NAME:

Shrewsbury School

SHREWSBURY SCHOOL

SIXTH FORM ENTRANCE EXAMINATION 2014

CHEMISTRY

(1 hour)

Instructions to candidates:

- Answer **ALL TWENTY** questions from **SECTION A** on the grid provided.
- Answer **THREE questions <u>ONLY</u>** from **SECTION B** in the spaces provided.
- **Section A** is worth **20 marks** and **Section B 30 marks.** (50 marks in total).
- You may use a calculator.
- You are provided with a **copy of the Periodic table** at the **end of Section B**

Name: .....

Sixth Form Assessment – Chemistry Answer Sheet

Answer all questions – circle the correct letter for each question below.

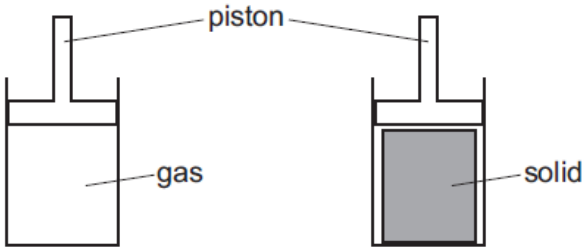
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

SECTION A

Answer **ALL** questions from **SECTION A** on the grid provided on **page 22.**

Question 1

An attempt was made to compress a gas and a solid using the apparatus shown.



Which substance would be compressed and what is the reason for this?

	substance	reason
A	gas	the gas particles are close together
B	gas	the gas particles are far apart
C	solid	the solid particles are close together
D	solid	the solid particles are far apart

Question 2

Which statements about a sodium atom, $^{23}_{11}Na$, are correct?

1 The number of protons and neutrons is the same.

2 The number of protons and electrons is the same.

3 The number of outer electrons is one.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Question 3

Rubidium is in Group I of the Periodic Table and bromine is in Group VII.

Rubidium reacts with bromine to form an ionic compound.

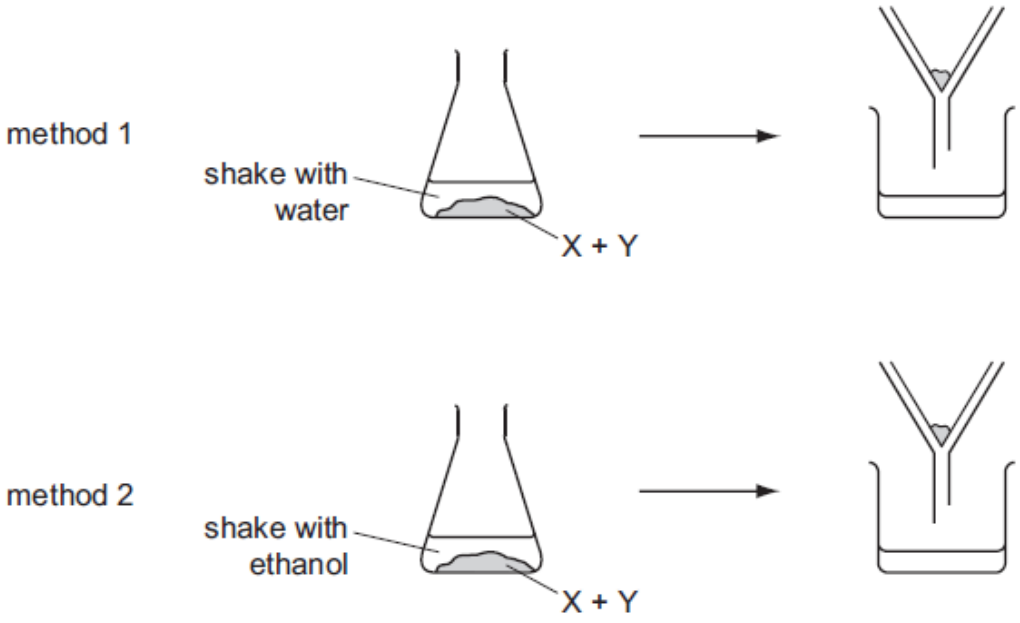
Which row shows the electron change taking place for rubidium and the correct formula of the rubidium ion?

	electron change	formula of ion formed
A	electron gained	Rb^+
B	electron gained	Rb^-
C	electron lost	Rb^+
D	electron lost	Rb^-

Question 4

A solid mixture contains an ionic salt, X, and a covalent organic compound, Y.

