IGCSE Edexcel Chemistry Revision

Experiments

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

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

- 16 questions
- 161 marks
- Recommended time: 175 minutes (just over 1 minute per mark)

1. This question is about barium chloride.

(a) Barium chloride can be made by reacting barium carbonate with dilute hydrochloric acid.

The chemical equation for the reaction is

$$BaCO_3(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a method to produce dry crystals of hydrated barium chloride, starting with barium carbonate powder and dilute hydrochloric acid. (6)

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(b) A colourless solution contains sodium carbonate and sodium sulfate.

Describe a test using barium chloride to show that the colourless solution contains sulfate ions. (2)

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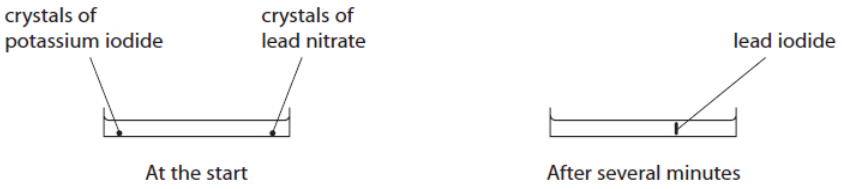
(Total for question = 8 marks)

2. Lead nitrate and potassium iodide react to form the insoluble solid lead iodide.
Crystals of lead nitrate and potassium iodide are placed at opposite ends of a container of water.
Solid lead iodide forms after several minutes.
The diagram shows the container at the start and after several minutes.



(a) Name the two processes that occur before the solid lead iodide forms. (2)

1 .....

2 .....

(b) Explain why solid lead iodide takes less time to form when the reaction is repeated using water at a higher temperature. (2)

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(c) The formula for lead nitrate is $Pb(NO_3)_2$

(i) Give the number of different elements in lead nitrate. (1)

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(ii) Give the charge on the lead ion in $Pb(NO_3)_2$ (1)

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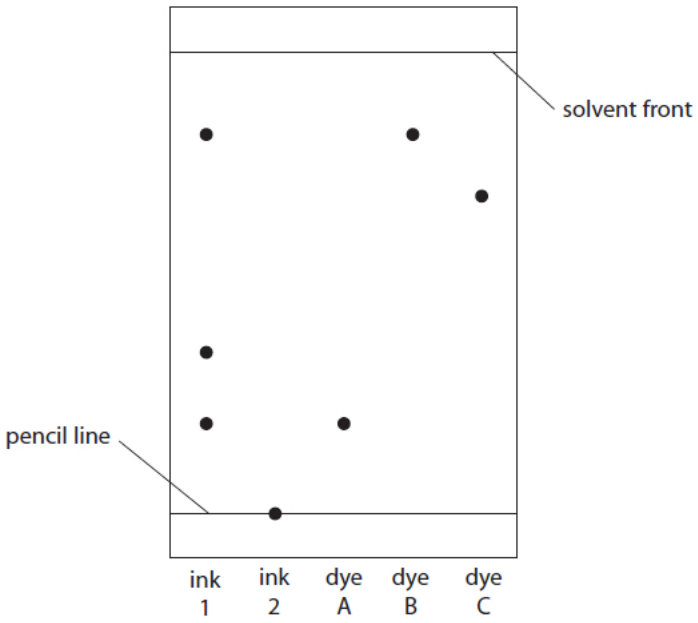
(d) Complete the chemical equation for the reaction between lead nitrate and potassium iodide. (1)

$Pb(NO_3)_2(aq)$ + ... $KI(aq) \rightarrow PbI_2(s)$ + ... $KNO_3(aq)$

(Total for question = 7 marks)

3. A student does a chromatography experiment using ink 1, ink 2, and three known dyes A, B and C. The student uses water as the solvent.
The diagram shows the student's chromatogram.



(a) Deduce what conclusions can be made about the composition of ink 1. (2)

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(b) (i) Give one conclusion that can be made about ink 2. (1)

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(ii) Suggest how the student could change the experiment to find the composition of ink 2. (1)

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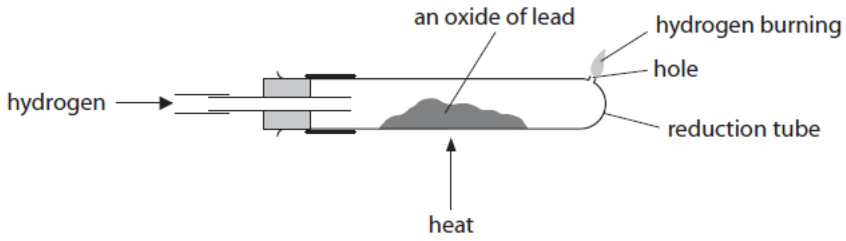
(c) Calculate the R_f value of dye C, giving your answer to 2 significant figures. (3)

R_f value = ...

(Total for question = 7 marks)

4.

(a) The diagram shows the apparatus a teacher uses to determine the formula of an oxide of lead.



This is the teacher's method.

Step 1 find the mass of the reduction tube
Step 2 add some of the lead oxide to the reduction tube
Step 3 find the mass of the reduction tube and lead oxide
Step 4 pass hydrogen gas over the lead oxide and ignite the hydrogen at the hole
Step 5 heat the lead oxide strongly for 10 minutes
Step 6 keep passing hydrogen through the reduction tube until the tube and contents are cool
Step 7 find the new mass of the reduction tube and its contents

(i) Give a reason why hydrogen is passed through the reduction tube until the tube and contents are cool. (1)

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(ii) Describe what the teacher should do next to make sure all the lead oxide has been reduced to lead. (2)

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(b) The teacher completes the experiment and obtains these results.

mass of reduction tube = 23.50 g
mass of tube + lead oxide = 28.64 g
mass of tube + lead = 28.16 g

(i) Calculate the mass of lead formed. (1)

mass of lead = ... g

(ii) Calculate the mass of oxygen removed from the lead oxide. (1)

mass of oxygen = ... g

(iii) Determine the empirical formula of the lead oxide. (4)

empirical formula of the lead oxide .....

(c) The insoluble salt lead(II) chloride ($PbCl_2$) can be prepared by reacting a solution of lead(II) nitrate with dilute hydrochloric acid.

(i) Complete the equation for the reaction by adding the state symbols. (1)

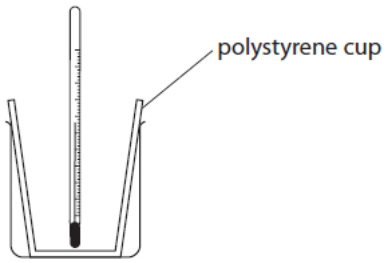
$Pb(NO_3)_2$(.....) + 2HCl(.....) → $PbCl_2$(.....) + 2HNO_3(.....)

