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

The Periodic Table of the Elements

Group

1	2											3	4	5	6	7	

Period

1

| | 1
H
Hydrogen
1 | |

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 |

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 |

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 |

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 |

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 |

7

| 223
Fr
Francium
87 | 226
Ra
Radium
88 | 227
Ac
Actinium
89 |

Key

Relative atomic mass
Symbol
Name
Atomic number

(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?
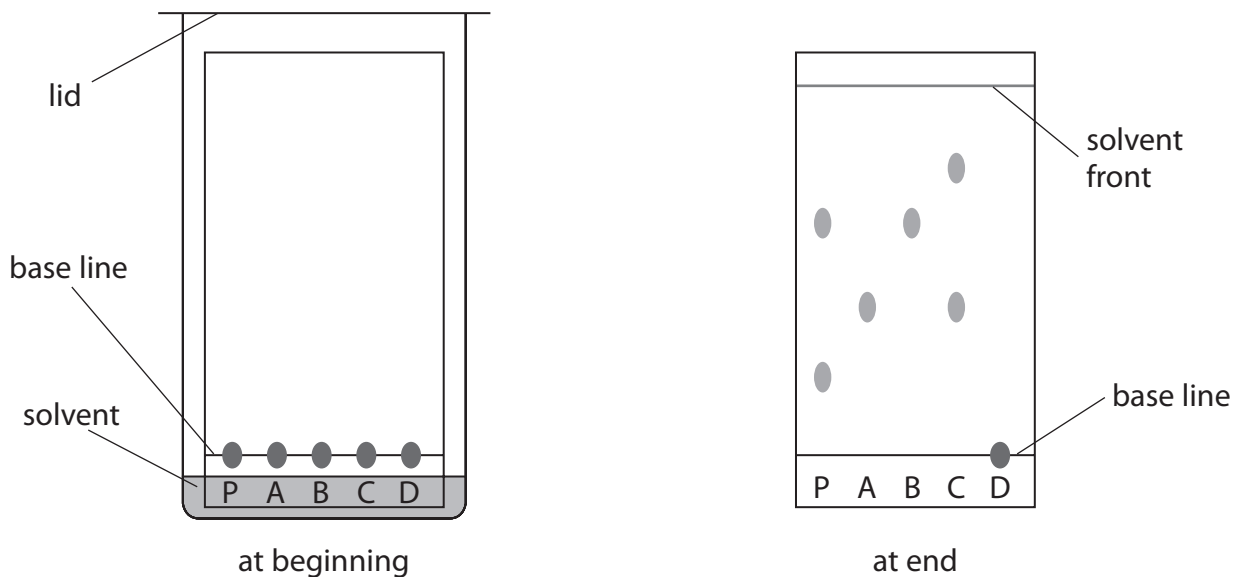
(1)

☒ **A** crystallisation

☒ **B** filtration

☒ **C** simple distillation

☒ **D** titration

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.

at beginning

at end

(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)

....

....

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

Complete the table for the dye in ink A.
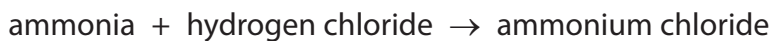
(2)

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.

cotton wool soaked in
concentrated ammonia solution

cotton wool soaked in
concentrated hydrochloric acid

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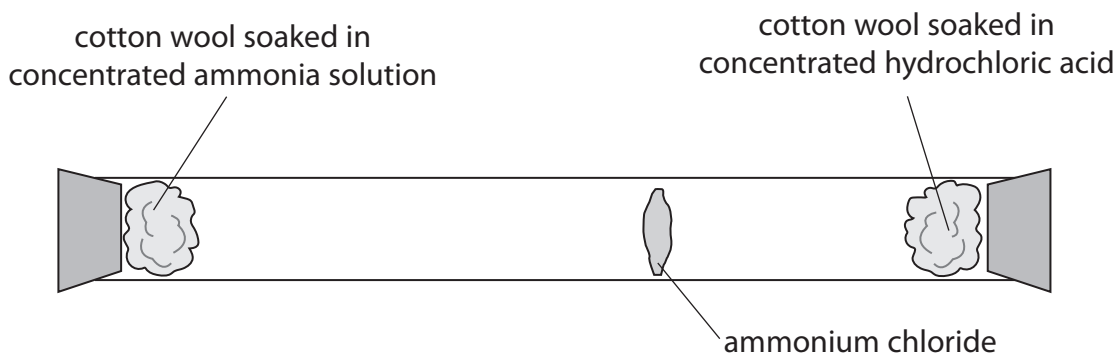
(i) The word equation for the reaction that occurs in this experiment is

