Pearson Edexcel

International GCSE

Chemistry (9–1) (Modular)

Sample Assessment Materials

Pearson Edexcel International GCSE in Chemistry (Modular) (4XCH1)

First teaching September 2024
First examination June 2025
First certification August 2025

Issue 1

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Contents

Introduction

The Pearson Edexcel International GCSE (9-1) in Chemistry (Modular) (4XCH1) is designed for use in schools and colleges. It is part of a suite of International GCSE modular qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

The sample assessment materials in this document are derived from the existing Edexcel International GCSE (9-1) in Chemistry qualification, which is linear in design.

Both linear and modular routes are designed to provide the same level of demand overall while offering candidates a choice of assessment options. In the modular qualification, candidates are able to sit and resit individual units in different series.

Note: Within International GCSE (9-1) in Chemistry (Modular), assessments are referred to as units. This is to support the modular nature of the qualification as each individual assessment is entered for as a separate unit.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive. However, different examples of responses will be provided at standardisation.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Subject specific marking guidance

Symbols and terms used in the mark scheme:

- Round brackets ( ): words inside round brackets are to aid understanding of the marking point but are not required to award the point
- Curly brackets { }: indicate the beginning and end of a list of alternatives (separated by obliques) where necessary, to avoid confusion
- Oblique /: words or phrases separated by an oblique are alternatives to each other and either answer should receive full credit
- ecf: indicates error carried forward which means that a wrong answer given in an early part of a question is used correctly in a later part of a question.

You will not see 'owtte' (or words to that effect). Alternative correct wording should be credited in every answer unless the mark scheme has specified otherwise.

The Additional Guidance column is used for extra guidance to clarify any points in the mark scheme. It may be used to indicate:

- what will not be accepted for that marking point, in which case the phrase 'do not accept' will appear alongside the relevant marking point
- it might have examples of possible acceptable answers which will be adjacent to that marking point.

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 **4WCH1/1C**

Chemistry (Modular)
UNIT 1

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 ▶

S81545A

S 8 1 5 4 5 A 0 1 2 8

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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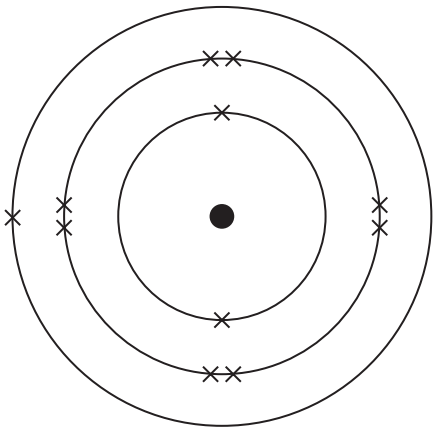
Answer ALL questions.

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 The diagram shows the electronic configuration of an atom of an element.



(a) Name the part of the atom that contains the protons and neutrons.

(1)

.....

(b) Give the number of protons in this atom.

(1)

.....

(c) Give the number of the group that contains this element.

(1)

.....

(d) Give the number of the period that contains this element.

(1)

.....

(Total for Question 1 = 4 marks)

DO NOT WRITE IN THIS AREA

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DO NOT WRITE IN THIS AREA

2 The diagram shows the positions of some elements in part of the Periodic Table.

Na												Al			S	Cl	
K																	Xe
												In					

(a) (i) Give the symbol of a metal from the diagram.

(1)

.....

(ii) Give the symbol of an element from the diagram that forms an acidic oxide.

(1)

.....

(b) Give a similarity in the electron configurations of Al and In.

(1)

.....

.....

(c) Explain which element in the diagram is unreactive.

(2)

.....

.....

.....

.....

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(d) One of the isotopes of Cl can be shown as ^{35}Cl

Determine the number of each sub-atomic particle in this isotope.

(3)

number of protons

.....

number of neutrons

.....

number of electrons

.....

(Total for Question 2 = 8 marks)

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3 This question is about changes of state and separation of mixtures.

(a) The box shows some changes of state.

boiling	condensation	evaporation
freezing	melting	sublimation

The table lists some physical changes.

Complete the table using words from the box to show the change of state for each physical change.

(4)

Physical change	Change of state
water to ice	
steam to water	
solid wax to liquid wax	
iodine crystals to iodine vapour	

(b) A student plans to obtain salt solution from a mixture of salt and sand.

The student adds pure water to the mixture to dissolve the salt.

State two things the student could do to make the salt dissolve quickly.

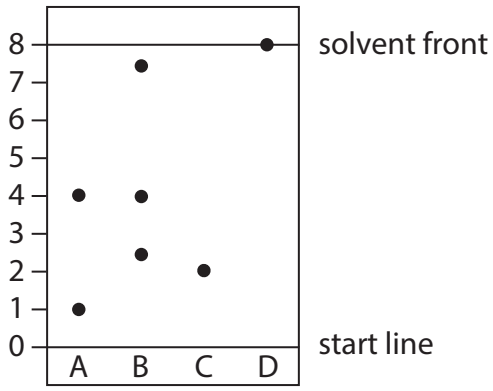
(2)

1 .....

2 .....

(c) Some mixtures can be separated using paper chromatography.

The diagram shows a chromatogram of the food dyes in four different food colourings, A, B, C and D.



(i) Give the letter of the food colouring that contains three different food dyes.

(1)

.....

(ii) Give the letters of the two food colourings that contain the same dye.

(1)

.....

(iii) Using the scale on the diagram, determine the R_f value of the dye in food colouring C.

(2)

R_f = ...

(iv) Give a reason why the dye in food colouring D moves the furthest from the start line.

(1)

.....

.....

(Total for Question 3 = 11 marks)

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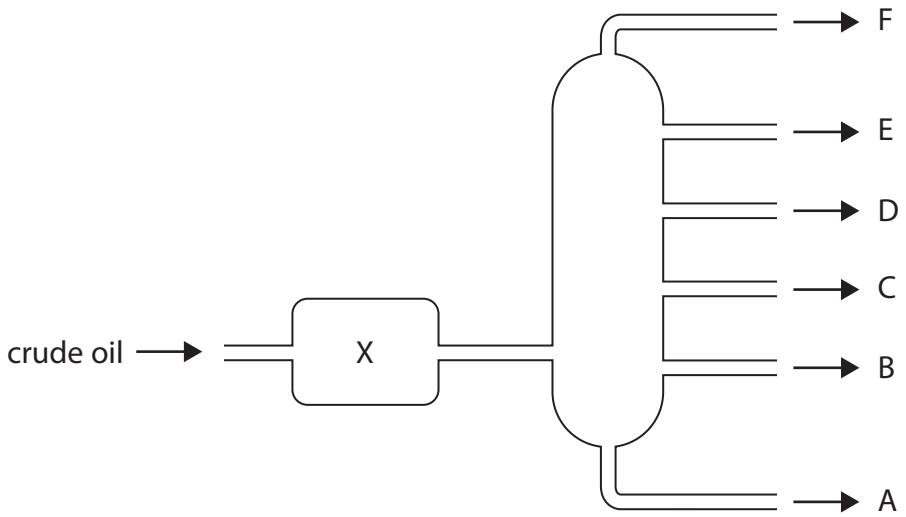
4 Crude oil is an important source of organic compounds.