(ii) Show that the maximum mass of lead(II) chloride that can be made from 0.0370 mol of hydrochloric acid is about 5 g.
[M_r of $PbCl_2$ = 278] (3)

maximum mass = ... g

(Total for question = 13 marks)

5. A student uses this apparatus to find the temperature change when sodium hydroxide solution reacts with dilute hydrochloric acid.



This is the student's method.

- pour 20 cm^3 of sodium hydroxide solution into a polystyrene cup
- record the temperature of the sodium hydroxide solution
- add 20 cm^3 of dilute hydrochloric acid and stir the mixture
- record the highest temperature of the mixture

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

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(ii) Suggest a pH value for the dilute hydrochloric acid. (1)

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(b) Explain why a polystyrene cup is used in this experiment. (2)

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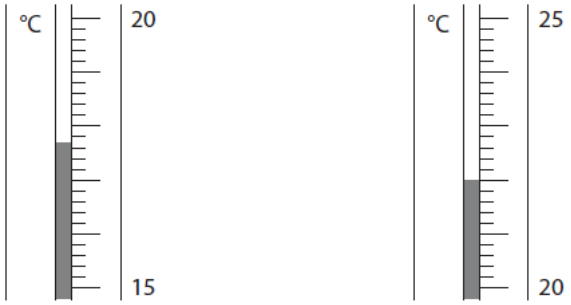
(c) The diagram shows the thermometer readings at the start and at the end of the experiment.



Use the readings to complete the table, giving all values to the nearest 0.1 °C.

(3)

temperature in °C at end	
temperature in °C at start	
temperature change in °C	

(d) Another student does the experiment, but uses 25 cm^3 of sodium hydroxide solution and 25 cm^3 of dilute hydrochloric acid.
She records a temperature change of 5.2 °C.
Calculate the heat energy (Q) in kilojoules (kJ) released in this reaction.
[mass of 1.0 cm^3 of solution = 1.0 g]
[for the solution, c = 4.2 J / g / °C] (4)

Q = ... kJ

(Total for question = 11 marks)

6. Some sugar is added to cold water in a beaker.
After some time, all the sugar dissolves and spreads throughout the water.

(a) (i) Name the process that occurs which causes the sugar to spread throughout the water. (1)

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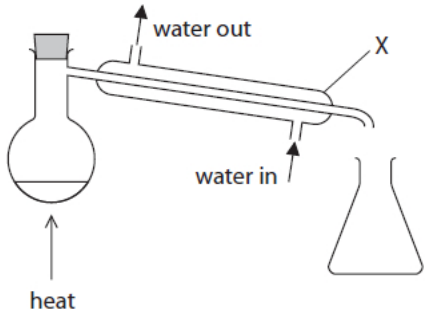
(ii) State two ways to make the sugar dissolve more quickly. (2)

1 .....

2 .....

(b) Pure water can be obtained from the sugar solution using this apparatus.



(i) Name the process used to obtain pure water from the sugar solution. (1)

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(ii) Explain the purpose of the piece of apparatus labelled X. (2)

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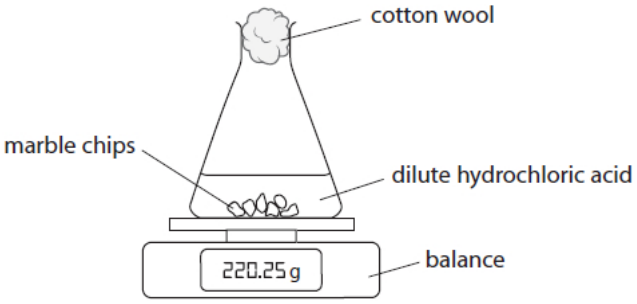
(Total for question = 6 marks)

7. A student uses this apparatus to investigate the rate of reaction between marble chips and dilute hydrochloric acid.



The equation for the reaction is

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

(a) During the reaction the mass of the contents of the flask decreases.

(i) State why the mass of the contents of the flask decreases. (1)

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(ii) State the purpose of the cotton wool. (1)

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(iii) Explain why sulfuric acid is not a suitable acid to use in this investigation. (2)

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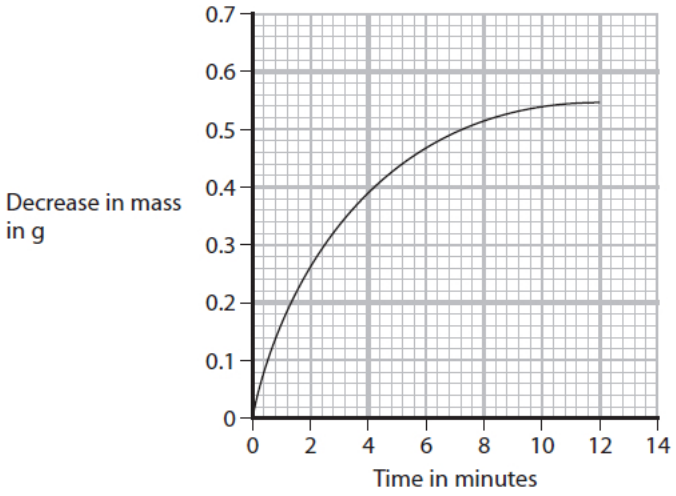
(b) The graph shows the student's results.



(i) In the investigation the marble chips are in excess.
Explain the shape of the graph. (4)

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(ii) The student repeats the experiment using the same volume of hydrochloric acid but of half the concentration of the original acid. All other conditions are kept the same.
On the grid, draw the curve the student would obtain. (2)

(c) Explain, using particle collision theory, how increasing the temperature affects the rate of a reaction. (4)

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(Total for question = 14 marks)

8. This question is about salts.

(a) Soluble salts can be prepared by the reaction between a metal oxide and an acid. The equation for this type of reaction is

metal oxide + acid → salt + water

(i) State the name given to this type of reaction. (1)

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(ii) State, in terms of protons, what happens in this reaction. (1)

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(b) (i) A student is given 50 cm^3 of dilute sulfuric acid and a bottle of solid copper(II) carbonate.

Describe the method that the student should use to prepare a saturated solution of copper(II) sulfate.

In your answer, refer to the pieces of apparatus that the student should use. (5)

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(ii) The student produces dry crystals of hydrated copper(II) sulfate from the saturated solution.
He calculates that 6.40 g of dry crystals should be formed.
The mass of dry crystals he actually obtains is 1.80 g less than he calculated.
Calculate the student's percentage yield.
Give your answer to one decimal place. (3)

percentage yield = ... %

(c) (i) Gypsum is hydrated calcium sulfate.
A sample of gypsum contains 79% of calcium sulfate by mass.
Calculate the value of x in $CaSO_4.xH_2O$
[M_r of $CaSO_4$ = 136 M_r of H_2O = 18] (3)

x = ...

