Write your name here

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Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Unit: KCH0/4CH0
Science (Double Award) KSC0/4SC0
Paper: 1C

Wednesday 11 January 2017 – Morning
Time: 2 hours

Paper Reference
KCH0/1C 4CH0/1C
KSC0/1C 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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1/2/1/1/1/1/

P 4 8 3 9 3 A 0 1 3 2

Pearson

THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
	Group																	
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

P 4 8 3 9 3 A 0 2 3 2

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Answer ALL questions.

1 Substances can be elements, compounds or mixtures.

(a) Which of these is a correct symbol for an element?

(1)

☒ **A** He

☒ **B** H_2

☒ **C** H_2O

☒ **D** H_2O_2

(b) Which of these substances is a compound?

(1)

☒ **A** air

☒ **B** hydrogen

☒ **C** oxygen

☒ **D** water

(c) Which of these methods is used to obtain water from a mixture containing salt and water?

(1)

☒ **A** crystallisation

☒ **B** filtration

☒ **C** simple distillation

☒ **D** titration

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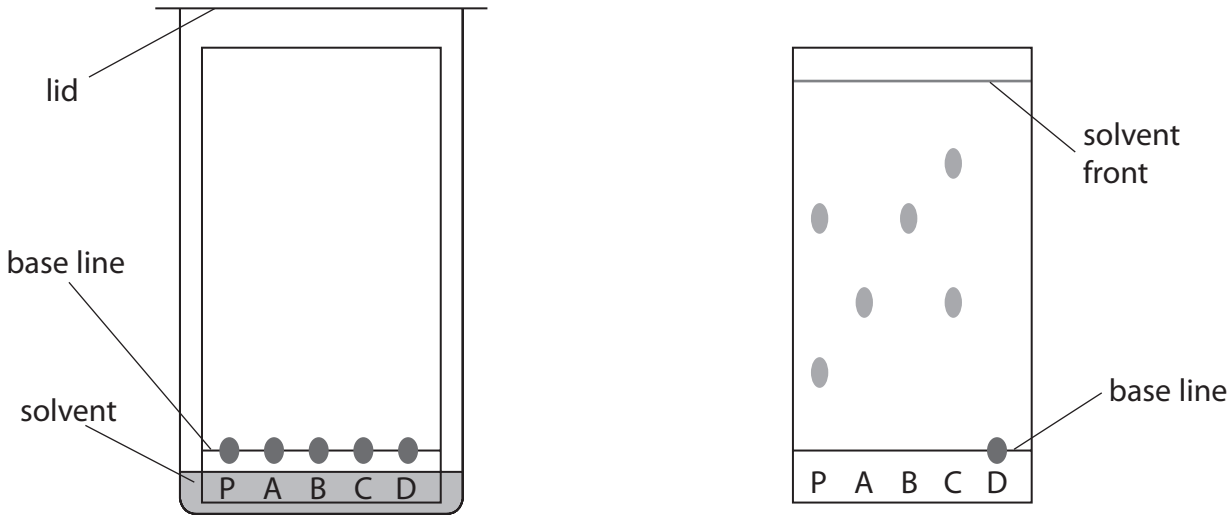
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(d) Paper chromatography is used to separate the dyes present in some inks.

A sample of ink, P, is spotted on to some chromatography paper.

Four known inks, A, B, C and D, are also spotted on to the same paper.

The diagram shows how the experiment is set up and the paper at the end of the experiment.



(i) State why the solvent level should not be above the base line at the start of the experiment.

(1)

.....

.....

(ii) Explain which dye, present in one of the inks A, B, C or D, is also present in ink P.

(2)

.....

.....

.....

.....

(iii) State why ink D does not move during the experiment.

(1)

.....

.....

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(iv) Dyes have an R_f value that can be calculated using this expression.

