MODEL ANSWERS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | | | | | |

Candidate Number | | | | |

Monday 11 January 2021

Morning (Time: 2 hours) | Paper Reference **4CH1/1CR 4SD0/1CR**

Chemistry

Unit: 4CH1

Science (Double Award) 4SD0

Paper: 1CR

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 110.
- 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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1/1/1/1/

P 6 7 0 8 0 A 0 1 3 2

Pearson

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.*

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

Answer ALL questions.

1 The box lists some substances.

air	bromine	carbon	copper	glucose
nitrogen	oxygen	sulfur	water	

Choose substances from the box to answer these questions.

Each substance may be used once, more than once or not at all.

(a) Name a metallic element.

Copper

(1)

(b) Name a compound.

Glucose / water

(1)

(c) Name a mixture.

Air

(1)

(d) Name an element that is a gas at room temperature.

Nitrogen / Oxygen

(1)

(e) Name an element that forms a basic oxide.

Copper

(1)

(f) Name two elements that are in the same group of the Periodic Table.

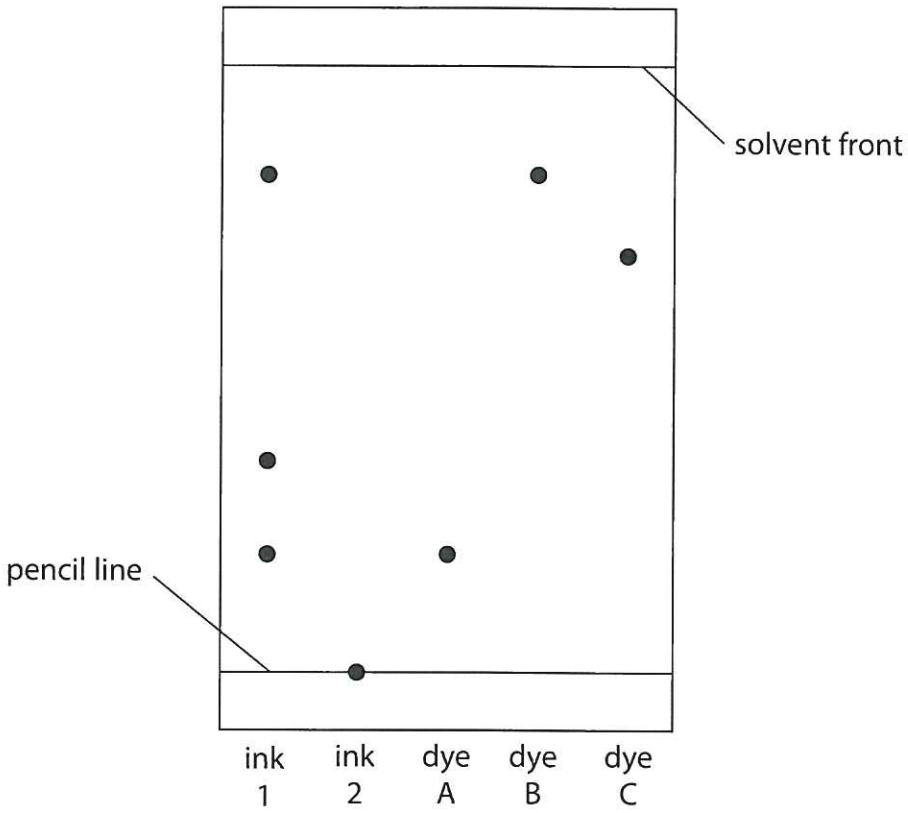
Oxygen & Sulphur.

(1)

(Total for Question 1 = 6 marks)

2 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)

Ink 1 Contains 3 dyes, A, B and one other unknown dye that isn't C.

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

(1)

It is insoluble in water.

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

(1)

Repeat the experiment using a different Solvent.

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

(3)

R_f = distance moved by spot / distance moved by Solvent

$= \frac{5.5}{8.0} = 0.6875$

R_f value = 0.69 (2 s.f.)

(Total for Question 2 = 7 marks)

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3 Crude oil is a mixture of organic compounds.

Most of these compounds are members of the same homologous series.

(a) State the name of this homologous series.

(1)

Alkanes

(b) An industrial process is used to separate crude oil into fractions.

(i) The process depends on a difference in a property of the fractions.

What is this property?