Two students suggest methods of separating the mixture as shown.



Which methods of separation are likely to work?

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

Question 5

The diagrams show the labels of four bottles.

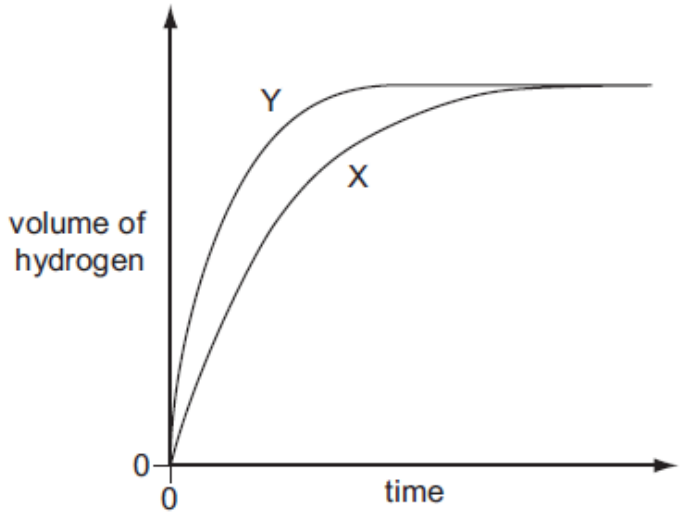
Which label is **not** correct?

A	B	C	D
Bromine Br_2 Harmful liquid. Do not spill.	Iodine I_2 Danger Avoid breathing vapour from the solid.	Potassium K Danger Store under water.	Sodium Na Danger Store under oil.

Question 6

A student investigates the rate of reaction between zinc and an excess of sulfuric acid.

The graph shows the results of two experiments, X and Y.



Which change explains the difference between X and Y?

A A catalyst is added in Y.

B A lower temperature is used in Y.

C Larger pieces of zinc are used in Y.

D Less concentrated acid is used in Y.

The diagrams show the labels of four bottles.

Which label is **not** correct?

A	**B**	**C**	**D**
Bromine Br_2 Harmful liquid. Do not spill.	Iodine I_2 Danger Avoid breathing vapour from the solid.	Potassium K Danger Store under water.	Sodium Na Danger Store under oil.

Question 7

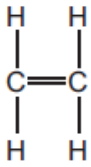
The nucleon number and proton number of the lithium atom are shown by the symbol $^{7}_{3}Li$.

What is the correct symbol for the lithium ion in lithium chloride?

A $^{6}_{2}Li^{-}$ **B** $^{6}_{3}Li^{+}$ **C** $^{7}_{3}Li^{+}$ **D** $^{7}_{3}Li^{-}$

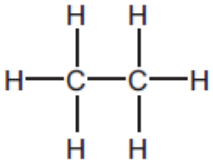
Question 8

The diagram represents ethene.

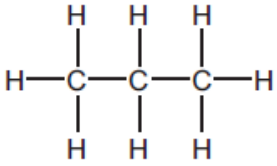


Which compound has chemical properties similar to those of ethene?

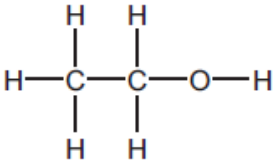
A



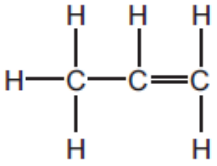
B



C



D



Question 9

A gas jar of bromine vapour and a gas jar of air are set up as shown in diagram 1.

