

Write your name here

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Candidate Number

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Chemistry

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

<p>Tuesday 14 January 2014 – Morning</p> <p>Time: 2 hours</p>	<p>Paper Reference</p> <p>KCH0/1C 4CH0/1C KSC0/1C 4SC0/1C</p>
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<p>You must have: Calculator Ruler</p>	<p>Total Marks</p>
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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.
- Keep an eye on the time.
- 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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PEARSON

THE PERIODIC TABLE

0

7

6

5

4

3

2

1

Group

Period

4	He	2
Helium		

1	H	1
Hydrogen		

1	7	Li	3	Lithium	23	Na	11	Sodium	39	K	19	Potassium	55	Mn	25	Manganese	87	Rb	37	Rubidium	133	Cs	55	Caesium	223	Fr	87	Francium
2	9	Be	4	Beryllium	24	Mg	12	Magnesium	40	Ca	20	Calcium	88	Sr	38	Strontium	137	Ba	56	Barium	179	Hf	72	Hafnium	226	Ra	88	Radium
3	11	Na	11	Sodium	23	Na	11	Sodium	39	K	19	Potassium	87	Rb	37	Rubidium	133	Cs	55	Caesium	223	Fr	87	Francium	227	Ac	89	Actinium
4	12	Ca	20	Calcium	40	Ca	20	Calcium	88	Sr	38	Strontium	137	Ba	56	Barium	179	Hf	72	Hafnium	226	Ra	88	Radium	227	Ac	89	Actinium
5	13	Al	13	Aluminium	27	Al	13	Aluminium	70	Ga	31	Gallium	115	In	49	Indium	204	Tl	81	Thallium	204	Pb	82	Lead	208	Po	84	Polonium
6	14	Si	14	Silicon	28	Si	14	Silicon	73	Ge	32	Germanium	119	Sn	50	Tin	207	Pb	82	Lead	208	Po	84	Polonium	210	At	85	Astatine
7	15	P	15	Phosphorus	31	P	15	Phosphorus	75	As	33	Arsenic	122	Sb	51	Antimony	209	Bi	83	Bismuth	209	Po	84	Polonium	210	At	85	Astatine
8	16	S	16	Sulfur	32	S	16	Sulfur	79	Se	34	Selenium	128	Te	52	Tellurium	209	Po	84	Polonium	210	At	85	Astatine	210	At	85	Astatine
9	17	Cl	17	Chlorine	35.5	Cl	17	Chlorine	79	Se	34	Selenium	128	Te	52	Tellurium	209	Po	84	Polonium	210	At	85	Astatine	210	At	85	Astatine
10	18	Ar	18	Argon	39.9	Ar	18	Argon	79	Se	34	Selenium	128	Te	52	Tellurium	209	Po	84	Polonium	210	At	85	Astatine	210	At	85	Astatine
11	19	K	19	Potassium	39	K	19	Potassium	79	Se	34	Selenium	128	Te	52	Tellurium	209	Po	84	Polonium	210	At	85	Astatine	210	At	85	Astatine
12	20	Ca	20	Calcium	40	Ca	20	Calcium	88	Sr	38	Strontium	137	Ba	56	Barium	179	Hf	72	Hafnium	226	Ra	88	Radium	227	Ac	89	Actinium
13	21	Sc	21	Scandium	45	Sc	21	Scandium	89	Y	39	Yttrium	139	La	57	Lanthanum	139	La	57	Lanthanum	139	La	57	Lanthanum	139	La	57	Lanthanum
14	22	Ti	22	Titanium	48	Ti	22	Titanium	91	Zr	40	Zirconium	179	Hf	72	Hafnium	179	Hf	72	Hafnium	179	Hf	72	Hafnium	179	Hf	72	Hafnium
15	23	V	23	Vanadium	51	V	23	Vanadium	93	Nb	41	Niobium	181	Ta	73	Tantalum	181	Ta	73	Tantalum	181	Ta	73	Tantalum	181	Ta	73	Tantalum
16	24	Cr	24	Chromium	52	Cr	24	Chromium	96	Mo	42	Molybdenum	184	W	74	Tungsten	184	W	74	Tungsten	184	W	74	Tungsten	184	W	74	Tungsten
17	25	Mn	25	Manganese	55	Mn	25	Manganese	99	Tc	43	Technetium	186	Re	75	Rhenium	186	Re	75	Rhenium	186	Re	75	Rhenium	186	Re	75	Rhenium
18	26	Fe	26	Iron	56	Fe	26	Iron	101	Ru	44	Ruthenium	190	Os	76	Osmium	190	Os	76	Osmium	190	Os	76	Osmium	190	Os	76	Osmium
19	27	Co	27	Cobalt	59	Co	27	Cobalt	103	Rh	45	Rhodium	192	Ir	77	Iridium	192	Ir	77	Iridium	192	Ir	77	Iridium	192	Ir	77	Iridium
20	28	Ni	28	Nickel	59	Ni	28	Nickel	106	Pd	46	Palladium	195	Pt	78	Platinum	195	Pt	78	Platinum	195	Pt	78	Platinum	195	Pt	78	Platinum
21	29	Cu	29	Copper	63.5	Cu	29	Copper	108	Ag	47	Silver	197	Au	79	Gold	197	Au	79	Gold	197	Au	79	Gold	197	Au	79	Gold
22	30	Zn	30	Zinc	65	Zn	30	Zinc	112	Cd	48	Cadmium	201	Hg	80	Mercury	201	Hg	80	Mercury	201	Hg	80	Mercury	201	Hg	80	Mercury
23	31	Ga	31	Gallium	70	Ga	31	Gallium	115	In	49	Indium	204	Tl	81	Thallium	204	Tl	81	Thallium	204	Tl	81	Thallium	204	Tl	81	Thallium
24	32	Ge	32	Germanium	73	Ge	32	Germanium	119	Sn	50	Tin	207	Pb	82	Lead	207	Pb	82	Lead	207	Pb	82	Lead	207	Pb	82	Lead
25	33	As	33	Arsenic	75	As	33	Arsenic	122	Sb	51	Antimony	209	Bi	83	Bismuth	209	Bi	83	Bismuth	209	Bi	83	Bismuth	209	Bi	83	Bismuth
26	34	Se	34	Selenium	79	Se	34	Selenium	128	Te	52	Tellurium	209	Po	84	Polonium	210	At	85	Astatine	210	At	85	Astatine	210	At	85	Astatine
27	35	Br	35	Bromine	80	Br	35	Bromine	127	I	53	Iodine	210	At	85	Astatine	210	At	85	Astatine	210	At	85	Astatine	210	At	85	Astatine
28	36	Kr	36	Krypton	84	Kr	36	Krypton	131	Xe	54	Xenon	222	Rn	86	Radon	222	Rn	86	Radon	222	Rn	86	Radon	222	Rn	86	Radon

