Write your name here

Surname	Other names

Pearson Edexcel
International GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Unit: 4CH0
Science (Double Award) 4SC0
Paper: 1C

Thursday 17 May 2018 – Morning
Time: 2 hours

Paper Reference
4CH0/1C
4SC0/1C

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.*
- Show all the steps in any calculations and state the units.
- 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 ☒.

Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 5 2 3 2 2 R A 0 1 3 6

Pearson

THE PERIODIC TABLE

Period	Group 1	2										3	4	5	6	7	0
1	1 H Hydrogen 1																4 He Helium 2
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
3	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
4	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
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

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Answer ALL questions.

1 Chromatography can be used to separate the substances in a mixture.

(a) Diagram 1 shows the apparatus used to separate the different dyes in a food colouring.

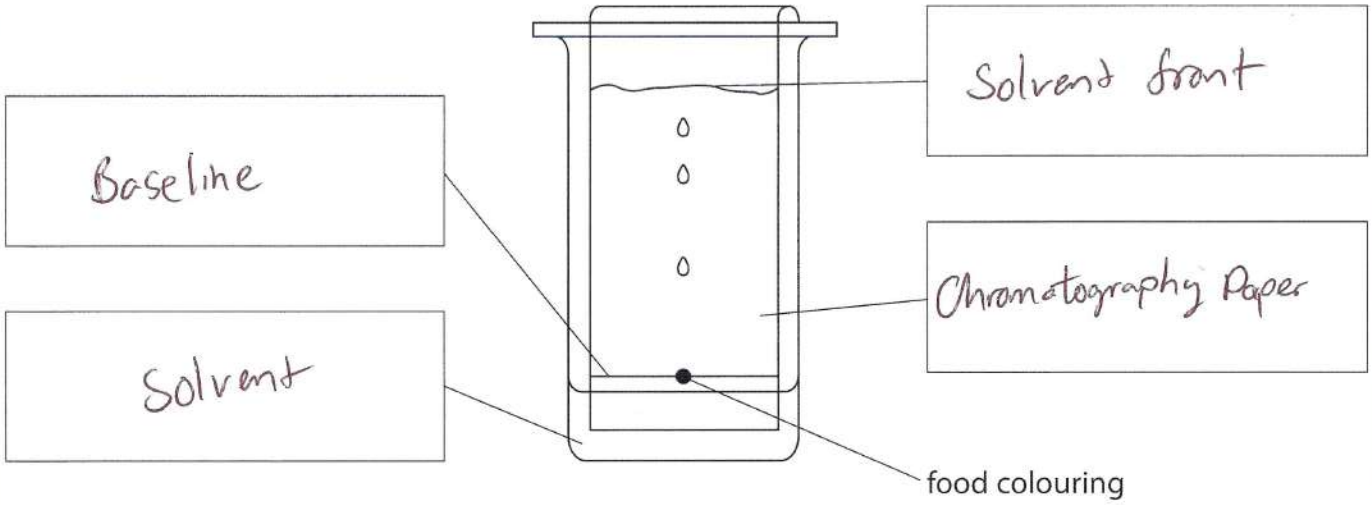

Diagram 1

The box lists some terms used in chromatography.

baseline	chromatography paper
solvent	solvent front

Use the terms from the box to label diagram 1.

(3)

(b) Diagram 2 shows a chromatogram produced using four different food colourings, P, Q, R and S.

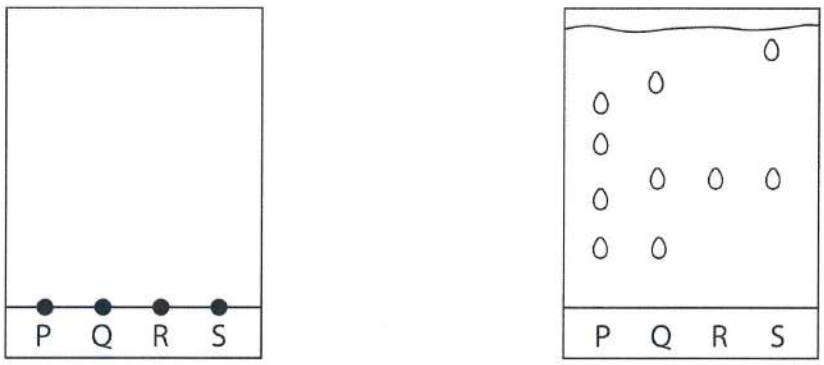

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Diagram 2

(i) Which food colouring contains only one dye?

(1)

- ☐ **A** P
- ☐ **B** Q
- ☒ **C** R
- ☐ **D** S

(ii) Which food colourings have one dye in common?

