ST EDWARD'S

OXFORD

16+ ENTRANCE EXAMINATION

For entry in September 2017

Chemistry

Use of a calculator is permitted

Time: 1 hour

Candidate's Name: ……

Total marks available: 60

THE PERIODIC TABLE

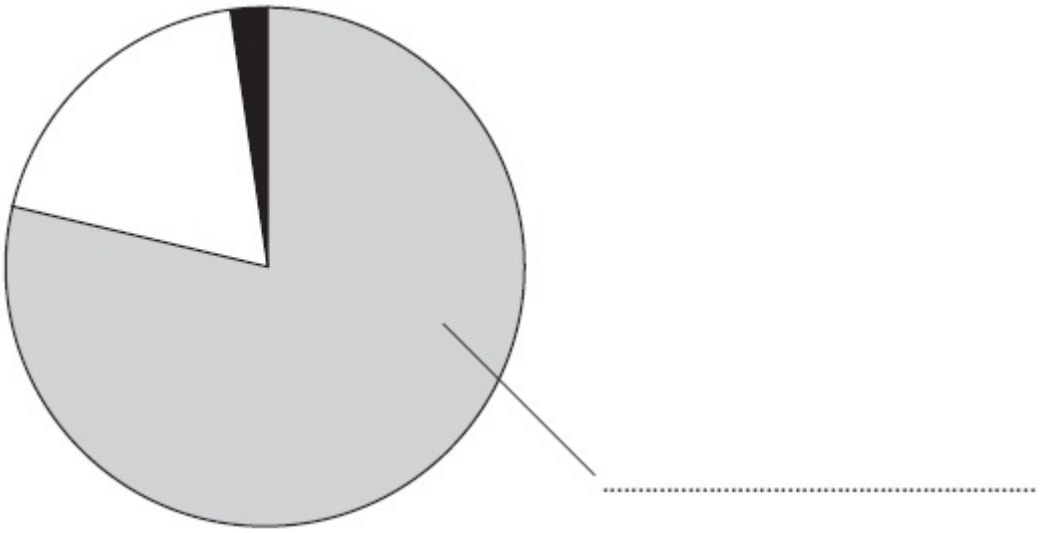
Period	1	2											3	4	5	6	7	0
	Group																	
1	1 H Hydrogen 1																	4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	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

1. Many chemical reactions occur in the atmosphere.

(a) The pie chart shows the relative amounts of some gases in air.



(i) Label the pie chart with the name of the gas that makes up most of the air.

(1)

(ii) What is the approximate percentage of oxygen in air?
Place a cross (☒) in one box.

(1)

- ☒ 1
- ☒ 20
- ☒ 25
- ☒ 78

(iii) Use words from the box to complete the sentences about some of the other gases in air.
Each word may be used once, more than once or not at all.

(2)

diatomic	dense	neon	nitrogen	unreactive	water

One of the gases in air is argon. It is called a noble gas because it is very

..... .

The percentage of ..... vapour in air varies with the weather.

(b) Rain water is naturally slightly acidic because carbon dioxide dissolves in it. The word equation for the reaction that occurs is:

carbon dioxide + water → carbonic acid

Acid rain is more acidic because pollutant gases in the atmosphere also dissolve in water.

(i) Identify the acid formed when sulfur dioxide reacts with water.

(1)

.....

(ii) Identify another pollutant gas that forms acid rain.

(1)

.....

(iii) State **two** problems caused by acid rain.

(2)

1 .....

.....

2 .....

.....

(Total for Question 1 = 8 marks)

2. 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_2H_6	30	–87
propane	C_3H_8	44	–42
butane	C_4H_{10}		0
pentane	C_5H_{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)

.....

.....

.....

(c) The molecular formula of ethene is C_2H_4

Ethene and ethane are in different homologous series.

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

(1)

.....

.....