Key

Relative atomic mass
Symbol
Name
Atomic number



Answer ALL questions.

- 1** Rock salt is a mixture of salt and sand. Crystals of pure salt can be obtained from rock salt by using the method below.

Use words from the box to complete the sentences.

You may use each word once, more than once or not at all.

(5)

crystals dissolve evaporate filter solution solvent

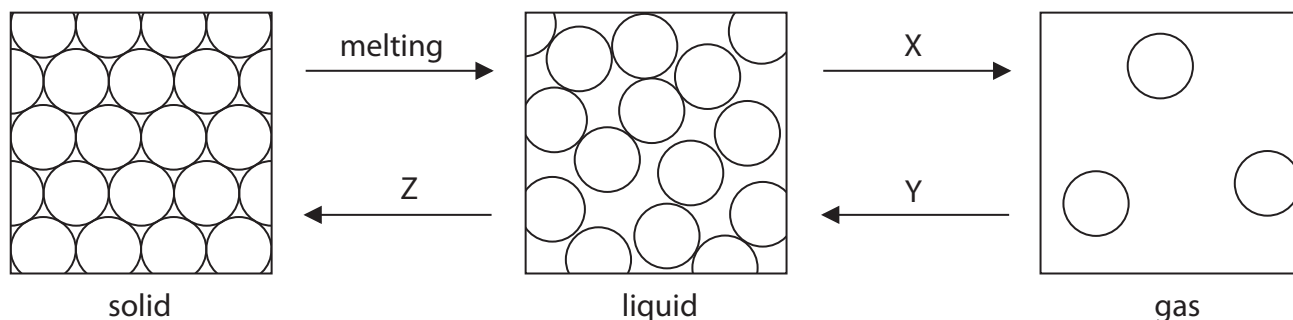
- Grind the rock salt into a fine powder.
- Add the powder to hot water and stir to the salt.
- Filter the mixture. The salt passes through the filter paper leaving behind the sand.
- Boil the filtrate to some of the water.
- Leave the saturated solution to cool so that of salt form.
- Finally, the cold mixture to separate the crystals from the remaining solution.

(Total for Question 1 = 5 marks)



2 The three states of matter are solid, liquid and gas.

The diagram shows how the particles are arranged in each of these states.



(a) Use words from the box to show the changes of state labelled X, Y and Z.

You may use each word once, more than once or not at all.

(3)

boiling condensing crystallisation diffusion freezing

X.....

Y.....

Z.....

(b) Which statement best describes the movement of the particles in a gas?

(1)