(ii) Describe a test for calcium ions in the sample of gypsum. (2)

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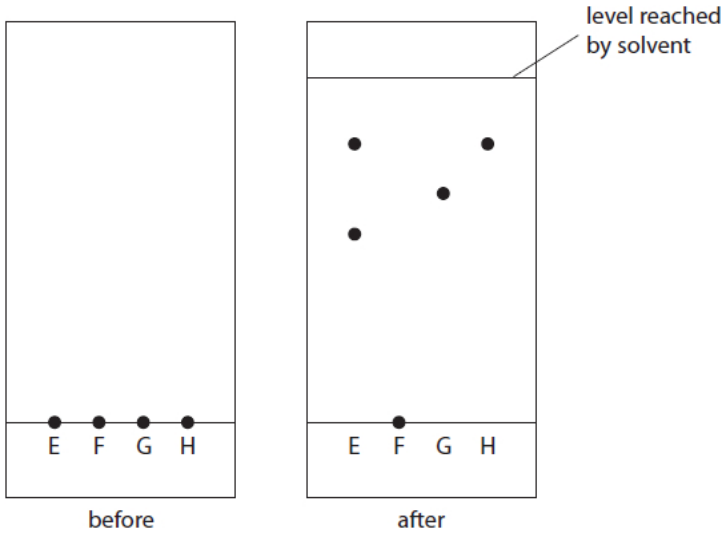
(Total for question = 15 marks)

9. A student uses paper chromatography in an experiment to separate the dyes in four different food colourings, E, F, G and H.
The diagram shows the appearance of the paper before and after the experiment.



(a) (i) Describe how the student should complete the experiment after putting a spot of each food colouring on the paper. (3)

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(ii) Deduce the number of dyes in food colouring H. (1)

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(iii) Suggest why food colouring F does not move during the experiment. (1)

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(iv) Explain which two food colourings contain the dye that is likely to be the most soluble in the solvent. (2)

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(b) Determine which food colouring contains a dye with R_f value closest to 0.67
Show your working. (3)

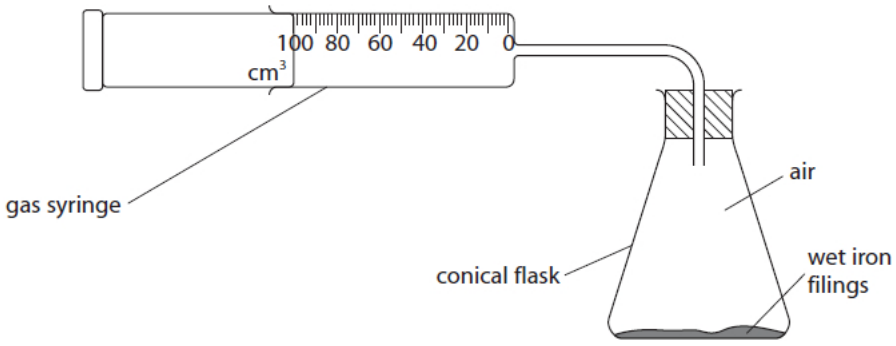
(Total for question = 10 marks)

10. This question is about rusting.

(a) When iron rusts, it reacts with oxygen in the air.

A student uses the rusting of iron to find the percentage of oxygen in a sample of air.

The diagram shows the apparatus.



These are the student's results.

volume of air in conical flask and connecting tube = 265 cm^3

volume of air in gas syringe at start = 100 cm^3

volume of air in gas syringe at end = 25 cm^3

Calculate the percentage of oxygen in the sample of air using the student's results. (3)

percentage of oxygen = ... %

(b) (i) Cars are painted to prevent the iron in car bodies from rusting.
Explain how painting prevents the iron in car bodies from rusting. (2)

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(ii) Some car manufacturers use paint containing tiny particles of zinc.
Explain how particles of zinc prevent iron in car bodies from rusting even when this paint is scratched. (2)

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(Total for question = 7 marks)

11. Zinc reacts with dilute hydrochloric acid to form hydrogen.

(a) (i) Give a chemical equation for this reaction. (2)

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(ii) Give a test for hydrogen gas. (1)

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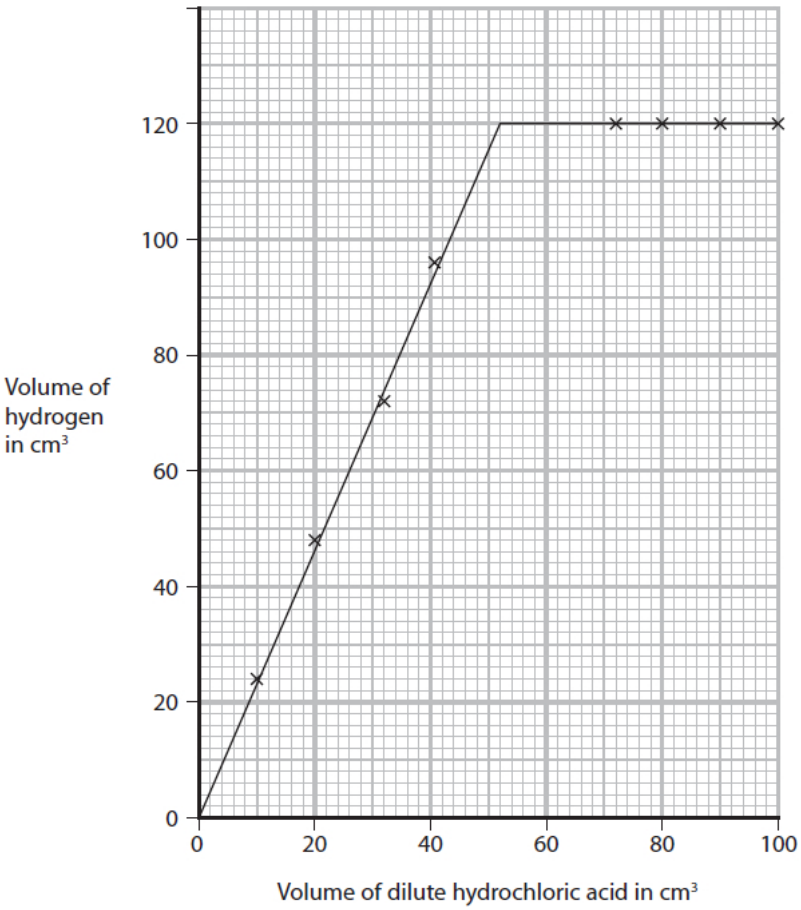
(b) A student investigates the reaction between pieces of zinc and dilute hydrochloric acid.
In each experiment, he uses the same mass of zinc but a different volume of the acid.
He collects the hydrogen and measures its volume in each experiment.
The graph shows the student's results.



