IGCSE Edexcel Chemistry Revision

Revision Guide Section 5: Physical Chemistry

Paper 1 [All Pathways]

Please note, these questions may have parts related to **other** topics within the GCSE Chemistry course. However, all questions are related at least in part to Inorganic Chemistry

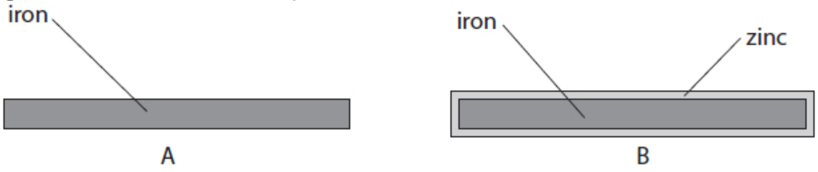
Topics included:

- Enthalpy (ΔH)
- Rates of Reaction

Questions taken from 2019 and 2020 January, June and November Papers (C and CR)

- 7 questions
- 85 marks
- Recommended time: 90 minutes (just over 1 mark per minute)

1. The diagram shows two samples of iron, A and B.



Sample B is coated with a thin layer of zinc.

(a) Name the process used to coat iron with zinc. (1)

....

(b) The two samples of iron are left outside for several weeks.
A brown solid containing hydrated iron(III) oxide forms on sample A.

(i) Give the common name for the brown solid. (1)

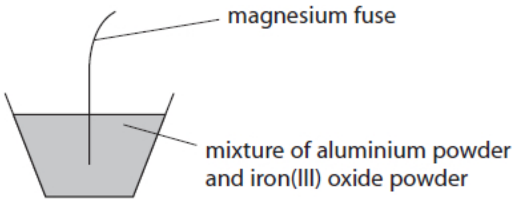
....

(ii) Give the names of the two substances that react with the iron to form the brown solid. (2)

1 ....

2 ....

(c) Iron can be formed by reacting aluminium powder with iron(III) oxide.
The diagram shows how this reaction can be demonstrated.



When the magnesium fuse is lit, a very exothermic reaction occurs.

(i) State the meaning of the term exothermic. (1)

....

....

(ii) The equation for the reaction between aluminium and iron(III) oxide is

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

Explain what this reaction shows about the relative reactivities of aluminium and iron. (2)

....

....

....

....

(iii) Explain why the reaction between aluminium and iron(III) oxide is a redox reaction. (3)

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(Total for question = 10 marks)

2. Nitric acid (HNO_3) is used in the production of fertilisers.
Nitric acid is manufactured in three stages.

Stage 1 ammonia reacts with oxygen in the presence of a platinum catalyst to produce nitrogen monoxide gas, NO, and water.

Stage 2 nitrogen monoxide gas reacts with more oxygen to produce nitrogen dioxide gas, NO_2.

Stage 3 nitrogen dioxide gas reacts with water to produce nitric acid and more nitrogen monoxide gas.

(a) (i) Complete the chemical equation for the reaction in stage 1. (1)

$$\ldots\ldots NH_3 + \ldots\ldots O_2 \rightleftharpoons \ldots\ldots NO + \ldots\ldots H_2O$$

(ii) Give the meaning of the symbol $\rightleftharpoons$ (1)

....

....

(iii) State the purpose of the platinum catalyst. (1)

....

....

(b) Give a chemical equation for the reaction of nitrogen monoxide and oxygen in stage 2. (1)

....

(c) (i) The equation for the reaction in stage 3 is

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

Calculate the maximum mass, in tonnes, of nitric acid that could be produced in this reaction from 11.5 tonnes of nitrogen dioxide.
[1 tonne = 1.0×10^6g] (4)

mass of nitric acid = ... tonnes

(ii) Suggest what use can be made of the nitrogen monoxide gas formed in stage 3.
(1)

....

....

(d) When copper(II) oxide reacts with dilute nitric acid, copper(II) nitrate is produced.
The equation for the reaction is

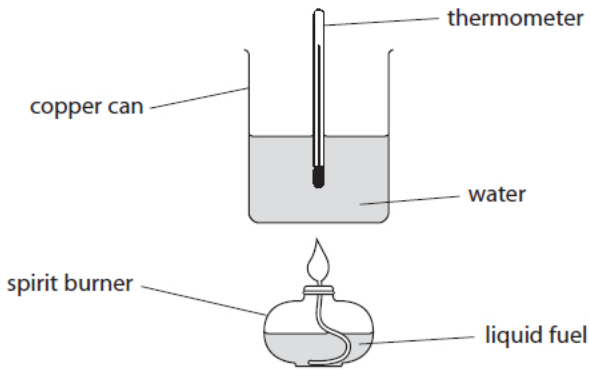
$$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$$

0.200 mol of nitric acid reacts with excess copper(II) oxide.
A mass of 15.3 g of copper(II) nitrate is produced.
Calculate the percentage yield of copper(II) nitrate.
[M_r of copper(II) nitrate = 187.5] (3)

percentage yield = ... %

(Total for question = 12 marks)

3. A student uses this apparatus to investigate the heat energy released when a liquid fuel is burned.



This is the student's method.