ammonia + hydrogen chloride → ammonium chloride

Complete the chemical equation for this reaction.

(1)

NH_3 + HCl → ....
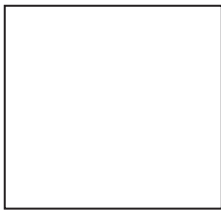
(ii) Draw a circle around each of the two state symbols that could be included in the chemical equation in part (e)(i).

(1)

s   l   g   aq

(Total for Question 1 = 11 marks)
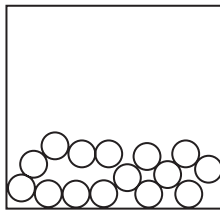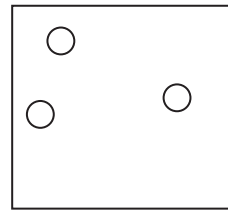
solid   liquid   gas

(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

....

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

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

(2)

....

....

(Total for Question 2 = 6 marks)

U	V	W
CH_4	$\begin{array}{c} H \\ | \\ H - C - Br \\ | \\ H \end{array}$	$CH_2{=}CH_2$
X	**Y**	**Z**
C_8H_{18}	$C_2H_4Cl_2$	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)

....

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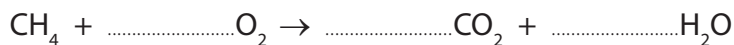
(ii) State why the carbon monoxide formed from compound W is poisonous.

(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)

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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....

....

....

(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)

Li															
Na															A
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)

....

....
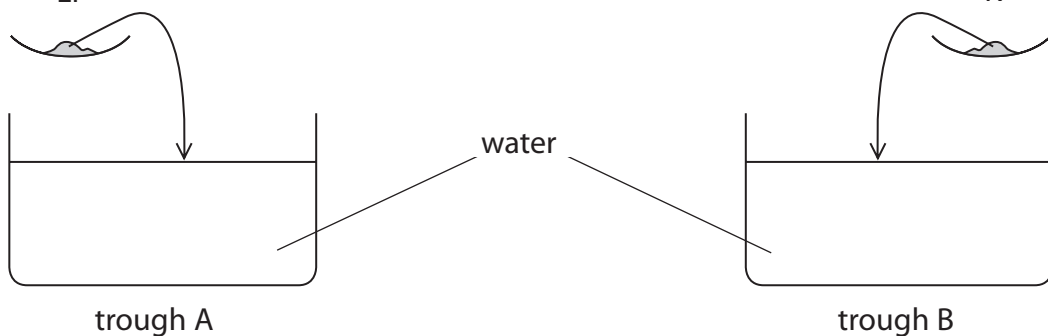
| trough A | trough B |

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

(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)

$$2Li + 2H_2O \rightarrow \text{...............................} + \text{...............................}$$
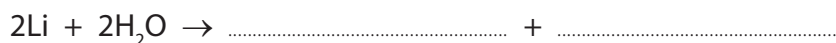
(iv) After the reaction in trough A is complete, a few drops of phenolphthalein are added.

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)

....

of silver oxide.

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

(1)

mass of oxygen = ...

(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)

(a) Write a chemical equation for this reaction.

(2)

....