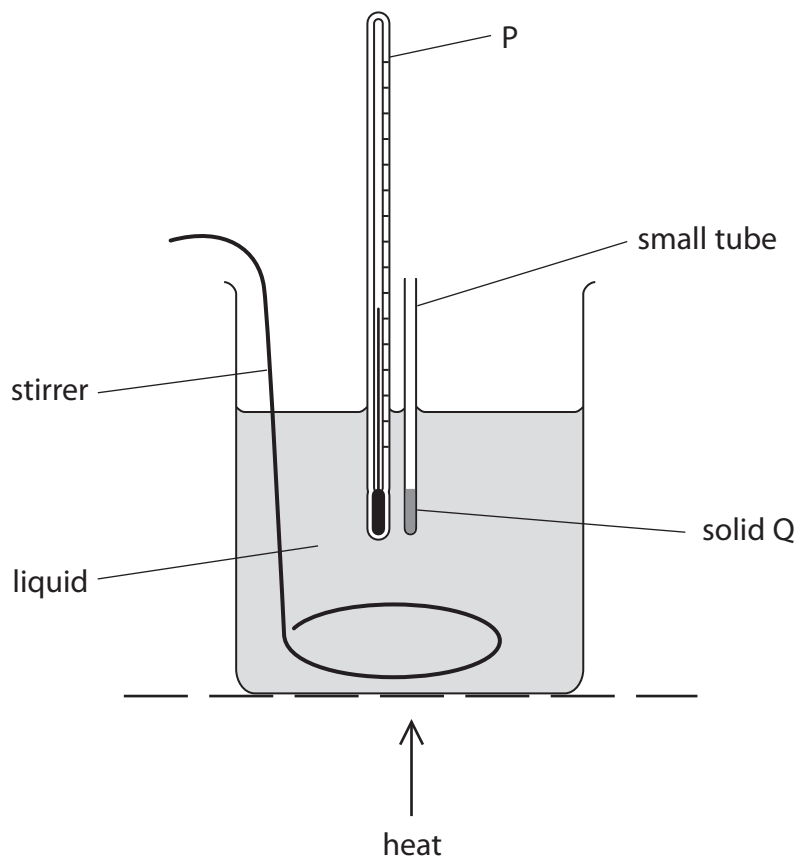
- A** The particles vibrate about fixed positions.
- B** The particles slide past one another.
- C** The particles move freely.
- D** The particles do not move at all.



(c) The diagram shows apparatus that can be used to measure the melting point of a solid.

The solid is placed in a small tube. The small tube is then put into a liquid contained in a beaker.

The liquid is gently heated and the temperature at which solid Q melts is recorded.



(i) Give the name of the apparatus labelled P.

(1)

(ii) Solid Q melts at 140°C .

Explain why water is not a suitable liquid to use in this experiment.

(1)

(iii) Suggest why the liquid in the beaker needs to be stirred constantly.

(1)

(Total for Question 2 = 7 marks)



3 Air is a mixture of gases.

The table gives the formulae of three gases and their approximate percentage by volume in a sample of dry, unpolluted air.

Gas	Percentage by volume
CO ₂	0.04
N ₂	78
O ₂	21

(a) (i) Give the names of the two main gases in the sample of air. (1)

..... and

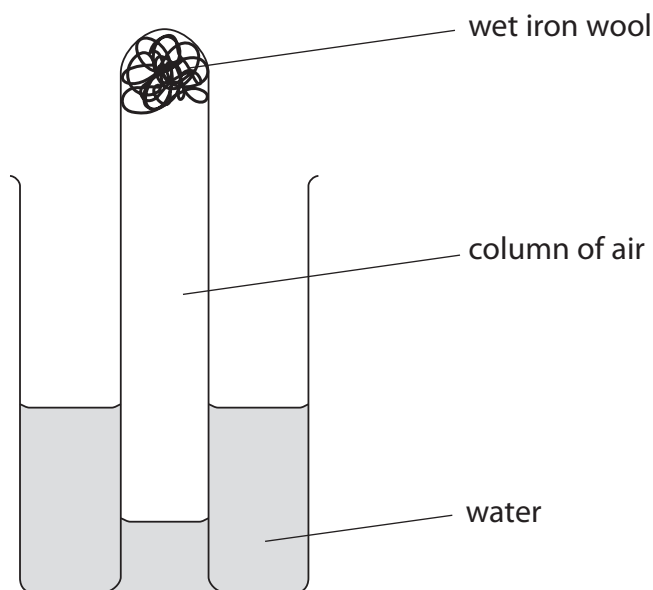
(ii) Give the name of the gas that makes up most of the remaining 0.96% of the air. (1)

(b) State a use for N₂ (1)

(c) Give the name of a gas present in **polluted** air that causes acid rain. (1)



- (d) A student used this apparatus to find the percentage by volume of oxygen in a sample of air.



She used this method.

- place some wet iron wool in the bottom of a test tube
- invert the test tube in a beaker containing water
- measure the height of the column of air in the test tube
- leave the test tube for one week
- measure the new height of the column of air

The table shows her results.

Initial height of column of air in mm	80
Final height of column of air in mm	63

- (i) Some of the iron turned into rust.

Write a word equation for this reaction.

(2)

- (ii) Use the student's results to calculate the percentage of oxygen in this sample of air.

(2)

Percentage of oxygen



(e) The student left the apparatus for another week and measured the height of the column of air again.

From this measurement, how could she tell whether all of the oxygen in the test tube had been used up in the first week?

(1)

(Total for Question 3 = 9 marks)



4 This is a description of how the orange colouring can be extracted from rose petals.

- crush the petals using a pestle and mortar
- add the crushed petals to some ethanol in a beaker
- heat to about 60°C and stir to produce an orange solution
- separate the orange solution from the petals

(a) (i) Suggest why ethanol is used instead of water.

(1)

(ii) Ethanol is a flammable liquid.

Suggest how it could be heated safely.

(1)

(iii) How could the orange solution be separated from the petals?