- measure the mass of the spirit burner and fuel
- add 100 cm^3 of water to the copper can
- record the temperature of the water
- use the spirit burner to heat the water until the temperature rises by 30 °C
- immediately measure the new mass of the spirit burner and fuel

(a) Suggest why the student measures the mass of the spirit burner and fuel immediately after heating the water. (1)

....

....

....

(b) When the fuel is burned, the student notices that a black solid forms on the bottom of the copper can.

(i) Identify the black solid. (1)

....

(ii) Explain why the black solid forms. (2)

....

....

....

....

(c) (i) Show that the heat energy change, Q, to raise the temperature of 100 cm^3 of water by 30 °C is approximately 13 kJ.
[mass of 1.0 cm^3 of water = 1.0 g]
[c for water = 4.2 J/g/ °C] (3)

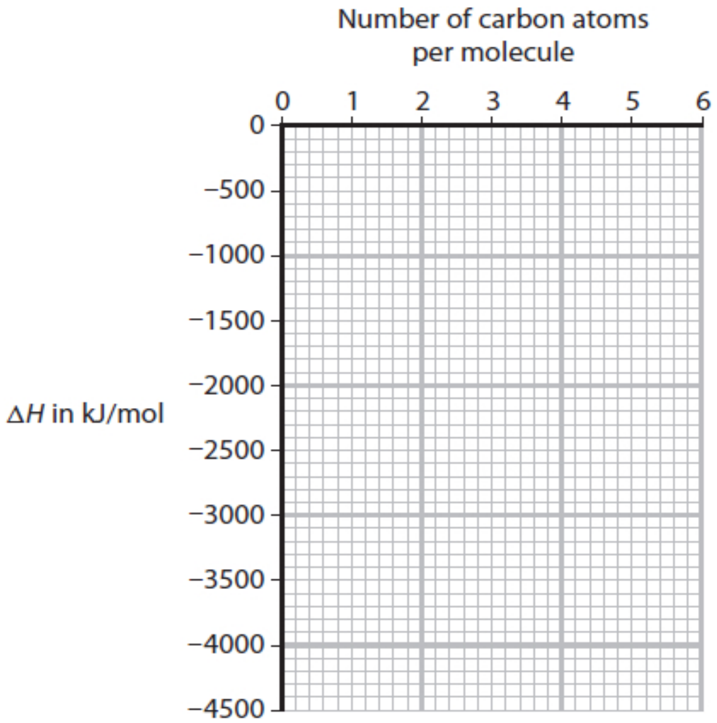
(ii) The student burns 0.96 g of methanol, CH_3OH
Calculate the molar enthalpy change, ΔH, in kJ/mol, for the combustion of methanol.
Include a sign in your answer.
[M_r of methanol = 32] (3)

ΔH = ... kJ/mol

(d) The table shows data book values for the molar enthalpy change, Δ*H*, for the combustion of some alcohols with different numbers of carbon atoms per molecule.

Number of carbon atoms per molecule	1	2	3	4	5
Molar enthalpy change, Δ*H*, in kJ/mol	−730	−1370	−2020	−2680	−3320

(i) Plot the data values from the table on the grid.
Draw a straight line of best fit. (2)



(ii) Deduce the value of Δ*H* for an alcohol with six carbon atoms per molecule.
Show on the graph how you obtained your answer. (2)

Δ*H* = ... kJ/mol

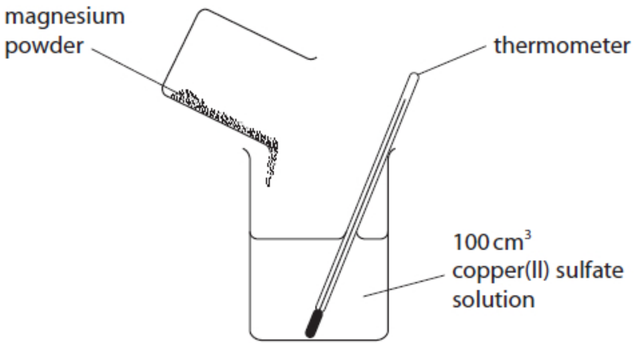
(iii) State the relationship between Δ*H* and the number of carbon atoms per molecule. (1)

....