(b) Explain the reaction that occurs.
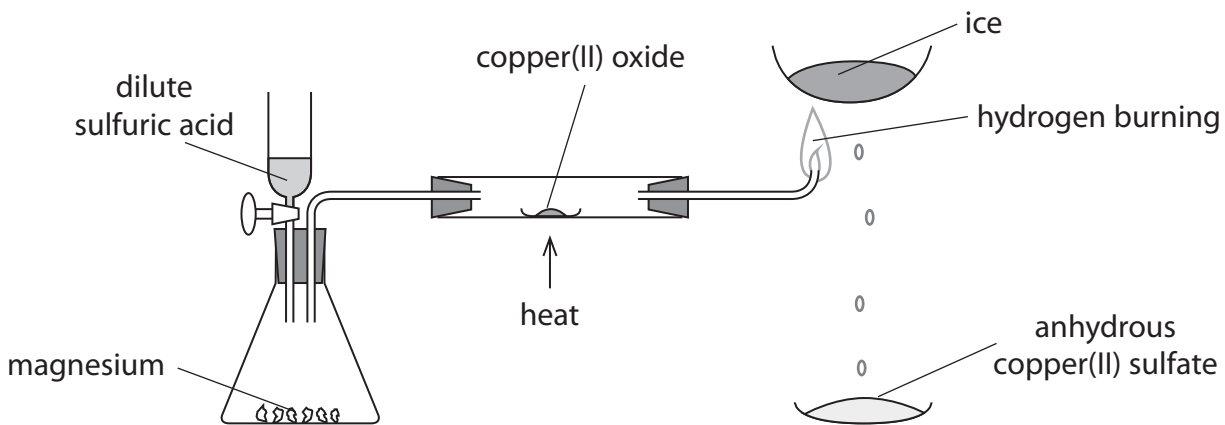
In your answer, refer to

- 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)

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(Total for Question 6 = 6 marks)

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)

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....

....

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

(2)

....

....

....

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

(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.
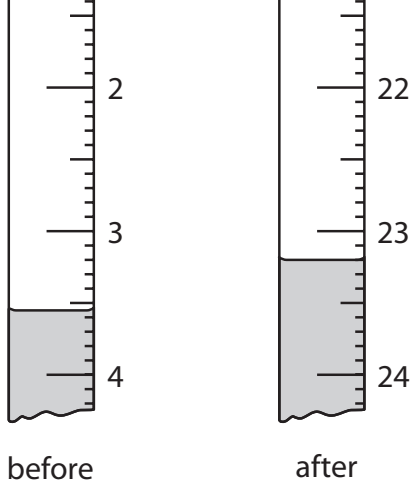
(2)

....

....

....

....

(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)

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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....

....

....

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....

....

....

....

....

2	22
3	23
4	24

before   after

Use these readings to complete the table, giving all values to the nearest 0.05 cm³.

(3)

burette reading in cm³ after adding solution	
burette reading in cm³ before adding solution	
volume of solution added in cm³	

(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)

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(Total for Question 8 = 13 marks)

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 = ... n

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

(2)

amount of sulfuric acid = ... n

(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)

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

(2)

maximum mass = ...

(Total for Question 9 = 8 marks)