(i) Use the graph to find the minimum volume of acid needed to react with all of the zinc. (1)

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(ii) The student repeats the investigation, using hydrochloric acid of double the original concentration.
Determine the volume of hydrogen that would be collected using 15 cm^3 of this acid.
Show your working on the graph. (2)

volume = ... cm^3

(c) Explain how increasing the concentration of the hydrochloric acid affects the rate of reaction. (3)

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(d) The rate of reaction could also be affected by changing the temperature of the hydrochloric acid, or by using a catalyst.
Explain one other way in which the rate of reaction between zinc and hydrochloric acid can be affected. (3)

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(Total for question = 12 marks)

12. This question is about reactions that form gases.

(a) Hydrogen peroxide decomposes to form water and oxygen.

The equation for the reaction is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

25.0 cm^3 of hydrogen peroxide solution are poured into a conical flask and 1.00 g of solid manganese(IV) oxide is added.

Bubbles of oxygen gas are formed.

(i) Give the test for oxygen gas. (1)

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(ii) Describe a method to show that solid manganese(IV) oxide is a catalyst in this reaction and not a reactant. (3)

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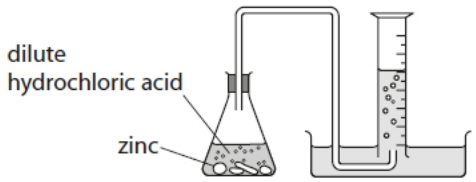
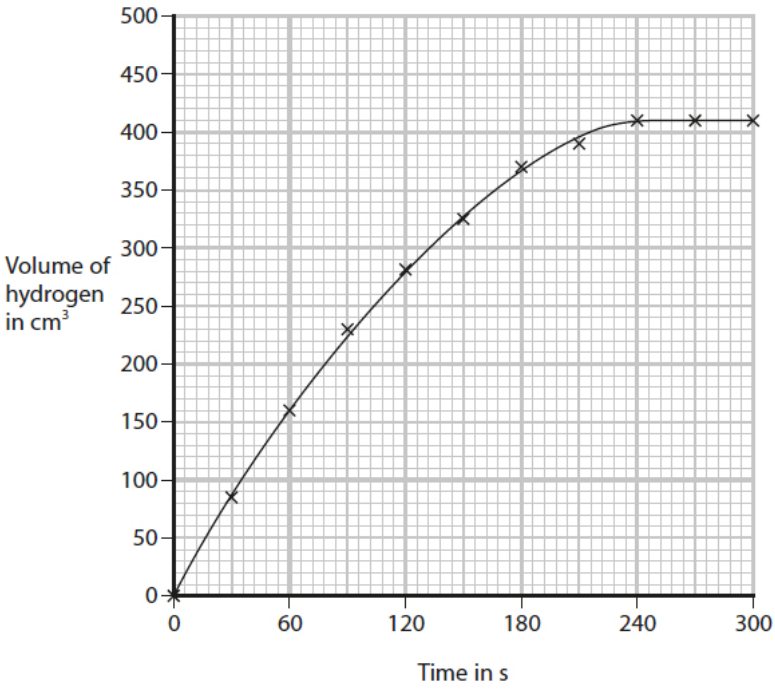
(b) A student uses this apparatus to investigate the rate of the reaction between zinc and an excess of dilute hydrochloric acid.



This is the student's method.

- pour 50 cm^3 of dilute hydrochloric acid into a conical flask
- add about 1.2 g of zinc lumps
- record the volume of hydrogen gas collected every 30 s until no more hydrogen is collected

The graph shows the student's results.



(i) Calculate the mean (average) rate of reaction, in cm^3 / s, in the first 120 s.(2)

mean rate = ... cm^3 / s

(ii) The equation for the reaction between zinc and hydrochloric acid is

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Use this equation and the particle collision theory to explain why the rate of reaction is greatest at the start of the reaction. (3)

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(iii) The student repeats the experiment at a higher temperature but keeps all other conditions the same.
On the grid, draw the curve you would expect to see in this experiment. (2)

(iv) Explain why the rate of reaction is greater if the same mass of zinc powder is used instead of zinc lumps. All other conditions are kept the same. (2)

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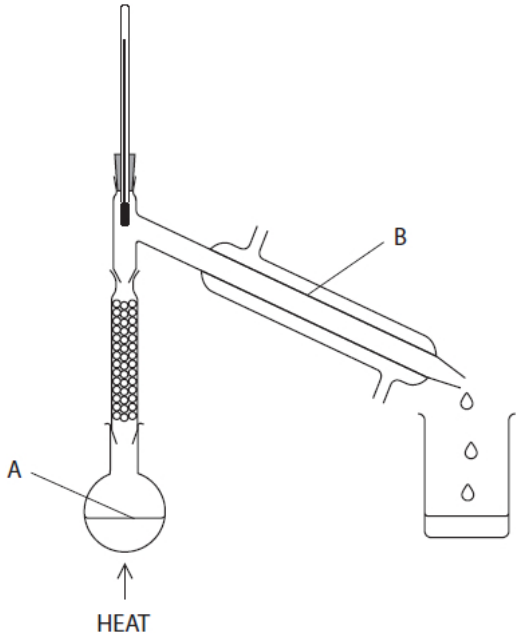
(c) In another experiment, the student adds 0.55 g of zinc to a solution containing 2.50×10^{-2} moles of hydrochloric acid.
Use the equation to show that hydrochloric acid is in excess.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

[Ar of Zn = 65] (2)

(Total for question = 15 marks)

13. A teacher uses this apparatus to separate a mixture of ethanol and water.



(a) (i) Name this method of separation. (1)

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(ii) Name the change of state taking place at A. (1)

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(iii) Name the change of state taking place at B. (1)

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(b) The mixture contains 15.5 cm^3 of ethanol.
1.0 cm^3 of ethanol has a mass of 0.79 g.
One mole of ethanol contains 6.00×10^{23} molecules.
[M_r of ethanol = 46]

(i) Calculate the amount, in moles, of ethanol in 15.5 cm^3 of ethanol. (2)

amount = ... mol

(ii) Calculate the number of molecules of ethanol in 15.5 cm^3 of ethanol. (1)

number of molecules = ...

(c) After five minutes, the teacher collects a sample of colourless liquid in a new beaker.

(i) Describe a chemical test to show that the colourless liquid contains water.(2)

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(ii) Describe a physical test to show if the colourless liquid is pure water. (2)

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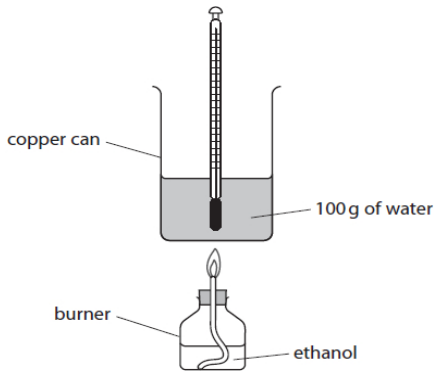
(d) The teacher uses this apparatus to heat 100 g of water.



