ST EDWARD'S

OXFORD

16+ ENTRANCE EXAMINATION

For entry in
September 2018

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. The reactivity of metals can be studied using displacement reactions. In these reactions, one metal is added to a solution of a salt of a different metal.

If a displacement reaction occurs, there is a temperature rise.
A student used the following method in a series of experiments.

- Pour some metal salt solution into a polystyrene cup supported in a glass beaker and record the temperature of the solution.
- Add a known mass of a metal and stir.
- Record the maximum temperature of the mixture.

(a) Suggest **three** variables that should be kept the same for the student's experiments to be a fair test.

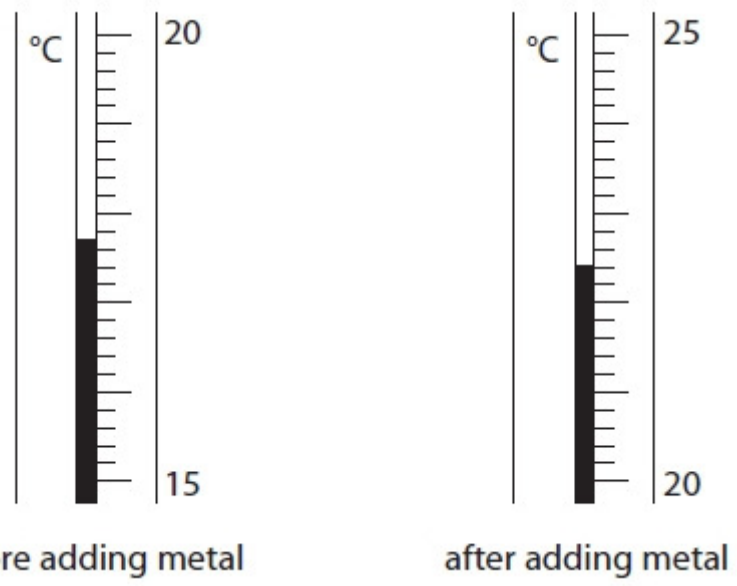
(3)

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(b) The student used a thermometer to measure the temperature rise. The diagrams show the thermometer readings before and after adding the metal.



before adding metal after adding metal

Use the diagrams to complete the table.

(3)

Temperature after adding the metal in °C	
Temperature before adding the metal in °C	
Temperature change in °C	

(c) The student used copper(II) sulfate solution in all her experiments. She used five different metals. She did not know the identity of the metal labelled **X**.
The student did each experiment twice. The table shows her results.

Metal	Temperature rise in °C		Average temperature rise in °C
	Run 1	Run 2	
magnesium	10.5	15.5	13.0
silver	0.0	0.0	0.0
iron	3.5	4.5	4.0
X	0.0	0.0	0.0
zinc	8.0	9.0	8.5

(i) Which of the metals gave the least reliable temperature rise?
Explain your choice.

(2)

Metal

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Explanation

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(ii) Identify the most reactive of the metals used.
Explain how the results show that it is the most reactive.

(2)

Metal

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Explanation

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(iii) Why is there no temperature rise when silver is added to copper(II) sulfate solution?

(1)

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(iv) Why do the results make it impossible to decide which of the metals is the least reactive?

(1)

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(d) A word equation for one of the reactions is

zinc + copper(II) sulfate → copper + zinc sulfate

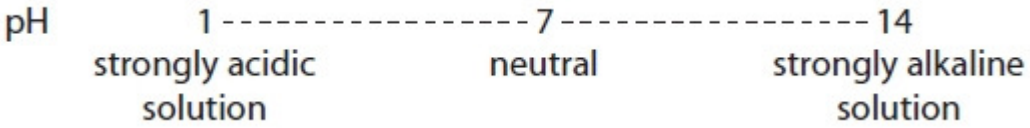
Write a chemical equation for this reaction.

(1)

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(Total for Question = 13 marks)

2. Part of the pH scale is shown.



Some of these experiments involve a pH change.

A sodium chloride (common salt) is dissolved in pure water
B carbon dioxide gas is dissolved in pure water
C sodium hydroxide solution is neutralised by adding dilute hydrochloric acid
D excess sodium hydroxide solution is added to a weakly acidic solution
E ammonia gas is dissolved in pure water

The table shows the pH at the start and at the end of the five experiments.

Complete the table by inserting the appropriate letter in each box.
You may use each letter only once.
The first one has been done for you.