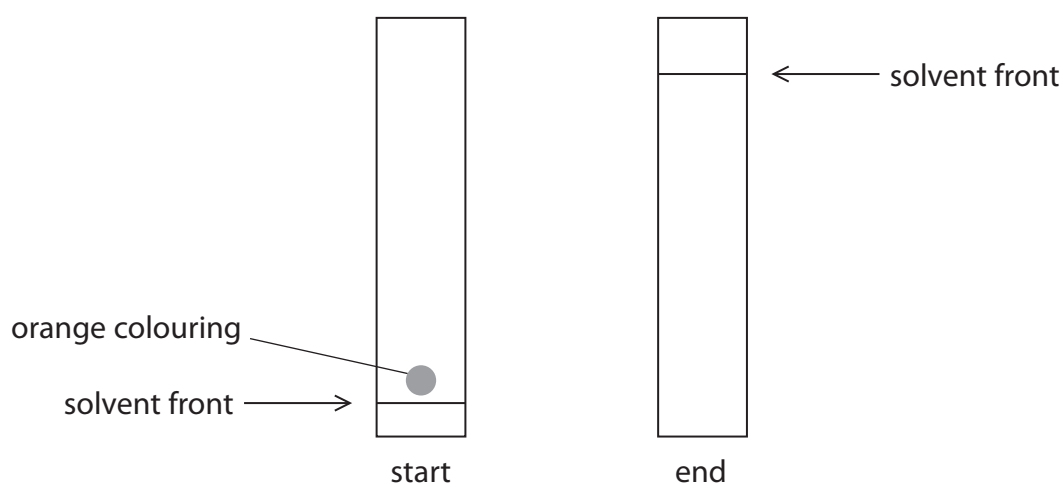
(1)

(b) The orange colouring is analysed using chromatography and is found to consist of two different colours, red and yellow.

The diagram shows the chromatography paper at the start of the experiment.

Complete the diagram to show a possible result at the end of the experiment.

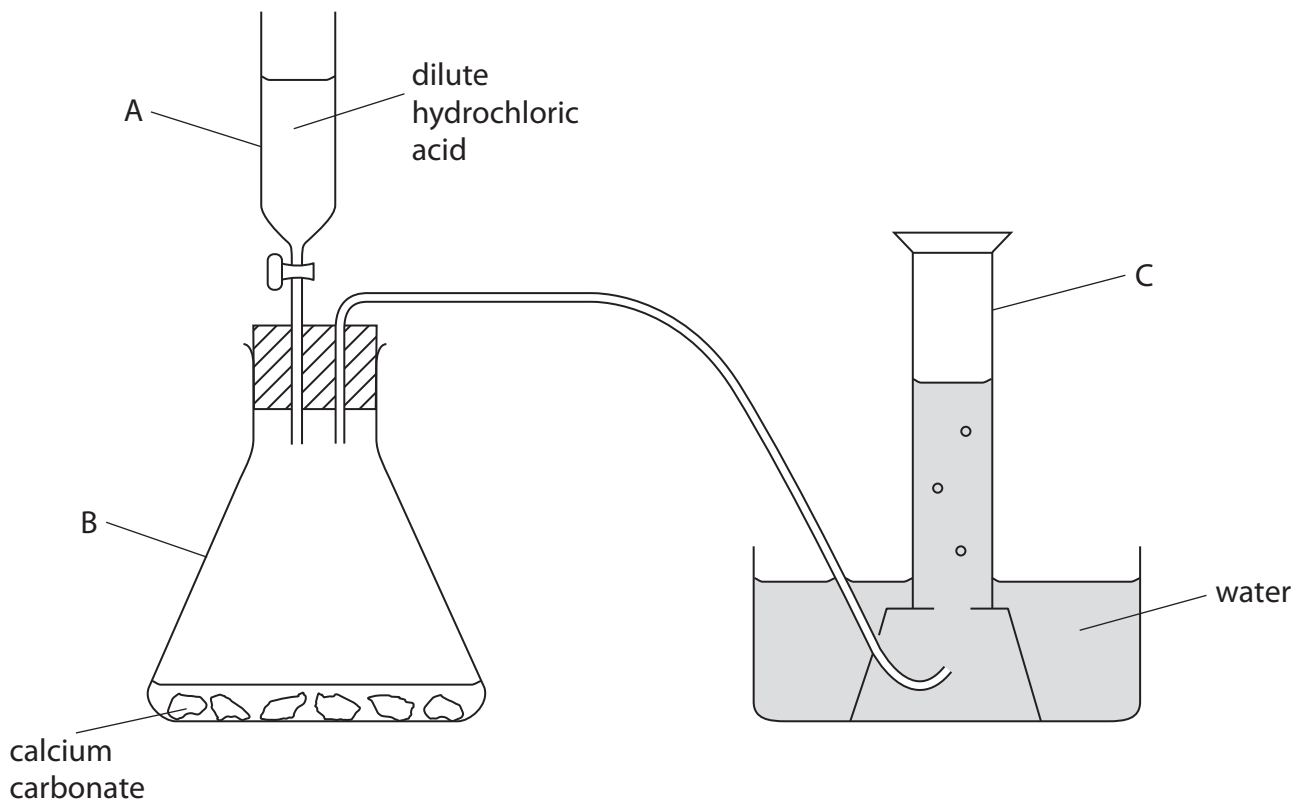
(2)



(Total for Question 4 = 5 marks)



- 5 This apparatus can be used to make and collect carbon dioxide.
This is done by adding dilute hydrochloric acid to calcium carbonate.