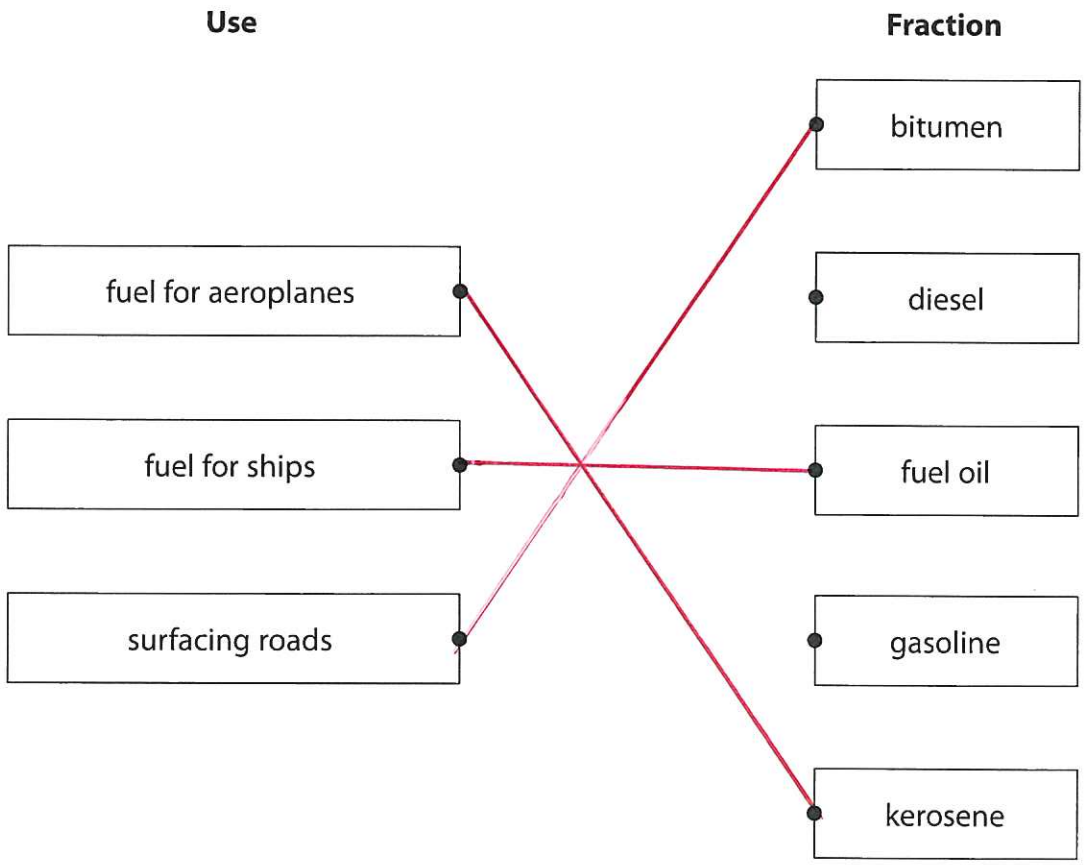
(1)

- [x] **A** boiling point
- [ ] **B** density
- [ ] **C** melting point
- [ ] **D** solubility

(ii) The boxes give some uses of fractions and some names of fractions.

Draw one straight line from each use to its correct fraction.

(3)



(c) Fuels obtained from the fractions may contain impurities.

Explain how the combustion of a common impurity in fuels may cause an environmental problem.

(3)

Sulphur impurities in the fuels burns in oxygen to form SO_2 which can dissolve in water to form acid rain.

(d) Some of the fractions contain long-chain molecules which are not very useful.

(i) Give the name of the process used to convert long-chain molecules into more useful shorter-chain molecules.

(1)

Cracking

(ii) Give the catalyst and temperature used in the industrial process to convert long-chain molecules into shorter-chain molecules.

(2)

catalyst Silica / Alumina.

temperature 600 - 700°C.

(iii) When $C_{13}H_{28}$ is used in this process, three different molecules are formed.

Complete the equation for this reaction.

(2)

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

(Total for Question 3 = 13 marks)

4 When iron is left in damp air, rust forms on its surface.

(a) (i) State the chemical name for rust.