....

(Total for question = 15 marks)

4. The reaction between magnesium and copper(II) sulfate solution is exothermic. This apparatus is used to measure the temperature increase when excess magnesium is added to 100 cm^3 of copper(II) sulfate solution.



(a) (i) State why a reaction occurs when magnesium is added to copper(II) sulfate solution. (1)

....

....

(ii) Complete the word equation for this reaction. (1)

magnesium + copper(II) sulfate → .... + ...

(b) The temperature at the start of the reaction is 20.2 °C.
The maximum temperature recorded is 56.3 °C.
(i) Calculate the heat energy change, in joules, for the reaction.
[mass of 1.00 cm^3 of solution = 1.00 g]
[c for the solution = 4.2 J/g/ °C] (2)

heat energy change = ... J

(ii) Explain why it is better to use a polystyrene cup rather than a glass beaker in this experiment. (2)

....

....

....

....

(c) The reaction between zinc and copper(II) sulfate solution is also exothermic.

(i) A mass of 0.500 g of zinc is reacted with an excess of copper(II) sulfate solution. The heat energy change is 1.67 kJ.
Calculate the molar enthalpy change, ΔH, in kJ/mol.
Include a sign in your answer.
Give your answer to three significant figures. (3)

ΔH = ... kJ/mol

(ii) The ionic equation for the reaction between zinc and copper(II) sulfate is

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Explain why this is a redox reaction. (3)

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(Total for question = 12 marks)

5. A student investigates the reaction between sodium hydroxide solution and hydrochloric acid.
He uses this method.

Step 1 add 50 cm^3 of dilute hydrochloric acid to a conical flask
Step 2 add a 5 cm^3 portion of sodium hydroxide solution to the conical flask
Step 3 test the pH of the mixture using both universal indicator paper and a pH meter

The student repeats step 2 and step 3 until a total of 50 cm^3 of sodium hydroxide solution has been added.

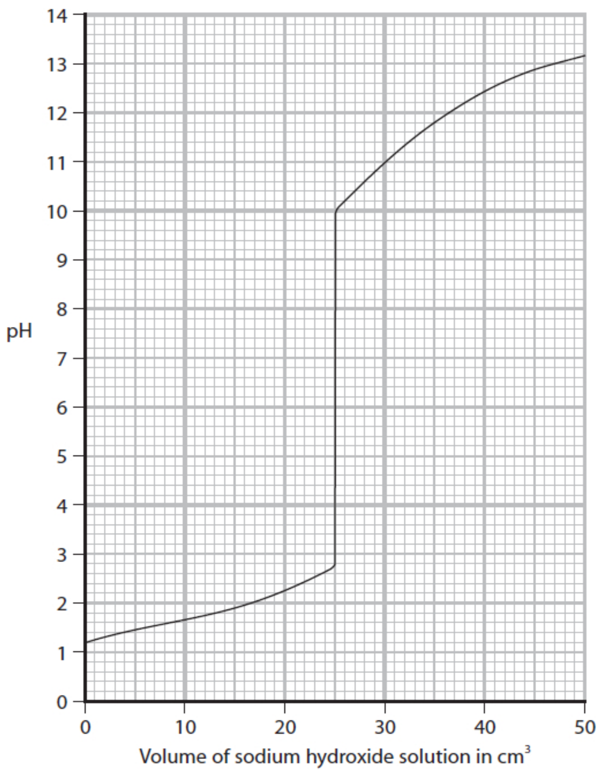
(a) (i) State the piece of apparatus that should be used to measure 50 cm^3 of hydrochloric acid. (1)

....

(ii) Name the type of reaction that occurs between hydrochloric acid and sodium hydroxide. (1)

....

(b) Graph 1 shows how the pH of the mixture changes as the sodium hydroxide solution is added.



Graph 1

(i) Determine the pH after 40 cm^3 of sodium hydroxide solution has been added. (1)

....

(ii) Suggest the colour of the universal indicator paper when these volumes of sodium hydroxide solution have been added. (2)

15 cm^3..

