Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Centre Number | Candidate Number

Time 1 hour 45 minutes

Paper reference **1CH0/1H**

Chemistry

PAPER 1H

Higher Tier

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.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*****), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

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.
- Good luck with your examination.

Turn over ▶

Answer ALL questions. Write your answers in the spaces provided.

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 When heated, zinc carbonate decomposes to form zinc oxide and carbon dioxide gas.

$$ZnCO_3 \rightarrow ZnO + CO_2$$

(a) A student investigated the decomposition of a sample of zinc carbonate.

The student used the following method.

step 1 the mass of an empty crucible was determined

step 2 a sample of zinc carbonate was placed into the crucible

step 3 the mass of the crucible and the zinc carbonate was determined

step 4 the crucible and zinc carbonate was heated for five minutes

step 5 the mass of the crucible and contents was determined.

Figure 1 shows the apparatus used.

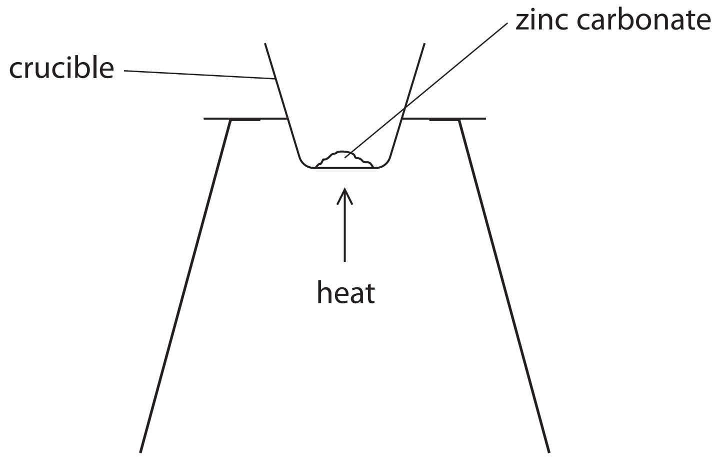

Figure 1

Suggest how the student could confirm that the decomposition was complete.

(3)

heat remaining solid/ heat it for longer / heat it again
• and determine mass
• repeat until mass after heating stays the same

(b) The theoretical maximum yield of zinc oxide was 1.86 g.

The actual yield was 1.63 g.

Calculate the percentage yield of zinc oxide.

(2)

1.63 (1) (= 0.876)
1.86
0.876 x 100 (1) (= 87.6 (%))

percentage yield = ...

(c) Another student carried out the experiment using a similar method.
The student used a blue, roaring Bunsen burner flame and placed a lid on the crucible.

State why the student used a blue, roaring flame and a lid.

(2)

why a blue, roaring flame blue flame: hot(test) / very hot (1)

why a lid lid: to stop {zinc oxide/ product} escaping

(Total for Question 1 = 7 marks)

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2 The scientist John Dalton lived over 200 years ago.

(a) John Dalton suggested an early model of atoms.

When Dalton first described atoms he said that

- all elements are made of atoms
- atoms are not formed of any smaller particles
- all atoms of the same element are identical.

Give two differences between Dalton's model of atoms and today's model of atoms.

(2)

1 • atoms are formed of sub-atomic particles (1)
• atoms have a nucleus

2

(b) Dalton also investigated different gases.

One of the gases that Dalton investigated was ethene.

The structure of one molecule of ethene is shown in Figure 2.

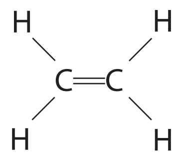

Figure 2

Give the molecular formula and the empirical formula of ethene.

(2)

molecular formula C2H4
:
empirical formula CH2

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(c) Another gas that Dalton investigated was chlorine.

Chlorine gas reacts with water.
The two products are a solution of hydrogen chloride and the substance HClO.

(i) Complete the balanced equation for this reaction, including the three missing state symbols.

(3)

..........(..........) + ... (..........) ⇌ .... (..........) + HClO (aq)

Cl2(g) + H2O(l) ⇌ HCl(aq)

(ii) Hydrogen chloride solution is acidic.

The formulae of four ions are shown in Figure 3.

H^+	H^-	Cl^+	Cl^-

Figure 3

Give the formula of the ion in Figure 3 that causes the hydrogen chloride solution to be acidic.

(1)

formula H+

(iii) An acid reacts with an alkali.