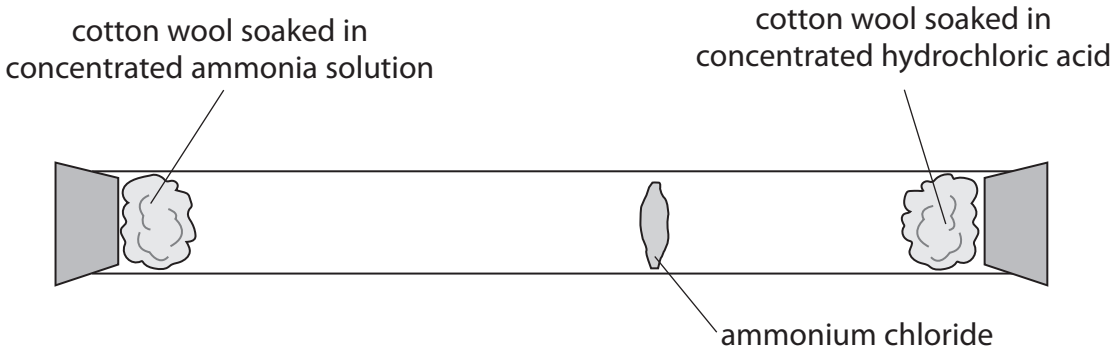
$$R_f = \frac{\text{distance moved by dye}}{\text{distance moved by solvent}}$$

Complete the table for the dye in ink A.

(2)

distance moved by dye in ink A in mm	
distance moved by solvent in mm	49
R_f value of dye in ink A	

(e) The diagram shows an experiment to demonstrate diffusion.



(i) The word equation for the reaction that occurs in this experiment is

ammonia + hydrogen chloride → ammonium chloride

Complete the chemical equation for this reaction.

(1)

$NH_3 + HCl \rightarrow$ .....

(ii) Draw a circle around each of the two state symbols that could be included in the chemical equation in part (e)(i).

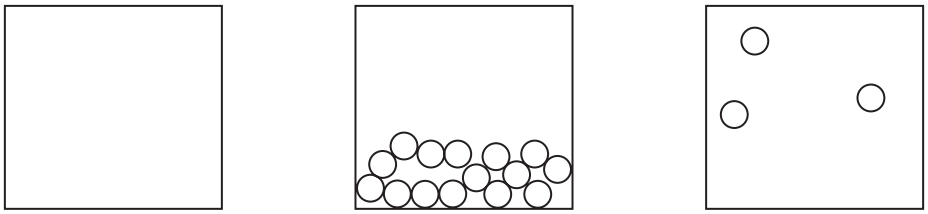
(1)

s l g aq

(Total for Question 1 = 11 marks)

2 The diagram shows the arrangement of the molecules in two of the three states of water.

Each circle represents a molecule of water.



solid liquid gas

(a) Complete the diagram to show how the molecules of water are arranged in the solid state.

(1)

(b) Which row of the table correctly describes the arrangement and movement of molecules of water in the solid state?

(1)

	Arrangement	Movement
☒ **A**	regular	moving freely
☒ **B**	random	moving freely
☒ **C**	regular	vibrating
☒ **D**	random	vibrating

(c) Which word describes water changing from a liquid to a solid?

(1)

☒ **A** boiling

☒ **B** condensing

☒ **C** freezing

☒ **D** melting

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(d) Give the word used to describe the change of state represented by this equation.

$$H_2O(s) \rightarrow H_2O(g)$$

(1)

.....

(e) Water is the name used for $H_2O(l)$.

Give the two names used for $H_2O(g)$.

(2)

1 .....

2 .....

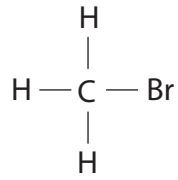
(Total for Question 2 = 6 marks)

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3 The diagram shows formulae for six organic compounds.

U CH_4	**V** 	**W** $CH_2{=}CH_2$
X C_8H_{18}	**Y** $C_2H_4Cl_2$	**Z** C_2H_6O

(a) Which letter represents a compound shown as a displayed formula?

(1)

.....

(b) Which two letters represent compounds that are members of the same homologous series?