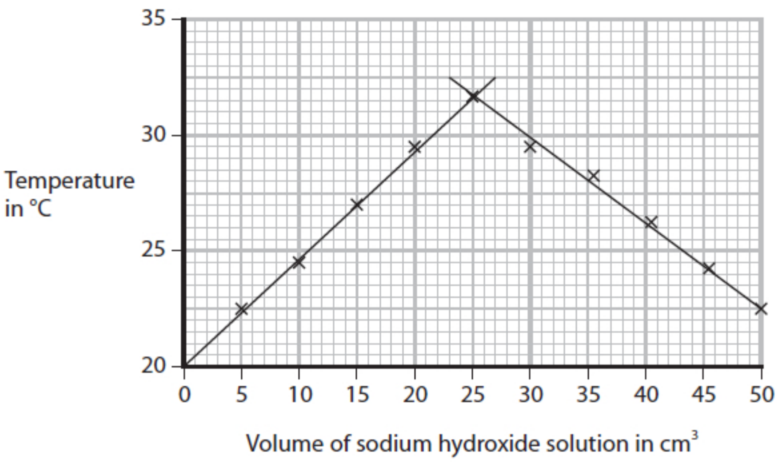
30 cm^3..

(iii) Give the formula of the ion that causes sodium hydroxide to be alkaline. (1)

....

(c) Another student investigates how the temperature changes when the sodium hydroxide solution is added to the hydrochloric acid.
The hydrochloric acid and the sodium hydroxide solution are at the same temperature at the start of the investigation.
The student records the temperature of the mixture after adding each 5 cm^3 portion of sodium hydroxide solution.

Graph 2 shows her results.



Graph 2

Explain the shape of graph 2. (3)

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(Total for question = 9 marks)

6. A solution of hydrogen peroxide decomposes when a catalyst of manganese(IV) oxide is added.
The products of the reaction are water and oxygen.

(a) Complete the chemical equation for this reaction. (1)

.... $H_2O_2 \rightarrow$ .... H_2O + ... O_2

(b) Give a test for oxygen. (1)

....

....

(c) State the reason for adding a catalyst. (1)

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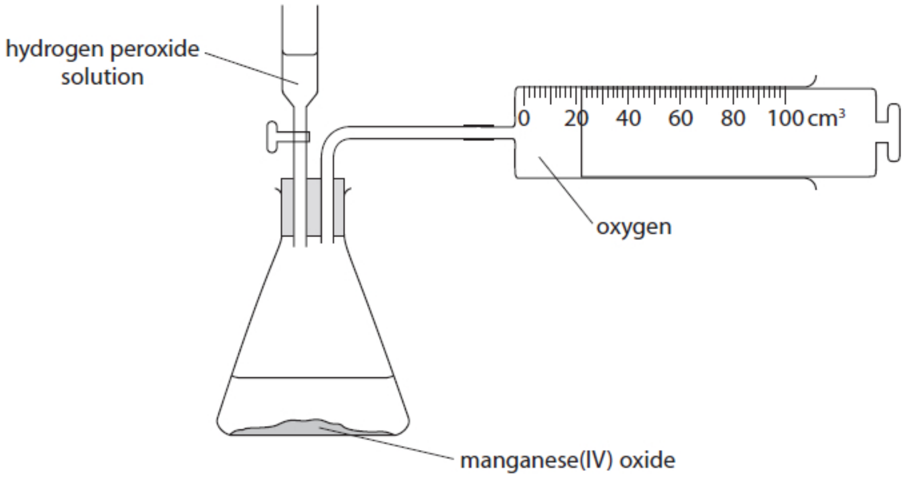
....

(d) A student investigates how changing the concentration of the hydrogen peroxide solution affects the rate of this reaction.
She uses this apparatus.



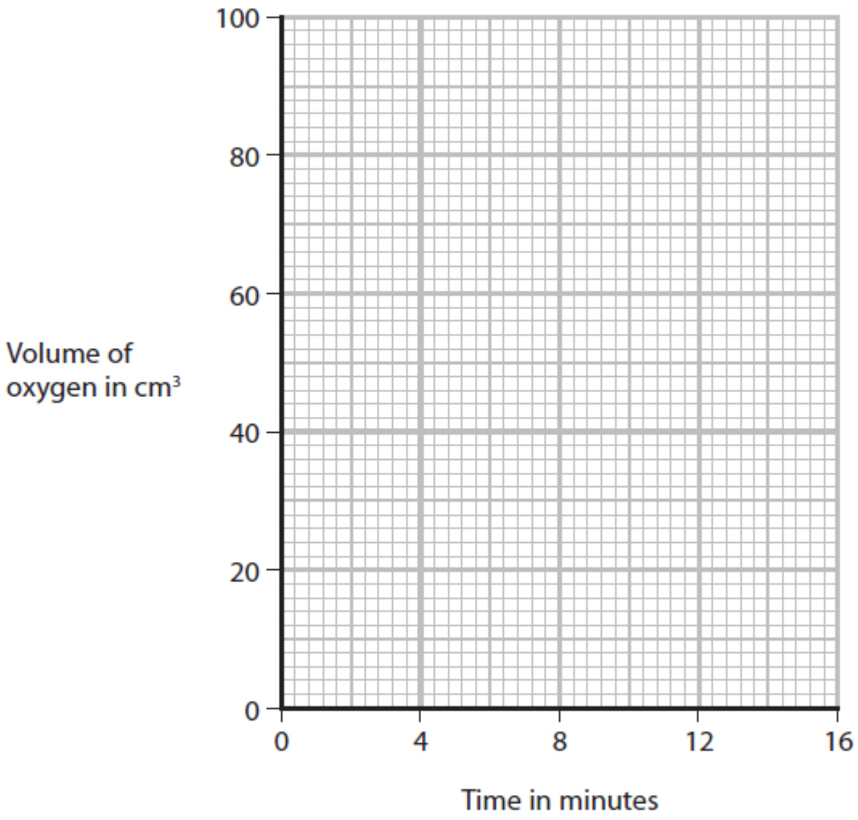
The student records the volume of oxygen that collects every 2 minutes for 16 minutes.
The table shows her results.