(1)

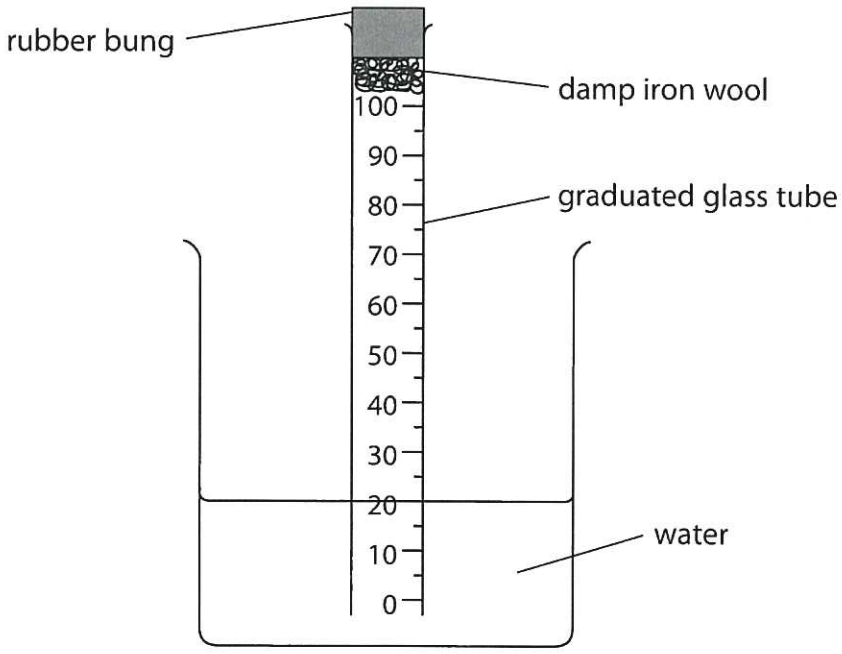
Hydrated iron(III) oxide.

(ii) Explain how a barrier method prevents rusting.

(2)

Coating the iron in paints, oil or plastic stops air and water from getting to the iron, meaning the iron can't rust.

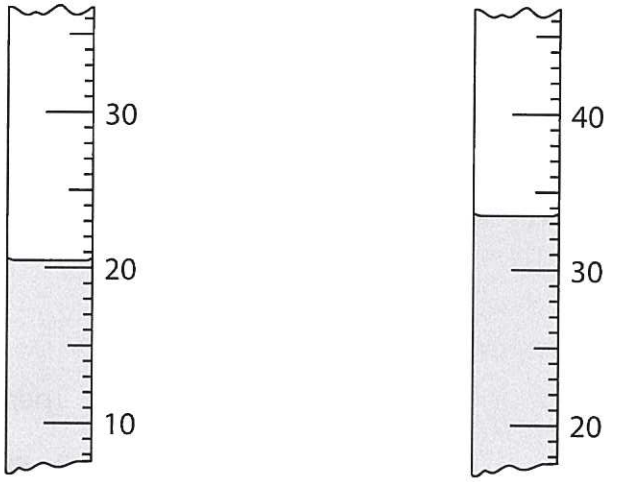
(b) A student uses this apparatus to find the approximate percentage by volume of oxygen in air.



This is the student's method.

- place a graduated glass tube in a beaker of water
- place some damp iron wool and a rubber bung in the top of the tube
- record the reading of the water level in the tube
- leave the apparatus for a few days
- record the reading of the water level again

The diagram shows the readings at the start and at the end of the experiment.



start end

(i) Use the readings to complete the table, giving all values to the nearest 0.5 cm^3.

(2)

reading at start in cm^3	20.5
reading at end in cm^3	33.5
volume of oxygen used in cm^3	13.0

(ii) The student uses these results to calculate the percentage by volume of oxygen in air.

Suggest why her calculated value is lower than the expected value.

(1)

Not all oxygen had reacted.

(c) The student repeats the experiment using the same apparatus.

These are her results for the second experiment.

volume of air in tube at start = 80.0 cm^3

reading at start = 20.0

reading at end = 35.5

Use the results to calculate the percentage by volume of oxygen in air.