The glass slide is removed. Diagram 2 shows the appearance of the gas jars after one hour.

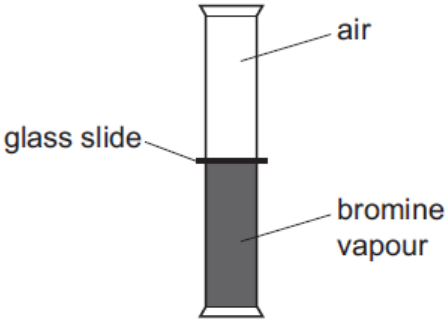


diagram 1

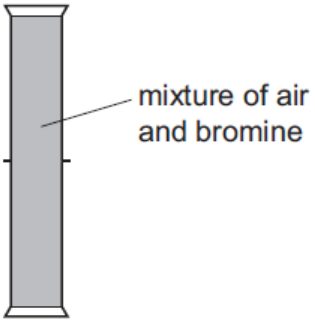


diagram 2

Which statement explains why the bromine and air mix together?

A Bromine is denser than air.

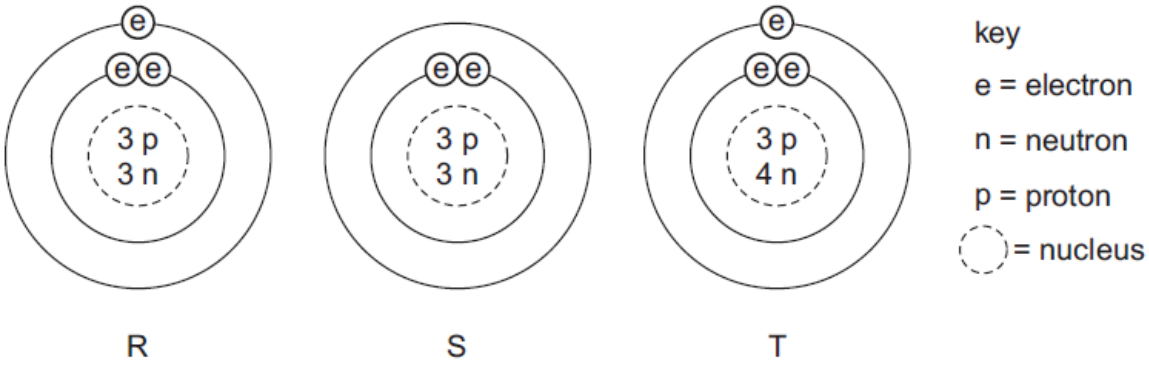
B Bromine is lighter than air.

C Bromine molecules moved upwards and molecules in air moved downwards.

D Molecules in bromine and air moved randomly.

Question 10

The diagram shows the structure of three particles, R, S and T.



Which row describes these particles?

	ions	isotopes
A	R	S and T
B	R and S	T
C	S	R and T
D	T	R and S

Question 11

The chemical formulae of two substances, W and X, are given.

W $NaAlSi_3O_8$

X $CaAl_2Si_2O_8$

Which statements are correct?

1 W and X contain the same amount of oxygen.

2 W contains three times as much silicon as X.

3 X contains twice as much aluminium as W.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1, 2 and 3

Question 12

The list gives the order of some metals (and hydrogen) in the reactivity series.

Metal X is also included:

Most reactive K
Mg
Zn
(H)
X
Least reactive Cu

Which row correctly shows the properties of metal X?

	reacts with dilute acids	oxide reduced by carbon
A	no	no
B	no	yes
C	yes	no
D	yes	yes

Question 13

Which are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

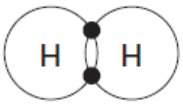
2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

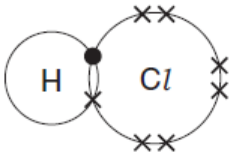
Question 14

Which diagram does **not** show the outer shell electrons in the molecule correctly?