(1)

..... and .....

(c) Which letter represents a compound that is formed from methane by a substitution reaction?

(1)

.....

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(d) Compounds U and W are burned in air.

Compound U undergoes complete combustion and compound W undergoes incomplete combustion.

(i) Balance the chemical equations for these reactions.

(2)

CH_4 + ...O_2 → .....CO_2 + ...H_2O

C_2H_4 + ...O_2 → .....CO + ...H_2O

(ii) State why the carbon monoxide formed from compound W is poisonous.

(1)

.....

.....

(e) Burning compound X in a car engine can cause an environmental problem.

These steps show how the environmental problem occurs.

step 1 two gases react to form nitrogen oxides

step 2 nitrogen oxides react with water in the atmosphere to form an acid

step 3 this acid damages some building materials

(i) Name the two gases that react to form nitrogen oxides.

(1)

..... and .....

(ii) Give the formula of the acid formed in step 2.

(1)

.....

(iii) Name a building material that is damaged by this acid.

(1)

.....

(Total for Question 3 = 9 marks)

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4 (a) The term species is sometimes used to refer to neutral atoms and to positive and negative ions.

The table shows the numbers of subatomic particles in eight different species.

Species	Number of protons	Number of neutrons	Number of electrons
A	5	5	5
B	5	6	5
C	6	7	5
D	6	7	7
E	7	7	7
F	7	7	10
G	8	8	10
H	8	10	10

(i) Explain which two letters represent neutral atoms of the same element.

(3)

(ii) Explain which two letters represent negative ions formed from the same element.

(3)

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(iii) Explain which letter represents the atom with the lowest mass number.

(2)

.....

.....

.....

(iv) What is the electronic configuration of species E?

(1)

.....

(b) The table shows the percentage composition of a sample of magnesium.

Isotope	^{24}Mg	^{25}Mg	^{26}Mg
Percentage (%)	78.6	10.1	11.3

Calculate the relative atomic mass of magnesium.

Give your answer to one decimal place.

(3)

relative atomic mass = ...

(Total for Question 4 = 12 marks)

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5 The diagram shows the positions of some elements in four periods of the Periodic Table.

Li																	
Na																	Ar
K																	
Rb										Ag							

(a) (i) What numbers are used to identify the periods shown in this diagram?

(1)

.....

(ii) Explain which element in the diagram is the least reactive.

(2)

.....

.....

.....

.....

(iii) State the similarity in the electronic configurations of Na and Ar.

(1)

.....

.....

(iv) State the similarity in the electronic configurations of Na and Rb.

(1)

.....

.....

(v) State a physical property of Na that shows it is a metal.

(1)

.....

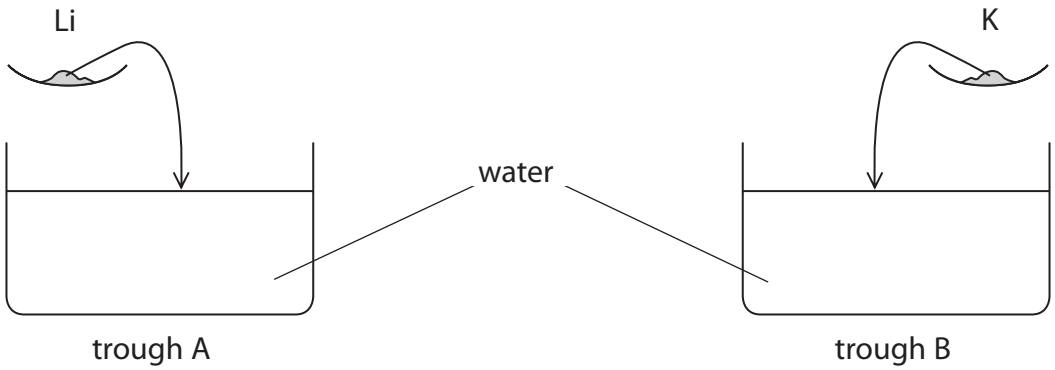
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(b) The diagram shows the addition of two of these elements to troughs containing water.