- (a) Give the names of the pieces of apparatus labelled A, B and C.

(3)

A.....

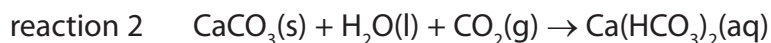
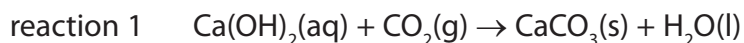
B.....

C.....



- (b) When an excess of carbon dioxide is bubbled through limewater, reaction 1 occurs, followed by reaction 2.

The equations for these reactions are



Suggest two observations that would be made when excess carbon dioxide is bubbled through limewater.

(2)

1.....

2.....

- (c) Carbon dioxide is used in some fire extinguishers because it does not support combustion. State another property of carbon dioxide that makes it suitable for use in fire extinguishers.

(1)

- (d) Carbon dioxide is slightly soluble in water. The solution formed has a pH of 5.6

Which is the best description of a solution of carbon dioxide in water?

(1)

- A strongly acidic
- B strongly alkaline
- C weakly acidic
- D weakly alkaline

(Total for Question 5 = 7 marks)



- 6 The table gives some data about the first six members of a homologous series of compounds called the alkanes.

Alkane	Molecular formula	Relative formula mass	Boiling point in °C
methane	CH ₄	16	-164
ethane	C ₂ H ₆	30	-87
propane	C ₃ H ₈	44	-42
butane	C ₄ H ₁₀		0
pentane	C ₅ H ₁₂	72	
hexane		86	69

(a) Complete the table by

- giving the molecular formula of hexane
- giving the relative formula mass of butane
- suggesting the boiling point of pentane

(3)

(b) What does the data show about the relationship between boiling point and relative formula mass?

(1)

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.....

(c) The molecular formula of ethene is C₂H₄

Ethene and ethane are in different homologous series.

Explain how the formulae of these compounds show that they are in different series.

(1)

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.....



- (d) (i) In the table, draw displayed formulae for the two alkanes with the molecular formula C_4H_{10} (2)

Displayed formula 1	Displayed formula 2

- (ii) What is the name given to compounds that have the same molecular formula but different displayed formulae? (1)

- (e) The reaction between ethane and bromine (Br_2) is similar to the reaction between methane and bromine.

- (i) Write a chemical equation for the reaction between ethane and bromine. (2)

- (ii) What is the name given to the type of reaction that occurs when ethane reacts with bromine? (1)

- (iii) Suggest the condition necessary for this reaction to occur. (1)

(Total for Question 6 = 12 marks)



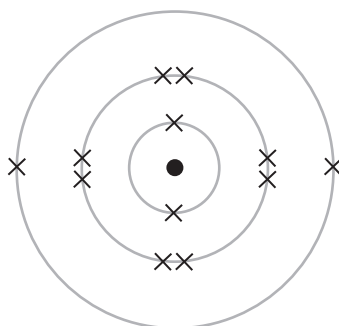
7 Distress flares are used to attract attention in an emergency. The flares contain magnesium, which burns with a bright, white flame to form magnesium oxide.

(a) The reaction between magnesium and oxygen is exothermic.

What is meant by the term **exothermic**?

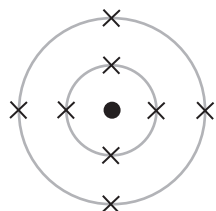
(1)

(b) The diagram shows the electronic configuration of a magnesium atom.

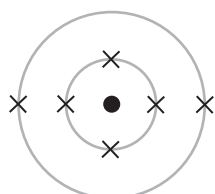


Put a cross in a box to indicate the diagram that shows the electronic configuration of an oxygen atom.

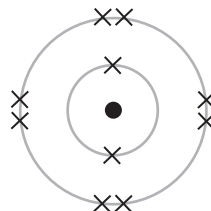
(1)



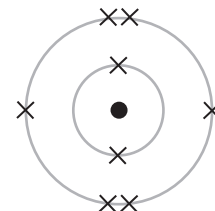
A



B



C

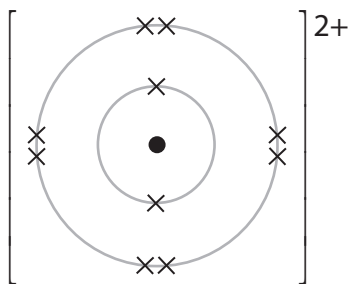


D



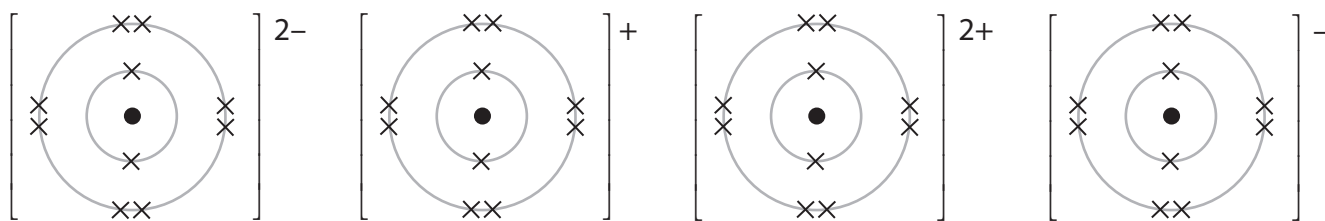
(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic configuration and charge of a magnesium ion.