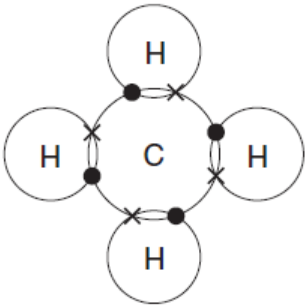
A



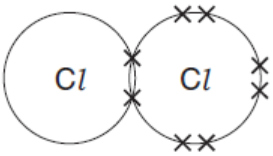
B



C

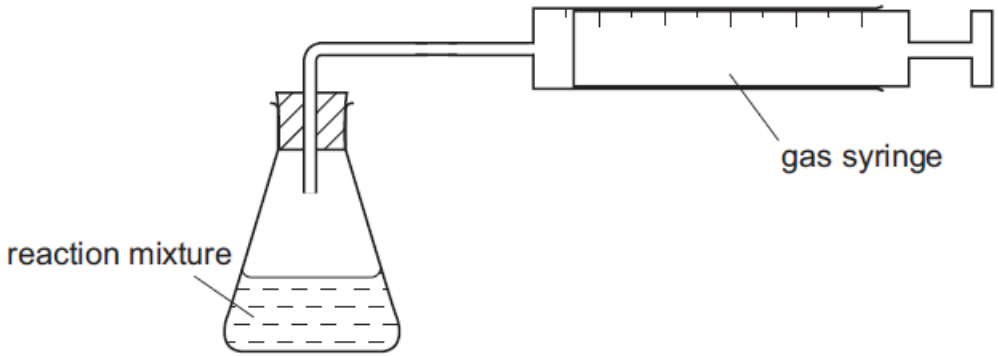


D



Question 15

The apparatus shown can be used to measure the rate of some chemical reactions.



For which two reactions would this apparatus be suitable?

reaction 1 $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

reaction 2 $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

reaction 3 $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$

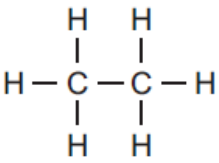
reaction 4 $ZnCO_3(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + CO_2(g) + H_2O(l)$

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

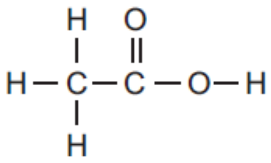
Question 16

Which structure is **incorrect**?

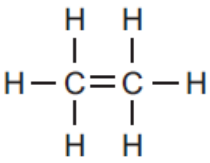
A



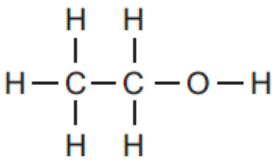
B



C



D



Question 17

To grow rose plants, a fertiliser containing nitrogen, phosphorus and potassium is often used.

For the best rose flowers, the fertiliser should contain a high proportion of potassium.

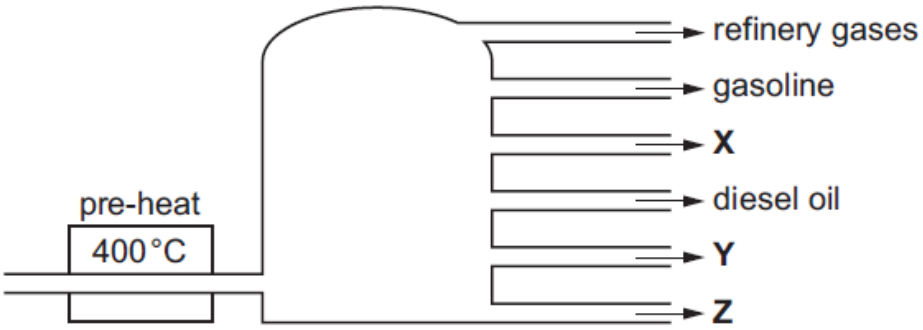
Which fertiliser is best for producing rose flowers?

fertiliser	proportion by mass		
	N	P	K
A	9	0	25
B	13	13	20
C	29	5	0
D	29	15	5

Question 18

In an oil refinery, petroleum is separated into useful fractions.