Give the name of this type of reaction.

(1)

neutralisation

(Total for Question 2 = 9 marks)

3 (a) A sample of potable water contains impurities.

Why is this sample of water potable even though it contains impurities?

(1)

- ☐ **A** the impurities have no smell
- ☐ **B** the impurities are colourless
- ☒ **C** the impurities are harmless
- ☐ **D** the impurities are soluble

(b) Waste water can be used to produce drinking water.
The processes used include sedimentation, filtration and chlorination.

(i) What is sedimentation?

(1)

- ☐ **A** the waste water is heated so the impurities evaporate
- ☐ **B** the waste water has an acid added to remove impurities
- ☒ **C** the impurities in the waste water settle to the bottom of their container
- ☐ **D** the impurities in the waste water are bleached

(ii) State why the waste water is filtered.

(1)

to remove {insoluble substances / solids

(iii) State the reason for chlorination.

(1)

to kill {bacteria / microorganisms}

(c) Some salts can be added to waste water to remove impurities.
In an experiment, different masses of salt **A** were added to 1000 cm^3 samples of waste water.
The experiment was repeated with salt **B**.
The percentages of impurities removed from the waste water are shown in Figure 4.

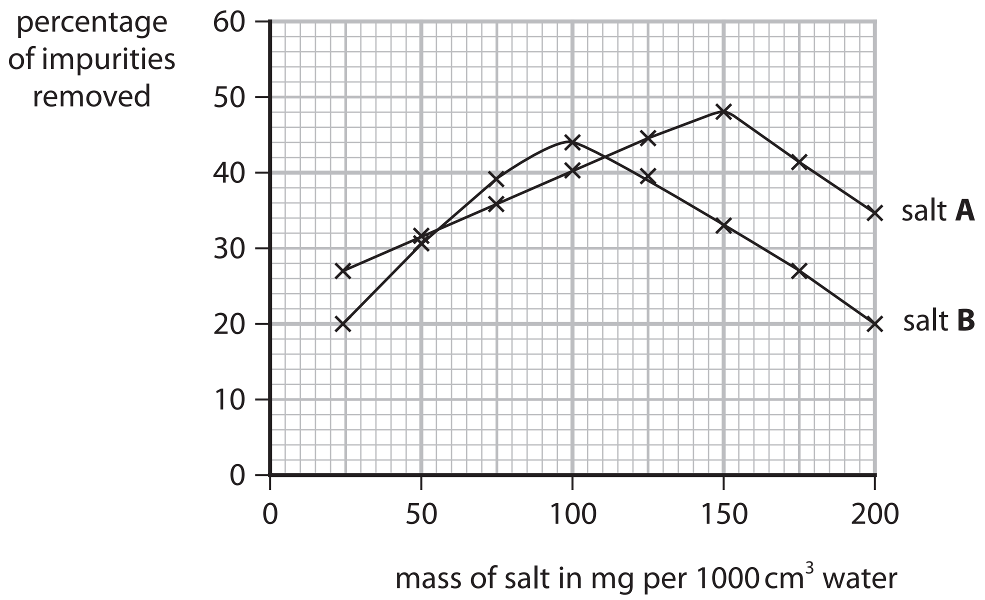

Figure 4

It was concluded that the best way to purify 1000 cm^3 of the waste water is to add 100 mg of salt **B**.

Use the information about salt **A** and salt **B** in Figure 4 to evaluate this conclusion.

(3)

- best amount of A is 150 (mg)
- 150 mg A removes more than 100 (mg) B
- so it is better to use salt A than salt B

(d) Waste water may contain phosphate ions, PO_4^{3-}.

Aluminium ions react with phosphate ions to form aluminium phosphate.

Complete the ionic equation for the formation of aluminium phosphate in this reaction.

(2)

Al3+ + PO_4^{3-} → AlPO4

(Total for Question 3 = 9 marks)

4 Aluminium alloys are used instead of pure aluminium in aircraft manufacture.

(a) Explain, in terms of the arrangement of metal particles, why aluminium alloys are stronger than pure aluminium.

(3)

(in pure aluminium all the atoms are the same (size) whereas) in alloy atoms are different sizes
• (in aluminium) {layers/rows/sheets} of atoms easily slide over each other
• (in alloy) {layers/rows/sheets} of atoms cannot easily slide over each other

(b) A 695.0 g sample of an aluminium-magnesium alloy contains 2.00% by mass of magnesium.