(1)

- ☐ **A** P, Q and R
- ☐ **B** P, R and S
- ☒ **C** Q, R and S
- ☐ **D** P, Q, R and S

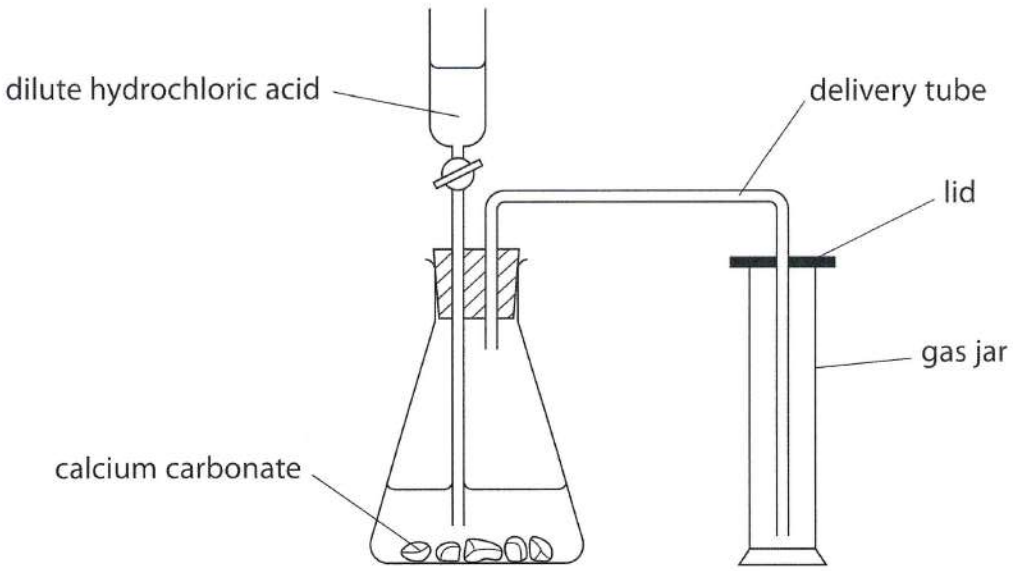
(iii) Explain which food colouring contains the largest number of dyes.

(2)

P, Largest number of spots.

(Total for Question 1 = 7 marks)

2 The diagram shows the apparatus used to prepare carbon dioxide in the laboratory.



(a) What is the name of the piece of apparatus containing the dilute hydrochloric acid?

(1)

- ☐ **A** burette
- ☐ **B** pipette
- ☒ **C** tap funnel
- ☐ **D** thistle funnel

(b) Complete the chemical equation for this reaction.

(2)

$$CaCO_3 + \underline{2} \; HCl \rightarrow CaCl_2 + CO_2 + \underline{H_2O}$$

(c) Which of these is a true statement about carbon dioxide?

(1)

- ☐ **A** it turns red litmus blue
- ☒ **B** it turns limewater milky
- ☐ **C** it relights a glowing spill
- ☐ **D** it burns with a squeaky pop

(d) The diagram shows how carbon dioxide is collected by downward delivery in air.

(i) Give a reason why carbon dioxide can be collected by downward delivery in air.

(1)

It is more dense than air.

(ii) Give another method of collecting carbon dioxide.

(1)

Gas syringe.

(e) When carbon dioxide dissolves in water, a weakly acidic solution forms.

Suggest a pH value for this solution.

(1)

5.0

(f) Carbon dioxide also forms when copper(II) carbonate is decomposed by heating.

The equation for this reaction is

$$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$$

State the change in colour of the solid when copper(II) carbonate decomposes.

(2)

from Green to Black

(g) Suggest two properties of carbon dioxide that make it suitable for use in fire extinguishers.

(2)

1 Does not support combustion

2 More dense than air.

(Total for Question 2 = 11 marks)

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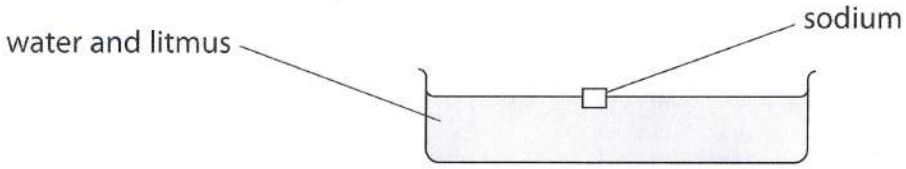
3 A teacher investigates the reaction between sodium and water.

The teacher fills a trough with water.

She adds a few drops of litmus solution to the water, and then adds a piece of sodium.