(3)

$V(O_2) = 35.5 - 20.0 = 15.5\ cm^3$

$\%\ O_2$ in air $= \frac{15.5}{80} \times 100$

$= 19.375\ \%$

percentage = 19.4 %

(Total for Question 4 = 9 marks)

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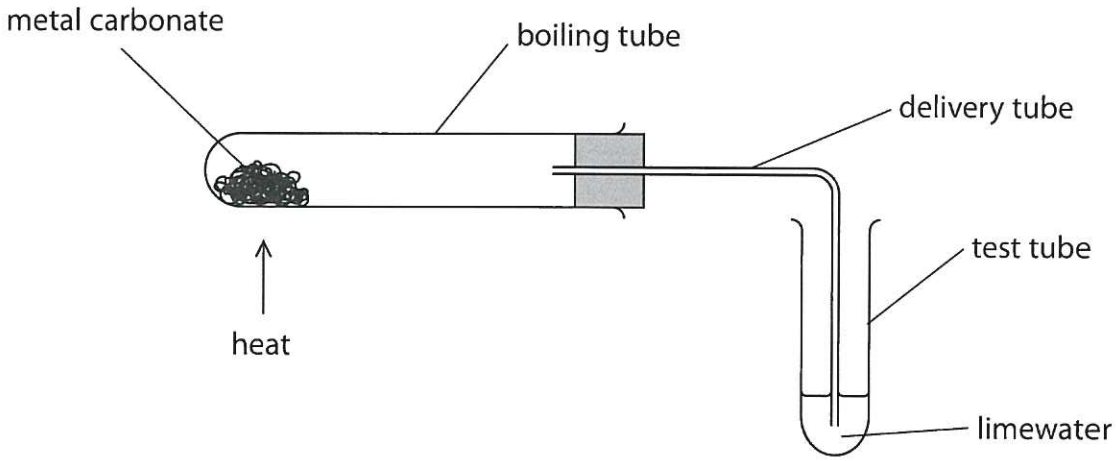
5 A student uses this apparatus to investigate the effect of heat on different solid metal carbonates.



This is the student's method.

- use a spatula to put some metal carbonate in the boiling tube
- fit the delivery tube into position
- pour some limewater into the test tube
- start a timer and immediately begin to heat the metal carbonate
- record the time when a change first occurs in the limewater

The student repeats the method using different metal carbonates.

When a metal carbonate is heated a reaction sometimes occurs.

The equation for the reaction is

metal carbonate $\rightarrow$ metal oxide + carbon dioxide

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

(1)

Thermal decomposition.

(b) State two variables that the student should control in this investigation.

(2)

1 Amount of metal Carbonate

Surface area of metal Carbonate.

2 ~~Same~~ Volume of limewater

distance of flame from boiling tube.

(c) Suggest why bubbles appear in the limewater immediately after heating has started but before there is any change to the metal carbonate.

(1)

Air from the tube expands on heating, causing bubbles to form in the limewater.

(d) Explain the purpose of limewater in this investigation.

(2)

When limewater turns cloudy it shows $CO_2(g)$ has been produced, showing that the metal Carbonate has decomposed.

(e) The table shows some of the results for the student's investigation.

Metal carbonate	Colour change of solid	Time taken for any change in limewater
calcium carbonate	remains white	90 seconds
sodium carbonate	remains white	no change
copper(II) carbonate		50 seconds

(i) State the colour change that occurs for copper(II) carbonate.

(2)

from green to black

(ii) Give a chemical equation for this reaction of copper(II) carbonate.

(1)

$CuCO_3 \longrightarrow CuO + CO_2$

(f) (i) There is a relationship between the position of a metal in the reactivity series and how easily the metal carbonate reacts when heated.

Use the student's results and your own knowledge to deduce this relationship.

(2)

the lower the metal is on the reactivity series, the more easily the metal carbonate decomposes.

(ii) State how you should extend the investigation to see if your deduction is correct.

(1)

Repeat the investigation using more (different) metal carbonates.

(Total for Question 5 = 12 marks)

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6 Zinc reacts with dilute hydrochloric acid to form hydrogen.

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

(2)

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

(ii) Give a test for hydrogen gas.

