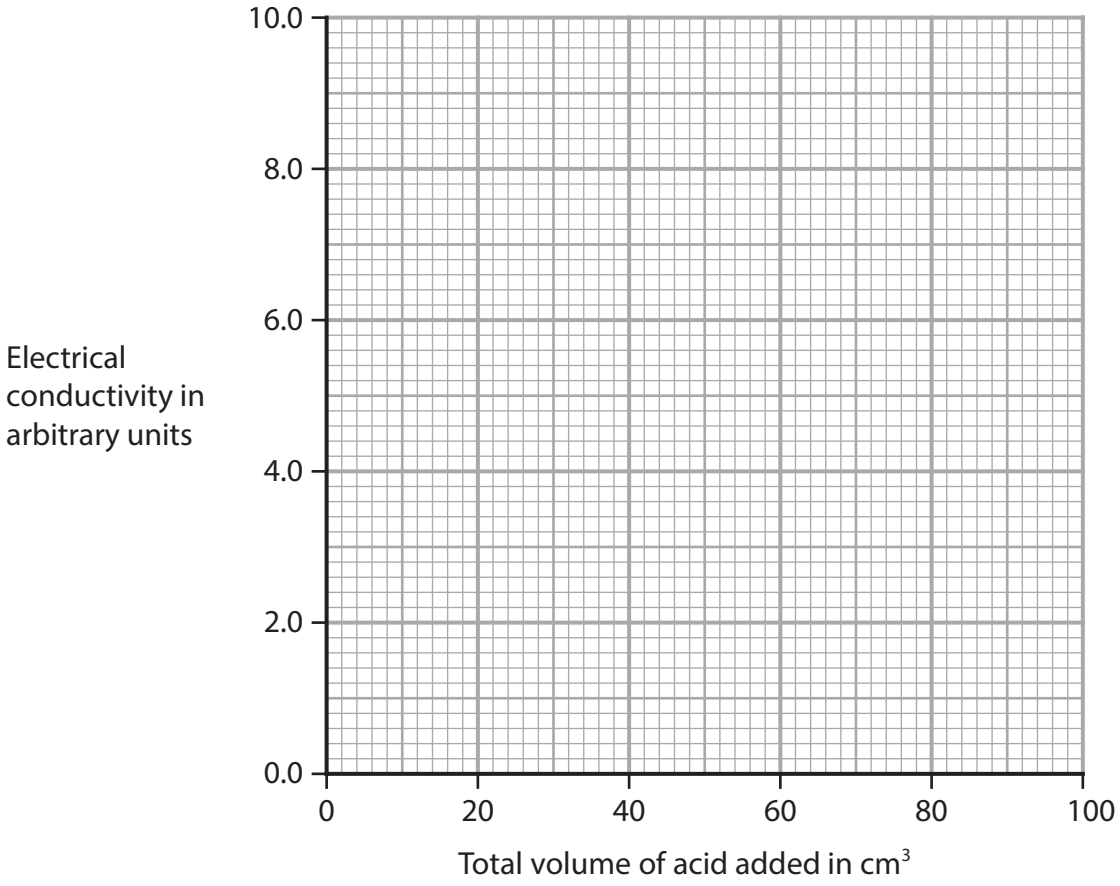
- ☒ **A** beaker
- ☒ **B** conical flask
- ☒ **C** measuring cylinder
- ☒ **D** test tube

(ii) Plot the student's results.

(2)

(iii) Ignoring the anomalous result, draw two lines of best fit, making sure that the two lines cross.

(1)



(iv) Give the trend shown on the graph for the first 50 cm^3 of acid added.

(1)

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(v) Suggest a mistake the student could have made to cause the anomalous result.

(1)

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(b) This is the equation for the reaction.

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

(i) When 50 cm^3 of dilute sulfuric acid have been added, only barium sulfate and water are present in the mixture.

Explain why this mixture does not conduct electricity.

Refer to the type of bonding in barium sulfate and in water in your answer.

(3)

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(ii) Name a technique the student could use to separate barium sulfate from the mixture after 100 cm^3 of dilute sulfuric acid has been added.