(i) State two observations that could be made in both troughs when the elements are added to water.

(2)

1 .....

.....

2 .....

.....

(ii) State one observation that could be made only in trough B.

(1)

.....

.....

(iii) Complete the chemical equation for the reaction that occurs in trough A.

(2)

$2Li + 2H_2O \rightarrow$ ..... + ...

(iv) After the reaction in trough A is complete, a few drops of phenolphthalein are added.

The phenolphthalein changes colour.

State the final colour of the phenolphthalein.

(1)

.....

(v) Give the formula of the ion formed during the reaction in trough A that causes phenolphthalein to change colour.

(1)

.....

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(c) Silver (Ag) can be obtained from silver oxide by heating.

In an experiment, 32.4 g of silver is obtained by completely decomposing 34.8 g of silver oxide.

(i) Calculate the mass of oxygen formed in this decomposition.

(1)

mass of oxygen = ... g

(ii) Determine the empirical formula of silver oxide by calculating the amounts, in moles, of silver atoms (Ag) and oxygen atoms (O) obtained in this experiment.

(3)

empirical formula of silver oxide = ...

(Total for Question 5 = 17 marks)

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6 Chlorine gas is bubbled through an aqueous solution of potassium bromide until a change in colour is seen.

(a) Write a chemical equation for this reaction.

(2)

(b) Explain the reaction that occurs.

In your answer, refer to

- the final colour
- the substance that causes the final colour
- the type of reaction
- the relative reactivities of the two Group 7 elements involved

(4)

(Total for Question 6 = 6 marks)

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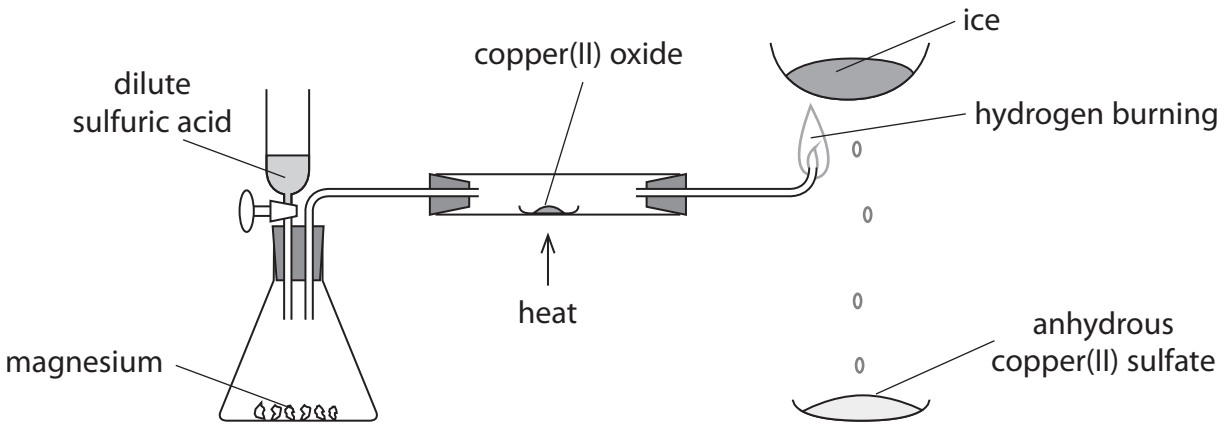
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7 This question is about the formation and reactions of some oxides.

(a) The diagram shows the apparatus that can be used to make hydrogen, which then reduces copper(II) oxide to copper.

The unreacted hydrogen is burned.



(i) Explain one safety precaution that should be taken after adding the dilute sulfuric acid and before lighting the unreacted hydrogen gas.

(2)

.....

.....

.....

.....

(ii) State two observations that could be made when the dilute sulfuric acid reacts with the magnesium.

(2)

1 .....

.....

2 .....

.....

(iii) State one observation that could be made when the hydrogen is passed over the heated copper(II) oxide.