Time in minutes	0	2	4	6	8	10	12	14	16
Volume of oxygen in cm^3	0	22	38	50	55	69	76	80	80

(i) Plot the student's results on the grid. (1)

(ii) Draw a circle on the grid around the anomalous result. (1)

(iii) Draw a curve of best fit through the points, ignoring the anomalous result. (1)



(iv) Suggest a mistake that the student might have made to cause the anomalous result. (1)

....

....

....

(v) Determine the volume of oxygen collected during the first 3 minutes.
Show on your graph how you obtain your answer. (2)

volume of oxygen = ... cm^3

(e) The student repeats the experiment using hydrogen peroxide solution of half the concentration of the original solution.
She keeps the volume of the hydrogen peroxide solution and all other conditions the same.

(i) Draw on the grid the curve you would expect the student to obtain. (2)

(ii) Explain how using hydrogen peroxide solution of half the concentration affects the rate of the reaction.
Refer to particle collision theory in your answer. (3)

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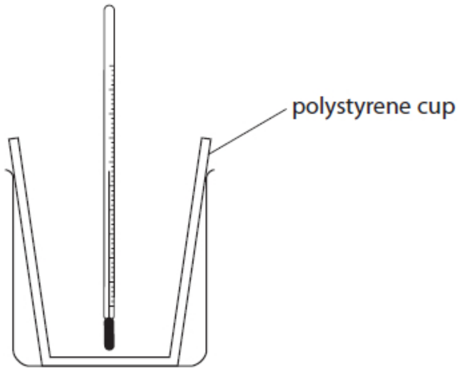
(Total for question = 14 marks)

7. A student uses this apparatus to investigate the reaction between potassium hydroxide solution and dilute hydrochloric acid.



This is her method.

- pour 25 cm^3 of potassium hydroxide solution into a polystyrene cup and record the temperature of the solution
- pour 25 cm^3 of dilute hydrochloric acid into a measuring cylinder and record the temperature of the acid
- add the acid to the polystyrene cup and stir the mixture
- record the highest temperature reached

(a) (i) Give a word equation for the reaction between potassium hydroxide and hydrochloric acid. (1)

....

(ii) Explain why the student needs to stir the mixture. (2)

....

....

....

....

(b) The table gives the temperatures of the solutions before the student mixes them.

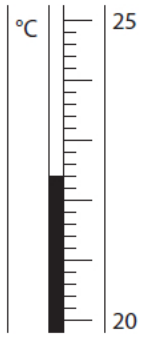
potassium hydroxide solution	17.8 °C
dilute hydrochloric acid	18.4 °C

Calculate the mean (average) temperature of the two solutions. (2)

mean temperature = ... °C

(c) The student repeats the experiment on a different day, using 25 cm^3 of potassium hydroxide solution and 25 cm^3 of dilute hydrochloric acid.

The thermometer shows the highest temperature reached at the end of the experiment.