(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 2 = 12 marks)

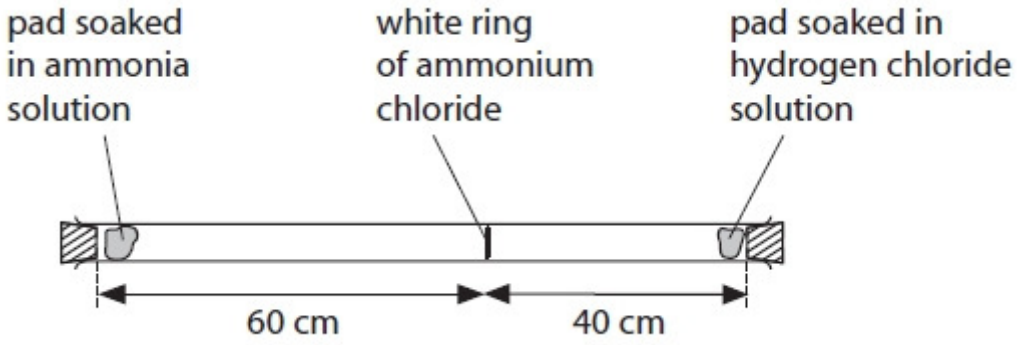
3. When ammonia gas and hydrogen chloride gas mix, they react together to form a white solid called ammonium chloride.

The equation for the reaction is:

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

A cotton wool pad was soaked in ammonia solution and another was soaked in hydrogen chloride solution. The two pads were then put into opposite ends of a dry glass tube at the same time.

After five minutes, a white ring of solid ammonium chloride formed.



(a) (i) What name is given to the movement of the two gases?

(1)

.....

(ii) Identify which gas is moving faster and give a reason for your choice.

(1)

.....

.....

(b) The experiment was repeated at a higher temperature.
State and explain how this change would affect the time taken for the white ring to form.

(3)

.....

.....

.....

.....

.....

.....

(c) Gas particles move at a speed of several hundred metres per second at room temperature.
Suggest **one** reason why it took five minutes for the white ring to form.

(1)

.....

.....

(Total for Question 3 = 6 marks)

4. Atoms contain three different types of particle.

These are electrons, neutrons and protons.

(a) Which **one** of the three particles has a negative charge?

(1)

.....

(b) Which **one** of the three particles has the smallest mass?

(1)

.....

(c) Use words from the box to complete the sentences below.

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

electrons	**elements**	**molecules**	**neutrons**	**protons**

(i) Atoms are neutral because they contain equal numbers of

..... and .....

(1)

(ii) Isotopes are atoms with the same number of .....

but different numbers of ..... in the nucleus.

(2)

(d) An atom of boron can be represented by the symbol $^{11}_{5}\mathrm{B}$.

Use numbers to complete these statements about this atom.

(i) The atomic number of this atom is .....

(1)

(ii) The mass number of this atom is .....

(1)

(iii) The electronic configuration of this atom is .....

(1)

(Total for question 4 = 8 marks)

5. 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.

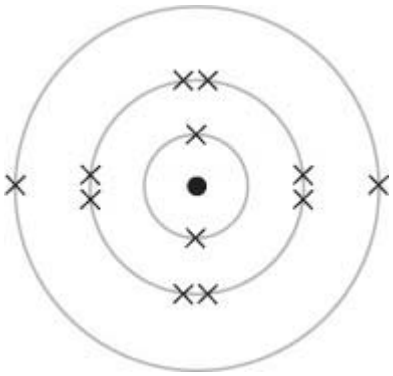
What is meant by the term **exothermic**?

(1)

.....

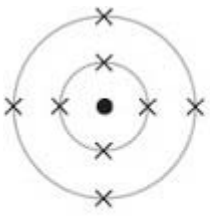
.....

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

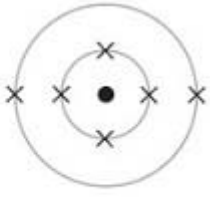


Put a cross in a box to indicate the diagram that shows the electronic configuration of an oxygen atom.

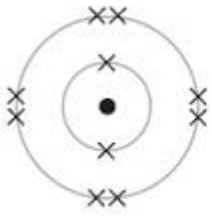
(1)