(1)

.....

.....

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(iv) State the final colour of the copper(II) sulfate.

(1)

.....

(v) Complete the word equations for the reactions that occur.

(3)

magnesium + sulfuric acid → ..... + ...

copper(II) oxide + hydrogen → ..... + ...

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

(b) A sample of sulfur is burned in a gas jar of oxygen.

A piece of damp litmus paper is placed in the gas jar. The litmus paper changes colour.

Explain what this colour change shows about the acid-base character of the oxide of sulfur formed.

(2)

.....

.....

.....

.....

(c) The formulae of two oxides are MgO and SO_2

Suggest the formula of the salt formed when these two oxides neutralise each other.

(1)

.....

(Total for Question 7 = 12 marks)

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8 Dilute sulfuric acid can be used to make soluble and insoluble salts.

(a) A student plans an experiment to obtain a pure, dry sample of the soluble salt, sodium sulfate, from dilute sulfuric acid.

(i) The student does a titration to find the volume of sulfuric acid needed for complete reaction with the other reactant.

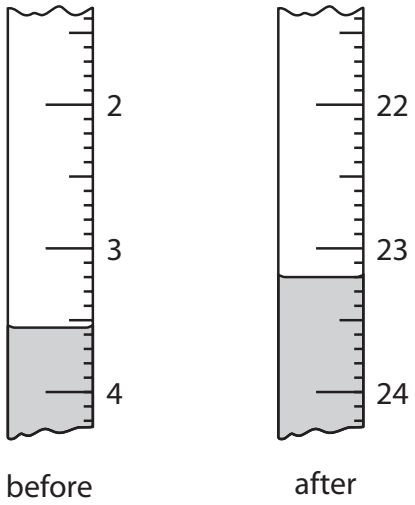
Describe the steps she should take in her titration.
Refer to these pieces of apparatus in your answer.

- pipette
- burette
- conical flask

(5)

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(ii) The diagram shows the burette readings in one titration.



Use these readings to complete the table, giving all values to the nearest 0.05 cm^3.

(3)

burette reading in cm^3 after adding solution	
burette reading in cm^3 before adding solution	
volume of solution added in cm^3	

(b) The student plans a different experiment to obtain a pure, dry sample of the insoluble salt, barium sulfate, from dilute sulfuric acid.

Describe the steps she should take in her experiment.

(5)

(Total for Question 8 = 13 marks)

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9 A student prepares a sample of copper(II) sulfate crystals using this reaction.

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

He obtains the crystals from the solution formed.

(a) He records this information about the reactants he uses.

mass of copper(II) oxide = 6.3 g

volume of sulfuric acid = 52 cm^3

concentration of sulfuric acid = 1.1 mol/dm^3

(i) Calculate the amount, in moles, of copper(II) oxide used.

(2)

amount of copper(II) oxide = ... mol

(ii) Calculate the amount, in moles, of sulfuric acid used.

(2)

amount of sulfuric acid = ... mol

(iii) Why is it important for the amount of copper(II) oxide to be greater than the amount of sulfuric acid?

(1)

.....

.....

(iv) Draw a diagram of the apparatus that the student should use to remove the excess copper(II) oxide from the reaction mixture.

(1)

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(b) In a similar preparation the student uses 0.12 mol of copper(II) oxide to obtain crystals of copper(II) sulfate, $CuSO_4.5H_2O$

Calculate the maximum mass of $CuSO_4.5H_2O$ that he could obtain using this preparation.