(1)

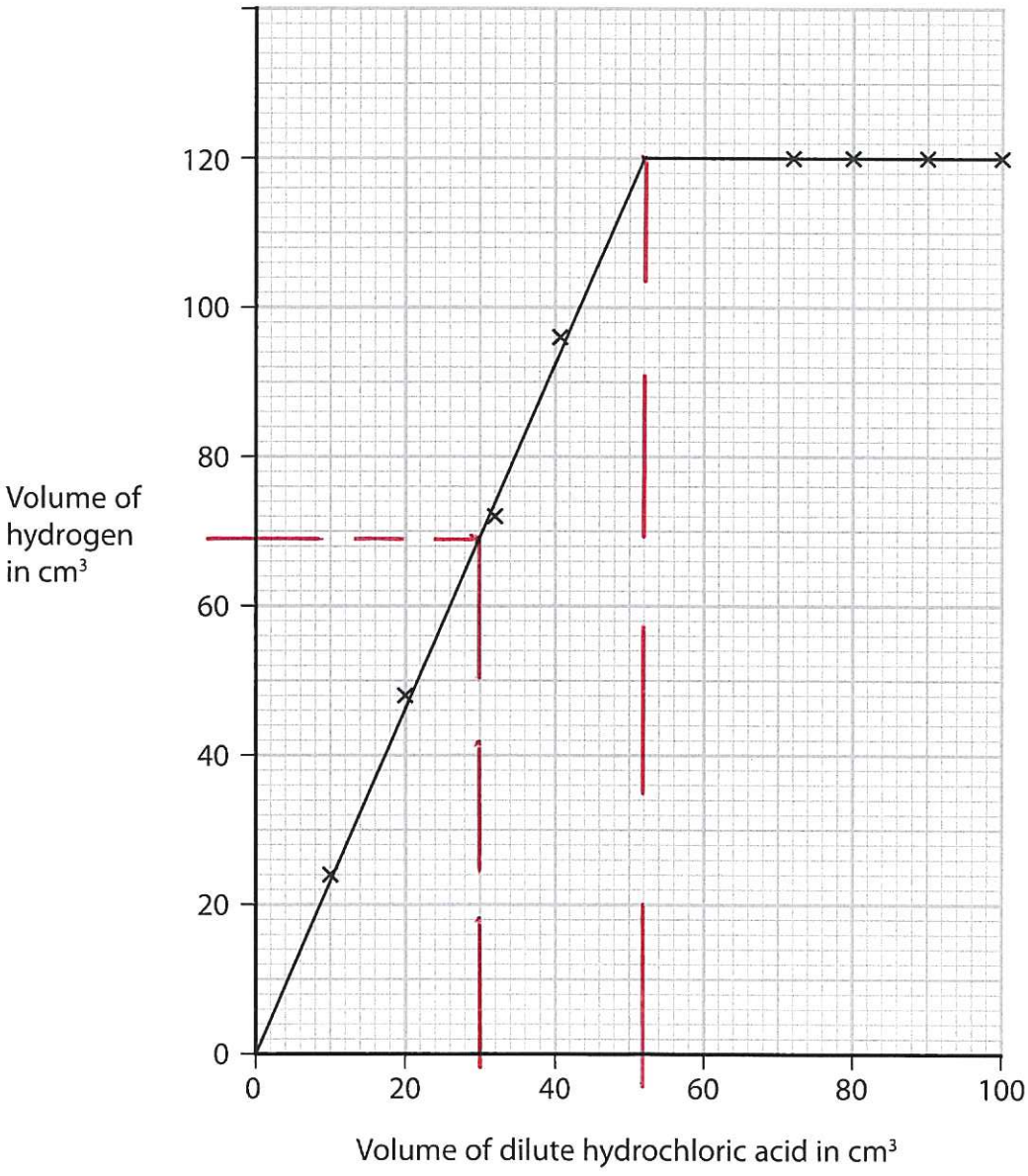
When a lit splint is added to the hydrogen gas, a squeaky pop is produced.

(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)

52 cm^3

(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)

↳ Equivalent to using 30 cm^3 of acid of half concentration.

volume = 79 cm^3

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

(3)

There are more H^+ ions per unit volume so there are more frequent successful collisions per unit time. This causes the rate to increase.

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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)

Increase the surface area of the zinc by using the same mass of zinc but of made of smaller pieces. This leads to more successful collisions per unit time so the rate increases.

(Total for Question 6 = 12 marks)

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7 The formation of ions and covalent bonds involves electrons.

The table gives the electronic configurations of atoms of hydrogen, lithium and chlorine.

Element	Electronic configuration of atom
hydrogen	1
lithium	2.1
chlorine	2.8.7

(a) Describe the different roles of electrons in the formation of

- ions in lithium chloride
- covalent bonds in hydrogen chloride

(3)

The formation of lithium Chloride sees the lithium atom lose an electron which is gained by a Chlorine atom.