(a) The diagram shows how crude oil can be separated into fractions by fractional distillation.



(i) State what happens to the crude oil when it is in X.

(1)

.....

(ii) Give the name of fraction E.

(1)

.....

(iii) Give a use for fraction A.

(1)

.....

(b) One of the compounds in fraction D is tridecane ($C_{13}H_{28}$) which can be cracked to form shorter-chain hydrocarbons.

(i) State the catalyst and temperature used in this cracking reaction.

(2)

catalyst

.....

.....

temperature

.....

.....

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DO NOT WRITE IN THIS AREA

(ii) The equation shows an example of a catalytic cracking reaction.

$$C_{13}H_{28} \rightarrow C_8H_{18} + C_2H_4 + C_3H_6$$

Give **two** reasons why this reaction is important.

(2)

1 .....

.....

2 .....

.....

(c) Sulfur is an impurity in crude oil.

Explain why this is a problem for the environment.

(3)

.....

.....

.....

.....

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.....

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.....

(Total for Question 4 = 10 marks)

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5 The reactions of metals with water and with dilute sulfuric acid can be used to determine the order of reactivity of the metals.

The table shows the reactions of four metals, W, X, Y and Z, with water and with dilute sulfuric acid.

Metal	Reaction with water	Reaction with dilute sulfuric acid
W	no reaction	no reaction
X	very slow reaction	reacts quickly
Y	no reaction	reacts slowly
Z	reacts quickly	reacts violently

(a) What is the order of reactivity of these metals?

(1)

Most reactive ⟶ least reactive

- ☒ **A** W X Y Z
- ☒ **B** Z X Y W
- ☒ **C** W Y X Z
- ☒ **D** Z Y X W

(b) (i) State which metal, W, X, Y or Z, could be copper.

(1)

.....

(ii) State which metal, W, X, Y, or Z, could be magnesium.

(1)

.....

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(c) A displacement reaction can also be used to decide the order of reactivity of two metals.

State two observations made when an excess of magnesium powder is added to an aqueous solution of copper(II) sulfate.

(2)

1 .....

.....

2 .....

.....

(Total for Question 5 = 5 marks)

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6 A salt can be made by reacting an acid with an insoluble base.

A student has a sample of copper(II) oxide.

The student uses this method.

Stage 1 pour 50 cm^3 of dilute sulfuric acid into a beaker

Stage 2 warm the acid using a Bunsen burner

Stage 3 add a small amount of copper(II) oxide to the warm acid and stir the mixture

Stage 4 add further amounts of copper(II) oxide until copper(II) oxide is in excess

Stage 5 filter the mixture

Stage 6 obtain crystals from the filtrate

(a) State why the acid is warmed in stage 2.

(1)

.....

.....

(b) State how the student would know that the copper(II) oxide is in excess in stage 4.

(1)

.....

.....

(c) State why the mixture is filtered in stage 5.

(1)

.....

.....

(d) State the colour of the filtrate obtained in stage 5.

(1)

.....

.....

(e) Describe how the student could obtain a pure, dry sample of hydrated copper(II) sulfate crystals from the filtrate in stage 6.

(5)

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(f) The overall equation for the formation of hydrated copper(II) sulfate crystals from copper(II) oxide is

$$CuO(s) + H_2SO_4(aq) + 4H_2O(l) \rightarrow CuSO_4.5H_2O(s)$$

(i) In an experiment, a student completely reacts 9.54 g copper(II) oxide.

Show that the maximum possible mass of $CuSO_4.5H_2O$ crystals that can be obtained is about 30 g.

[M_r of CuO = 79.5 M_r of $CuSO_4.5H_2O$ = 249.5]

Give your answer to an appropriate number of significant figures.

(3)

mass = ... g

(ii) In this experiment, the actual yield of $CuSO_4.5H_2O$ crystals is 23.92 g.

Calculate the percentage yield of $CuSO_4.5H_2O$

(2)

percentage yield = ... %

(Total for Question 6 = 14 marks)

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7 Titanium is an important metal in industry. Titanium metal is extracted from its ore.

The first stage in this extraction is the conversion of titanium dioxide to titanium(IV) chloride.

(a) This is the equation for the reaction.

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Calculate the volume, in dm^3, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.

Give your answer in standard form.

[1 tonne = 10^6 g M_r of TiO_2 = 80]

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

(4)

volume of chlorine gas = ... dm^3

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(b) Aeroplanes are made of an alloy containing aluminium and titanium.

Explain why the alloy is stronger than pure titanium metal.

You may include diagrams in your answer.

(3)

(Total for Question 7 = 7 marks)

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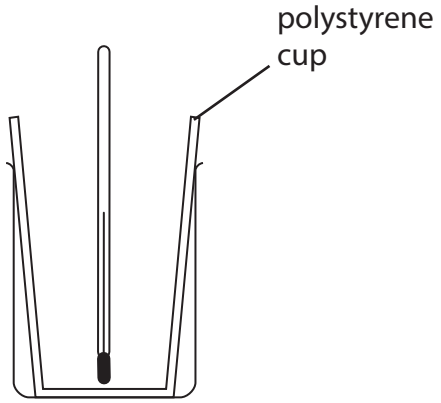
8 A student uses this apparatus to investigate the temperature change that occurs when ammonium nitrate is dissolved in water.



The student uses this method.

- put 100 cm^3 of water into the polystyrene cup and measure the initial temperature of the water
- add 8.00 g of ammonium nitrate and stir
- record the lowest temperature reached by the solution

The table shows her results.

Initial temperature of water in °C	20.0
Lowest temperature of solution in °C	14.2

(a) Use the results of the experiment to explain what type of reaction is taking place when ammonium nitrate is added to water.

(2)

.....

.....

.....

.....

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(b) Show that the heat energy change, Q, is about 2400 J.

[mass of 1.00 cm^3 of solution = 1.00 g]

[for the solution, c = 4.18 J/g/°C]

(3)

Q = ... J

(c) Use your answer to part (b) to calculate the enthalpy change, ΔH, in kilojoules per mole of ammonium nitrate.

[M_r of ammonium nitrate = 80.0]

Include a sign in your answer.

(4)

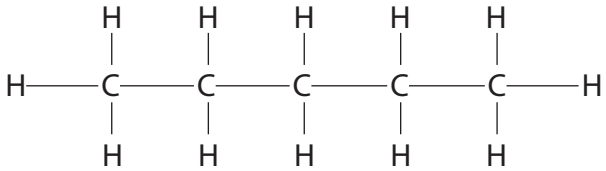
ΔH = ... kJ / mol

(Total for Question 8 = 9 marks)

9 (a) There are three isomers with the molecular formula C_5H_{12}

One of these isomers is pentane.

The displayed formula for pentane is



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

(2)

.....

.....

.....

.....

(ii) Draw the displayed formula for another isomer of C_5H_{12}

(2)

(b) Pentane reacts with bromine in the presence of ultraviolet radiation.