Put a cross in a box to indicate the diagram that shows the electronic configuration and charge of an oxide ion.

(1)



A

B

C

D

(d) A major use of magnesium oxide is as a refractory material, which is a material that can withstand very high temperatures.

Explain, in terms of its structure and bonding, why magnesium oxide has a very high melting point.

(4)

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(e) Magnesium oxide is also used as an antacid. It helps relieve indigestion by neutralising hydrochloric acid in the stomach.

Give the name and formula of the salt produced when magnesium oxide reacts with hydrochloric acid.

(2)

Name

Formula

(Total for Question 7 = 9 marks)



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8 The table gives information about the first three elements in Group 1 of the Periodic Table.

Element	Atomic number	Relative atomic mass	Electronic configuration	Density in g / cm ³	Melting point in °C
lithium	3	7	2.1	0.53	180
sodium	11	23	2.8.1	0.97	98
potassium	19	39	2.8.8.1	0.86	64

(a) Which information shows that the elements have similar chemical properties?

Give a reason for your choice.

(2)

Information

Reason

(b) The elements in Group 1 show a clear trend (regular pattern) in some of their **physical** properties.

Identify the physical property that shows a clear trend.

(1)

(c) The elements also show a clear trend in their **chemical** properties, such as their reaction with water.

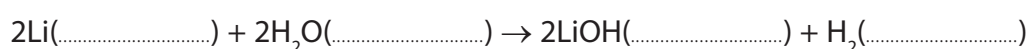
When a small piece of lithium is added to water it fizzes gently and eventually disappears to form a solution.

(i) Describe a test to show that the gas given off is hydrogen.

(1)

(ii) Complete the equation for the reaction by inserting the state symbols.

(1)



(iii) State and explain the effect that the solution formed has on red litmus paper.

(2)

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.....

(d) State two similarities and two differences between the reactions of lithium and potassium with water.

(4)

Similarities

.....

.....

Differences

.....

.....

(e) When lithium burns in oxygen it forms lithium oxide (Li_2O).

(i) Write a chemical equation for the reaction between lithium and oxygen.

(2)

.....

(ii) When sodium burns in oxygen, one of the products is sodium peroxide (Na_2O_2).

Balance the equation to show the formation of sodium peroxide.

(1)



(Total for Question 8 = 14 marks)

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- 9 A student investigates how temperature affects the rate of reaction between two colourless solutions containing ions.

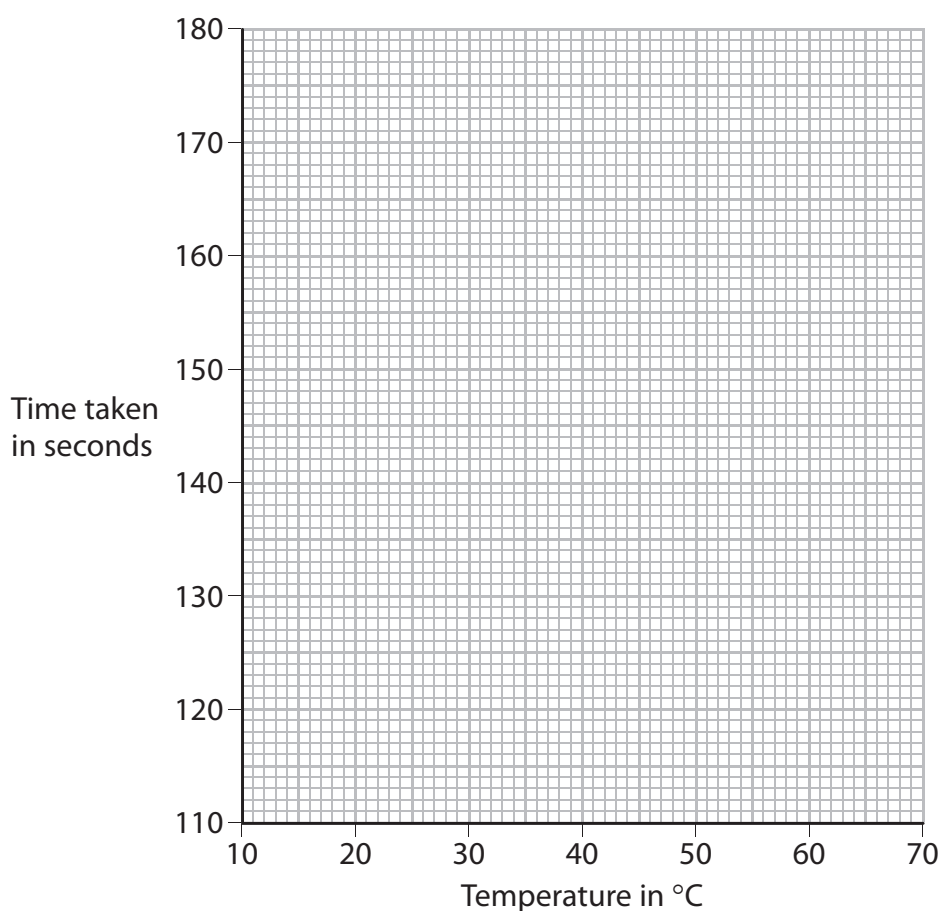
When he mixes the solutions, a reaction takes place between the ions and after a while the mixture suddenly turns blue. He performs the experiment at five different temperatures and on each occasion he measures the time taken for the mixture to turn blue.