He records the temperature of the water before and after heating.

Temperature of water before heating = 21.0 °C
temperature of water after heating = 70.5 °C

(i) Calculate the heat energy change (Q) in joules.
[specific heat capacity of water is 4.2 J /g/°C] (3)

Q = ... J

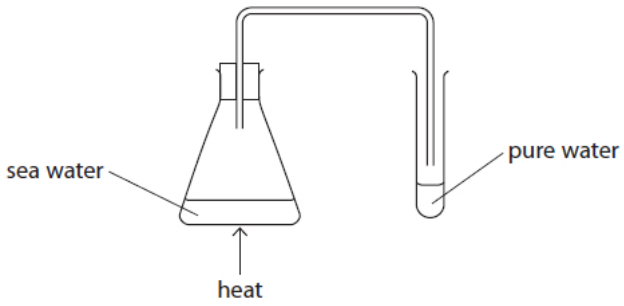
(ii) The student burns 0.0200 mol of ethanol.
Use this information and your value for Q to calculate the molar enthalpy change (ΔH), in kJ/mol, for the combustion of ethanol.
Include a sign in your answer. (2)

ΔH = ... kJ/mol

(Total for question = 15 marks)

14. This question is about separating mixtures.

(a) The diagram shows apparatus that can be used to obtain pure water from sea water.



(i) Give the name of this technique. (1)

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(ii) Explain a change to the apparatus that would improve the collection of pure water from the heated sea water. (2)

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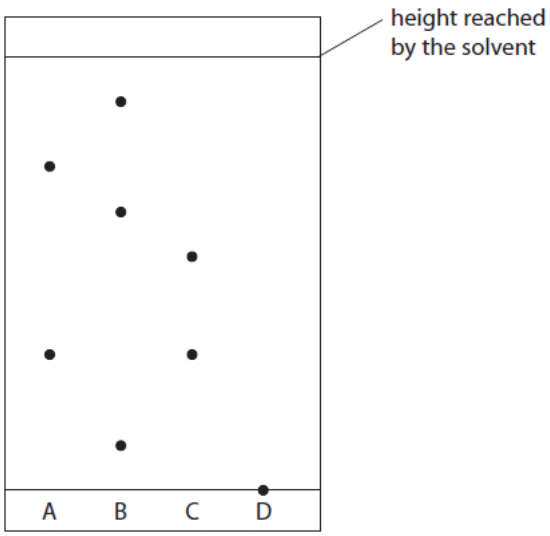
(b) The dyes in samples of four inks, A, B, C and D, were analysed using paper chromatography. The solvent used was water.
The diagram shows the results obtained.



(i) Determine the R_f value of the dye that is in ink A and in ink C. (3)

R_f = ...

(ii) Ink D is a mixture of three dyes.
Give a change to the experiment that would be needed to separate the dyes in ink D. (1)

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(Total for question = 7 marks)

15. This question is about the separation of mixtures.

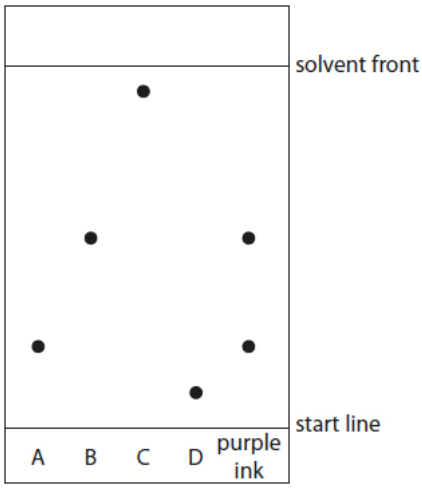
(a) The box gives some methods used to separate mixtures.

crystallisation	filtration	fractional distillation	simple distillation

Complete the table by giving the correct method from the box for each separation.
Each method can be used once, more than once or not at all. (4)

Separation	Method
insoluble solid from a liquid	
pure water from a solution	
liquid from a mixture of liquids with different boiling points	
soluble solid from a solution	

(b) A student uses chromatography to analyse the composition of purple ink.
The diagram shows the student's chromatogram at the end of the experiment.



(i) Explain which dyes are contained in the purple ink. (2)

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(ii) Explain which dye is least soluble in the solvent. (2)

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(c) A different chromatography experiment is set up.
A spot of food colouring is placed on the start line.
A food dye in the colouring has an R_f value of 0.72
The distance between the start line and the solvent front is 120 mm.
Calculate the distance the food dye moves from the start line. (2)

distance = ... mm

(Total for question = 10 marks)

16. This question is about the separation of mixtures.

(a) Name the method used to separate the dyes in a sample of ink. (1)

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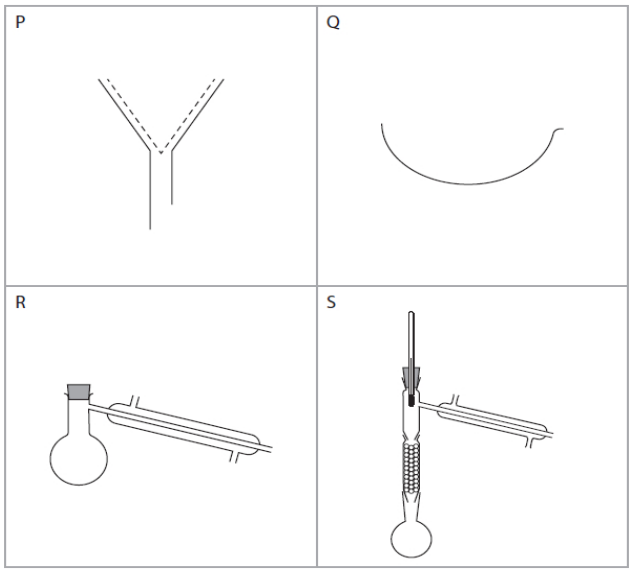
(b) The diagram shows four pieces of apparatus, P, Q, R and S, used in the separation of mixtures.



(i) Which type of separation is apparatus P used for? (1)

- ☐ A crystallisation
- ☐ B filtration
- ☐ C fractional distillation
- ☐ D simple distillation

(ii) Which type of separation is apparatus S used for? (1)

- ☐ A crystallisation
- ☐ B filtration
- ☐ C fractional distillation
- ☐ D simple distillation

(iii) Give the name of apparatus Q. (1)

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(Total for question = 4 marks)

Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	Any six from: M1 add barium carbonate (one spatula at a time) to the acid M2 until the barium carbonate is in excess M3 filter off the excess barium carbonate M4 heat solution to evaporate some of the water M5 cool or leave to crystallise	 ALLOW until some barium carbonate is left/no longer effervesces /fizzes/bubbles M3 dep on M2 ALLOW heat until crystals start to form ALLOW heat until solution is saturated ALLOW heat until crystals form on the end of a glass rod/heat to crystallisation point	6
	M6 filter the crystals (from the solution) M7 leave crystals in a warm place to dry	M6 dep on M5 IGNORE washing ALLOW leave to dry ALLOW dry on filter paper ALLOW dry in a desiccator ALLOW dry in a (warm) oven If solution is evaporated to dryness M5, M6 and M7 cannot be scored	
(b)	M1 add (dilute) acid before adding the barium chloride M2 white precipitate	ALLOW any named acid except sulfuric acid M2 is dependent on M1	2
			8

(**Q08 4CH1/1C, Nov 2021**)

Q2.