(i) Complete the equation for this reaction.

(2)

$C_5H_{12} + Br_2 \rightarrow$ ..... + ...

(ii) Give the name of this type of reaction.

(1)

.....

(Total for Question 9 = 7 marks)

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10 When a bottle of wine is left open for several days, some of the ethanol in the wine turns to ethanoic acid, CH_3COOH

(a) A scientist uses a titration method to investigate how much ethanoic acid is formed if a bottle of white wine is left open for one week.

The scientist uses this method.

- fill a burette with the white wine and record the reading
- add 25.0 cm^3 of sodium hydroxide solution to a conical flask
- add a few drops of phenolphthalein indicator to the flask
- swirl the flask continuously while adding wine from the burette
- add the wine drop by drop near the end point
- record the reading at the end point

(i) Name the piece of apparatus that would be most suitable for measuring the 25.0 cm^3 of sodium hydroxide solution.

(1)

.....

.....

(ii) Suggest why red wine would not be suitable to use for this investigation.

(1)

.....

.....

.....

(iii) State why the scientist swirls the flask continuously.

(1)

.....

.....

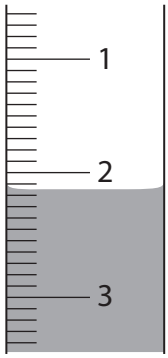
(iv) State why the scientist adds the wine drop by drop near the end point.

(1)

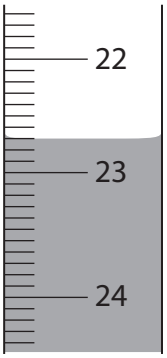
.....

.....

(b) The diagram shows the burette readings at the start and end of one of the titrations.



start



end

Use the readings to complete the table.

Give your values to the nearest 0.05 cm^3.

(3)

Burette reading at end	
Burette reading at start	
Volume of wine added in cm^3	

(c) The scientist repeats the titration four more times.

The table shows the results for these four titrations.

Titration number	1	2	3	4
Volume Volume of wine added in cm^3	20.40	20.10	20.35	20.45
Concordant results dant results				

Concordant results are those within 0.20 cm^3 of each other.

(i) Add ticks (✓) to the table to show the concordant results.

(1)

(ii) Use your ticked results to calculate the mean (average) volume of wine added.

(2)

mean volume of wine added = ... cm^3

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(d) Another scientist repeats the titration with a different bottle of white wine that has been left open for a week.

The equation for the reaction that occurs in this titration is

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

The mean volume of wine added is 19.50 cm^3.

(i) The concentration of the sodium hydroxide solution is 0.0500 mol / dm^3.

Calculate the amount, in moles, of NaOH in 25.0 cm^3 of sodium hydroxide solution.

(2)

amount of NaOH = ... mol

(ii) Deduce the amount, in moles, of CH_3COOH in 19.50 cm^3 of the wine.

(1)

amount of CH_3COOH = ... mol

(iii) Calculate the concentration, in mol / dm^3, of CH_3COOH in wine.

(2)

concentration of CH_3COOH = ... mol/dm^3

(Total for Question 10 = 15 marks)

TOTAL FOR UNIT = 90 MARKS

Chemistry Unit 1 (Modular)
Mark Scheme

Question Number	Answer	Notes	Mark
1(a)	nucleus	**ACCEPT** nuclei	**1**

Question Number	Answer	Mark
1(b)	11 / eleven	**1**

Question Number	Answer	Mark
1(c)	1 / one / group 1	**1**

Question Number	Answer	Mark
1(d)	3 / three / period 3	**1**

Question Number	Answer	Notes	Mark
2(a)(i)	Any one from: Na K Al In	ALLOW names of elements Apply list principle	**1**

Question Number	Answer	Notes	Mark
2(a)(ii)	Any one from: S Cl	ALLOW names of elements	**1**

Question Number	Answer	Notes	Mark
2(b)	same number / three electrons in the outer shell	ALLOW valence shell	**1**

Question Number	Answer	Notes	Mark
2(c)	M1 Xe or xenon M2 as it has a full outer shell (of electrons)	 ALLOW has eight electrons in outer shell ACCEPT does not (easily) gain/lose/share electrons M2 dep on M1	**2**

Question Number	Answer	Mark
2(d)	M1 (number of protons) 17 M2 (number of neutrons) 18 M3 (number of electrons) 17	**3**

Question Number	Answer	Notes	Mark
3(a)	<table><tr><th>Change</th><th>Change of state</th></tr><tr><td>water to ice</td><td>freezing</td></tr><tr><td>steam to water</td><td>condensation</td></tr><tr><td>solid wax to liquid wax</td><td>melting</td></tr><tr><td>iodine crystals to iodine vapour</td><td>sublimation</td></tr></table>	ALLOW condensing ALLOW subliming	**4**

Question Number	Answer	Notes	Mark
3(b)	M1 heat M2 stir / mix	ALLOW use hot water IGNORE add more water ALLOW grind / crush the solid / mixture	**2**

Question Number	Answer	Mark
3(c)(i)	B	**1**

Question Number	Answer	Mark
3(c)(ii)	A and B	**1**

Question Number	Answer	Notes	Mark
3(c)(iii)	M1 2 and 8 M2 0.25	0.25 without working scores 2 ALLOW M1 for 1.8-2.2 and 8 and ALLOW M2 ECF as long as correctly evaluated to at least 2 SF (Special case if used ruler and then) 1.4-1.7 and 5.9-6.2 used no M1 but ALLOW M2 ECF as long as correctly evaluated to at least 2 SF	**2**

Question Number	Answer	Mark
3(c)(iv)	the dye is the most soluble (in the solvent/water)	**1**

Question Number	Answer	Notes	Mark
4(a)(i)	(crude oil/it is) heated / vapourised	ALLOW evaporated / boiled REJECT melted	**1**

Question Number	Answer	Notes	Mark
4(a)(ii)	gasoline	ALLOW petrol	**1**

Question Number	Answer	Mark
4(a)(iii)	road (surfacing) / roofs / tarmac	**1**

Question Number	Answer	Notes	Mark
4(b)(i)	M1 silica / alumina (catalyst) M2 600 to 700 ^{o}C	ACCEPT SiO_2/Al_2O_3 / silicon dioxide / aluminium oxide /aluminosilicates / zeolites	**2**

Question Number	Answer	Notes	Mark
4(b)(ii)	Any two from: M1 shorter-chain alkanes are in high(er) demand / more useful / used for petrol / more flammable M2 alkenes are needed / used to make polymers	 ALLOW $\underline{C_8H_{18}}$ is in high(er) demand (than $C_{13}H_{28}$) / more useful / used for petrol / more flammable IGNORE shorter-chain alkanes are used as fuels ALLOW C_2H_4 / C_3H_6 are needed / used to make polymers / plastics shorter chain hydrocarbons / the products are in high(er) demand / more useful / more flammable scores 1 if no other mark awarded to create shorter alkanes and alkenes scores 1 if no other mark awarded	**2**