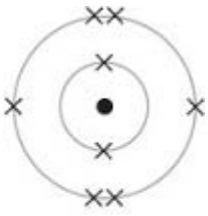
A ☐



B ☐



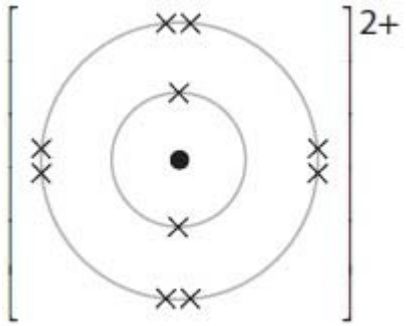
C ☐



D ☐

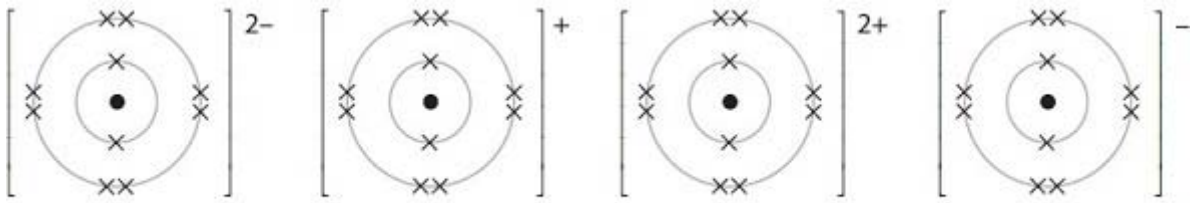
(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

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)

.....

.....

.....

.....

.....

.....

.....

.....

(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

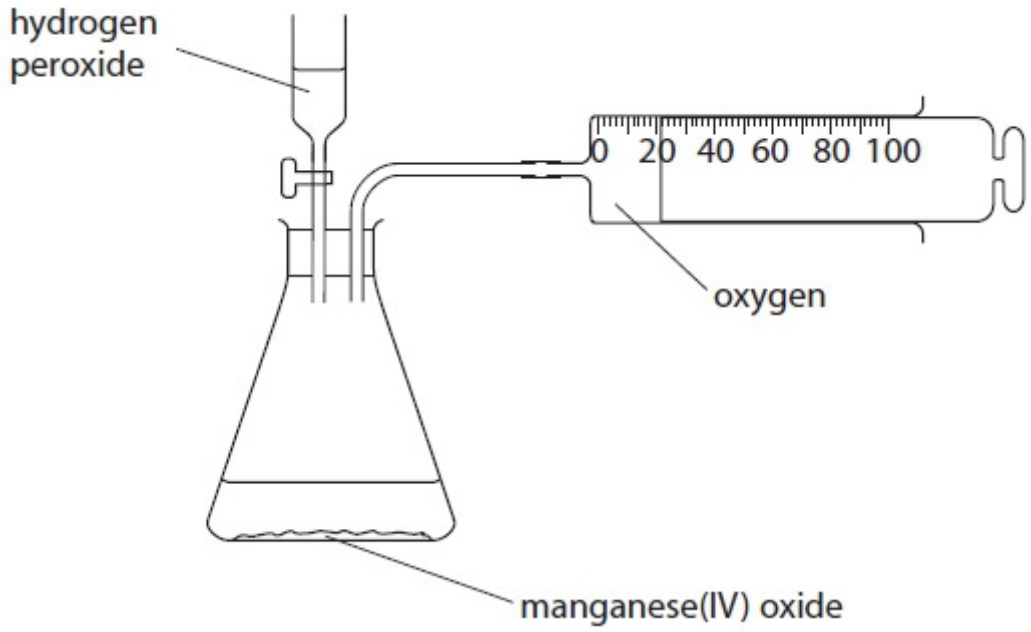
.....

Formula

.....

(Total for Question 5 = 9 marks)

6. The apparatus in the diagram is used to collect the oxygen produced by the decomposition of hydrogen peroxide, H_2O_2



(a) Write a chemical equation for the decomposition of hydrogen peroxide.

(2)

.....

(b) Describe a test to show that the gas collected in the syringe is oxygen.

(1)

.....

.....

(c) Manganese(IV) oxide is a catalyst for this reaction.

State and explain the effect of a catalyst on the rate of this reaction.

(3)

.....

.....