Question number	Answer	Notes	Marks
(a) (i)	M1 dissolving M2 diffusion	Answers can be in either order	2
(b) (i)	An explanation that links any two of the following points M1 crystals dissolve faster M2 (potassium iodide/ lead nitrate/ water) particles move faster / (lead/ iodide) ions move faster / rate of diffusion increases M3 therefore (lead and iodide) ions/ particles meet / collide after a shorter period of time/ sooner	 **ALLOW** (potassium iodide /lead nitrate/ water) particles have more energy **ALLOW** molecules in place of particles if referring to water **IGNORE** references to more collisions or more energetic collisions	2
(c) (i) (aq) (ii)	3 / three 2+ /+2	 **ALLOW** Pb	1 1
(d)	$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$	**ALLOW** multiples and fractions	1
			7 marks

(**Q03 4CH1/1C, Jan 2021**)

Q3.

Question number	Answer	Notes	Marks
(a)	Any two from the following: M1 contains 3 dyes M2 contains (dye) A M3 contains (dye) B M4 does not contain (dye) C / contains an unknown dye OWTTE		2
(b) (i)	(Ink 2) is insoluble (in solvent/water)	ALLOW does not contain (dye) A/B/C	1
(ii)	(repeat) using different solvent	ALLOW named alternative solvent eg alcohol/ethanol	1

(c)	M1 correct measurement of distance moved by spot AND correct measurement of distance moved by solvent M2 use and evaluation of R_f = distance moved by spot / distance moved by solvent front M3 answer to 2 sig fig	ALLOW 5.4-5.6 ALLOW 7.9-8.1 Expected: 5.5 / 8.0 = 0.6875 = 0.69 ALLOW ECF from M1 M2 correct answer with no working scores 3	3
		(Total for Question = 7)	

(**Q02 4CH1/1CR, Jan 2021**)

Q4.

Question number	Answer	Notes	Marks
(a) (i)	so that the (hot) lead does not react with oxygen/air (converting back into lead oxide)	**ACCEPT** so that lead is not oxidised (back to lead oxide)	1
(ii)	M1 repeat the heating M2 until the mass remains constant/ does not change	**ACCEPT** heat to constant mass for both marks	2
(b) (i)	4.66 (g)		1
(ii)	0.48 (g)		1
(iii)	• calculate the moles of lead and oxygen • divide by the smaller number • calculate the whole number ratio • give the empirical formula Example calculation **M1** $\frac{4.66}{207}$ and $\frac{0.48}{16}$ **OR** 0.0225 and 0.03(00) **M2** $\frac{0.0225}{0.0225}$ and $\frac{0.03(00)}{0.0225}$ **OR** 1:1.33 **M3** 1 x 3 and 1.33 x 3 **OR** 3:4 **M4** Pb_3O_4	Division by atomic numbers or upside down calculation scores 0 3:4 ratio without working scores 3 Pb_3O_4 without working scores 4 **ALLOW** ECF from incorrect masses.	4

Question number	Answer	Notes	Marks
(c) (i)	$Pb(NO_3)_2$ (aq) + 2HCl (aq) → $PbCl_2$ (s) + 2HNO_3 (aq)	**ALLOW** any combination of uppercase and lowercase letters	1
(ii)	• calculate the amount of $PbCl_2$ • multiply the moles by the M_r of $PbCl_2$ • evaluation to show that the value is about 5 g Example calculation **M1** $n(PbCl_2) = \frac{0.0370}{2}$ **OR** 0.0185 (mol) **M2** mass of $PbCl_2$ = 0.0185 x 278 (g) **M3** 5.143 (g)	**MAX 1** for 0.0370 x 278 if no division by 2 in **M1** **ALLOW** any number of sig figs 5.1, 5.14 and 5.143 g without working score 3 5 g without working scores 0 **ALLOW** alternative methods	3
			Total 13

(**Q10 4CH1/1C, June 2021**)

Q5.

Question number	Answer	Notes	Marks
(a) (i)	OH^-	**ALLOW** $HO^-/OH^{-1}/OH^{1-}$ **ALLOW** lower case letters	1
(ii)	Any value between 0 and 3 inclusive		1
(b)	An explanation that links the following two points **M1** polystyrene is an insulator **M2** less heat (energy) will be lost	**ALLOW** no heat (energy) will be lost	2
(c)	temperature in °C at end: 22.0 temperature in °C at start: 17.7 temperature change in °C: 4.3 1 mark each	**ALLOW** 22 If initial and final temperatures are reversed deduct 1 mark **ALLOW** ECF on temperature change	3

(d)	• give the expression for Q • substitute correct numbers into $Q = mc\Delta T$ • evaluation in J • conversion to kJ Example calculation **M1** $Q = mc\Delta T$ **M2** 50 x 4.2 x 5.2 **M3** 1092 (J) **M4** 1.1 (kJ)	**M2** subsumes **M1** **ALLOW** ECF for **M3** and **M4** on incorrect values in **M2** **ACCEPT** answers correctly rounded to 2 or more sig figs 1.1, 1.09, 1.092 without working scores 4 1100, 1090, 1092 without working scores 3 0.546, 0.55 without working scores 3 546, 550 without working scores 2 **ALLOW** use of 4.18 giving an answer of 1.0868	4 Total 11

(**Q05 4SS0/1C, June 2021**)

Q6.

Question number	Answer	Notes	Marks
(a) (i)	diffusion		1
(ii)	Any two from **M1** stir (the mixture) **M2** heat (the mixture) **M3** grind the sugar or break into smaller pieces or increase its surface area	**ALLOW** shake/swirl **ALLOW** any description of heating	2
(b) (i)	(simple) distillation	**REJECT** fractional distillation **ALLOW** distilling OWTTE	1
(ii)	An explanation that links the following two points **M1** (water/ vapour/ steam / gas) is cooled **M2** and condenses **OR** in the condenser		2
			Total 6

(**Q03 4CH1/1C, June 2021**)

Q7.