(1)

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(Total for Question 4 = 10 marks)

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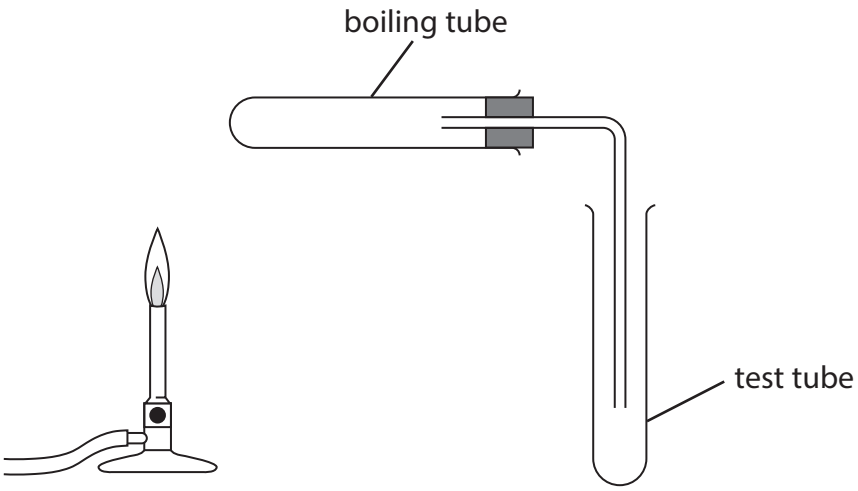
5 This question is about metal carbonates.

When heated, some metal carbonates decompose to form a metal oxide and carbon dioxide gas.

(a) A student is given three solid metal carbonates, a timer, some limewater and this apparatus.



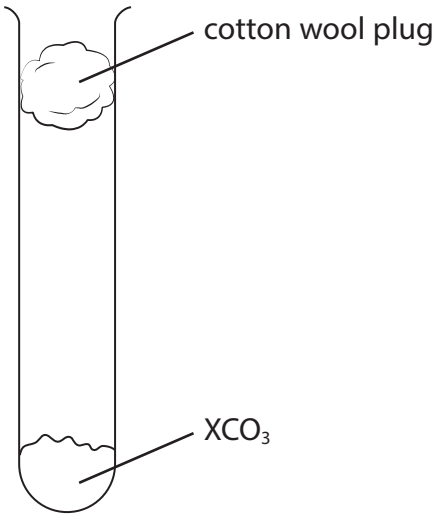
Describe a method the student can use to find out which metal carbonate decomposes fastest when heated.

(4)

(b) A student is given a solid metal carbonate with the formula XCO_3

X represents the symbol of a Group 2 metal.

A student uses this apparatus to heat a sample of XCO_3 until it all decomposes.



The equation for the decomposition of XCO_3 is

$$XCO_3 \rightarrow XO + CO_2$$

The student records the mass of XCO_3 and the mass of carbon dioxide that escapes through the cotton wool plug.

These are the student's results.

mass of XCO_3 = 7.40 g

mass of CO_2 = 2.20 g

(i) What is the reason for using the cotton wool plug?

(1)

☒ **A** to prevent air entering the tube

☒ **B** to absorb water vapour from the air

☒ **C** to stop solid particles leaving the tube

☒ **D** to slow down the escape of carbon dioxide

(ii) Show that the amount of carbon dioxide formed is 0.0500 mol.

(1)

[for carbon dioxide, $M_r = 44.0$]

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.....

(iii) Use the equation to determine the amount, in mol, of XCO_3 that decomposed.

(1)

amount of XCO_3 = ... mol

(iv) Use the mass of XCO_3 and your answer to (b)(iii) to calculate the relative formula mass (M_r) of XCO_3

(2)

M_r of XCO_3 = ...

(v) Use your answer to (b)(iv) and the Periodic Table on page 2 to determine the identity of the Group 2 metal X.

Show your working.

(2)

identity of X = ...

(Total for Question 5 = 11 marks)

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6 This question is about alcohols, carboxylic acids and esters.

(a) Ethanol can be manufactured by the fermentation of a solution of glucose.

(i) Complete the chemical equation for the reaction.

(1)

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH +$ .....

(ii) State the substance that needs to be added for the reaction to occur.

(1)

.....

(b) In the presence of an acid catalyst, ethanoic acid is heated with butanol to form an ester.

(i) Which of these is the formula of the ester?

(1)

☒ **A** $CH_3COOC_3H_7$

☒ **B** $CH_3COOC_4H_9$

☒ **C** $C_2H_5COOC_4H_9$

☒ **D** $C_3H_7COOC_2H_5$

(ii) State how you would know that an ester has formed.

(1)

.....

.....

(iii) Give one use of an ester.

(1)

.....

.....

(c) When solid magnesium carbonate is added to a solution of ethanoic acid, effervescence occurs.

Complete the equation for the reaction.

(2)

$MgCO_3 + 2CH_3COOH \rightarrow$ ..... + ... + ...

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(d) Aspirin is a compound used to reduce pain.

Aspirin contains a carboxylic acid functional group and an ester functional group.

(i) State what is meant by the term **functional group**.