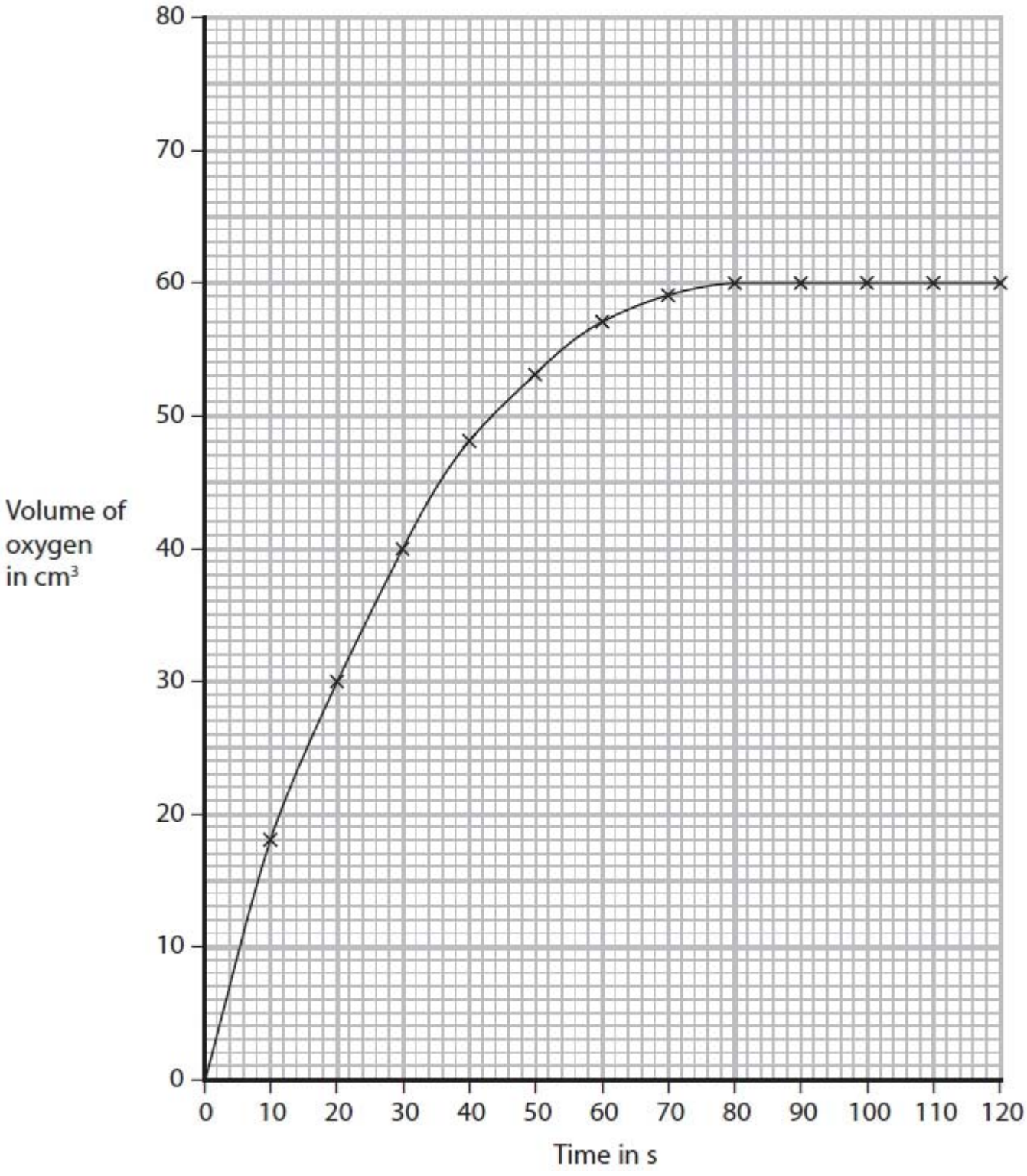
.....

.....

.....

.....

(d) The graph shows the results from an experiment using a 0.50 mol/dm^3 solution of hydrogen peroxide at 25 °C.



(i) On the same axes, sketch the curve you would expect with the same volume of a 0.25 mol/dm^3 solution of hydrogen peroxide at 25 °C. Label this curve **A**.

(2)

(ii) On the same axes, sketch the curve you would expect with the same volume of a 0.50 mol/dm^3 solution of hydrogen peroxide at 35 °C. Label this curve **B**.

(2)

(Total for Question 6 = 10 marks)

7. This question is about elements in Group 1 of the Periodic Table.

(a) Which statement about lithium is correct?

(1)

- ☒ **A** It is a good electrical conductor and forms an acidic oxide
- ☒ **B** It is a poor electrical conductor and forms an acidic oxide
- ☒ **C** It is a good electrical conductor and forms a basic oxide
- ☒ **D** It is a poor electrical conductor and forms a basic oxide

(b) A small piece of sodium is added to a large trough of water.

(i) State two observations that could be made.

(2)

1 .....

.....

2 .....

.....

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

(2)

$2Na(s) + 2H_2O(.....) \rightarrow 2NaOH(.....) + H_2(.....)$

(c) Potassium reacts in a similar way to sodium, but is more reactive.

State one observation that could be made when a small piece of potassium is added to a large trough of water, but would not be observed with sodium.

(1)

.....

.....

(d) Explain why elements in Group 1 have similar reactions.

(1)

.....

.....

(Total for Question 7 = 7 marks)

END OF QUESTIONS