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

Solubility of
potassium nitrate
g per 100 g of water
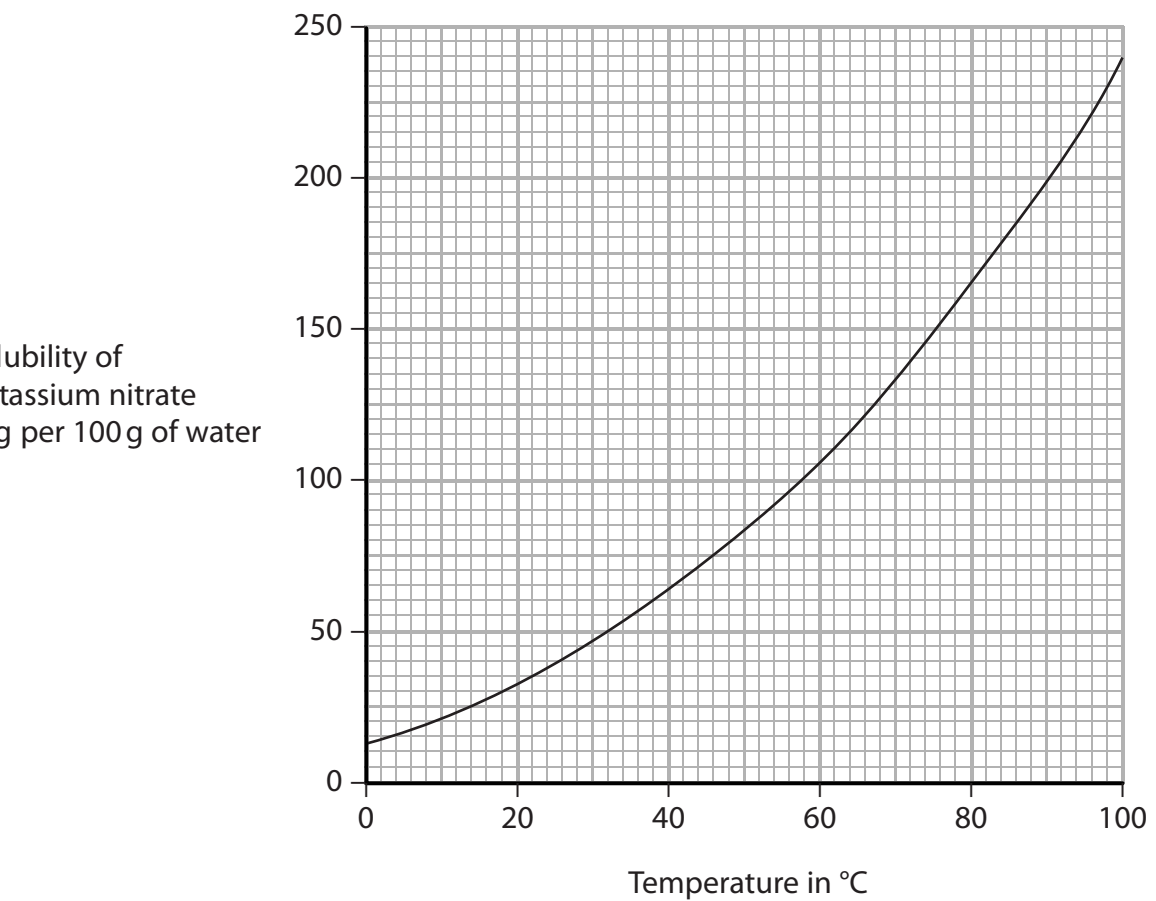
Temperature in °C

(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)

....