The diagram shows some of these fractions.



What are fractions X, Y and Z?

	X	Y	Z
A	fuel oil	bitumen	paraffin (kerosene)
B	fuel oil	paraffin (kerosene)	bitumen
C	paraffin (kerosene)	bitumen	fuel oil
D	paraffin (kerosene)	fuel oil	bitumen

Question 19

The table shows the structure of different atoms and ions.

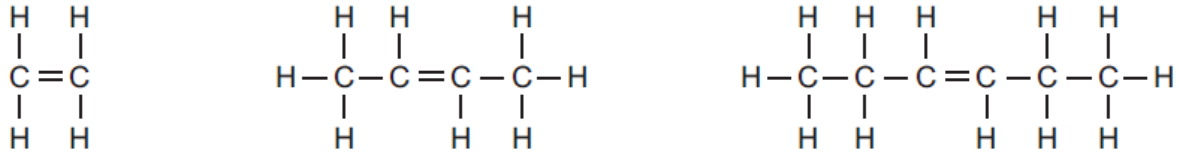
particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Mg	12	24	12	W	12
Mg^{2+}	X	24	12	12	10
F	9	19	9	Y	9
F^-	9	19	9	10	Z

What are the values of W, X, Y and Z?

	W	X	Y	Z
A	10	10	9	9
B	10	12	10	9
C	12	10	9	10
D	12	12	10	10

Question 20

The structures of three compounds are shown.



Why do these substances all belong to the same homologous series?

A They all contain an even number of carbon atoms.

B They all contain the same functional group.

C They are all hydrocarbons.

D They are all saturated.

SECTION B

Answer THREE of the following FOUR questions

Question 1

This question is about metals and their properties. All metals have a giant metallic structure and have many important uses.

a) Describe what is meant by metallic bonding.

_____

_____

_____[2]

b) Why are metals good conductors of electricity?

_____

_____[1]

c)(i) Rhodium, platinum and palladium are metals that are present in catalytic converters to reduce the toxicity of emissions from car engines. These metals act as catalysts.

Explain how catalysts speed up the rate of reactions.

_____

_____[1]

(ii) The metals in **c(i)** catalyse the reaction of carbon monoxide with nitrogen monoxide (NO) to produce harmless gases, nitrogen and carbon dioxide.

Write an equation for this reaction.

_____[2]

d) The reactivity of a metal is a measure of its ability to form positive ions. When **excess** copper was added to aqueous silver nitrate the following reaction takes place.

$$Cu\ (s) + AgNO_3\ (aq) \rightarrow CuSO_4\ (aq) + Ag\ (s)$$

(i) State **two** observations that will be seen in this reaction.

1. _____

2. _____ [2]

(ii) What *type of reaction* is taking place in the equation above?

_____ [1]

e) A chemist investigated the reaction of copper with nitrogen. He predicted that two possible products were likely copper(I) nitride and copper(II) nitride.

State the formulae of these two nitrides.

compound	**ions**	**formula**
copper(I) nitride	Cu^{+} and N^{3-}	
copper(II) nitride	Cu^{2+} and N^{3-}	

[1]

TOTAL: 10

Question 2
This question is about organic chemistry, which is the chemistry of carbon containing compounds.

a) Alkenes are a group of unsaturated hydrocarbons that have the general formula of C_nH_{2n}.

(i) State what is meant by the term *unsaturated*.

_____

_____[1]

(ii) Name and draw the structure of the alkene with three carbon atoms.

name _____

[2]

b) Alkenes can be obtained from alkanes. This process involves a long hydrocarbon alkane being broken down into a smaller alkane and an alkene.

(i) Suggest the name of this process.

_____ [1]

(ii) State the reaction conditions for this process.

_____[2]

c) Cycloalkanes have the same general formula as alkenes.

(i) Cyclopentane, C_5H_{10}, can be prepared from pentane. A small molecule by-product is also formed in this reaction.
Construct the equation for this reaction.