(a) The sodium floats on the water. It reacts with the water and produces bubbles of hydrogen gas.

(i) State two other observations that are made during the reaction.

(2)

1 Sodium disappears

2 Sodium moves around

(ii) Balance the equation for the reaction between sodium and water.

Include the state symbols.

(2)

2 Na(s) + 2 H_2O(l) → 2 NaOH(aq) + 1 H_2(g)

(b) Lithium and potassium react in a similar way to sodium when added to water.

(i) State why they have a similar reaction in terms of the electronic configurations of their atoms.

(1)

Both contain one electron in the outer shell.

(ii) Place the elements lithium, potassium and sodium in order of reactivity.

(1)

most reactive Potassium

Sodium

least reactive Lithium

(Total for Question 3 = 6 marks)

4 Use the Periodic Table on page 2 to help you answer this question.

(a) Which word correctly describes substances found in the Periodic Table?

(1)

- ☐ **A** alloys
- ☐ **B** compounds
- ☒ **C** elements
- ☐ **D** mixtures

(b) The substances in the Periodic Table are arranged in order of increasing

(1)

- ☒ **A** atomic number
- ☐ **B** mass number
- ☐ **C** nucleon number
- ☐ **D** relative atomic mass

(c) The table lists properties of some of the gases in Group 0 of the Periodic Table.

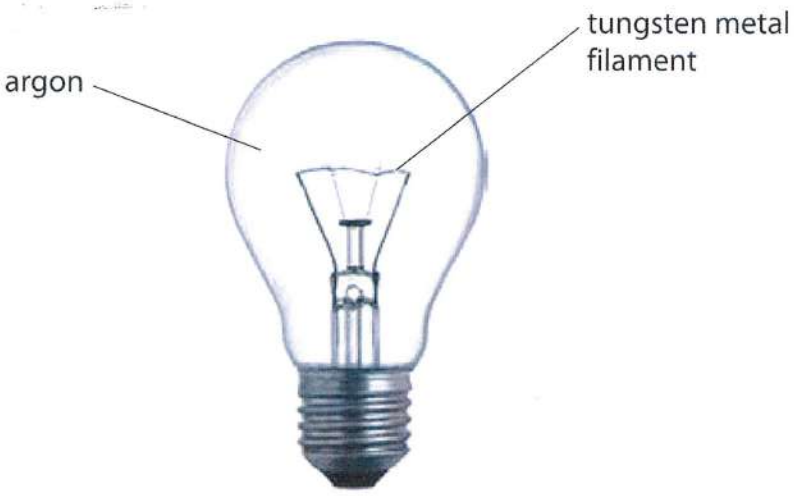
Gas	Symbol	Boiling point in K	Reaction with metals
helium	He	4	no reaction
neon	Ne	27	no reaction
argon	Ar	80	no reaction
krypton	Kr	121	no reaction
xenon	Xe	165	No reaction

Complete the table by giving

- the symbol for neon
- an estimate for the boiling point of argon
- the reaction of xenon with metals

(3)

(d) The photograph shows an electric light bulb.



The tungsten filament becomes very hot when the light bulb is switched on.

Suggest why argon is a more suitable gas than air to use in the light bulb.

(2)

Argon doesn't react with tungsten filament. Because Argon ~~does~~ has a full outer shell of electrons.

(Total for Question 4 = 7 marks)

5 A student tries to make a pure, dry sample of hydrated cobalt(II) chloride crystals.

He uses dilute hydrochloric acid and solid cobalt(II) oxide.

This is the student's method.

Step 1 pour about 50 cm^3 of dilute hydrochloric acid into a beaker

Step 2 warm the acid using a Bunsen burner

Step 3 add a small amount of cobalt(II) oxide and stir the mixture with a glass rod

Step 4 add further small amounts of cobalt(II) oxide until it stops reacting

Step 5 filter the final mixture and collect the filtrate in an evaporating basin

Step 6 leave the filtrate until all of the water has evaporated

His sample of cobalt(II) oxide contains a small amount of a solid impurity that dissolves in water, but does not react with the acid.

(a) State why it is not necessary to have a precise measurement of the volume of hydrochloric acid in step 1.

(1)

Because all of the HCl is used up.

(b) State why the acid is warmed in step 2.

(1)

To increase the rate of reaction

(c) Suggest why a glass rod, rather than a metal spatula, is used to stir the mixture in step 3.

(1)

Glass won't react with the solution.

(d) State how the student will know when the cobalt(II) oxide stops reacting in step 4.

(1)

Solid stops disappearing.

(e) State why the method used in step 6 will not produce a pure sample of hydrated cobalt(II) chloride crystals.