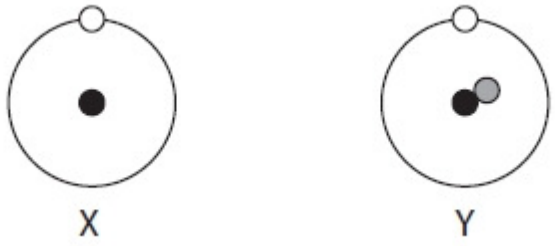
(4)

pH at start	pH at end	Experiment
5	14	D
7	7	
7	11	
14	7	
7	6	

(Total for Question = 4 marks)

3. This question is about the elements hydrogen and oxygen.

(a) The diagram below shows two different atoms of hydrogen.



Place a cross ☒ in the appropriate box to indicate your choice of answer: A, B, C or D.

(i) The particle furthest from the centre of each atom is

(1)

☒ **A** an electron

☒ **B** a neutron

☒ **C** a nucleus

☒ **D** a proton

(ii) The particle present in atom Y but not in atom X is

(1)

☒ **A** an electron

☒ **B** a neutron

☒ **C** a nucleus

☒ **D** a proton

(iii) Both atoms are neutral because they have the same number of

(1)

☒ **A** electrons and neutrons

☒ **B** electrons and protons

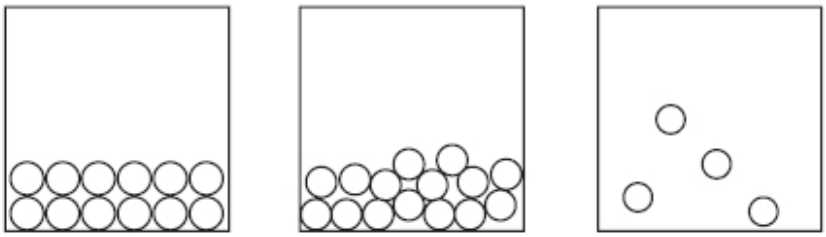
☒ **C** electrons, neutrons and protons

☒ **D** neutrons and protons

(b) The circles in the diagrams represent molecules of hydrogen (H_2).

Place a cross ☒ in the box under the diagram that represents hydrogen gas.

(1)



☒ ☒ ☒

(c) The two hydrogen atoms in a molecule of hydrogen are joined by a strong covalent bond.

Explain how the hydrogen atoms are held together by the covalent bond.

(2)

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(d) Draw a dot-and-cross diagram to represent a molecule of hydrogen.

(2)

(e) Explain, with reference to the forces between the molecules, why hydrogen is a gas at room temperature.

(2)

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(f) Hydrogen reacts with oxygen to form water.

(i) Complete the equation for this reaction, including state symbols:

(3)

$2H_{2(.....)} + O_{2(g)} \rightarrow .....$

(ii) Draw a dot-and-cross diagram to represent a molecule of water.

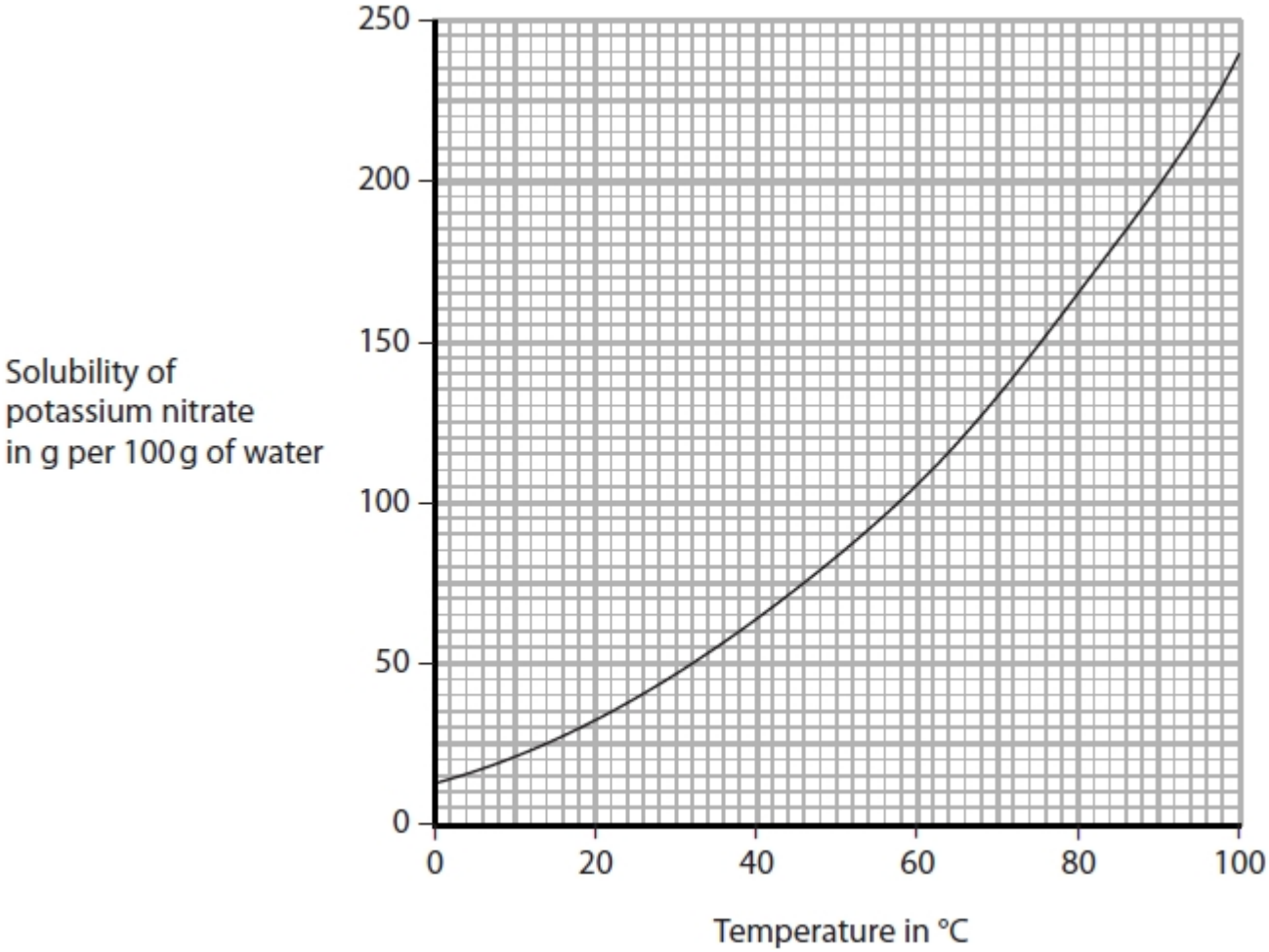
Show only the outer electrons of each atom.