Question Number	Answer	Notes	Mark
4(c)	An explanation that links the following three points: M1 sulfur dioxide produced when fuel is burned M2 (sulfur dioxide) dissolves in / reacts with rain / water M3 (causing) acid rain	 ALLOW sulfur / fuel reacts with oxygen / oxidises forming sulfur dioxide IGNORE sulfur trioxide and sulfur oxide ACCEPT (sulfur oxide / sulfur trioxide) dissolves in / reacts with rain / water IGNORE mixes	**3**

Question Number	Answer	Mark
5(a)	The only correct answer is **B** (Z X Y W) *A is not correct as Z is the most reactive metal* *C is not correct as Z is the most reactive metal* *D is not correct as X is more reactive than Y*	**1**

Question Number	Answer	Mark
5(b)(i)	W	**1**

Question Number	Answer	Mark
5(b)(ii)	X	**1**

Question Number	Answer	Notes	Mark
5(c)	M1 brown/pink/pink-brown solid forms M2 solution turns colourless	ALLOW red-brown /orange-brown IGNORE red or orange alone ALLOW precipitate for solid ALLOW solution becomes paler IGNORE clear IGNORE incorrect initial colour of solution IGNORE references to magnesium disappearing IGNORE references to heat	**2**

Question Number	Answer	Notes	Mark
6(a)	to increase the rate of reaction	ACCEPT to make the reaction faster/ to speed up the reaction REJECT any reference to increasing the solubility of copper(II) oxide	**1**

Question Number	Answer	Notes	Mark
6(b)	(the copper(II) oxide/it) stops disappearing OR mixture turns cloudy (black) OR (black) solid settles (at the bottom of the beaker)	ALLOW stops dissolving REJECT any other colour REJECT any other colour ALLOW copper(II) oxide/ it settles (at the bottom of the beaker) IGNORE precipitate	**1**

Question Number	Answer	Notes	Mark
6(c)	to remove excess/unreacted copper(II) oxide/solid/base (from the mixture)	ACCEPT to separate the copper(II) sulfate solution (from the copper(II) oxide/unreacted solid/excess solid)	**1**

Question Number	Answer	Mark
6(d)	blue	**1**

Question Number	Answer	Notes	Mark
6(e)	M1 heat/boil the filtrate M2 until crystals form in a cooled sample/ on a glass rod M3 leave the solution to cool/crystallise M4 filter (to remove the crystals) M5 dry the crystals on filter paper/on paper towel/in a warm oven /in a desiccator /leave to dry	NOTE: If the solution is heated to remove all the water then only M1 can be awarded NOTE If the solution is left to evaporate all the water without heating only 1 mark can be awarded ACCEPT to crystallisation point /to form a saturated solution /until crystals start to form /to remove some of the water M2 dep on M1 NOTE: If the solution is left to completely evaporate after heating then award MAX 3 ACCEPT decant the (excess) solution IGNORE references to washing the crystals REJECT hot oven or any method of direct heating e.g. Bunsen burner No M5 if crystals washed after drying	**5**

Question Number	Answer	Notes	Mark
6(f)(i)	• calculate the moles of CuO • calculate the mass of $CuSO_4.5H_2O$ • give the answer to an appropriate number of significant figures Example calculation M1 *n*[CuO] = 9.54 ÷ 79.5 OR 0.120 (mol) M2 mass of $CuSO_4.5H_2O$ = 0.120 × 249.5 OR 29.94 (g) M3 = 29.9 OR M1 249.5 ÷ 79.5 M2 9.54 (g) x (249.5 ÷ 79.5) (g) OR 29.94 (g) M3 = 29.9	Final answer must be to 3 sig figures 29.94 with no working scores 2 29.9 with no working score 3	**3**

Question Number	Answer	Notes	Mark
6(f)(ii)	M1 (23.92 ÷ 29.9) × 100 OR (23.92 ÷ M3 from (i)) × 100 M2 = 80(%)	ALLOW use of M2 from (i) 29.94 gives 79.89% ALLOW any number of sig figs ACCEPT answer of 79.7(3)% using 30g Correct answer without working scores 2	**2**

Question Number	Answer	Notes	Mark
7(a)	M1 (moles of TiO_2 =) $\frac{20 \times 10^6}{80}$ OR 2.5×10^5 (mol) M2 (moles of Cl_2 =) $2.5 \times 10^5 \times 2$ OR 5.0×10^5 (mol) M3 (vol of Cl_2 =) $5.0 \times 10^5 \times 24$ OR 12 000 000 (dm^3) M4 1.2×10^7 (dm^3)	correct answer with or without working scores 4 ACCEPT 250 000 (mol) ACCEPT 500 000 (mol) ALLOW ecf on M2 and M3 6×10^6 scores 3 3×10^6 scores 3 6 000 000 scores 2 3 000 000 scores 2 2.083×10^4 scores 3	**4**

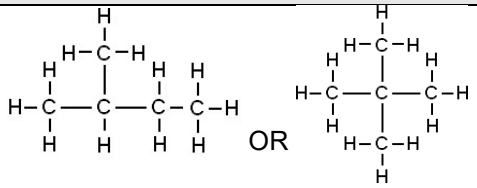
Question Number	Answer	Notes	Mark
7(b)	An explanation that links the following three points M1 in pure titanium all atoms are the same size OR layers/atoms can slide over each other (making it soft /malleable) M2 the alloy has atoms of different sizes M3 (which disrupts the structure so that) atoms/layers do not/harder to slide over each other (making it stronger) OWTTE	all marks can be awarded from labelled diagrams ALLOW cations/ions /particles in place of atoms throughout REJECT mention of molecules once only	**3**

Question Number	Answer	Notes	Mark
8(a)	An explanation that links together M1 the reaction is endothermic and either of the following points: M2 it takes in thermal energy/heat (from the surroundings) OR M3 as shown by the decrease in temperature (of the reaction mixture)	REJECT exothermic for both marks ALLOW references to cooling No M2 or M3 if the statements contradict each other	**2**

Question Number	Answer	Notes	Mark
8(b)	• calculation of temperature change • substitution into $Q = mc\Delta T$ • evaluation Example calculation M1 14.2 – 20.0 = (-)5.8 M2 $Q = 100 \times 4.18 \times (-)5.8$ M3 = (–)2420 (J)	100 x 4.18 x (20 – 14.2) scores M1 and M2 ACCEPT any number of sig figs greater than 2 Calculator answer is 2424.4 and M3 (= 2618) 2400 alone scores 0 ALLOW use of 4.2 for all 3 marks (= 2436)	**3**

Question Number	Answer	Notes	Mark
8(c)	• calculation of moles (n) of ammonium nitrate • division of Q by n • conversion of J to kJ • answer given with + sign Example calculation M1 $n[NH_4NO_3]$ = 8.00 ÷ 80 OR 0.1(00) (mol) M2 $\frac{Q}{n}$ OR $\frac{2420}{0.1(00)}$ OR $\frac{\text{answer to b}}{\text{answer to M1}}$ M3 ΔH = (+)24.2 (kJ/mol) M4 positive sign included	ACCEPT any number of sig figs in the numerator except 1 ACCEPT any number of sig figs except 1 ALLOW ecf from M2 correct answer with no working and no sign or incorrect sign scores 3 correct answer with no working and correct sign scores 4	**4**