(1)

The soluble impurity will also be present with the crystals.

(f) Describe how the student could produce a pure, dry sample of crystals from the filtrate in step 5.

(5)

Heat the filtrate, until crystals form on the end of a glass rod. Leave the solution to cool and filter to remove the crystals. Wash the crystals with a small amount of deionised water. Dry the crystals with filter paper.

(g) The table shows the formula and colour of three different types of cobalt(II) chloride.

Formula	Colour
$CoCl_2$	blue
$CoCl_2.2H_2O$	purple
$CoCl_2.6H_2O$	pink

When water is added very slowly to solid $CoCl_2$, the colour of $CoCl_2$ changes from blue to purple and then to pink.

(i) Write a chemical equation for the change from the purple solid to the pink solid.

(1)

$CoCl_2 \cdot 2H_2O + 4H_2O \rightarrow CoCl_2 \cdot 6H_2O$

(ii) Which of these words describes the change taking place when the pink solid is heated to form the blue solid?

(1)

- ☐ **A** crystallisation
- ☒ **B** dehydration
- ☐ **C** hydration
- ☐ **D** redox

(Total for Question 5 = 12 marks)

6 Tests are done on a sample of a solid, X.

Solid X contains the ammonium ion, NH_4^+, one other cation and one anion.

The table lists details of the tests done on solid X and the observations made for each test.

	Test	Observation
1	Add dilute sodium hydroxide and warm	gas given off, gas turns damp litmus paper from red to blue
2	Flame test	lilac coloured flame
3	A sample of solid X is dissolved in deionised water. The solution is divided into three test tubes and the following tests are done:	
	A to the first test tube, add dilute hydrochloric acid	no observable change
	B to the second test tube, add dilute nitric acid and a few drops of silver nitrate solution	no observable change
	C to the third test tube, add dilute hydrochloric acid and a few drops of barium chloride solution	white precipitate forms

(a) Identify the gas given off in test 1.

(1)

NH_3

(b) Give the formula of the other cation present in solid X.

(1)

K^+

(c) (i) State what test 3A and test 3B tell you about solid X.

(2)

test 3A No carbonate ion present.

test 3B No halide ion present.

(ii) Identify the anion in solid X.

(1)

SO_4^{2-}

(Total for Question 6 = 5 marks)

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7 Antimony, Sb, is an element in Group 5 of the Periodic Table.

The mineral, stibnite, contains antimony sulfide, Sb_2S_3

Antimony can be obtained from stibnite in a two-stage process.

Stage 1 stibnite is roasted in air

$$Sb_2S_3 + 5O_2 \rightarrow Sb_2O_4 + 3SO_2$$

Stage 2 the oxide produced is heated with carbon to form antimony and carbon dioxide

(a) (i) State why the sulfur in stage 1 is said to be oxidised.

(1)

It has gained oxygen.

(ii) Complete the equation for the reaction in stage 2.

(1)

$$Sb_2O_4 + \underline{2}\ C \rightarrow \underline{2}\ Sb + \underline{2}\ CO_2$$

(b) Bismuth is another element in Group 5 of the Periodic Table.

Bismuth forms an oxide, Bi_2O_3, which has a giant ionic structure.

(i) Give the formula of the bismuth ion in bismuth oxide.

(1)

Bi^{3+}

(ii) Explain why bismuth oxide has a high melting point.

(2)

Strong electrostatic forces between oppositely charged ions which require a large amount of energy to overcome.

(iii) Bismuth oxide reacts with dilute hydrochloric acid to form bismuth chloride.

Write a chemical equation for this reaction.

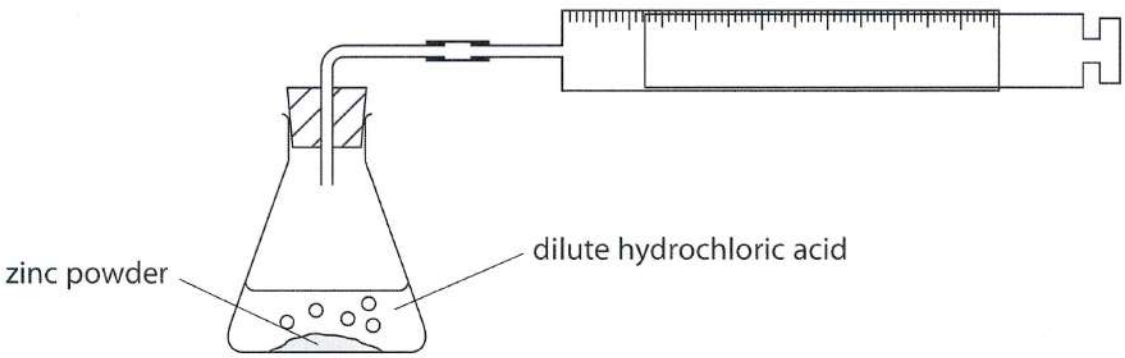
(2)

$Bi_2O_3 + 6HCl \rightarrow 2BiCl_3 + 3H_2O$

(Total for Question 7 = 7 marks)

8 A student investigates the rate of reaction between zinc and hydrochloric acid, using an excess of zinc powder.

She uses this apparatus.