(2)

(Total for Question = 15 marks)

4. 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.

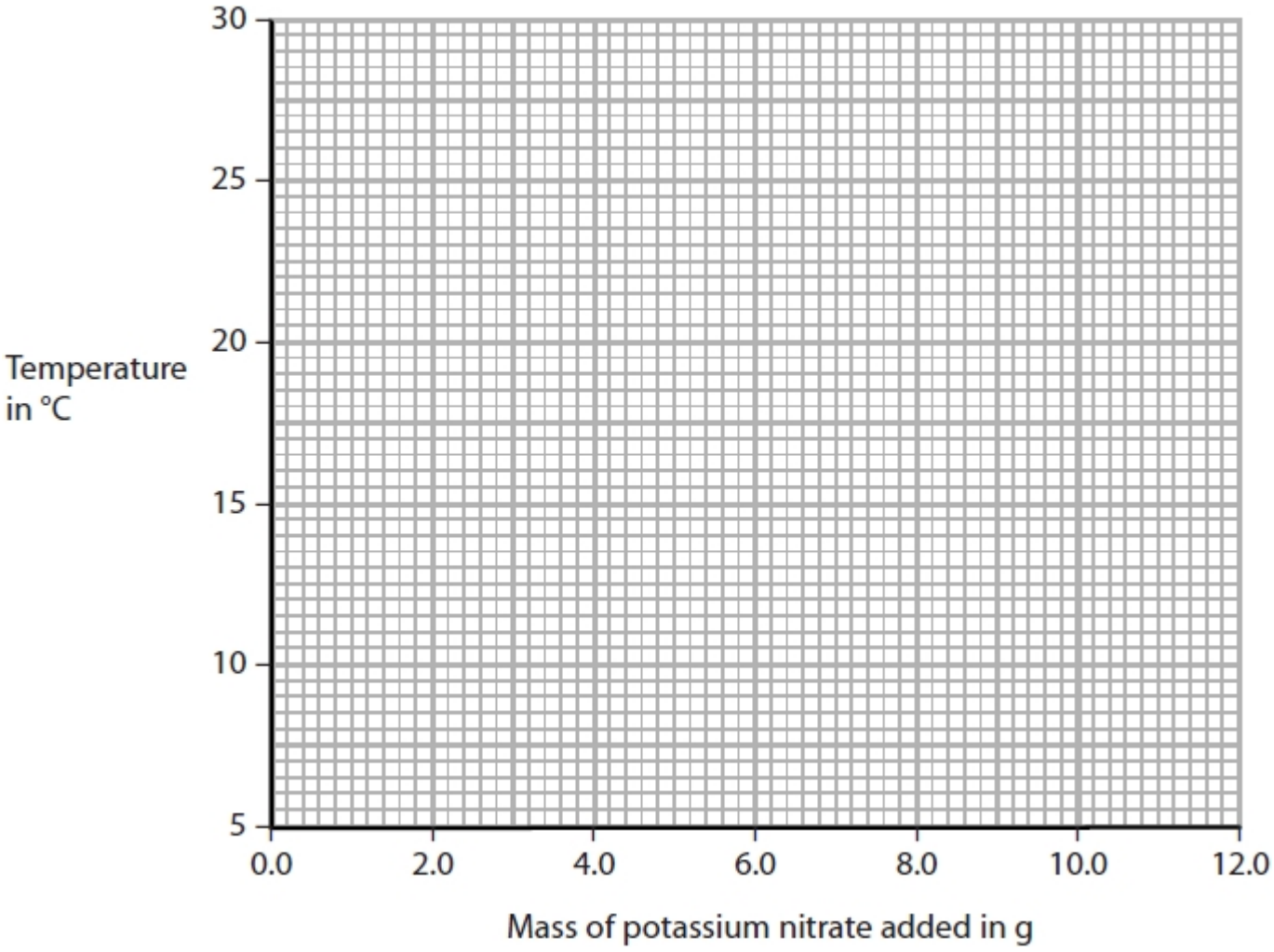
- add the first sample of potassium nitrate to the beaker and stir until the sample dissolves
- record the temperature of the solution
- add the second sample of potassium nitrate to the solution in the beaker and stir until the sample dissolves
- record the new temperature of the solution
- repeat until 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)