Calculate the mass of aluminium in this sample.

(2)

$\frac{2.00 \times 695.0}{100}$ (1) (= 13.9)
695.0 – 13.9 (1) (= 681.1 (g))
OR
$\frac{98.00}{100}$ (1) x 695.0 (1) (= 681.1 (g))

mass of aluminium = ... g

(c) Figure 5 shows a graph of the relative strength of aluminium-magnesium alloys when the percentage by mass of magnesium in the alloy is changed.

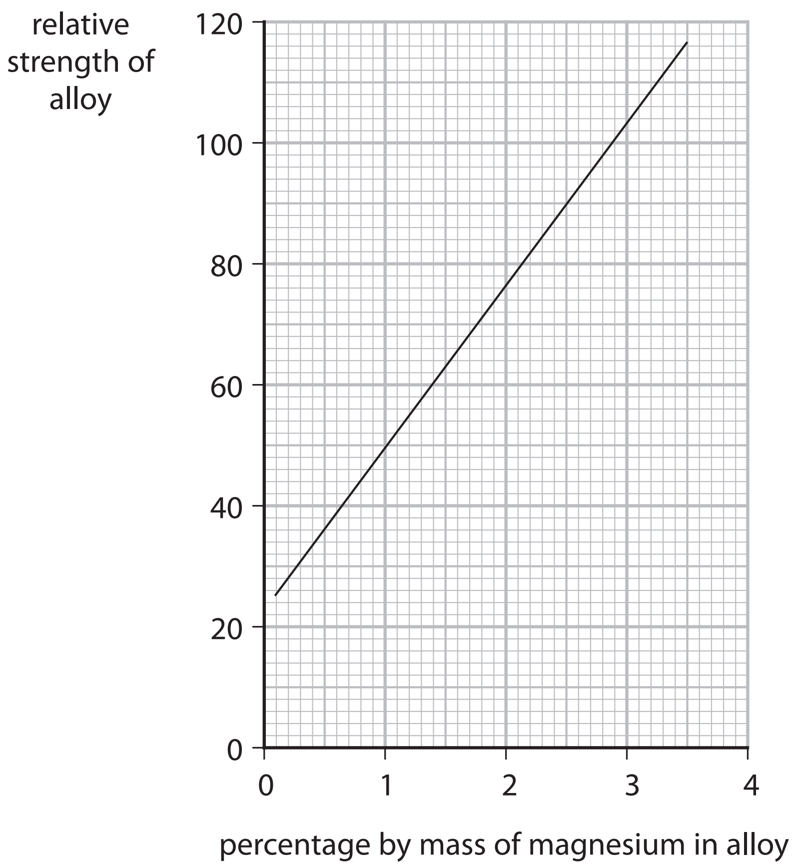

Figure 5

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(i) Describe what Figure 5 shows about the relative strength of these alloys when the percentage by mass of magnesium changes.

(2)

the strength increases (1)

• as percentage of magnesium (by mass in the alloy) increases

(ii) Determine, using Figure 5, the percentage by mass of aluminium in an aluminium-magnesium alloy with a relative strength of 103.

(2)

(from graph)
percentage by mass of magnesium
= 3.0 %
percentage aluminium in alloy
= 100 – 3 (1) (= 97 (%))
credit MP1 if wr

percentage by mass of aluminium = ...

(d) Metal objects can be electroplated with gold.

Give two reasons why metal objects are electroplated with gold.

(2)

1 improve the appearance (1)
•

2 increase resistance to corrosion

(Total for Question 4 = 11 marks)

5 This question is about electrolysis.

(a) A sample of molten potassium bromide is electrolysed.

What are the two products formed?

(1)

☐ **A** hydrogen and oxygen

☐ **B** hydrogen and bromine

☐ **C** potassium and oxygen

☒ **D** potassium and bromine

(b) Zinc chloride and zinc carbonate contain ions.

Zinc chloride mixed with water can be electrolysed.
Zinc carbonate mixed with water cannot be electrolysed.

Explain this difference.

(2)

zinc chloride soluble and zinc carbonate insoluble (1)
• so ions free to move only in zinc chloride solution / comparison with zinc carbonate

(c) In the electrolysis of sodium chloride solution, bubbles of a colourless gas form at the cathode.
This gas, when mixed with air, burns with a squeaky pop.