The table shows his results.

Temperature in °C	15	19	26	38	60
Time taken in seconds	175	150	134	123	119

- (a) (i) Plot the results on the grid and draw a curve of best fit.

(3)



- (ii) Use your graph to estimate the time taken for the mixture to turn blue at 50°C.

(1)

- (iii) What does the graph show about the relationship between temperature and time taken?

(1)



(b) Explain, in terms of particles, why an increase in temperature increases the rate of this reaction.

(3)

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(c) State a variable that must be kept constant for the experiment to be valid (a fair test).

(1)

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(Total for Question 9 = 9 marks)



10 A student investigates the reaction between dilute hydrochloric acid and marble chips.

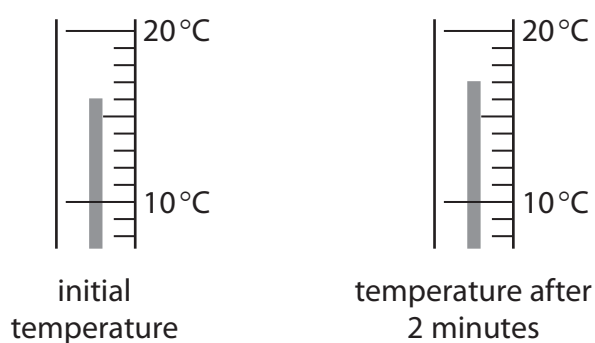
She uses this method.

- put 50 cm³ of dilute hydrochloric acid into a polystyrene cup
- measure the initial temperature of the acid
- add 5.0 g of marble chips to the acid and stir the mixture
- measure the temperature of the mixture after 2 minutes

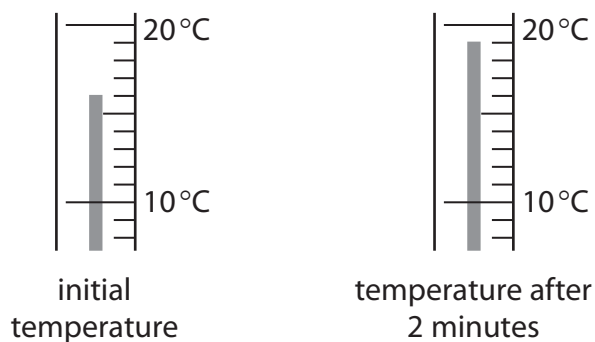
She carries out the experiment three times, using different sizes of marble chips each time.

The diagram shows the temperatures for each experiment.

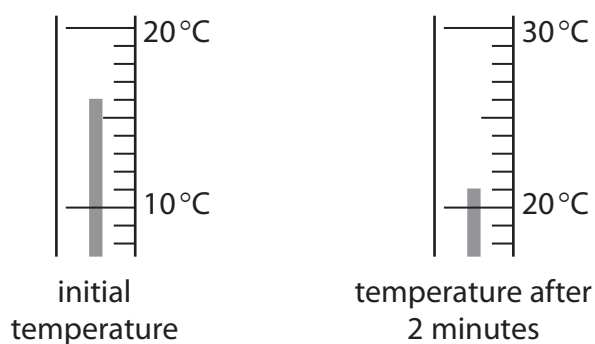
Experiment 1 –
large marble chips



Experiment 2 –
medium marble chips



Experiment 3 –
small marble chips



- (a) Record the temperature readings in the table and calculate the temperature changes. (3)

	Initial temperature in °C	Temperature in °C after 2 minutes	Temperature change in °C
experiment 1			
experiment 2			
experiment 3			

- (b) Explain why the temperature change in experiment 2 is greater than the temperature change in experiment 1. (2)

.....

.....

.....

.....

.....

- (c) Experiment 3 is repeated using 100 cm³ of dilute hydrochloric acid in place of 50 cm³. The acid is in excess in both reactions.

State and explain how the temperature change would be different for 100 cm³ of dilute hydrochloric acid. (2)

.....

.....

.....

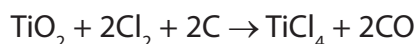
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(Total for Question 10 = 7 marks)

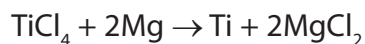


11 Titanium is extracted from its main ore, rutile, in a three-stage process.

Stage 1 Rutile is heated with chlorine and coke (carbon) at a temperature of about 900°C.



Stage 2 TiCl_4 is then added to liquid magnesium at a temperature of about 800°C in an atmosphere of argon.



During the reaction the temperature rises to about 1100°C.

Stage 3 The magnesium chloride is removed by distillation from the mixture formed in stage 2, leaving behind pure titanium.

(a) In stage 1, is the carbon oxidised or reduced?