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

(1)

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

(2)

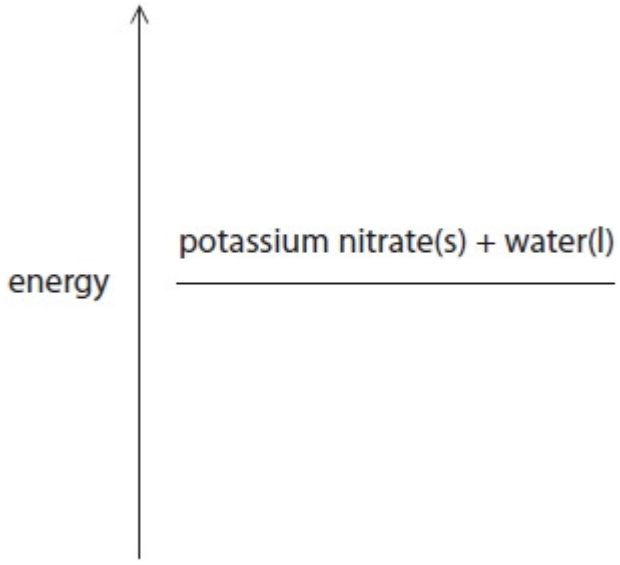
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(iv) Complete the energy level diagram for this experiment.

(1)



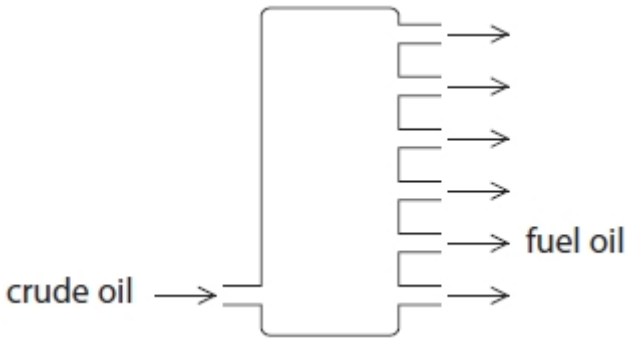
(Total for question = 8 marks)

5. 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)

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

(i) 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)

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

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

(2)

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

(2)

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(c) 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 = 12 marks)

6. The table gives information about barium salts.

Barium salt	Formula	Solubility in water	Toxic (poisonous)
barium chloride		Soluble	Yes
barium nitrate	$Ba(NO_3)_2$	Soluble	Yes
barium carbonate		Insoluble	No
barium sulfate	$BaSO_4$	Insoluble	No

(a) Complete the table by giving the formula of barium chloride and of barium carbonate.

(2)

(b) The human stomach contains hydrochloric acid.

Suggest why barium carbonate may cause poisoning when it enters the stomach.

(2)

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(c) Before patients have stomach X-rays they are given a barium salt to swallow.

Which salt in the table is safe to use?

(1)

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(d) A student accidentally swallowed a small amount of barium hydroxide solution, which is poisonous.

Suggest a reason why a solution of magnesium sulfate could be given to the student to swallow as a first aid treatment. Write a word equation for the reaction that takes place.

(3)

Reason ……..

……..

……..

Word equation

……..

(Total for Question = 8 marks)

END OF QUESTIONS