The student measures the volume of gas in the syringe every minute for ten minutes.

The table shows her results.

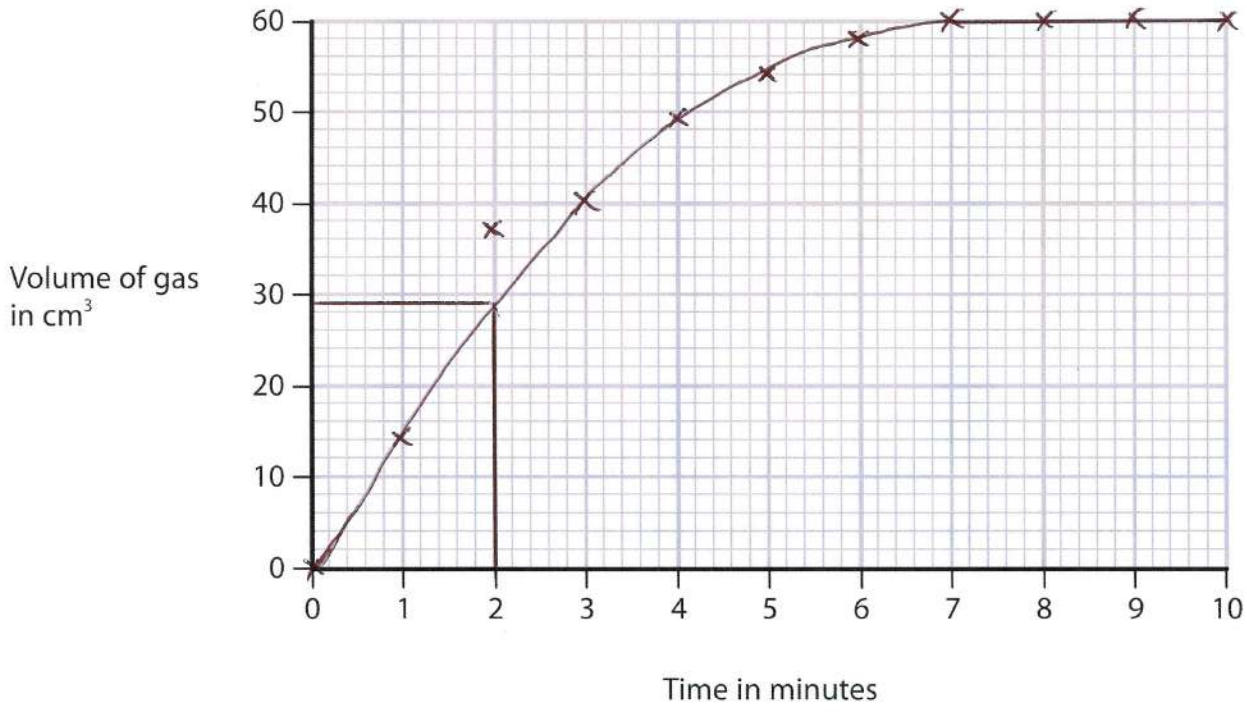
Time in minutes	0	1	2	3	4	5	6	7	8	9	10
Volume of gas in cm^3	0	14	37	40	49	54	58	60	60	60	60

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

(2)

(ii) Draw a curve of best fit.

(1)



(b) The result at two minutes is anomalous.

(i) Suggest a mistake that the student could have made to produce this anomalous result.

(1)

Measured volume of gas later.

(ii) Use your graph to estimate the volume of gas that was given off at two minutes.

Show clearly on your graph how you obtain your answer.

(2)

volume of gas = 29 cm^3

(c) Explain why the last four readings for the volume of gas are the same.

(2)

The reaction has finished because all of the acid has reacted.

(d) (i) State how the graph shows that the rate of reaction decreases during the first seven minutes.

(1)

The gradient of the line curve decreases.