(i) Complete the table by giving the missing information.
Give both temperatures to the nearest 0.1 °C. (2)

mean temperature at start in °C	
temperature at end in °C	
temperature rise in °C	5.2

(ii) Show that the heat energy change, *Q*, in the student's experiment is about 1100 J.
[for the mixture, c = 4.2 J/g/°C]
[mass of 1.0 cm^3 of mixture = 1.0 g] (3)

(iii) The student uses 0.020 mol of potassium hydroxide in his experiment.
Calculate the enthalpy change (ΔH) in kJ/mol, for 1.0 mol of potassium hydroxide.
Include a sign in your answer. (3)

ΔH = ... kJ/mol

(Total for question = 13 marks)

END OF QUESTIOJS

Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	galvanising	**ACCEPT** galvanisation	1
(b) (i)	rust		1
(ii)	M1 oxygen / air	**ACCEPT** O_2 **IGNORE** O	2
	M2 water	**ACCEPT** H_2O/moisture	
		ACCEPT in either order	
(c) (i)	(a reaction which) gives out / produces / releases heat (energy) / thermal energy	**IGNORE** energy without mention of heat or thermal	1
(ii)	An explanation that links the following two points		2
	M1 aluminium/Al is more reactive than iron/Fe	**ACCEPT** aluminium/Al is higher in reactivity series than iron/Fe **ACCEPT** reverse argument	
	M2 (because) aluminium/Al displaces iron/Fe (from its oxide)	**ALLOW** replaces/takes place of	
(iii)	An explanation that links the following three points		3
	M1 aluminium is oxidised and iron/iron oxide is reduced	**ALLOW** both oxidation and reduction occur	
	M2 aluminium gains oxygen	**ALLOW** aluminium/Al loses electrons	
	M3 iron oxide/iron loses oxygen	**ALLOW** iron <u>ions</u> /Fe^{3+} gains electrons **ALLOW** correct references to changes in oxidation number for M2 and M3	
			Total 10

(Q03 4CH1/1C, Jan 2020)

Q2.

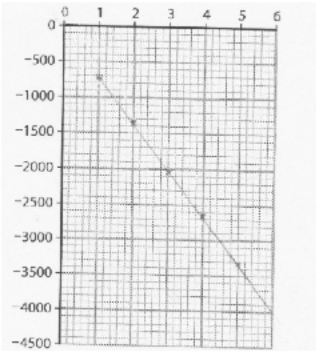
Question number	Answer	Notes	Marks
(a) (i)	**4**NH_3 + **5**O_2 ⇌ **4**NO + **6**H_2O	**ACCEPT** multiples and fractions	1
(ii)	reversible (reaction)	**ACCEPT** reaction that goes both ways / both forwards and backwards reactions occur **IGNORE** references to equilibrium	1
(iii)	to increase the rate of the reaction / to speed up the reaction OWTTE	**IGNORE** references to lowering the activation energy	1
(b)	2NO + O_2 → $2NO_2$	**ACCEPT** multiples and fractions	1
(c) (i)	• calculate M_r of NO_2 and HNO_3 • calculate the amount, in moles, of NO_2 • calculate the amount, in moles, of HNO_3 • calculate the mass in tonnes of HNO_3 Example calculation **M1** M_r of NO_2 = 46 M_r of HNO_3 = 63 **M2** $n(NO_2)$ = 11.5 x 10^6 ÷ 46 **OR** 250 000 (mol) **M3** $n(HNO_3)$ = $\frac{2 \times 25\,0000}{3}$ **OR** 167 000 / 170 000 **M4** (167 000 x 63 g) = 10.5 (tonnes)	**ALLOW** working in megamoles i.e. 11.5 ÷ 46 **OR** 0.25 **ALLOW** ECF from incorrect Mr of NO_2 calculator answer 166666.66 **ALLOW** working in megamoles i.e. $\frac{2 \times 0.25}{3}$ **OR** 0.167 / 0.17 **ALLOW** ECF from M2 10.5 (tonnes) with no working scores 4 **ACCEPT** 10.7 (if 170 000 used) **ALLOW** ECF from M3 **ALLOW** ECF from incorrect M_r of HNO_3	4
(ii)	can be (re)used in stage 2 / to make more nitrogen dioxide (in stage 2) / can be used to make more nitric acid	**IGNORE** can be recycled/reused unless qualified	1

Question number	Answer	Notes	Marks
(d)	• calculate the amount, in moles, of copper(II) nitrate • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the percentage yield Example calculation **M1** nCu(NO$_3$)$_2$ formed = 15.3 ÷ 187.5 **OR** 0.0816 **M2** theoretical nCu(NO$_3$)$_2$ = 0.200 ÷ 2 **OR** 0.100 **M3** (% yield) = $\frac{(0.0816 \times 100)}{(0.100)}$ = 81.6 (%) Alternative method • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the theoretical mass of copper nitrate that should be formed • calculate the percentage yield	**ALLOW** 0.082 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2	3
	Example calculation **M1** theoretical nCu(NO$_3$)$_2$ = 0.200 ÷ 2 **OR** 0.100 **M2** theoretical mass of copper nitrate = 0.1 x 187.5 = 18.75 **M3** (% yield) = $\frac{15.3}{18.75}$ x 100 = 81.6 (%)	**ALLOW** 18.8 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2 81.6(%) with no working scores 3 marks	**Total 12**

(Q10 4CH1/1C, Jan 2020)

Q3.