Question number	Answer	Notes	Marks
(a) (i)	carbon dioxide/a gas is given off/escapes	**REJECT** incorrect gas	1
(ii)	to prevent acid/ liquid/ solution/ spray from leaving the flask OWTTE		1
(iii)	An explanation that links two of the following **M1** (insoluble) calcium sulfate will form **M2** which will form a coating/ layer on the marble chips **M3** slowing down/ preventing/ stopping the reaction	 M3 dep on M1 or M2	2

(b)	(i)	An explanation that links the following four points **M1** the curve is steep(est) at the start **M2** because the (acid) concentration is high(est) **M3** the curve becomes less steep as the solution/ acid is becoming more dilute **M4** the curve levels off/ stops going up when the acid has all been used up **OR** **M1** the curve is steep(est) at the start **M2** because the reaction is fast(est) at the start **M3** the curve becomes less steep because the reaction slows down **M4** the curve levels off/stops going up when the acid has all been used up	 **ALLOW** there are the most (acid) particles in solution **ALLOW** the curve becomes less steep as there are fewer acid particles/particles in solution **IGNORE** references to particles of marble chips **IGNORE** references to energy	4
	(ii)	M1 curve drawn starting at the origin and below the original curve M2 curve levels off at 0.27 g + or – half a small square		2

Question number	Answer	Notes	Marks
(c)	An explanation that links the following four points **M1** the rate of reaction increases/ the reaction is faster/ the reaction speeds up and any three from **M2** because the particles gain (kinetic) energy /move faster **M3** there are more collisions per unit time **M4** more collisions/particles have energy greater than the activation energy **M5** more collisions are successful	there are more frequent successful collisions scores **M3** and **M5**	4 **Total 14**

(**Q09 4CH1/1C, June 2021**)

Q8.

Question number	Answer	Notes	Marks
(a) (i)	neutralisation	ALLOW acid - base	1
(ii)	acid donates proton(s)/base accepts proton(s)	ALLOW metal oxide for base	1

(b) (i)	description including M1 appropriate use of at least three named pieces of apparatus AND any four of the following points M2 add copper(II) carbonate to (dilute sulfuric) acid (a spatula/little at a time and stir after each addition) M3 until no more effervescence M4 filter (to remove excess copper(II) carbonate/to obtain (copper(II) sulfate) solution) M5 heat/warm filtrate/(copper(II) sulfate) solution until crystals start to appear (solution saturated) OWTTE M6 filter to obtain (the saturated) solution	ALLOW until no more reacts/dissolves ALLOW until in excess IGNORE if continue and prepare crystals instead of saturated solution	5
(b) (ii)	M1 calculation of actual mass of crystals obtained M2 division by expected mass of crystals (6.4) and multiplication by 100 to convert to percentage M3 correct to 1 dp Example calculation M1 (6.40 – 1.80 =) 4.6(0) M2 (% yield =) $\frac{4.6}{6.4}$ x100 OR 71.875 (%) M3 = 71.9 (%)	M2 ECF M1 M3 DEP M2	3

Question number	Answer	Notes	Marks
(c) (i)	M1 find percentage of water M2 divide each percentage by Mr to find number of moles M3 divide each answer by smallest to find ratio and value of x Expected calculation: M1 (79%) $CaSO_4$ 21% H_2O M2 $\frac{79}{136}$ (= 0.58) $\frac{21}{18}$ (= 1.17) M3 $\frac{0.58}{0.58}$ $\frac{1.17}{0.58}$ = 1 : 2 so x = 2	correct answer without working scores 3	3
(ii)	description including M1 do a flame test M2 orange-red flame	ALLOW description of flame test	2
		(Total for Question = 15)	

(**Q10 4CH1/1CR, Jan 2021**)

Q9.

Question number	Answer	Notes	Marks
(a) (i)	A description including any three of the following **M1** pour some solvent into a beaker /chromatography tank **M2** place the paper in the solvent so that the food colourings are above the level of the solvent **M3** leave the paper until the solvent reaches the level shown in the diagram/ has moved to near the top of the paper OWTTE **M4** take the paper out and leave to dry	**M1** and **M2** can be scored from a labelled diagram **ALLOW** any named solvent	3
(ii)	one/1		1
(iii)	(F/it is) insoluble (in the solvent)/ does not dissolve (in the solvent)		1
(iv)	**M1** E and H **M2** they contain a dye that moved the furthest (distance up the paper)/ is closest to the solvent front / has the greatest R_f value	**M2** dep on **M1**	2
(b)	**M1** distance moved by solvent = 59-61mm **and** distance moved by the dye = 37-41mm **M2** distance moved by the dye ÷ distance moved by the solvent ≈ 0.67 **M3** (the dye in food colouring) G	**ALLOW** distances in cm e.g. 6cm and 4cm If paper has been printed on A4 distances will be 51-53mm and 33-37mm **ALLOW** alternative methods	3 **Total 10**

(**Q04 4CH1/1C, June 2021**)

Q10.

Question number	Answer	Notes	Marks
(a)	Example calculation M1 (volume of oxygen =) 100 – 25 **OR** 75 (cm^3) M2 75 ÷ 365 × 100 M3 20.5 (%)	Correct answer of 20.5 % with or without working scores 3 **ALLOW** ecf from M1 **ALLOW** ecf from M2 **ALLOW** 2 or more significant figures **REJECT** incorrect rounding Use of 265 instead of 365 gives an answer of 28.3 and scores 2 Alternative method M1 (volume of air left =) 265 + 25 **OR** 290 (cm^3) M2 290 ÷ 365 × 100 **OR** 79.5 (%) M3 (100 – 79.5 =) 20.5 (%)	3

(b) (i)	M1 paint provides a barrier M2 which prevents oxygen / water getting to /reacting with the iron	**ALLOW** paint forms a coating (on the iron) / paint is non-permeable **ALLOW** air	2
(ii)	M1 zinc is more reactive/higher in the reactivity series (than iron) M2 zinc will oxidise / react / corrode instead of /before iron	**ALLOW** zinc is a sacrificial metal **IGNORE** references to zinc rusting **IGNORE** references to galvanising	2
			7 marks

(**Q04 4CH1/1C, Jan 2021**)

Q11.

Question number	Answer	Notes	Marks
(a) (i)	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ M1 all symbols and formulae correct M2 correctly balanced	 M2 DEP M1	2
(ii)	lighted splint (produces squeaky) pop		1
(b) (i)	52 (cm^3)	ALLOW 51.5-52.5	1
(ii)	M1 vertical line from 15 cm^3 acid to graph line M2 volume hydrogen from graph multiplied by 2 OR M1 vertical line from 30 cm^3 acid to graph line M2 volume hydrogen from graph	ALLOW extra point drawn at 15 cm^3 ALLOW 68-70 ALLOW extra point drawn at 30 cm^3 ALLOW 68-70	2
(c)	explanation linking M1 more (acid) particles/(hydrogen) ions/H^+ in same volume M2 more (successful) collisions per second/unit time M3 rate increases	 REJECT molecules once only ALLOW particles are closer together ACCEPT more frequent collisions IGNORE more chance/probability of collision ALLOW reaction is faster /speeds up MAX 1 if refer to particles moving faster/having more energy	3
(d)	explanation including M1 (increase/decrease) surface area M2 increase surface area by using smaller pieces of zinc M3 more (successful) collisions per second/unit time (so rate increases)	 ACCEPT more frequent collisions IGNORE more chance/probability of collision M2 M3 ACCEPT reverse arguments	3
		(Total for Question = 12)	

(**Q06 4CH1/1CR, Jan 2021**)

Q12.