(2)

maximum mass = ... g

(Total for Question 9 = 8 marks)

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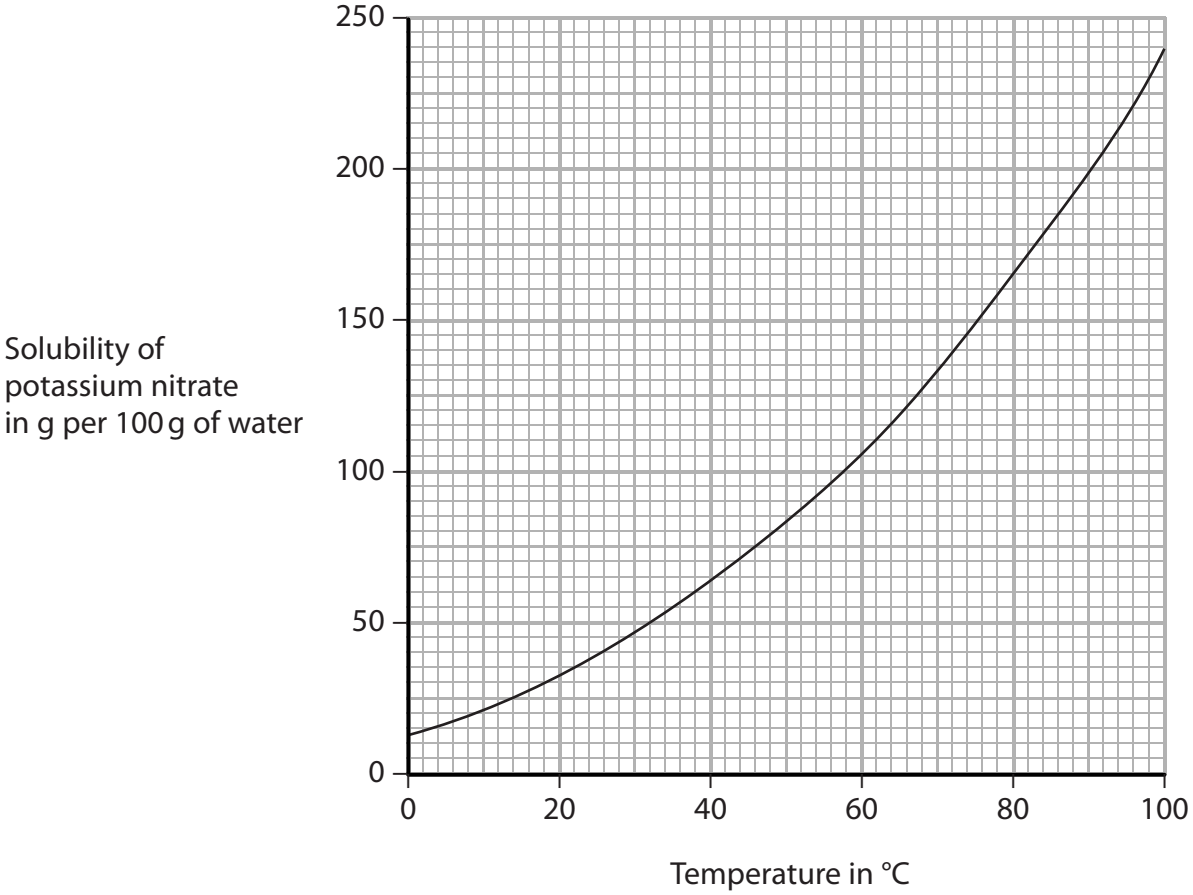
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10 A student does an experiment to investigate how the temperature changes as different masses of solid potassium nitrate are dissolved in water.

She looks at this graph to help her decide the masses of water and potassium nitrate to use in her experiment.



(a) The student decides to use a mass of 50 g of water at a temperature of 25 °C.

From the graph, find the maximum mass of potassium nitrate that dissolves in this experiment.

(1)

.....

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(b) The student prepares six samples of potassium nitrate, each with a mass of 2.0 g.

She pours 50 cm^3 of water into a 100 cm^3 beaker and records the temperature of the water.

She then uses this method to find the change in temperature as she adds each sample of potassium nitrate.