Question Number	Answer	Notes	Mark
9(a)(i)	M1 (compounds/molecules) with the same molecular formula M2 but with different structural/displayed formula	ACCEPT same number and same type of atoms REJECT elements for compounds/molecules once only ACCEPT different structures ACCEPT atoms arranged differently REJECT contradicting statements, e.g. same displayed formula but different structures scores 0 out of 2	**2**

Question Number	Answer	Notes	Mark
9(a)(ii)	 OR M1 correct carbon skeleton M2 all hydrogen atoms and all bonds shown	M2 dep on M1	**2**

Question Number	Answer	Notes	Mark
9(b)(i)	$(C_5H_{12} + Br_2) \rightarrow C_5H_{11}Br + HBr$ M1 correct formula of organic product M2 HBr as a product and correctly balanced	deduct 1 mark if cases or subscripts incorrect ACCEPT multiple substitutions of bromine $C_5H_{10}Br_2 + H_2$ scores M1	**2**

Question Number	Answer	Notes	Mark
9(b)(ii)	substitution		**1**

Question Number	Answer	Mark
10(a)(i)	pipette	**1**

Question Number	Answer	Notes	Mark
10(a)(ii)	red wine would mask the colour of the indicator / difficult to see colour change (at end point)	ACCEPT indicator and red wine are a similar colour OWTTE	**1**

Question Number	Answer	Notes	Mark
10(a)(iii)	to mix the contents (of the flask so that they can react) OWTTE	ACCEPT to ensure the colour change is permanent OWTTE ALLOW to speed up the reaction/ to ensure complete reaction	**1**

Question Number	Answer	Notes	Mark
10(a)(iv)	so as not to add more wine than is needed (for complete reaction)/ so as not to overshoot the end point OWTTE	ACCEPT to find the actual/precise point of neutralisation IGNORE to obtain an accurate reading	**1**

Question Number	Answer	Notes	Mark
10(b)	M1 final burette reading in cm^3 22.70 M2 initial burette reading in cm^3 2.15 M3 volume of wine added in cm^3 20.55	MAX 2 if final and initial burette readings are reversed. MAX 2 if readings not given to 2 decimal places. ALLOW ECF for M3 on correct subtraction of M1 – M2	**3**

Question Number	Answer	Mark
10(c)(i)	Ticks in boxes 1, 3 and 4	**1**

Question Number	Answer	Notes	Mark
10(c)(ii)	• setting out of calculation • answer M1 $\frac{20.40 + 20.35 + 20.45}{3}$ M2 20.40	20.40 without working scores 2 20.4 with or without working scores 1 If no results ticked then only use of 2 or 3 concordant titres can score both marks in (ii) If only one result ticked then M2 can be scored for averaging two or more titre values correctly M1 CQ on results ticked M2 CQ on correct calculation from M1 Answer to M2 must be correct to 2dp	**2**

Question Number	Answer	Notes	Mark
10(d)(i)	• setting out of calculation • final answer M1 $\frac{25.0 \times 0.05(00)}{1000}$ M2 0.00125	If no division by 1000 giving an answer of 1.25 award 1 mark Correct answer without working scores 2	**2**

Question Number	Answer	Mark
10(d)(ii)	0.00125 OR answer to (i)	**1**

Question Number	Answer	Notes	Mark
10(d)(iii)	• setting out of calculation • final answer M1 $\frac{0.00125 \times 1000}{19.50}$ OR $\frac{\text{answer to (ii)} \times 1000}{19.5}$ M2 0.0641 OR answer to M1	ACCEPT any number of sig fig cept 1 Correct answer without working scores 2 $\frac{\text{answer to (ii)}}{19.5}$ correctly evaluated to 2 or more sig figs. scores 1 Do not penalise not multiplying by 1000 in (iii) if they have not divided by 1000 in (i)	**2**

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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S 8 1 5 4 6 A 0 1 2 8

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)

.....

(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)

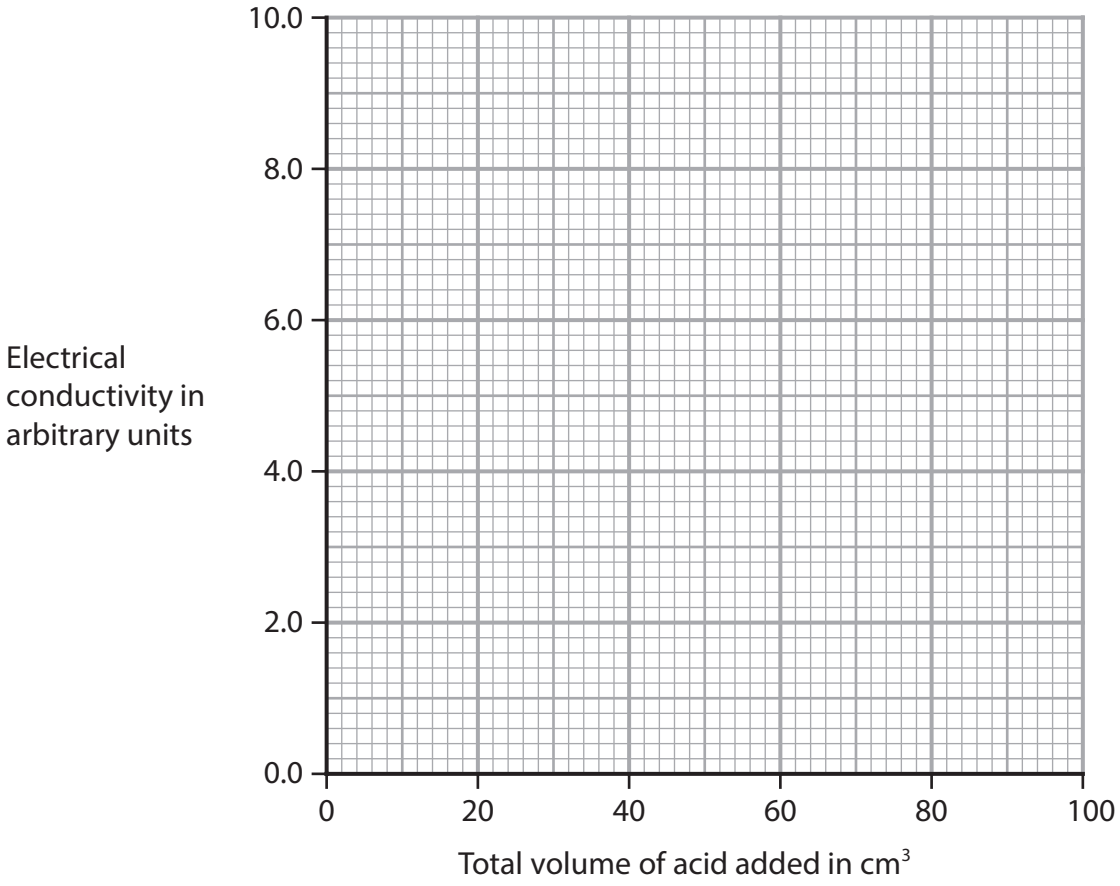
- ☒ **A** beaker
- ☒ **B** conical flask
- ☒ **C** measuring cylinder
- ☒ **D** test tube