Question number		Answer	Notes	Marks
(a)	(i)	glowing splint relights	**REJECT** burning splint	1
	(ii)	A description that refers to the following three points M1 filter out manganese(IV) oxide / solid M2 leave to dry M3 same mass/ 1g of manganese(IV) oxide / solid		3
(b)	(i)	M1 280 ÷ 120 M2 2.33	 **ALLOW** ecf from M1 **ALLOW** any number of significant figures except 1	2
	(ii)	An explanation that links the following three points M1 the concentration of hydrochloric acid is greatest M2 therefore there are more collisions M3 per unit time	 **ALLOW** the surface area of zinc is greatest **ALLOW** greatest number of/more particles (of hydrochloric acid/ zinc) More frequent collisions scores M2 and M3 Max 1 if incorrect reference to energy	3 2
	(iii)	M1 curve above original and starts at 0 M2 curve goes flat at same volume (410cm^3)		
	(iv)	M1 greater surface area M2 more collisions per unit time / more frequent collisions		2
(c)		M1 8.46 × 10^{-3} mol of zinc M2 therefore 1.69 × 10^{-2} mol hydrochloric acid needed (which is less than 2.50 × 10^{-2} mol) **OR** M1 1.25 × 10^{-2} mol of zinc are needed M2 therefore 0.8(13) g of zinc is needed (and there is only 0.55g)	**ALLOW** any number of sig figs including one e.g. 0.008 moles of zinc, therefore 0.016 moles of acid needed scores M1 and M2	2
				15 marks

(**Q11 4CH1/1C, Jan 2021**)

Q13.

Question number	Answer	Notes	Marks
(a) (i)	fractional distillation	**ALLOW** distillation **REJECT** simple distillation	1
(ii)	evaporation	**ALLOW** evaporating /boiling	1
(iii)	condensation	**ALLOW** condensing	1

(b) (i)	**M1** (mass ethanol 15.50×0.79 =) 12.245 (g) **M2** (moles ethanol = $12.245 \div 46$ =) 0.266 (mol) **OR** **M1** (1 cm^3 ethanol = $0.79 \div 46$ =) 0.0172 mol **M2** (15.5 cm^3 ethanol = 0.0172×15.5 =) 0.267 (mol)	 **ALLOW** any number of significant figures except 1 **ALLOW** ecf from M1 **ALLOW** any number of significant figures except 1 **ALLOW** ecf from M1 correct answer with or without working scores 2.	2
(ii)	answer from (b)(i) $\times 6 \times 10^{23}$ e.g. ($0.266 \times 6.0 \times 10^{23}$ =) 1.60×10^{23}	**ALLOW** any number of significant figures except 1 **ALLOW** answer in ordinary form	1

Question number	Answer	Notes	Marks
(c) (i)	**M1** add anhydrous copper sulfate **M2** turns blue	**ALLOW** add white copper sulfate **M2** dependent on M1 **ALLOW** **M1** add anhydrous cobalt chloride/ cobalt chloride paper **M2** turns pink **M2** dependent on M1	2
(ii)	**M1** measure boiling point **M2** is 100°C	 **ALLOW** melting/freezing point is 0°C for both marks	2

(d) (i)	M1 $\Delta T = 49.5^{\circ}C$ M2 $Q = mc\Delta T$ **OR** $100 \times 4.2 \times 49.5$ M3 20 790 J	correct answer with or without working scores 3 **ALLOW** ecf from M1 **ALLOW** 20 800	3
(ii)	M1 20.790 kJ M2 (20.790 ÷ 0.0200 =) -1039.5 (kJ/mol)	**ALLOW** answer to 10(c)(i) ÷ 1 000 **ALLOW** any number of significant figures from 3 **ALLOW** M1 ÷ 0.0200 as long as answer is negative. **REJECT** incorrect rounding. **REJECT** positive answer.	2
			15

(**Q10 4CH1/1C, Nov 2021**)

Q14.

Question number	Answer	Notes	Marks
(a) (i)	(simple) distillation	**REJECT** fractional distillation	1
(ii)	M1 a way of cooling side arm/test tube	**ALLOW** any method of cooling eg beaker of ice around beaker **ALLOW** use a condenser	2
	M2 (so) water vapour/steam cools/condenses		
(b) (i)	M1 correct measurement of distance moved by the spot common to A and C	**ALLOW** 2.2-2.5	3
	M2 correct measurement of distance moved by the solvent	**ALLOW** 7.3-7.5	
	M3 use and evaluation of $R_f = \frac{\text{distance moved by spot}}{\text{distance moved by solvent}}$	eg $\frac{2.3}{7.4} = 0.31$ **ALLOW** 1-4 sig fig **but must be correctly rounded** **ALLOW** ECF from M1 M2 as long as only one spot distance in M1 and $R_f < 1$	
(ii)	use a different solvent	**ALLOW** any named solvent e.g. ethanol	1
		Total for question = 7	

(**Q02 4SS0/1C, Nov 2021**)

Q15.

Question number	Answer	Notes	Marks
(a)	**Method** filtration simple distillation **or** fractional distillation fractional distillation crystallisation	**ALLOW** filtering **ALLOW** distillation **REJECT** simple distillation or distillation	4
(b) (i)	M1 A and B M2 because they are the same height /moved the same distance up the paper / have the same R_f values as the spots in the purple ink	M2 dep on M1 correct or missing	2
(ii)	M1 D M2 because the spot is closest to the start line /travelled the least distance (from the start line) / has the lowest R_f value	M2 dep on M1 correct or missing	2
(c)	Example calculation M1 120 × 0.72 M2 86 / 86.4 (mm)	Correct answer of 86 or 86.4 (mm) with or without working scores 2	2
			10 marks

(**Q05 4CH1/1C, Jan 2021**)

Q16.

Question number	Answer	Notes	Marks
(a)	(paper) chromatography		1
(b) (i)	**B** filtration A is incorrect as P is not used for crystallisation C is incorrect as P is not used for fractional distillation D is incorrect as P is not used for simple distillation		1
(ii)	**C** fractional distillation A is incorrect as S is not used for crystallisation B is incorrect as S is not used for filtration D is incorrect as S is not used for simple distillation		1
(iii)	evaporating basin/dish	**ALLOW** evaporating bowl	1
			Total 4

(**Q01 4SS0/1C, June 2021**)