- add the first sample of potassium nitrate to the beaker and stir until the sample dissolves
- record the temperature of the solution
- add the second sample of potassium nitrate to the solution in the beaker and stir until the sample dissolves
- record the new temperature of the solution
- repeat until all six samples of potassium nitrate have been added

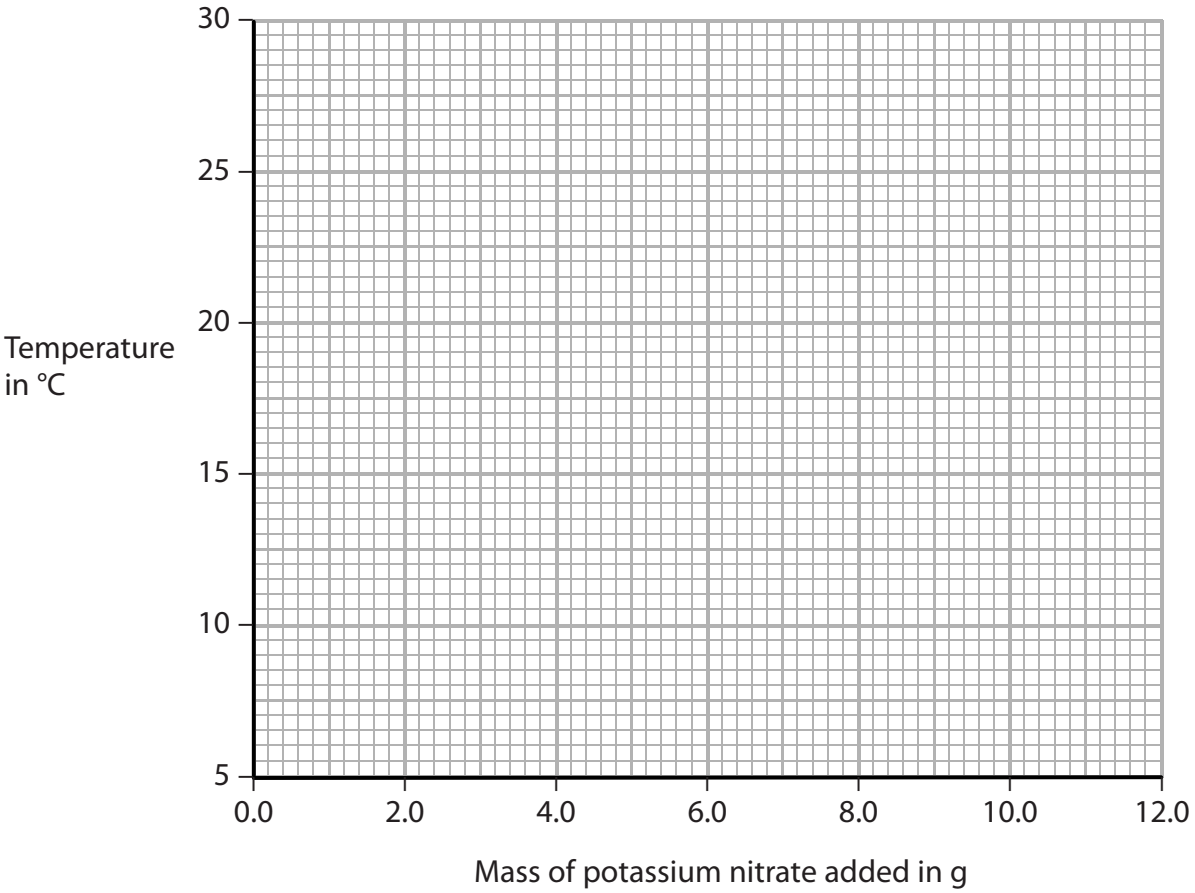
The table shows her results.

Mass of potassium nitrate added in g	0.0	2.0	4.0	6.0	8.0	10.0	12.0
Temperature in °C	25.2	22.2	19.4	16.9	14.1	11.4	8.8

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

Draw a straight line of best fit.

(3)



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(ii) From the graph, find the mass of potassium nitrate that would be needed to produce a temperature change of 10.0 °C.

(1)

.....

.....

(iii) Explain how the student's results show the type of heat change that occurs when potassium nitrate dissolves in water.

(2)

.....