The formation of Covalent bonds in hydrogen Chloride sees a pair of electrons (one from each atom) shared between a hydrogen atom and a Chlorine atom.

(b) Explain why lithium chloride has a higher melting point than hydrogen chloride.

Refer to structure and bonding in your answer.

(5)

Lithium Chloride has a giant ionic Structure with Strong electrostatic attractions between oppositely charged ions.

Hydrogen Chloride has a Simple molecular Structure with weak intermolecular forces between the molecules which require less energy ~~to overcome than to breaks~~ and lower temperatures to overcome than the Strong ionic bonds between ~~the~~ the ions in LiCl.

(Total for Question 7 = 8 marks)

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8 (a) (i) Organic compounds can exist as isomers.

Explain what is meant by the term **isomers**.

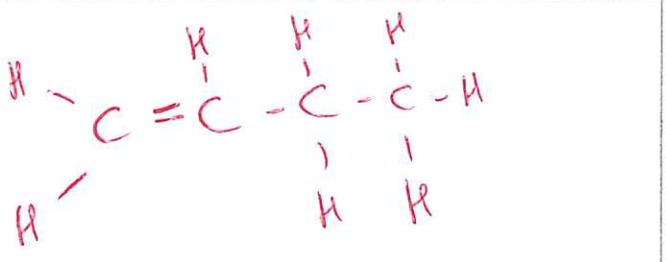
(2)

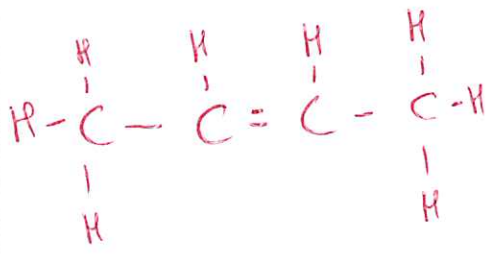
Compounds ~~Molecules~~ with the same molecular formula but different displayed formulae.

(ii) Organic compound Q reacts with bromine, without the presence of ultraviolet radiation, to form the compound $C_4H_8Br_2$

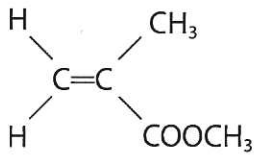
Draw the displayed formulae of two isomers of Q.

(2)





(b) An acrylic polymer can be formed from molecules with this structure.



(i) A student describes the molecule as an unsaturated hydrocarbon.

Explain whether this is a correct description.

(2)

The molecule is unsaturated as it contains a C=C double bond.

The molecule isn't a hydrocarbon as it contains oxygen.

Hence the description is incorrect.

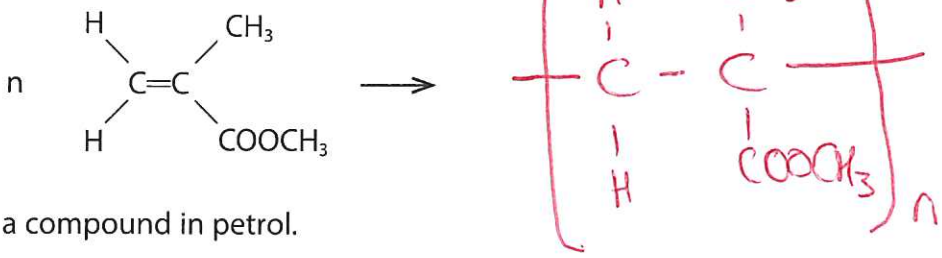
(ii) Name the type of polymerisation that occurs in the formation of the polymer.

(1)

Addition.

(iii) Complete the equation for the polymerisation reaction.

(2)



(c) Octane is a compound in petrol.

The equation for the complete combustion of octane is

$$C_8H_{18} + 12.5\ O_2 \rightarrow 8\ CO_2 + 9\ H_2O$$

(i) The fuel tank of a car contains 50.0 dm^3 of octane.

Calculate the mass, in kg, of carbon dioxide formed if all the octane in the fuel tank undergoes complete combustion.

[mass of 1 dm^3 of octane = 700 g]

(5)

Mass of octane $= 50 \times 700 = 35000$ g

$n(\text{Octane}) = \frac{35000}{8(12)+18} = 307.0$ mol

$n(CO_2) = 8 \times 307 = 2456$ mol

$m(CO_2) = (12+2(16)) \times 2456$

$= 108070.1754$ g

$= 108.0701754$ kg

mass = 108 kg (3 sig fig)

(ii) State an environmental problem caused by carbon dioxide.