(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)

(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)

(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)

(Total for Question 4 = 10 marks)

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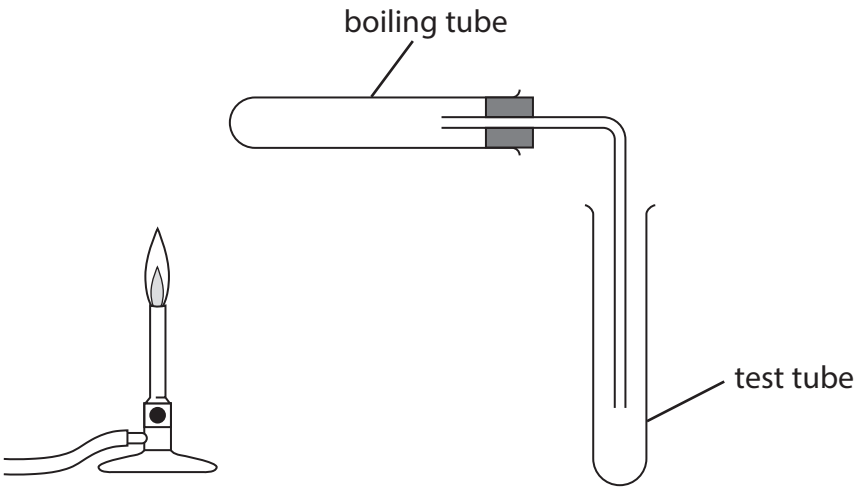
5 This question is about metal carbonates.

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.



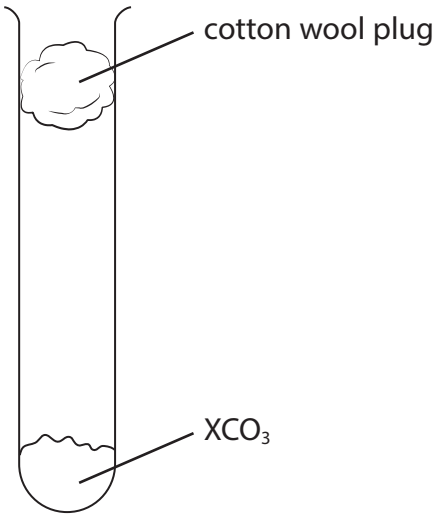
Describe a method the student can use to find out which metal carbonate decomposes fastest when heated.

(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, $M_r = 44.0$]

.....

.....

.....

.....

(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.

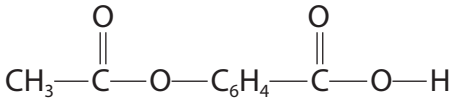
(i) State what is meant by the term **functional group**.

(1)

.....

.....

(ii) This is the structural formula of aspirin.

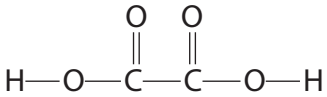


Draw a circle around the carboxylic acid functional group.

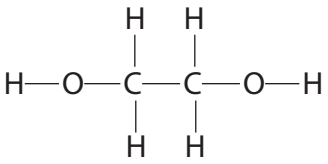
(1)

(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)

.....

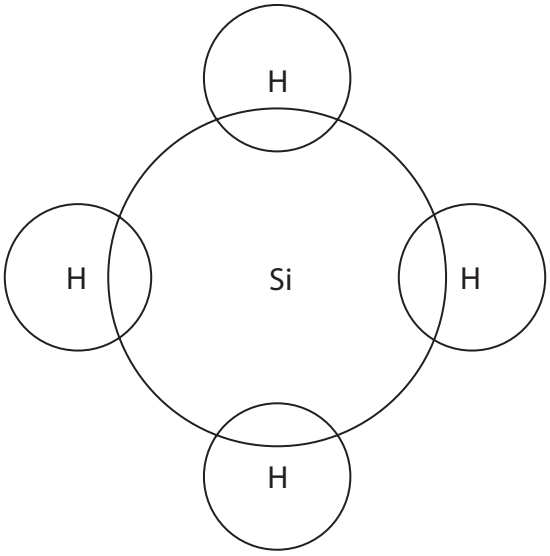
.....

.....

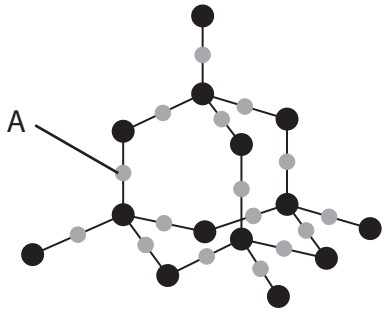
.....

(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.

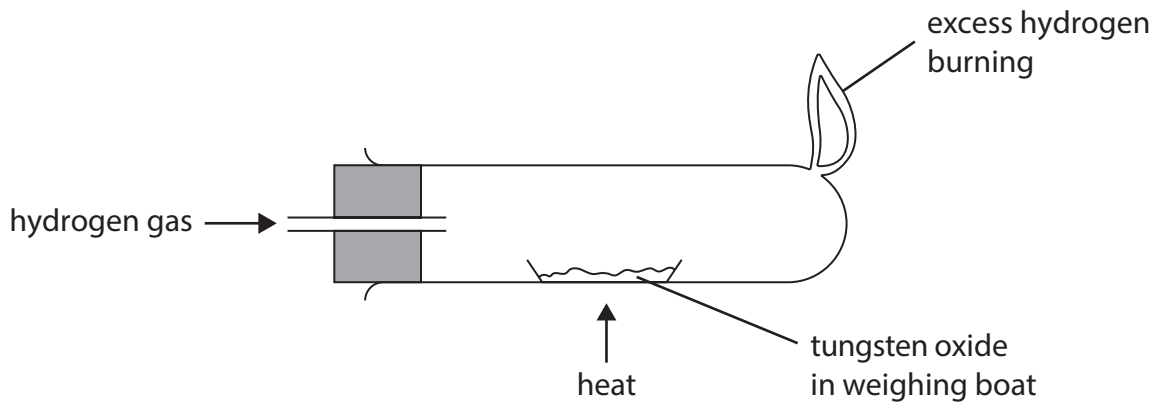
Write a chemical equation for the reaction between silicon hydride and oxygen.