(i) Identify this gas.

(1)

Hydrogen

(ii) Explain how this gas is formed at the cathode.

(2)

• hydrogen ions attracted to cathode/negatively charged electrode
• (two) hydrogen ions {gain (two) electrons /are reduced / form hydrogen molecules} / correct half equation (2H+ + 2e(-) → H2)

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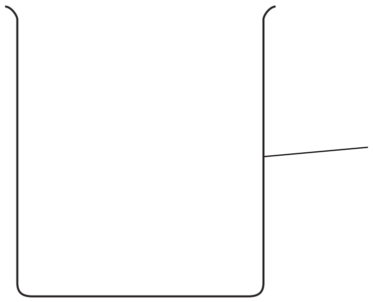
(d) A solution of copper sulfate in a beaker is electrolysed using copper electrodes.

(i) Draw a labelled diagram to show how this experiment would be set up.

The beaker has been drawn for you.

(2)



(ii) During the electrolysis, the anode gets smaller, the cathode gets larger and the solution remains the same shade of blue.

Give the reason for each of these observations.

(3)

the anode gets smaller

anode: smaller because copper atoms form ions (and go into solution) / oxidation of Cu atoms (1)

•

the cathode gets larger

cathode: larger because copper atoms are formed (from ions in the solution) / reduction of Cu2+ (1)

•

the solution remains the same shade of blue

solution: the same number of ions enter and leave solution (1)

(Total for Question 5 = 11 marks)

6 (a) Copper carbonate reacts with dilute nitric acid.

(i) During the reaction the copper carbonate powder completely disappears.

State what can be deduced about the amount of acid used.

(1)

The acid is in excess

(ii) During the reaction, the pH of the mixture changed from 2 to 6.

By what factor has the concentration of the hydrogen ions in the mixture changed?

(1)

- ☐ **A** × 10 000
- ☐ **B** × 4
- ☐ **C** × ¼
- ☒ **D** × $\frac{1}{10\,000}$

(b) Using different reactants, a solution of copper sulfate was prepared.

Describe what should be done to obtain copper sulfate crystals from this copper sulfate solution.

(2)

heat solution (to evaporate water and concentrate the salt solution) (1)

• leave to cool (1)

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(c) When chloride ions are added to a pale blue solution containing copper ions, the mixture turns yellow.

This is a reversible reaction.

$$\text{pale blue solution} + \text{chloride ions} \rightleftharpoons \text{yellow solution} + \text{water}$$

What effect does the removal of chloride ions have on the colour of the yellow mixture?

(1)

- ☐ **A** does not change colour
- ☒ **B** turns blue
- ☐ **C** turns colourless
- ☐ **D** turns darker yellow

(d) Hydrated copper sulfate has the formula $CuSO_4.5H_2O$.
The formula tells us that each mole of copper sulfate contains 5 moles of water.

A sample of $CuSO_4.5H_2O$ was heated gently until all the water was removed to form anhydrous copper sulfate, $CuSO_4$.

$$CuSO_4.5H_2O \rightarrow CuSO_4 + 5H_2O$$

The mass of water formed was 4.5 g.

Calculate the mass of hydrated copper sulfate that was heated.

(relative atomic masses: H = 1.0, O = 16.0;
relative formula mass: $CuSO_4.5H_2O$ = 249.5)

(4)

Mr H2O = 18.0

moles of H2O = 4.5 / 18.0 (= 0.25)
moles CuSO4.5H2O = 1/5 x 0.25 (= 0.05)
mass CuSO4.5H2O = 0.05 x 249.5 (= 12.475 g)

mass of $CuSO_4.5H_2O$ = ... g

(Total for Question 6 = 9 marks)

7 (a) The order of reactivity of copper, magnesium and zinc can be determined by the displacement reactions between these metals and solutions of their salts.

You are provided with

- samples of the three metals
- solutions of copper sulfate, magnesium sulfate and zinc sulfate.

Describe the experiments that can be done to determine the order of reactivity of these metals by displacement reactions.

(3)

place separate pieces of each metal into solutions of each of salt (in spotting tray/container)
• observe changes in appearance/colour of {metal/solution}
• the more reactive metal shows the greater number of reactions

(b) Metals can be extracted from ores found in the Earth's crust.

Explain why aluminium cannot be extracted from its ore by heating with carbon but can be extracted by electrolysis.