(1)

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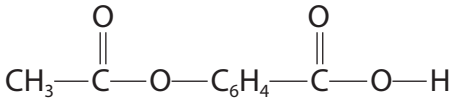
(ii) This is the structural formula of aspirin.

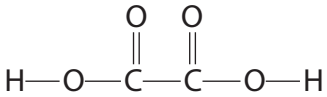


Draw a circle around the carboxylic acid functional group.

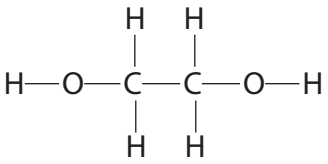
(1)

(e) A polyester can be made by reacting ethanedioic acid with ethanediol

These are the displayed formulae of the two reactants.



ethanedioic acid



ethanedioic acid

Draw the **displayed** formula for the repeat unit of the polyester.

(2)

(Total for Question 6 = 11 marks)

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7 Silicon hydride (SiH_4) and silicon dioxide (SiO_2) both contain covalent bonds but they have different structures.

(a) Describe the forces of attraction in a covalent bond.

(2)

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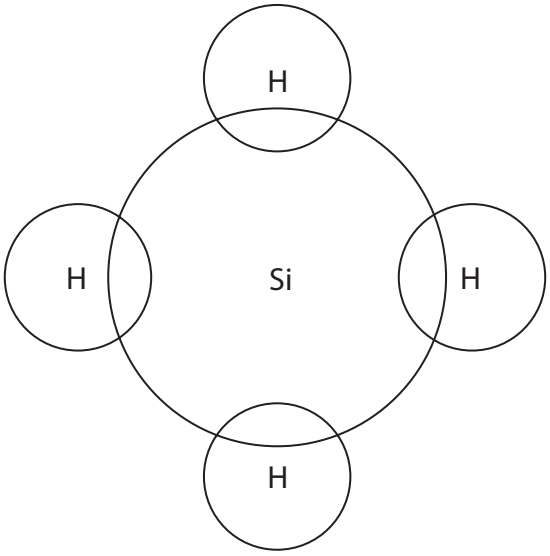
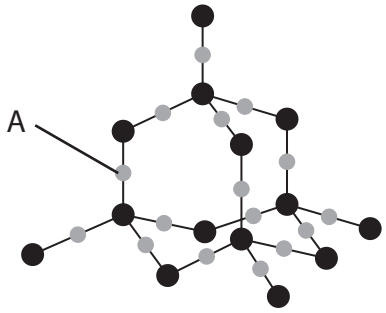
(b) Complete the diagram to show the outer shell electrons in a molecule of silicon hydride (SiH_4).

(1)



(c) The diagram represents part of the structure of silicon dioxide (SiO_2).



(i) State how the diagram shows that the atom labelled A is oxygen, not silicon.

(1)

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(ii) Silicon hydride has a simple molecular structure.

Silicon dioxide has the same type of structure as diamond.

Explain why silicon dioxide has a much higher melting point than silicon hydride.

Refer to structure and bonding in your answer.

(4)

(d) Silicon hydride reacts with oxygen to form silicon dioxide and water.

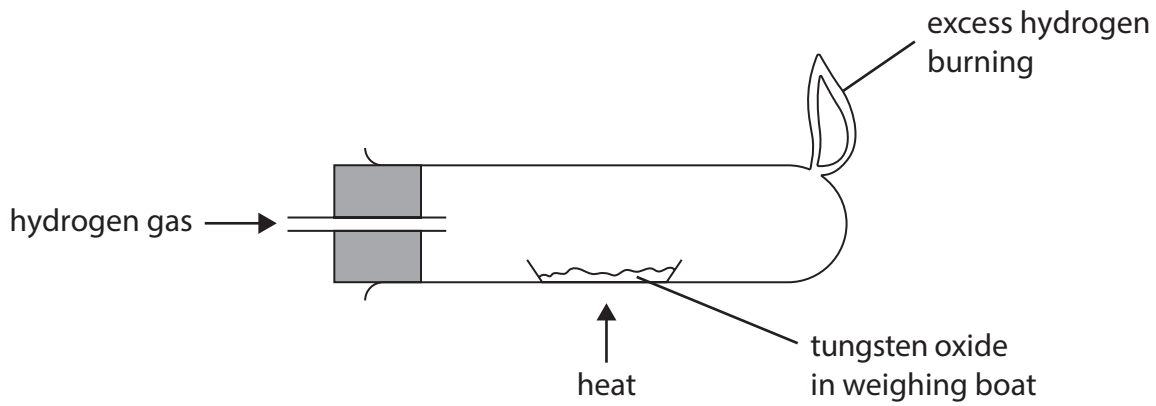
Write a chemical equation for the reaction between silicon hydride and oxygen.