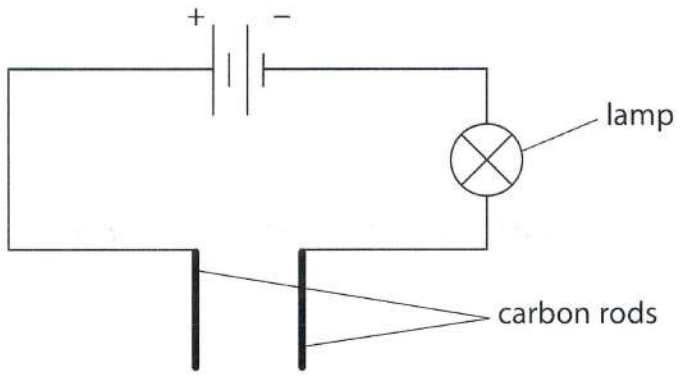
(ii) Explain, in terms of the particle collision theory, why the rate of reaction decreases during the first seven minutes.

(2)

Fewer particles of acid and zinc to react.
Fewer successful collisions per second.

(Total for Question 8 = 11 marks)

9 This apparatus is used to test whether magnesium, solid magnesium chloride and an aqueous solution of magnesium chloride conduct electricity.



The table shows the results.

Substance	Conducts electricity
magnesium	yes
solid magnesium chloride	no
aqueous solution of magnesium chloride	yes

Explain these results, with reference to the type of particles in each substance.

(6)

Magnesium contains delocalised electrons which are free to move and carry charge.

solid

Magnesium chloride contains ions which are in a fixed position.

Aqueous Magnesium chloride contains ions which are free to move in solution.

(Total for Question 9 = 6 marks)

10 Bromine is a red-brown liquid at room temperature.

Liquid bromine forms a brown gas when warmed.

(a) Explain what happens to the bromine molecules when liquid bromine is warmed to form a gas.

(2)

The average energy of the molecules increases and some of them escape from the liquid.

(b) Bromine reacts with water to form a mixture of hydrobromic acid, HBr, and hypobromous acid, HBrO.

Write a chemical equation for this reaction.

(1)

$Br_2 + H_2O \rightarrow HBr + HBrO$

(c) Hydrobromic acid reacts with magnesium carbonate to form a solution containing magnesium bromide.

$$MgCO_3(s) + 2HBr(aq) \rightarrow MgBr_2(aq) + H_2O(l) + CO_2(g)$$

Crystals of hydrated magnesium bromide, $MgBr_2.6H_2O$, can be obtained from this solution.

$$MgBr_2 + 6H_2O \rightarrow MgBr_2.6H_2O$$

(i) An excess of hydrobromic acid is reacted with 0.125 mol of magnesium carbonate.

Show, by calculation, that the maximum theoretical mass of hydrated magnesium bromide that can be made is 36.5 g.
[M_r of $MgBr_2.6H_2O$ = 292]

(3)

$n(MgCO_3) = 0.125$ mol $\therefore$ $n(MgBr_2) = 0.125$ mol

$\therefore$ $n(MgBr_2 \cdot 6H_2O) = 0.125$ mol

$m = nM_r$ $\quad 0.125 \times 292 = 36.5$ g

(ii) In an experiment using 0.125 mol of magnesium carbonate, with an excess of hydrobromic acid, the mass of hydrated magnesium bromide obtained is 26.4 g.

Suggest two reasons why the actual mass obtained is less than the maximum theoretical mass.

(2)

1 Solution not left for long enough.

2 Magnesium carbonate is impure.

(Total for Question 10 = 8 marks)

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11 Malachite is an ore of copper containing copper(II) carbonate and several other compounds that are insoluble in water.

You are supplied with several pieces of malachite, these chemicals and items of apparatus.

Chemicals: dilute sulfuric acid magnesium powder

Apparatus: beakers filter funnel and paper pestle and mortar

Describe how you would use the chemicals and the apparatus to obtain a sample of copper from the malachite.

(6)

Crush the malachite using the pestle and mortar.
Add the powder to dilute sulfuric acid in a beaker.
Filter the solution using the filter funnel and paper.
Add magnesium powder to the solution.
Collect the copper by filtering the solution again.

(Total for Question 11 = 6 marks)

12 Crude oil is a mixture of hydrocarbons.

Fractional distillation of crude oil and cracking of hydrocarbon fractions are two of the processes used in an oil refinery.

(a) Which property of hydrocarbons is used to separate crude oil into fractions?

(1)

- [X] **A** boiling point
- [ ] **B** chemical reactivity
- [ ] **C** density
- [ ] **D** melting point

(b) These are the main fractions obtained from crude oil.

- bitumen
- diesel
- fuel oil
- gasoline
- kerosene
- refinery gases

(i) Give one use for the refinery gases.