(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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(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]

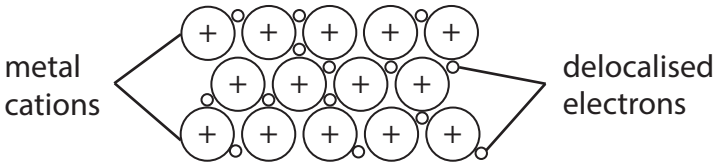
[for tungsten, A_r = 184 for oxygen, A_r = 16]

(3)

mass of tungsten = ... tonnes

(Total for Question 8 = 10 marks)

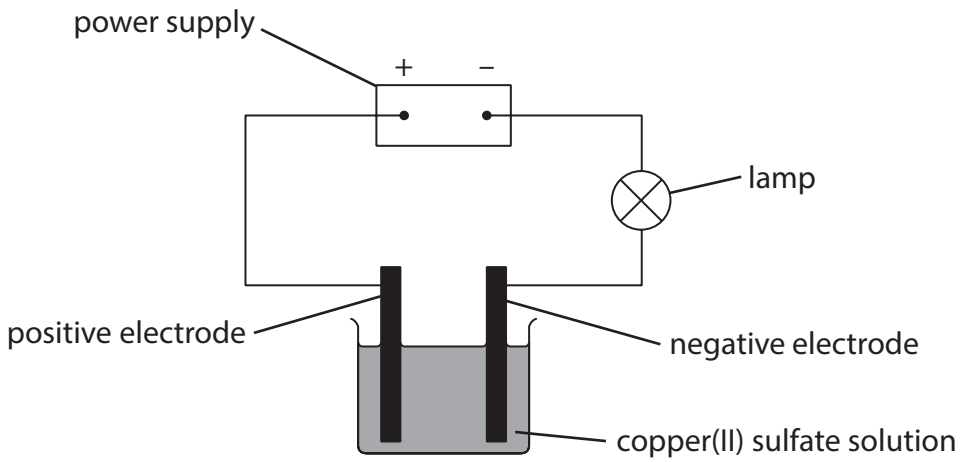
9 (a) The diagram represents the structure of copper metal.



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)

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

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(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

Question Number	Answer	Notes	Mark
1(a)(i)	argon	ALLOW Ar	**1**

Question Number	Answer	Notes	Mark
1(a)(ii)	nitrogen	ALLOW N_2/N	**1**

Question Number	Answer	Notes	Mark
1(a)(iii)	hydrogen	ALLOW H_2/H	**1**

Question Number	Answer	Notes	Mark
1(b)	climate change/global warming /oceans becoming more acidic	ALLOW greenhouse effect ALLOW effects of global warming e.g. melting of polar ice caps/flooding/wild fires IGNORE acid rain REJECT references to ozone layer	**1**

Question Number	Answer	Notes	Mark
1(c)	M1 bubble/pass/add the gas/carbon dioxide into limewater M2 (limewater) turns cloudy/milky	 ALLOW white precipitate M2 dep on mention of limewater REJECT addition of extra reagents for both marks	**2**

Question Number	Answer	Mark
1(d)	M1 volume of oxygen = 90 – 73 = 17 cm3 M2 percentage of oxygen = $\frac{17 \times 100}{90}$ = 18.9 %	**2**

Question Number	Answer	Mark
2(a)(i)	2.5	**1**

Question Number	Answer	Mark
2(a)(ii)	P has the same number of outer shell electrons as N	**1**

Question Number	Answer	Mark
2(b)(i)	<table><tr><td>**M1** ammonium chloride</td><td>ammonium carbonate</td></tr><tr><td>NH_4Cl</td><td>**M2** $(NH_4)_2CO_3$</td></tr></table>	**2**

Question Number	Answer	Notes	Mark
2(b)(ii)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	ALLOW multiples IGNORE state symbols even if incorrect	**1**

Question Number	Answer	Notes	Mark
2(b)(iii)	M1 add sodium hydroxide (solution) M2 test (gas / ammonia) with (damp) red litmus paper / (damp) universal indicator paper M3 (red litmus) turns blue / universal indicator) turns blue / purple	REJECT if solution / ammonium (sulfate) tested with litmus / universal indicator paper	**3**

Question Number	Answer	Notes	Mark
2(c)	M1 2 x 14 ÷ 80 OR 0.35 M2 (0.35 x 100 =) 35 (%)	correct answer without working scores 2 **ALLOW** 1 mark for 17 / 17.5 / 18 (%)	**2**

Question Number	Answer	Notes	Mark
3(a)(i)	M1 copper(II) sulfate (solution) M2 shortest time taken to turn colourless	ALLOW copper sulfate ALLOW gave greatest increase in rate OWTTE ALLOW made reaction happen fastest OWTTE M2 dep on M1	**2**

Question Number	Answer	Notes	Mark
3(a)(ii)	M1 a catalyst provides an alternative pathway M2 of lower activation energy	Any reference to increasing energy/speed of particles scores 0	**2**

Question Number	Answer	Notes	Mark
3(b)(i)	An explanation with following four points M1 the rate of reaction increases/ the reaction is faster/ the reaction speeds up M2 because the particles gain (kinetic) energy/move faster M3 there are more collisions per unit time M4 more of the collisions are successful / more collisions/particles have energy greater than the activation energy	ACCEPT more frequent collisions OWTTE No M4 if refer to lower activation energy there are more frequent successful collisions scores M3 and M4	**4**

Question Number	Answer	Notes	Mark
3(b)(ii)	M1 fewer particles per unit volume M2 (hence) fewer collisions per unit time	ALLOW particles less tightly packed / particles further apart ALLOW decrease in the frequency of collisions between particles Any reference to changing energy/speed of particles scores 0	**2**

Question Number	Answer	Mark
4(a)(i)	C Measuring cylinder	**1**

Question Number	Answer	Notes	Mark
4(a)(ii)	M1 and M2 all the points correct ± half a square	If only one plotting error scores M1	**2**

Question Number	Answer	Notes	Mark
4(a)(iii)	2 straight lines of best fit, ignoring the anomalous point	Left line does not have to go through/use (0.0, 10.0) if point has not been plotted	**1**

Question Number	Answer	Notes	Mark
4(a)(iv)	as the volume of sulfuric acid increases the (electrical) conductivity decreases	IGNORE references to gradient/slope/correlation	**1**

Question Number	Answer	Notes	Mark
4(a)(v)	(the student) forgot to stir the mixture	ALLOW any reference to adding less acid/lower volume (than should have done) OWTTE	**1**

Question Number	Answer	Notes	Mark
4(b)(i)	M1 barium sulfate has a (giant) ionic structure OR has ionic bonding M2 ionic substances do not conduct when solid M3 water has covalent bonding and covalent compounds do not (usually) conduct electricity	 ALLOW only conduct when dissolved/molten ALLOW in solid ions cannot move ALLOW water does not conduct because it is covalent IGNORE explanations of why covalent do not conduct	**3**

Question Number	Answer	Mark
4(b)(ii)	filtration **OR** filtering	**1**

Question Number	Answer	Notes	Mark
5(a)	M1 (put the carbonate in the boiling tube) and the limewater in the test tube M2 heat the carbonate and time how long it takes for the limewater to turn cloudy OWTTE M3 repeat with the same mass / amount / number of moles of another carbonate M4 (the carbonate which decomposes the fastest) will turn the limewater cloudy in the least time	 **ACCEPT** repeat with another carbonate using same volume of limewater OWTTE To score M4 reference to limewater turning cloudy must be mentioned at least once somewhere in answer	**4**