(1)

(Total for Question 7 = 9 marks)

8 This question is about the reduction of tungsten oxide, WO_3

(a) A teacher uses this apparatus to reduce tungsten oxide.



This is the teacher's method.

- record the mass of a weighing boat
- add tungsten oxide and record the mass again
- heat the weighing boat and tungsten oxide strongly for two minutes and then allow to cool
- record the mass of the weighing boat and its contents

(i) Complete the equation by adding the state symbols.

(2)

WO_3(.....) + $3H_2$(.....) → W(.....) + $3H_2O$(.....)

(ii) Give an addition to the method to check that the tungsten oxide has been completely reduced.

(1)

.....

.....

(iii) The table shows the teacher's results.

	Mass in g
empty weighing boat	14.72
weighing boat and tungsten oxide	17.04
weighing boat and tungsten	16.56

Use the teacher's results to show that the empirical formula of tungsten oxide is WO_3

[for tungsten, $A_r = 184$ for oxygen, $A_r = 16$]

(3)

(iv) The teacher wears eye protection and a lab coat during the experiment.

Give one other safety precaution the teacher should take.

(1)

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.....

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(b) In industry, tungsten oxide is reduced on a large-scale using hydrogen.

The percentage yield of tungsten is 73.5%

This is the equation for the reaction.

$$WO_3 + 3H_2 \rightarrow W + 3H_2O$$

Calculate the mass, in tonnes, of tungsten that is produced when 2784 tonnes of tungsten oxide are reacted with an excess of hydrogen.

[1 tonne = 1×10^6 g]

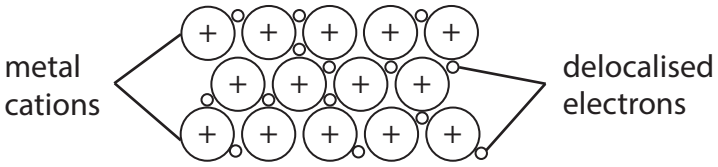
[for tungsten, A_r = 184 for oxygen, A_r = 16]

(3)

mass of tungsten = ... tonnes

(Total for Question 8 = 10 marks)

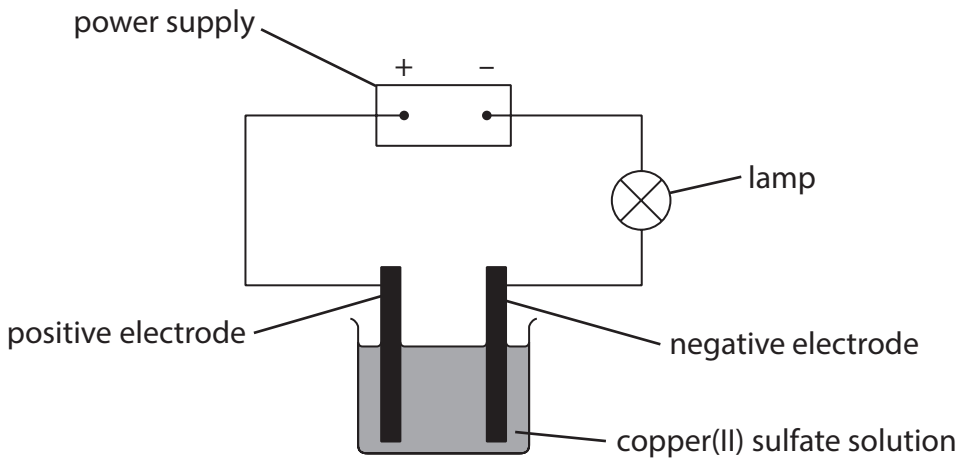
9 (a) The diagram represents the structure of copper metal.



Explain three properties of copper that make it a suitable metal to use in electrical wiring.

(5)

(b) The diagram shows the electrolysis of copper(II) sulfate solution, using graphite electrodes.



Copper forms at the negative electrode and oxygen forms at the positive electrode.

(i) Give the formula of the copper ion in the solution.

(1)

.....

(ii) State what would be seen at the positive electrode.

(1)

.....

.....

(iii) Complete the ionic half-equation for the formation of oxygen at the positive electrode.

(2)

$2H_2O \rightarrow$ ..... + ... + ...

(iv) During the experiment, 120 cm^3 of oxygen gas are formed.

Calculate the amount, in mol, of the oxygen formed.

[molar gas volume = 24 dm^3 at rtp]

(2)

oxygen = ... mol

(Total for Question 9 = 11 marks)

TOTAL FOR UNIT = 90 MARKS