(1)

Camping gas

(ii) Give one use for kerosene.

(1)

Fuel for planes

(iii) State which fraction is the most viscous.

(1)

Bitumen

(c) Catalytic cracking is used to break down long-chain alkanes into shorter-chain alkanes and alkenes.

(i) Name the catalyst used in industrial cracking.

(1)

Silica

(ii) State the temperature used in industrial cracking.

(1)

600-700°C

(iii) Tetradecane ($C_{14}H_{30}$) can be cracked to make ethene (C_2H_4) and only one other hydrocarbon.

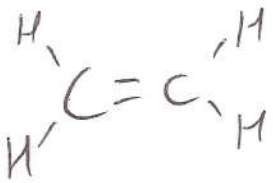
Write a chemical equation for this reaction.

(1)

$C_{14}H_{30} \rightarrow C_2H_4 + C_{12}H_{26}$

(iv) Draw the displayed formula of ethene.

(1)



(v) Name the polymer formed from ethene.

(1)

Polyethene

(vi) Explain why this polymer is difficult to dispose of.

(2)

It is inert, so it doesn't ~~do~~ biodegrade.

(Total for Question 12 = 11 marks)

13 A student investigates the reaction between zinc and dilute sulfuric acid.

She uses this method.

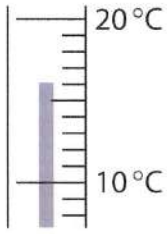
- put 50 cm^3 of dilute sulfuric acid into a polystyrene cup
- measure the initial temperature of the acid
- add 2.0 g of zinc to the acid and stir the mixture
- measure the temperature of the mixture after one minute

The student does the experiment three times. For each experiment, she uses the same size pieces of zinc but different concentrations of sulfuric acid.

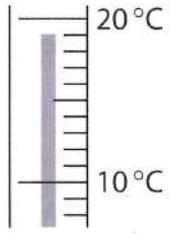
The diagram shows the temperatures for each experiment.

Experiment 1

1.0 mol/dm^3 H_2SO_4



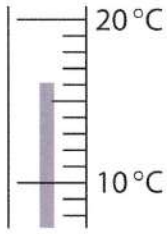
initial temperature



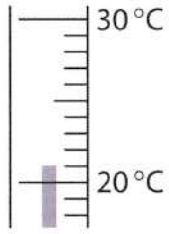
temperature after one minute

Experiment 2

1.5 mol/dm^3 H_2SO_4



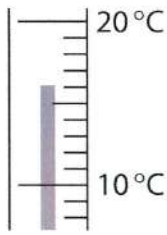
initial temperature



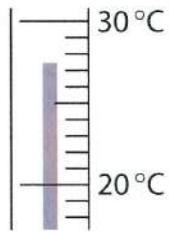
temperature after one minute

Experiment 3

2.0 mol/dm^3 H_2SO_4



initial temperature



temperature after one minute

(a) Record the temperature readings in the table and calculate the temperature increase for each experiment.

Give all values to the nearest 0.5 °C.

(3)

	Initial temperature in °C	Temperature after one minute in °C	Temperature increase in °C
experiment 1	16.0	19.0	3.0
experiment 2	16.0	21.0	5.0
experiment 3	16.6	27.5	11.5

(b) Explain why the temperature increase changes as the concentration of the sulfuric acid increases.

(2)

The reaction occurs more quickly so the thermal energy is transferred to the water quickly.

(c) The student does another experiment at the same initial temperature as experiment 3.

She uses the same size pieces of zinc but uses 25 cm^3 of dilute sulfuric acid.

The acid is in excess in both reactions.

(i) Explain the effect, if any, of this change on the initial rate of reaction when compared to experiment 3.

(2)

Remains the same because its the same temperature and same surface area of zinc.

(ii) Explain the effect, if any, of this change on the temperature increase when compared to experiment 3.

(3)

Greater temperature increase. Same amount of energy releases but a smaller volume of water to heat.

(Total for Question 13 = 10 marks)

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14 Iron deficiency anaemia occurs when the body does not have enough iron(II) ions. Iron deficiency can be overcome by taking iron tablets.

A chemist wants to find out the percentage of iron(II) ion (Fe^{2+}) in an iron tablet.

She uses this method.

- weigh an iron tablet
- dissolve the tablet in an excess of dilute sulfuric acid
- titrate the solution with potassium permanganate solution, $KMnO_4$

The table shows her results.

mass of iron tablet	0.298 g
concentration of $KMnO_4$ solution	0.0200 mol/dm^3
volume of $KMnO_4$ solution added	17.40 cm^3

(a) Calculate the amount, in moles, of $KMnO_4$ in 17.40 cm^3 of 0.0200 mol/dm^3 potassium permanganate solution.