_____[1]

(ii) Draw the structural formula of cyclopentane, C_5H_{10}.

[1]

(iii) In the presence of ultraviolet light, cyclopentane, C_5H_{10}, undergoes a reaction with bromine to form dibromopentane, $C_5H_{10}Br_2$. as the **only** product.

Draw a structure for this product, $C_5H_{10}Br_2$.

[1]

(iv) Suggest the name of this type of reaction.

_____ [1]

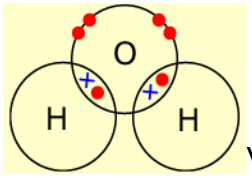
Total: 10

Question 3

This question is about chemical bonding. The table shows some information about some compounds.

Formula	Type of structure	Melting point in °C
CaO (calcium oxide)	Giant	2900
H_2O (water)	Molecular	0
$NaNH_2$ (sodium amide)	Giant	210
NH_3 (ammonia)	Molecular	-78

a) The structure of a water molecule compound can be represented like this:



Water

The atoms are held together by covalent bonds. Define the term covalent bonding.

_____

_____[1]

b) Ammonia, NH_3, is also a covalent molecule.

Draw the *dot and cross* diagram to show the arrangement of electrons in a molecule of NH_3. You need only show electrons in outer shells.

[2]

c) Sodium amide can be prepared by the reaction of sodium with liquid ammonia. Hydrogen is a by-product in this reaction.

(i) Construct an equation for this reaction.

_____[2]

(ii) Suggest a possible observation in this reaction.

_____ [1]

(d) Sodium amide is a base.

(i) Define the term base.

_____

_____[1]

(ii) The reaction of sodium amide with hydrochloric acid is **similar** to that of sodium hydroxide with hydrochloric acid.

Predict the two products of the reaction of sodium amide with hydrochloric acid.

1. _____

2. _____ [2]

(iii) Calcium oxide is also a base.

Draw the '*dot-and-cross*' diagram for the oxide ion. Include the **charge** for the ion.

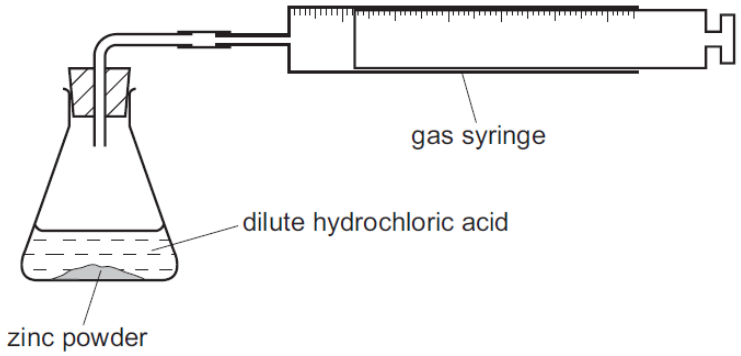
[1]