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
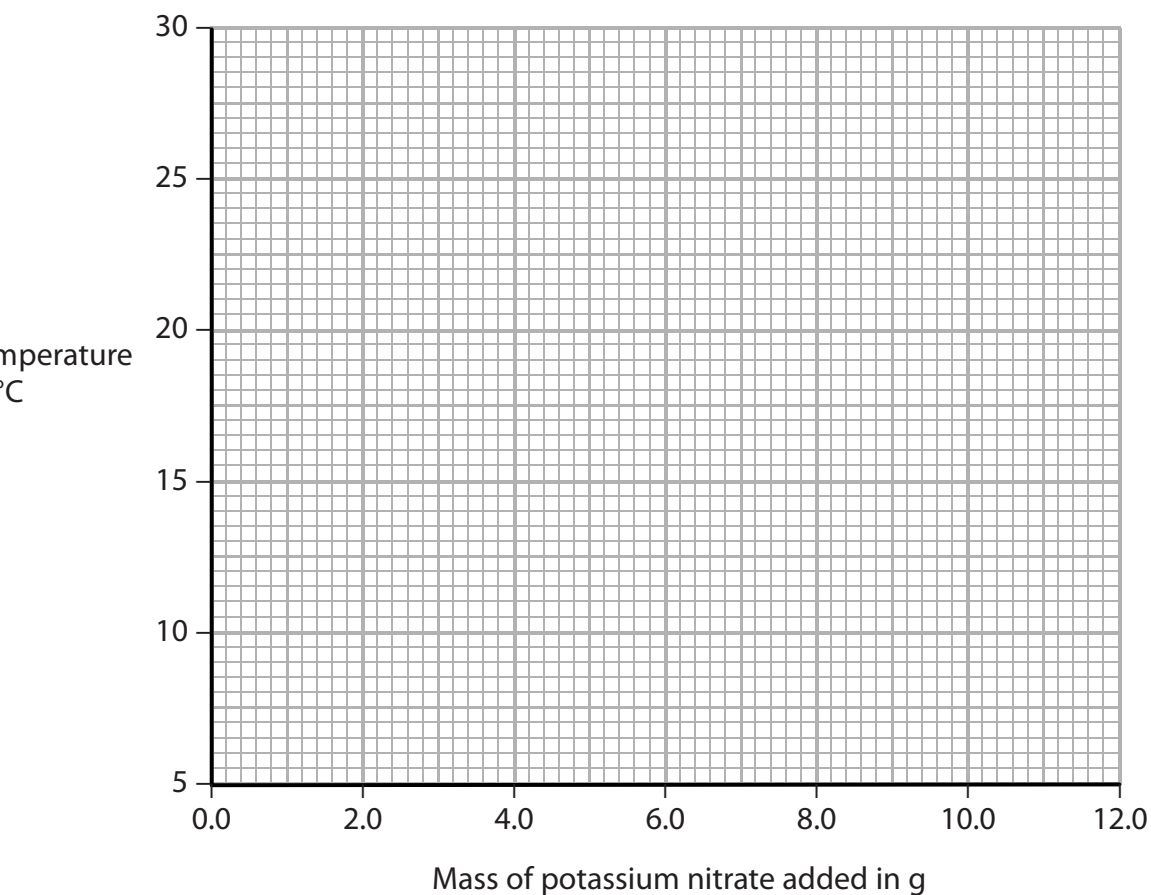- repeat until all six samples of potassium nitrate have been added

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)

Temperature
°C

Mass of potassium nitrate added in g

....

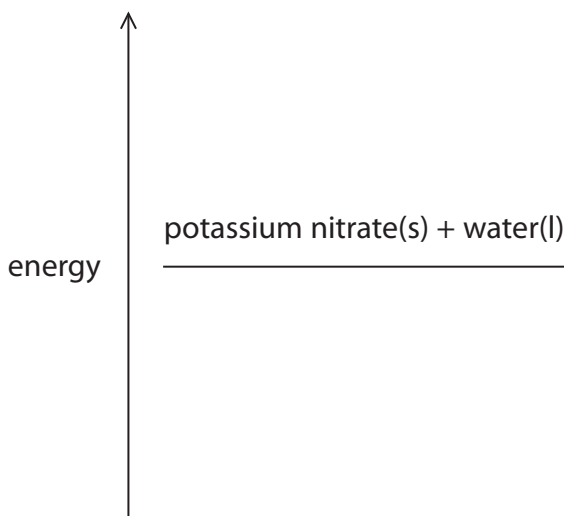..

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

(2)

....

....

....

....

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

(1)

energy   potassium nitrate(s) + water(l)
         ─────────────────────

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

$$Q = m \times 4.2 \times \Delta T$$
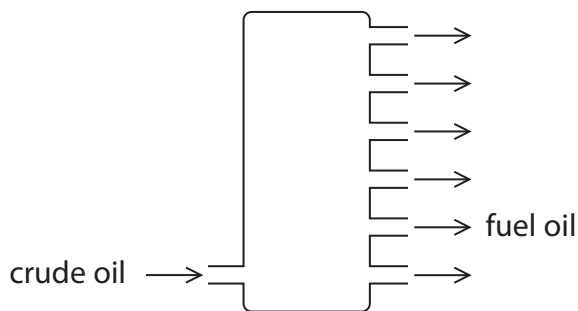
[ΔT is the temperature change]

(2)

heat energy change (Q) = ...

(Total for Question 10 = 10 marks)

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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)

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....

(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)

$$C_{17}H_{36} \rightarrow 2C_3H_6 + \text{.............................}$$
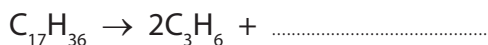
(iv) Explain which two compounds in this cracking reaction are described as saturated.

(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 = ...

☒ **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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