(2)

$0.01740 \times 0.0200 = 3.48 \times 10^{-4}$ mol

$n = cV$

amount of $KMnO_4$ = 3.48×10^{-4} mol

(b) In the titration, 1 mol of $KMnO_4$ reacts with 5 mol of Fe^{2+}.

Calculate the amount, in moles, of Fe^{2+} in the iron tablet.

(1)

$3.48 \times 10^{-4} \times 5 = 1.74 \times 10^{-3}$ mol

amount of Fe^{2+} = 1.74×10^{-3} mol

(c) Calculate the mass, in grams, of Fe^{2+} in the iron tablet.
[A_r of Fe^{2+} = 56.0]

(1)

$1.74 \times 10^{-3} \times 56 = 0.09744\ g$

$m = nM_r$

mass of Fe^{2+} = 0.0974 g

(d) Calculate the percentage by mass of Fe^{2+} in the iron tablet.

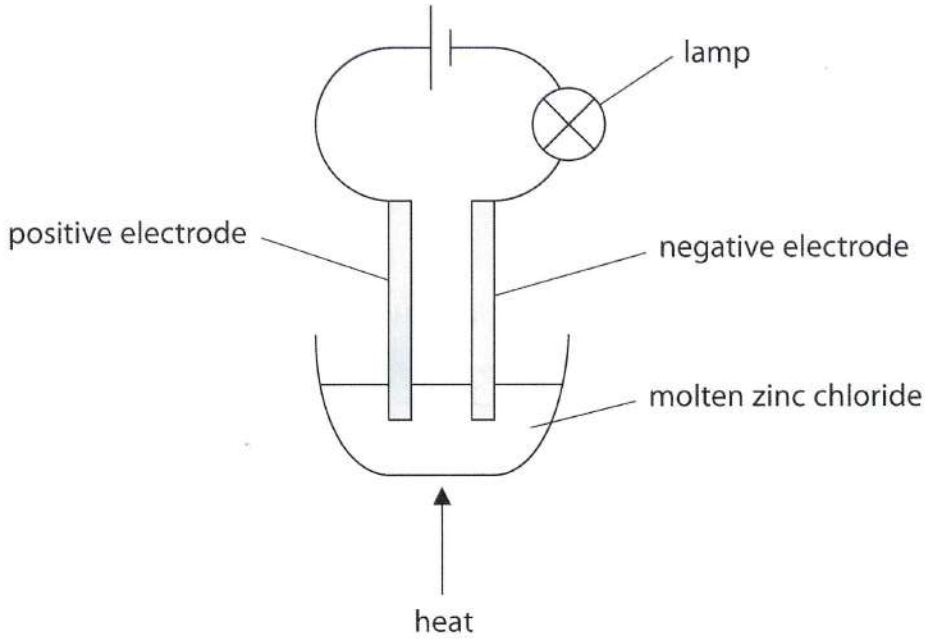
(1)

$\frac{0.09744}{0.298} \times 100\% = 32.7\%$

percentage of Fe^{2+} = 32.7 %

(Total for Question 14 = 5 marks)

15 A teacher uses this apparatus to demonstrate the electrolysis of molten zinc chloride.



A student records these observations.

- crystals of a shiny, grey solid form at one of the electrodes
- a pale green substance forms at the other electrode
- the lamp goes out after the teacher stops heating the zinc chloride

(a) State what is meant by the term **electrolysis**.

(2)

Decomposition of a compound using electricity.

(b) State why graphite is more suitable to use for the electrodes than magnesium in this electrolysis.

(1)

Graphite will not react with chlorine.

(c) Which of these is a correct statement for this electrolysis?

(1)

☐ **A** the pale green substance is chloride

☒ **B** both products are elements

☐ **C** the pale green substance forms at the negative electrode

☐ **D** the shiny grey solid is zinc chloride

(d) The student writes this ionic half-equation for the reaction that forms the pale green substance.

$$2Cl^- + 2e^- \rightarrow 2Cl$$

(2)

Identify the two mistakes in her ionic half-equation.

1 Electrons are on the wrong side

2 2Cl should be Cl_2

(e) The lamp goes out after the teacher stops heating the zinc chloride, because electrons are no longer flowing through the wires.

Explain why electrons are no longer flowing through the wires.

(2)

The ions cannot flow, so no loss or gain of electrons takes place at the electrode.

(Total for Question 15 = 8 marks)

TOTAL MARKS FOR PAPER = 120 MARKS

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