Total: 10

Question 4

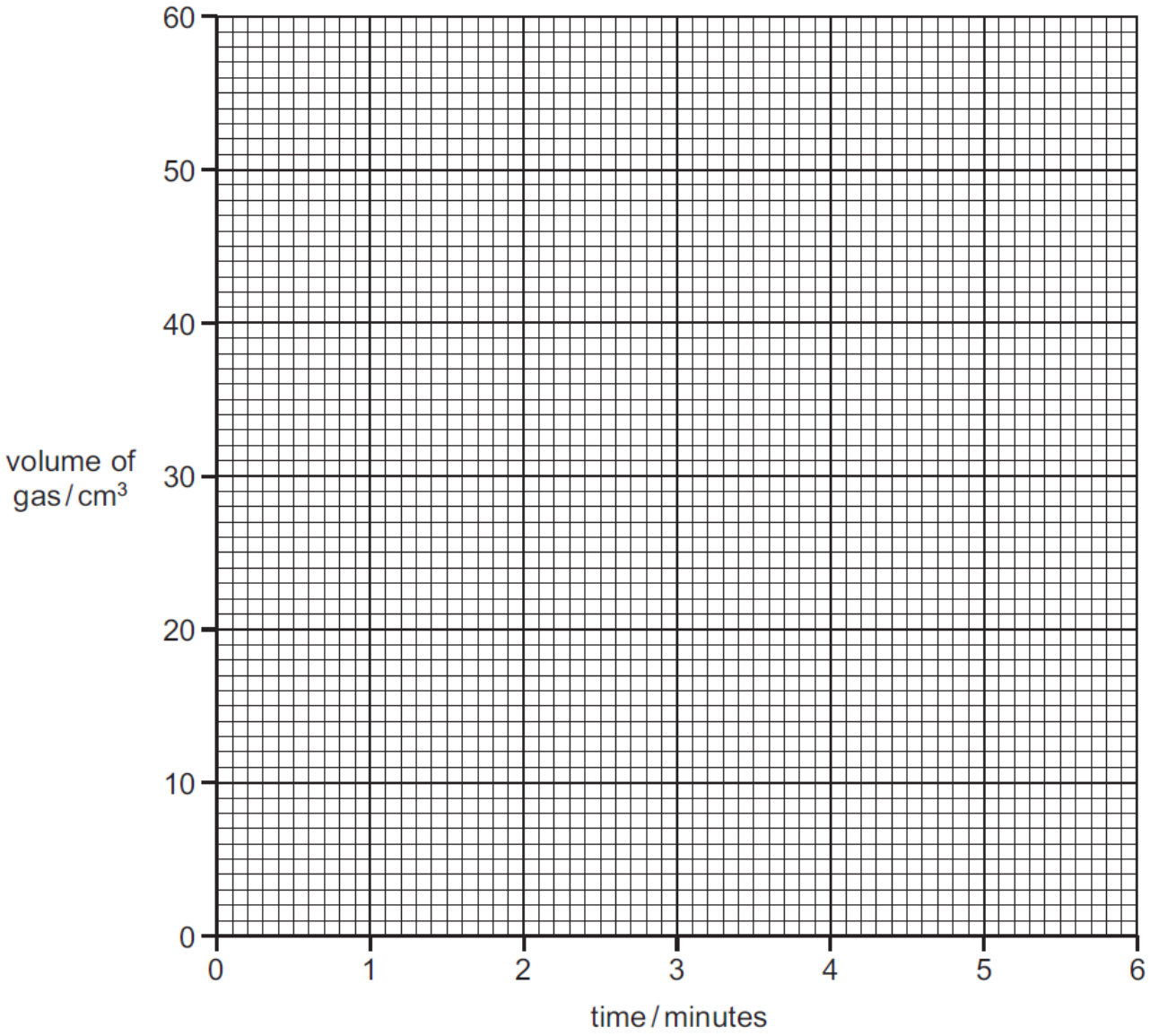
A student carried out an experiment to investigate the speed of reaction between 50 cm^3 of dilute hydrochloric acid and excess zinc powder using the apparatus shown below.

The reaction was carried out at a room temperature of 25 °C.



Time/ minutes	Volume of hydrogen collected/ cm^3
0	0
1	17
2	25
3	40
4	47
5	54
6	56

a) Plot the results on the grid below and draw a smooth line graph.
Circle any anomalous point.



[3]

b) Sketch, on the grid, the graph you would expect if the experiment was repeated

(i) At 60 °C,

(ii) using excess lumps of zinc

[2]

c) Beach sand is a mixture of sand and broken shells (calcium carbonate). Calcium carbonate reacts with dilute hydrochloric acid to form a solution of calcium chloride.

Plan an investigation to find out the percentage of shell material in a given sample of beach sand.

Your answer should include a stepwise method and any apparatus used and measurements taken.

[5]

Total: 10

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	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	64 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	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	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).