Question number		Answer	Notes	Marks
(a)		to minimise/prevent (mass loss by) evaporation of the (liquid) fuel OWTTE	**ALLOW** to find mass of fuel used/burned	1
(b)	(i)	soot/carbon	**REJECT** copper oxide	1
	(ii)	An explanation that links the following two points. **M1** incomplete combustion (occurs) **M2** (because) the air/oxygen supply is limited OWTTE	**ALLOW** mark for soot/carbon if not seen in (i), unless copper oxide is mentioned in (i) If copper oxide in (i) ALLOW 1 mark for (because) copper reacts with oxygen (in air)	2
(c)	(i)	• substitution into $Q = mc\Delta T$ • calculation of heat energy in Joules • conversion to kJ Example calculation **M1** Q = 100 x 4.2 x 30 **M2** = 12600 (J) **M3** = 12.6 kJ	12600 (J) with no working scores M1 and M2 M2 ECF M1 **ALLOW** approximately = 13 kJ 12.6 kJ with no working scores 3	3
	(ii)	• calculate the amount, in moles, of methanol • divide Q by the amount in moles • give the answer with the correct sign Example calculation **M1** 0.96 ÷ 32 **OR** 0.03 **M2** 12.6 ÷ 0.03 **OR** 420 (kJ/mol) **M3** – 420 (kJ/mol)	**ACCEPT** 13 ÷ 0.03 **OR** 430/433 for **M2** **AND** – 430 / – 433 for **M3**	3

Question number		Answer	Notes	Marks
(d)	(i)	**M1** all points plotted correctly **M2** line of best fit drawn with a ruler 	does not need to start at (0,0)	2
	(ii)	**M1** straight line extrapolated up to 6 carbon atoms **M2** value of ΔH read from their graph	**ALLOW** extra point shown at 6 carbon atoms negative sign needed	2
	(iii)	The greater the number of carbon atoms (per molecule) the greater (the magnitude/ value of) ΔH	**ALLOW** ΔH is (directly) proportional to the number of carbon atoms per molecule **ALLOW** The greater the number of carbon atoms (per molecule) the more exothermic the ΔH value	1
				Total 15

(Q09 4CH1/1C, Jan 2020)

Q4.

Question number	Answer	Notes	Marks
(a) (i)	magnesium is more reactive than copper	**ALLOW** magnesium can displace copper **ALLOW** magnesium is higher than copper in the reactivity series **REJECT** magnesium is more reactive than copper(II) **or** Cu^{2+} **or** copper sulfate	1
(ii)	magnesium sulfate + copper	Both are required for the mark. Either order. **REJECT** copper(II) **IGNORE** any chemical formulae given	1
(b) (i)	**M1** Temperature rise = 36.1(°C) **M2** 15 162J	Correct answer with or without working scores 2 **ALLOW** ecf from M1 **ALLOW** 2 or more significant figures **IGNORE** negative sign	2
(ii)	An explanation that links any **two** of the following points **M1** polystyrene is an insulator **M2** (so) reduces heat loss (to the surroundings) OWTTE **M3** temperature rise/change/reading will be closer to true value OWTTE	 **ALLOW** polystyrene is not a (good) conductor of heat **ALLOW** polystyrene is a poor conductor of heat **ALLOW** prevents heat loss **ALLOW** keeps heat in **ALLOW** temperature rise/change/reading will be more accurate/valid	2

(c)(i)	**M1** calculate the amount, in moles, of zinc **M2** divide Q by the amount in moles **M3** give the answer to three significant figures with a - sign Example calculation **M1** 0.500 ÷ 65 **OR** 0.00769 **M2** 1.67 ÷ 0.00769 **OR** 217 (kJ/mol) **M3** -217 (kJ/mol) **OR** **M1** 1.67 ÷ 0.5 **OR** 3.34 kJ/g) **M2** 3.34 × 65 **OR** 217 (kJ/mol) **M3** -217 (kJ/mol)	 **M2** subsumes **M1** Correct answer of -217 with or without working scores 3 marks. Allow ECF throughout	3
(c)(ii)	**M1** zinc is oxidised **and** Cu^{2+} is reduced **M2** Zinc loses electrons **M3** Cu^{2+} gains electrons	**ALLOW** zinc is oxidised and copper(sulfate) is reduced in **M1** **ALLOW** oxidation and reduction occur **ALLOW** references to changes in oxidation number for **M2** and **M3** Must mention copper ions for M3	3

(Q06 4CH1/1CR, Jan 2020)

Q5.