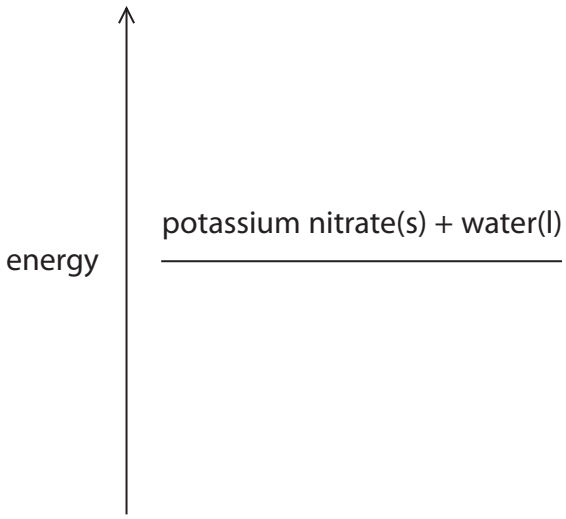
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(iv) Complete the energy level diagram for this experiment.

(1)



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(c) The student repeats the experiment and obtains these results.

mass of water (m) = 50 g

total mass of potassium nitrate added = 15 g

starting temperature = 32 °C

final temperature = 13 °C

Calculate the heat energy change (Q), in joules, using the expression

$$Q = m \times 4.2 \times \Delta T$$

[ΔT is the temperature change]

(2)

heat energy change (Q) = ... J

(Total for Question 10 = 10 marks)

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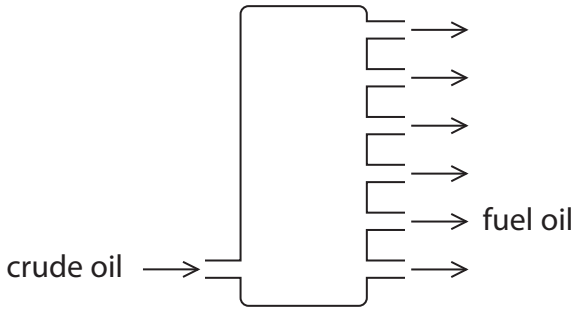
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11 Synthetic polymers are often manufactured from crude oil.

The main stages in the manufacture of one of these polymers are shown in this sequence.

crude oil → fuel oil → propene → poly(propene)

(a) The diagram represents the fractionating column used in an oil refinery.



Describe how fractional distillation produces fuel oil from crude oil.

(4)

(b) Catalytic cracking at about 650 °C converts fuel oil into propene.

(i) Name a catalyst used in this process.

(1)

(ii) One of the compounds in fuel oil has the formula $C_{17}H_{36}$

Complete the equation for the cracking of one molecule of $C_{17}H_{36}$ to form two molecules of propene and one molecule of another compound.

(1)

$C_{17}H_{36} \rightarrow 2C_3H_6 +$ .....

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(iii) Explain why all the compounds in this cracking reaction are classified as hydrocarbons.

(2)

(iv) Explain which two compounds in this cracking reaction are described as saturated.

(2)

(c) Some crude oil contains an impurity known as DMDS.

DMDS contains atoms of carbon, hydrogen and sulfur in a 1:3:1 ratio.

The relative molecular mass of DMDS is 94.

Determine the molecular formula of DMDS.

(2)

molecular formula = ...

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(d) Propene reacts with bromine.

Which of these is the formula of the product of this reaction?

(1)

☒ **A** C_3H_7Br

☒ **B** $C_3H_6Br_2$

☒ **C** $C_3H_5Br_3$

☒ **D** $C_3H_4Br_4$

(e) The conversion of propene into poly(propene) can be represented by this equation.

$$nC_3H_6 \rightarrow (C_3H_6)_n$$

(i) Draw the displayed formula of propene.

(1)

(ii) Draw the repeat unit of poly(propene).

(2)

(Total for Question 11 = 16 marks)

TOTAL FOR PAPER = 120 MARKS

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