(1)

Global warming.

(Total for Question 8 = 15 marks)

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9 Lithium, sodium and potassium are the first three elements in Group 1 of the Periodic Table.

(a) Suggest why these three elements are all stored in paraffin oil.

(1)

To prevent reaction with an oxygen or water.

(b) Caesium, Cs, is below potassium in Group 1.

(i) Give a similarity and a difference between the reactions of potassium with water and caesium with water.

(2)

similarity Both fizz, moving on the surface and produce a flame.

difference A more violent reaction occurs.

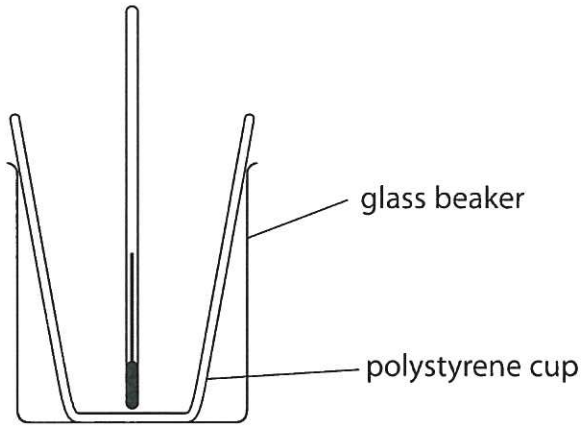
(ii) Give the chemical equation for the reaction between caesium and water.

(2)

$2Cs + 2H_2O \rightarrow 2CsOH + H_2$

(c) A student investigates the temperature change in the reaction between dilute acids and solutions of Group 1 hydroxides.

He uses this apparatus.



This is the student's method.

- measure the temperature of 50 cm^3 of hydrochloric acid
- pour the acid into a polystyrene cup
- add 50 cm^3 of sodium hydroxide solution to the acid
- measure the maximum temperature of the mixture

(i) Suggest what could be added to the apparatus to improve the experiment.

(1)

A lid over the Cup.

(ii) Explain a change to the method that would improve the accuracy of the experiment.

(2)

Stir the Solution - Obtain a more accurate temperature.

Measure the temperature of NaOH - Check if it's the same as or different to that of the acid.

(d) These are the student's results.

temperature of hydrochloric acid = 19.9 °C

maximum temperature of mixture = 26.5 °C

(i) Calculate the energy change, Q, in joules for this reaction.

[mass of 1.0 cm^3 of mixture = 1.0 g]

[for the mixture, c = 4.2 J/g/°C]

(3)

$Q = mc\Delta T$

$= 100 (4.2)(26.5 - 19.9)$

$= 2772$ J

Q = 2770 (3 sf) J

(ii) In the student's reaction between hydrochloric acid and sodium hydroxide, 0.050 mol of water forms.

Calculate the molar enthalpy change, ΔH, in kJ/mol for this reaction.

(2)

$\Delta H = -\frac{Q}{n}$

$= -\frac{2772 \times 10^{-3}}{0.05}$

$= -55.44$ kJ mol^{-1}

ΔH = −55.4 (3 sf) kJ/mol

(Total for Question 9 = 13 marks)

10 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)

Neutralisation.

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

(1)

The acid donates protons which are accepted by the base.

(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)

Add Copper (II) Carbonate to the dilute Sulphuric acid in a beaker using a Spatula. Stir the mixture. Continue to add more Copper (II) Sulphate until no more fizzing occurs. Filter the mixture to remove the excess Copper (II) Carbonate before heating the Solution of Copper (II) Sulphate with a bunsen burner until Crystals start to form. Filter the Solution to obtain the desired Saturated Solution.

(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)

% yield = $\frac{6.4-1.8}{6.4} \times 100$

$= 71.875\ \%$

percentage yield = 71.9 ATM (1 dp.) %

(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)

	$CaSO_4$		H_2O
mass / mr	79 / 136		100 − 79 / 18
=	0.580	:	1.167
/ Smallest	0.580		0.580
=	1	:	2

$\therefore x = 2$

x = 2

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

(2)

Flame test produces orange-red flame.

(Total for Question 10 = 15 marks)

TOTAL FOR PAPER = 110 MARKS

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