Give a reason for your answer.

(1)

(b) What does the reaction in stage 2 indicate about the reactivity of magnesium compared to the reactivity of titanium?

Explain your answer.

(2)

(c) In stage 3, suggest why distillation can be used to remove magnesium chloride from titanium.

(1)



(d) Titanium has these properties.

- it is corrosion resistant
- it has a high melting point
- it has a very high strength-to-weight ratio
- it is non-toxic

Complete the table to suggest an important property of titanium for each use.

Choose from the four properties listed.

You must choose a different property for each use.

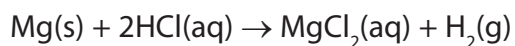
(3)

Use	Property
aircraft engines	
replacement hip joints	
propellers for boats	

(Total for Question 11 = 7 marks)



12 Magnesium reacts with dilute hydrochloric acid. The equation for the reaction is



(a) 0.0960 g of magnesium was added to 25.0 cm³ of 0.400 mol/dm³ hydrochloric acid.

(i) Calculate the amount, in moles, of magnesium used.

(2)

amount of magnesium = mol

(ii) Calculate the amount, in moles, of HCl in the 25.0 cm³ of hydrochloric acid.

(2)

amount of HCl = mol

(b) Use your answers from (a) to determine which of the reactants is in excess.

Show your reasoning.

(2)

The reactant in excess is

(Total for Question 12 = 6 marks)

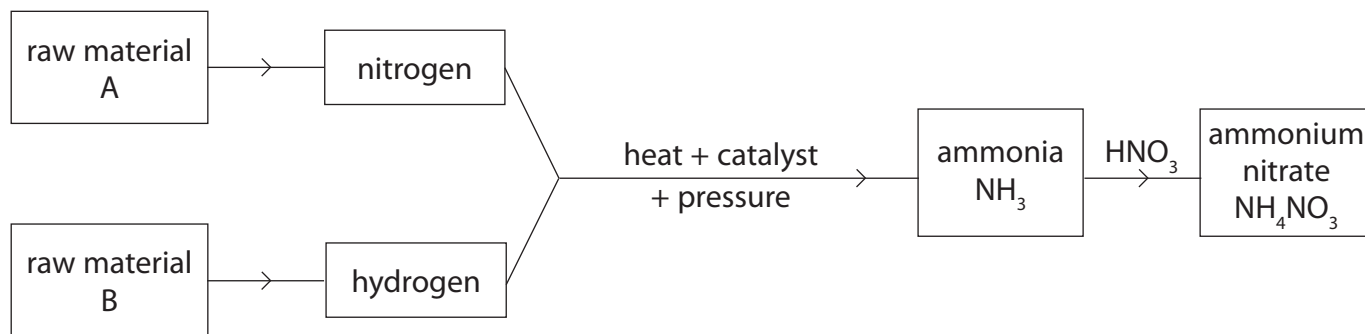


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P 4 2 8 6 3 A 0 2 7 3 2

13 The diagram shows the manufacture of ammonia by the Haber process and its conversion into the fertiliser ammonium nitrate.



(a) Give the names of the raw materials A and B.

(2)

A.....

B.....

(b) State the temperature, pressure and catalyst used to convert the mixture of nitrogen and hydrogen into ammonia.

(3)

temperature.....

pressure.....

catalyst.....

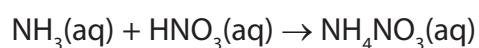
(c) Give the name of the substance that has the formula HNO₃

(1)

.....



(d) The equation for the formation of ammonium nitrate from ammonia is



25.0 cm³ of a solution of ammonia of concentration 0.300 mol/dm³ were reacted with a solution of HNO₃

15.0 cm³ of HNO₃ were required to exactly neutralise the ammonia solution.

Calculate the concentration, in mol/dm³, of the HNO₃ solution.

(3)

concentration of HNO₃ = mol/dm³

(Total for Question 13 = 9 marks)



14 Carbon monoxide and hydrogen are used in the manufacture of methanol (CH₃OH).

The reaction is reversible and can reach a position of dynamic equilibrium.



The reaction is carried out at a pressure of about 100 atmospheres and a temperature of 250°C.

(a) State two features of a reaction that is in dynamic equilibrium.

(2)

1

.....

2

.....

(b) (i) How would a decrease in temperature at constant pressure affect the amount of methanol in the equilibrium mixture?

Explain your answer.

(2)

.....

.....

.....

.....

(ii) How would an increase in pressure at constant temperature affect the amount of methanol in the equilibrium mixture?

Explain your answer.

(2)

.....

.....

.....

.....



(c) Methanol (CH_3OH) can be converted into methanal (H_2CO).

A mixture of methanol and oxygen is passed over an iron oxide catalyst at 250°C .

Methanal and water are the only two products.

(i) Write a chemical equation for the conversion of methanol into methanal. (2)

(ii) What is meant by the term **catalyst**? (2)

(iii) Explain how a catalyst works. (2)

(d) Methanol can be used in racing cars as an alternative fuel to petrol.

Write the chemical equation for the complete combustion of methanol. (2)

(Total for Question 14 = 14 marks)

(TOTAL FOR PAPER = 120 MARKS)



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