(2)

aluminium is more reactive than carbon (so electrolysis required)
• carbon cannot remove the oxygen / there is no reaction between carbon and aluminium oxide / carbon cannot displace aluminium

(c) Titanium is extracted from its ore in several stages.

In the first stage, titanium chloride is formed as a gas.

The gas is cooled to form liquid titanium chloride containing **dissolved** impurities.

Suggest how pure titanium chloride could be separated from the impurities.

(1)

Distillation

(d) In another stage, the pure titanium chloride, $TiCl_4$, is reacted with 500 moles of magnesium, an excess.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

(i) Calculate the number of moles in 45 000 grams of titanium chloride.

(relative atomic masses: Cl = 35.5, Ti = 48.0)

(2)

Mr TiCl4 = 48.0 + (4 x 35.5) (1) (= 190)
moles of TiCl4 = 45 000/190 = 236.8

number of moles titanium chloride = ...

(ii) Show that the 500 moles of magnesium added is an excess.

(1)

minimum) moles of Mg needed = 236.8 x 2 = 473.6 (1)
500 moles of Mg added > minimum 473.6 moles required

(e) After this reaction, there is a mixture of the solids magnesium, titanium and magnesium chloride.

Titanium does not react with dilute hydrochloric acid.

Suggest a simple method to separate titanium from the mixture.

(2)

add dilute hydrochloric acid (to solid mixture sample to react with the magnesium to form magnesium chloride solution) (1)
• filter the mixture (to remove titanium) / filter off the titanium (1)

(Total for Question 7 = 11 marks)

8 Hydrogen-oxygen fuel cells, rather than chemical cells, can be used to power some vehicles.

(a) Give **one** advantage of using a hydrogen-oxygen fuel cell, rather than using a chemical cell, to power a vehicle.

(1)

Voltage constant

(b) Complete the half-equation for the reaction taking place at one of the electrodes in a hydrogen-oxygen fuel cell.

(2)

O_2 + 4 H^+ + 4e(-) → 2 H_2O

(c) Calculate the volume of 48 g of oxygen at room temperature and pressure.

(relative atomic mass: O = 16,
1 mol of gas occupies 24 dm^3 at room temperature and pressure)

(2)

moles of oxygen = 48/32 (1) (= 1.5 mol)
volume of oxygen = 1.5 x 24.0 dm3
(= 36 dm3)

volume of oxygen = ... dm^3

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*(d) The hydrogen used in a hydrogen-oxygen fuel cell can be produced from methanol, CH_3OH.

$$CH_3OH + H_2O \rightleftharpoons CO_2 + 3H_2$$

In this reaction the forward reaction is endothermic and heat energy is taken in from the surroundings.
The conditions used for this reaction are

- a nickel catalyst
- a temperature of 220 °C

Explain, in terms of their effects on the rate of attainment of equilibrium and the equilibrium yield of hydrogen, why the reaction is carried out using a catalyst at 220 °C rather than without a catalyst at a lower temperature.

(6)

effect of using a catalyst)
• increases rate of attainment of equilibrium
• increasing rate of both forward and back reaction
• lowers activation energy
• provides an alternative reaction pathway
• no effect on equilibrium yield
(effects of using a temperature of 220°C rather than lower temperatures)
• equilibrium attained in a shorter period of time / faster rate of attainment of equilibrium
• because particles move faster/ have higher (kinetic) energy
• increased collision frequency and more energetic collisions
• equilibrium yield of hydrogen increases with higher temperatures
• because heat energy is taken in the forward reaction (endothermic)
• increasing the temperature shifts equilibrium further to the right-hand side

(Total for Question 8 = 11 marks)

9 (a) An ion of element **X** can be represented as

$$^{125}\mathbf{X}^{2-}$$

This ion of element **X** has 54 electrons.

Calculate the number of protons and the number of neutrons in this ion.

(2)

number of protons 52

number of neutrons 124

(b) A sample of silicon contains isotopes.

(i) State, in terms of subatomic particles, how atoms of these isotopes are the same.

(1)

isotopes of same element) have the same number of protons

(ii) This sample of silicon contains three isotopes.

92% of the atoms are silicon-28
5% of the atoms are silicon-29
3% of the atoms are silicon-30

Calculate the relative atomic mass of silicon in this sample.