Question number		Answer	Notes	Marks
(a)	(i)	Measuring cylinder / burette / (volumetric) pipette		1
	(ii)	Neutralisation	**ACCEPT** exothermic **IGNORE** base or alkali	1
(b)	(i)	12.4		1
	(ii)	$15cm^3$ - red/orange $30cm^3$ - blue/purple		2
	(iii)	OH^- / hydroxide (ion)	**REJECT** OH	1
(c)		**M1** the reaction is exothermic (therefore the temperature rises)	**ALLOW** the reaction gives out heat (energy) **or** thermal energy **IGNORE** energy alone	3
		M2 (after $25cm^3$ of sodium hydroxide) the reaction is complete OWTTE	**ALLOW** (after $25cm^3$ of sodium hydroxide) neutralisation happens	
		M3 so adding more sodium hydroxide / liquid / solution cools the mixture down	**ALLOW** so no more heat (energy) **or** thermal energy is given out OWTTE **IGNORE** energy alone	

(Q07 4CH1/1CR, Jan 2020)

Q6.

Question number		Answer	Notes	Marks
(a)		2 H_2O_2 → 2 H_2O + (1) O_2	ALLOW multiples and fractions	1
(b)		Relights a glowing splint/spill		1
(c)		Speeds up/increases rate of the reaction	IGNORE references to lowering activation energy	1
(d)	(i)	All points plotted correctly	ALLOW ± half a square	1
	(ii)	Point at 8 minutes circled		1
	(iii)	Smooth curve of best fit		1
	(iv)	took the reading too soon/before 8 minutes	ACCEPT misread the volume (of oxygen)	1
	(v)	M1 vertical line on graph drawn to curve from 3 mins M2 value obtained from candidate's graph	Expected value 29 or 30 cm^3 ALLOW ± half a square	2

Question number		Answer	Notes	Marks
(e)	(i)	M1 curve drawn on graph that is less steep than curve of student's results. M2 curve levels off at 40 cm^3	ALLOW ± half a square	2
	(ii)	An explanation that links the following three points M1 reaction is slower M2 fewer particles/molecules (in the same volume) M3 fewer collisions per unit time	ACCEPT particles are further apart / less crowded ACCEPT less frequent collisions IGNORE less chance of a collision	3
				Total 14

(Q04 4CH1/1CR, Nov 2020)

Q7.

Question number	Answer	Notes	Marks
(a) (i)	potassium hydroxide + hydrochloric acid → potassium chloride + water	**ALLOW** correctly balanced chemical equation	1
(ii)	**M1** to mix (the two solutions more thoroughly) **M2** (so that) more reactant particles come into contact with each other OWTTE **M3** so that the heat energy is given out more quickly OWTTE **M4** so that the mixture is the same temperature throughout OWTTE	ALLOW references to increasing rate of reaction	2
(b)	Correct answer with or without working scores 2 • setting out of calculation • evaluation Example calculation **M1** $\frac{17.8 + 18.4}{2}$ **M2** 18.1		2

Question number	Answer	Notes	Marks
(c) (i)	Mean temperature at start in °C 17.2 Temperature at end in °C 22.4 Temperature rise in °C 5.2		2
(ii)	• calculation of volume/mass of mixture • substitution of values into $Q = mc\Delta T$ • evaluation Example calculation **M1** (volume/mass =) 25 + 25 **OR** 50 (cm^3 , (g) **M2** (Q =) 50 x 4.2 x 5.2 **M3** (Q =) 1092	**ALLOW** ecf if 25 used in calculation 1092 without working scores 3 marks	3

(iii)	• division of *Q* by moles of KOH • conversion of J to kJ • answer with correct sign Example calculation **M1** $\frac{1092}{0.02}$ **OR** 54600 **M2** conversion from J to kJ OR 54.6(00) **M3** (ΔH =) − 54.6 (kJ/mol)	**ALLOW** ecf from answer to (ii) **ALLOW** any number of sig figs greater than 1 throughout **ACCEPT** 1092 or 1100 used in calculation **ALLOW** ecf from M1 Minus sign must be present **ALLOW** ecf from M2 **ACCEPT** any value between 54.5 and 55 **M3** dep on division of Q by moles Correct answer with correct sign and without working scores 3 Correct answer without sign or with incorrect sign and without working scores 2.	3 **Total 13**

(Q10 4CH1/1CR, Nov 2020)