Question Number	Answer	Mark
5(b)(i)	C to stop solid particles leaving the tube	**1**

Question Number	Answer	Mark
5(b)(ii)	2.20 ÷ 44.0 (= 0.0500 mol)	**1**

Question Number	Answer	Notes	Mark
5(b)(iii)	0.05	ALLOW ECF from (ii)	**1**

Question Number	Answer	Notes	Mark
5(b)(iv)	M1 7.40 ÷ 0.05 M2 148	correct answer with or without working scores 2 ALLOW ECF from (iii)	**2**

Question Number	Answer	Notes	Mark
5(b)(v)	M1 A_r of metal = 148-60 OR 88 M2 metal is strontium / Sr	If (iv) correct strontium/Sr scores 2 without working ALLOW ECF from (iv) ALLOW ECF from M1 as long as answer is nearest Group 2 metal	**2**

Question Number	Answer	Mark
6(a)(i)	$2CO_2$	**1**

Question Number	Answer	Notes	Mark
6(a)(ii)	yeast	IGNORE zymase/enzymes	**1**

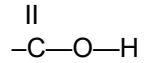
Question Number	Answer	Mark
6(b)(i)	The only correct answer is **B** $CH_3COOC_4H_9$ *A is incorrect as this is propyl ethanoate* *C is incorrect as this is butyl propanoate* *D is incorrect as this is ethyl butanoate*	**1**

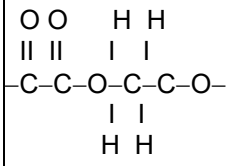
Question Number	Answer	Mark
6(b)(ii)	sweet/fruity/distinctive smell OWTTE	**1**

Question Number	Answer	Notes	Mark
6(b)(iii)	perfumes/(food) flavourings/solvents	IGNORE (food) colourings ACCEPT any other appropriate use e.g. emulsifiers	**1**

Question Number	Answer	Mark
6(c)	M1 $(CH_3COO)_2Mg$ M2 $H_2O + CO_2$	**2**

Question Number	Answer	Notes	Mark
6(d)(i)	(atom/group of atoms in a compound that) determines its chemical properties/reactions OWTTE	ALLOW (atom/group of atoms that) determines which homologous series a compound is in OWTTE	**1**

Question Number	Answer	Mark
6(d)(ii)	circle around 	**1**

Question Number	Answer	Notes	Mark
6(e)	 M1 correct displayed ester functional group M2 rest of structure correct	O can be on LHS instead of on RHS ALLOW structure without extension bonds IGNORE n and brackets	**2**

Question Number	Answer	Notes	Mark
7(a)	M1 shared pair(s) of electrons M2 attracted to (two) nuclei	REJECT nucleus. Must be plural for M2 M2 dep on mention of electrons in M1	**2**

Question Number	Answer	Notes	Mark
7(b)	a pair of electrons in each bond and no non-bonding electrons.	ALLOW dots, crosses or any combination	**1**

Question Number	Answer	Mark
7(c)(i)	Any one from M1 oxygen is a smaller atom/particle than silicon M2 each (atom of) oxygen forms two bonds (to silicon atoms)	**1**

Question Number	Answer	Notes	Mark
7(c)(ii)	M1 silicon dioxide has a giant (covalent) structure M2 (in melting silicon dioxide) strong/many covalent bonds (need to be broken) M3 (in melting silicon hydride) weak intermolecular forces (of attraction need to be overcome/broken) M4 more (thermal/heat) energy is needed to break the (covalent) bonds (in SiO_2) than break/overcome the intermolecular forces (in SiH_4)	ALLOW description of covalent bonds as long as strong/many mentioned ALLOW weak intermolecular bonds Max 2 if contradictions/references to incorrect forces/particles	**4**

Question Number	Answer	Notes	Mark
7(d)	$SiH_4 + 2O_2 \rightarrow SiO_2 + 2H_2O$ all formula correct and equation correctly balanced	IGNORE state symbols ALLOW multiples and fractions	**1**

Question Number	Answer	Notes	Mark
8(a)(i)	M1 $WO_3(s) + 3H_2(g)$ M2 $W(s) + 3H_2O(g \text{ or } l)$	ALLOW upper case	**2**

Question Number	Answer	Mark
8(a)(ii)	heat again to constant mass OWTTE	**1**

Question Number	Answer	Notes	Mark
8(a)(iii)	M1 (mass of tungsten =) 1.84g AND (mass of oxygen =) 0.48g M2 (moles of tungsten) = $\frac{1.84}{184}$ or 0.01 AND (moles of oxygen) = $\frac{0.48}{16}$ or 0.03 M3 therefore ratio is 1:3	M2 subsumes M1 ALLOW M2 ECF from incorrect masses M3 dep on M2 ALLOW ECF from incorrect M2 only if does give 1:3 when rounded	**3**

Question Number	Answer	Notes	Mark
8(a)(iv)	Any one from M1 use a safety screen M2 position the class some distance from the apparatus OWTTE M3 do the experiment in a fume cupboard	ALLOW heat proof/safety gloves ALLOW tie back hair	**1**

Question Number	Answer	Notes	Mark
8(b)	Example calculation M1 moles of tungsten oxide = (2784 × 10^6 ÷ 232) = 12 000 000 M2 maximum mass of tungsten = (12 000 000 × 184) = 2208 000 000 g OR 2208 tonnes M3 mass of tungsten (considering 73.5% yield) = (73.5 × 2208 ÷ 100) = 1622.88 (tonnes)	correct answer without working scores 3 ALLOW any number of significant figures ≥2 throughout ALLOW other correct methods ALLOW working in megamoles ALLOW ECF M1×184 ALLOW ECF from M2	**3**

Question Number	Answer	Notes	Mark
9(a)	An explanation of properties that includes five of the following points M1 conducts electricity M2 (because the) delocalised electrons can move/flow (through structure) M3 malleable/ductile M4 (because) layers of cations/atoms M5 layers/cations/atoms can slide/slip/move over each other M6 high melting point M7 (because) strong (electrostatic) attraction between cations and delocalised electrons	reason must be linked to correct property IGNORE references to cost/reactivity/hardness/ strength/shiny If any mention of ions/atoms moving cannot score M2 ALLOW explanations of malleable/ductile ALLOW sheets/rows IGNORE high boiling point ALLOW giant metallic lattice/strong bonds between cations and delocalised electrons /strong metallic bonds Max 4 if any mention of intermolecular forces/covalent/ionic bonding	**5**

Question Number	Answer	Mark
9(b)(i)	Cu^{2+}	**1**

Question Number	Answer	Notes	Mark
9(b)(ii)	effervescence/bubbles/fizzing	IGNORE oxygen/gas	**1**

Question Number	Answer	Mark
9(b)(iii)	M1 O_2 M2 $4H^+ + 4e^{(-)}$	**2**

Question Number	Answer	Mark
9(b)(iv)	M1 conversion to 0.120 dm^3 M2 amount = $\frac{0.120}{24}$ = 0.005 (mol)	**2**

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