(2)

total mass of 100 atoms =
(28 x 92) + (29 x 5) + (30 x 3) (1) (= 2811)
relative atomic mass = 2811 (= 28.11)
100

relative atomic mass = ...

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*(c) Figure 6 shows some properties of three substances, **A**, **B** and **C**.

substance	melting point in °C	ability to conduct electricity	
		solid	molten
A	1180	poor	good
B	1538	good	good
C	115	poor	poor

Figure 6

Deduce, using the information in Figure 6, the structure and bonding of substances **A**, **B** and **C**, explaining their properties in terms of their structure and bonding.

(6)

Substance A
• giant ionic structure
• (high melting point) strong electrostatic attractions between ions
• due to a lot of energy required to overcome strong forces
• (electrical conductivity) in solid ions strongly attracted in lattice
ions cannot move, so poor conductor when solid
• when molten ions free to move, so good conductor when molten
Substance B
• metallic structure
• (high melting point) strong attraction between metal ions and delocalised electrons
• due to a lot of energy required to overcome strong forces between particles in solid
• (electrical conductivity) in solid delocalised electrons
• free to move throughout metallic lattice, so good conductor when solid
• delocalised electrons and ions free to move when molten, so good conductor when molten
Substance C
• covalent simple molecular
• (low melting point) weak intermolecular forces/ attractions between molecules
• little energy needed to separate molecules, so low melting point
• (electrical conductivity) in solid and when molten no delocalised electrons or ions to carry charge, so poor
conductor

(Total for Question 9 = 11 marks)

10 A sample of solid potassium hydroxide contained soluble, unreactive impurities.

A student tried to find the mass of potassium hydroxide in the sample, using the following method.

step 1 measure the mass of the sample of impure potassium hydroxide

step 2 dissolve the sample in 250 cm^3 of water in a beaker

step 3 take a 25 cm^3 sample of the potassium hydroxide solution using a measuring cylinder and pour into a conical flask

step 4 add 3 drops of indicator to the solution

step 5 put the conical flask on a white tile

step 6 using a burette, add dilute sulfuric acid of known concentration drop by drop to the solution, while swirling the flask

step 7 continue adding the sulfuric acid until the colour of the solution changes

step 8 record the volume of sulfuric acid added

step 9 use this result to calculate the mass of pure potassium hydroxide in the sample.

(a) (i) Suggest **three** ways to improve this method to obtain a more accurate mass of pure potassium hydroxide.

(3)

1 make the potassium hydroxide solution using a volumetric flask
• use distilled / deionised water (to make up solution)

2 • make solution of total volume 250 cm3 (rather than adding 250 cm3 water to the solid)
• use of pipette to measure out the potassium hydroxide solution (1)

3 • repeat until titres within ±0.2(0) cm3 of each other / concordant titres and use to calculate the mean titre

(ii) The indicator used was phenolphthalein.

Which row shows the colour change that would be seen in this titration?

(1)

		colour at start	colour at end point
☐	**A**	yellow	orange
☐	**B**	orange	yellow
☒	**C**	pink	colourless
☐	**D**	colourless	pink

(b) Another student carried out the titration accurately.

12.15 cm^3 of dilute sulfuric acid with a concentration of 0.140 mol dm^{-3} reacted completely with 25.00 cm^3 of potassium hydroxide solution.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

Calculate the concentration of this potassium hydroxide solution.

(4)

moles of sulfuric acid = 0.140 x 12.15
1000
(= 0.001701 mol)
ratio 2 : 1 KOH to H2SO4
moles of KOH = 2 x 0.001701
(= 0.003402 mol)
concentration of KOH = 0.003402 x 1000
25.00
(= 0.136 mol dm-3)

concentration of potassium hydroxide solution = ... mol dm^{-3}

(c) A different solution of potassium hydroxide had a concentration of 0.175 mol dm^{-3}.

This potassium hydroxide solution was made by dissolving 2.56 g of impure potassium hydroxide to form 250 cm^3 of solution.

Calculate the percentage by mass of potassium hydroxide in the impure potassium hydroxide.

(relative formula mass: KOH = 56.0)

(3)

0.175 x 56.0 = 9.80 g dm-3
mass in 250 cm3 sample = 0.25 x 9.80 = 2.45 g
% pure KOH = 2.45 /2.56 x 100 = 95.7 (%)

percentage by mass of potassium hydroxide = ...

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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The periodic table of the elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

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

***** The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.**

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