ST EDWARD'S
OXFORD

16+ ENTRANCE EXAMINATION

For entry in
September 2016

CHEMISTRY

Time: 1 hour

Candidates 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 Sulphur 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 Indium 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

Questions

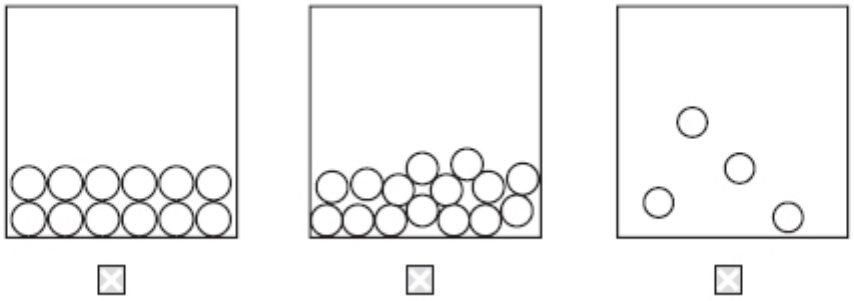
Q1.

This question is about the elements hydrogen and oxygen.

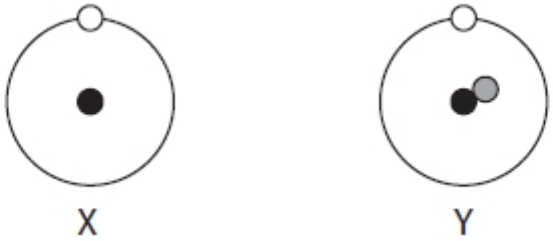
(a) The circles in the diagrams represent molecules of hydrogen.

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

(1)



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



(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

(c) Different atoms of oxygen can be represented as

$$^{16}_{8}O \text{ and } ^{18}_{8}O$$

Select words or phrases from the box to complete the sentence about these atoms of oxygen.
You may use each word or phrase once, more than once or not at all.

atomic numbers	isotopes	mass numbers	numbers of electrons

(3)

These atoms of oxygen are called .....

because their ..... are the same

but their ..... are different.

(Total for question = 7 marks)

Q2.

This question is about the separation of mixtures.

(a) The table shows some methods used to separate mixtures.

(i) Place a tick (✓) in one box in each row of the table to show the best method of separation for each mixture.

(4)

Separation		Method of separation			
		Chromatography	Simple distillation	Filtration	Fractional distillation
P	red ink from a mixture of coloured inks				
Q	ethanol from a mixture of ethanol and water				
R	sand from a mixture of sand and water				
S	water from copper(II) sulfate solution				

(ii) Which of the mixtures P, Q, R or S contains an undissolved solid?

(1)

.....

(b) Pure dry crystals of magnesium nitrate can be obtained from magnesium nitrate solution by crystallisation.

These steps describe the method, but the steps are in the wrong order.

A allow the solution to cool to room temperature

B heat the solution to evaporate some of the water

C pour the mixture of crystals and solution through filter paper

D put the crystals in a warm place to dry

E dip a glass rod into the solution to see if crystals form

Write a letter in each box to show the correct order.
One has been done for you.

(2)

	E			

(Total for question = 7 marks)

Q3.

The alkanes are a homologous series of hydrocarbons obtained from the fractions in crude oil.

(a) Describe how crude oil is separated into fractions in industry.

(4)

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(b) (i) State the general formula of the alkanes.

(1)

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(ii) State two characteristics, other than having the same general formula, of members of a homologous series.

(2)

1

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.....

2

.....

.....

(c) Propane is an alkane used as a fuel.

Balance the equation for the complete combustion of propane.

(1)

$$C_3H_8 + \text{.....}O_2 \rightarrow \text{.....}CO_2 + \text{.....}H_2O$$

(d) Incomplete combustion of propane leads to the formation of a poisonous gas.

(i) Identify this gas.

(1)

.....

(ii) Explain why the gas is poisonous.

(1)

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.....

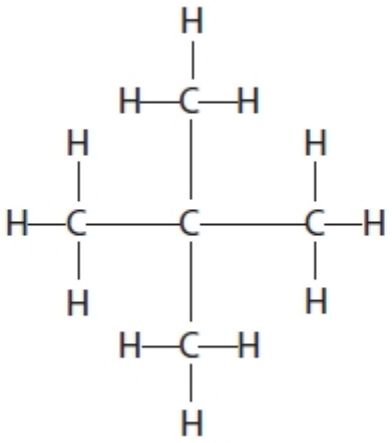
(iii) During the combustion of propane at high temperatures, gases represented by the formula NO_x can form.
Which two elements combine to form these gases?

(1)

..... and .....

(e) The alkane C_5H_{12} has three isomers.

The displayed formula of one of these isomers is



Draw the displayed formulae of the other two isomers.

(2)

(f) Methane is used in many countries as a fuel in houses. It has no smell, so substances are mixed with it to allow any leaks to be identified.

One of these substances is compound X which has this composition by mass.

C = 53.3%, H = 11.1%, S = 35.6%

(i) Use this information to calculate the empirical formula of X.

(3)

empirical formula of X.....

(ii) The relative formula mass of X is 90
What is the molecular formula of X?

(1)

molecular formula of X.....

(Total for question = 17 marks)

Q4.

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

(a) Which statement is correct about lithium?

(1)

- ☒ **A** lithium is a non–metal
- ☒ **B** lithium forms a sulfate with the formula $LiSO_4$
- ☒ **C** lithium reacts with water to form an alkali
- ☒ **D** lithium reacts with water to form a white precipitate

(b) Lithium and potassium have similar chemical properties because their atoms

(1)

- ☒ **A** have the same number of electrons in the outer shell
- ☒ **B** have the same number of protons
- ☒ **C** have two electrons in the first shell
- ☒ **D** form positive ions

(c) Lithium and potassium have similar chemical properties because their atoms

State one observation that would be similar for each element, and one that would be different for each element.

(2)

similar

.....

.....

different

.....

.....

(d) Suggest the formula of the compound formed when potassium reacts with oxygen, and when potassium reacts with chlorine.

(2)

oxygen .....

chlorine .....

(e) Complete the equation for the reaction between rubidium and water by inserting state symbols.

(1)

$$2Rb(\quad\quad) + 2H_2O(\quad\quad) \rightarrow 2RbOH(\quad\quad) + H_2(\quad\quad)$$

(f) The table shows information about the isotopes in a sample of rubidium.

Isotope	Number of protons	Number of neutrons	Percentage of isotope in sample
1	37	48	72
2	37	50	28

Use information from the table to calculate the relative atomic mass of this sample of rubidium. Give your answer to one decimal place.

(2)

relative atomic mass = ...

(Total for question = 9 marks)

Q5.

A student investigates the rate of the reaction between marble chips (calcium carbonate) and dilute hydrochloric acid. She is given a bottle containing hydrochloric acid labelled 100%.

She uses this method to find out how changing the concentration of the acid affects the rate of reaction.

- add some marble chips to a conical flask
- pour 50.0 cm^3 of dilute hydrochloric acid into the flask
- place the flask on a balance and start a timer
- record the time taken for the mass of the flask and contents to decrease by 1.0 g
- repeat the experiment using different concentrations of hydrochloric acid

(a) Suggest two features of the marble chips that the student should keep the same to ensure that the results are valid (a fair test).

(2)

1

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2

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(b) Why does the mass of the flask and contents decrease during the experiment?

(1)

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.....

(c) The student should have put some cotton wool in the neck of the conical flask after placing the flask on the balance.

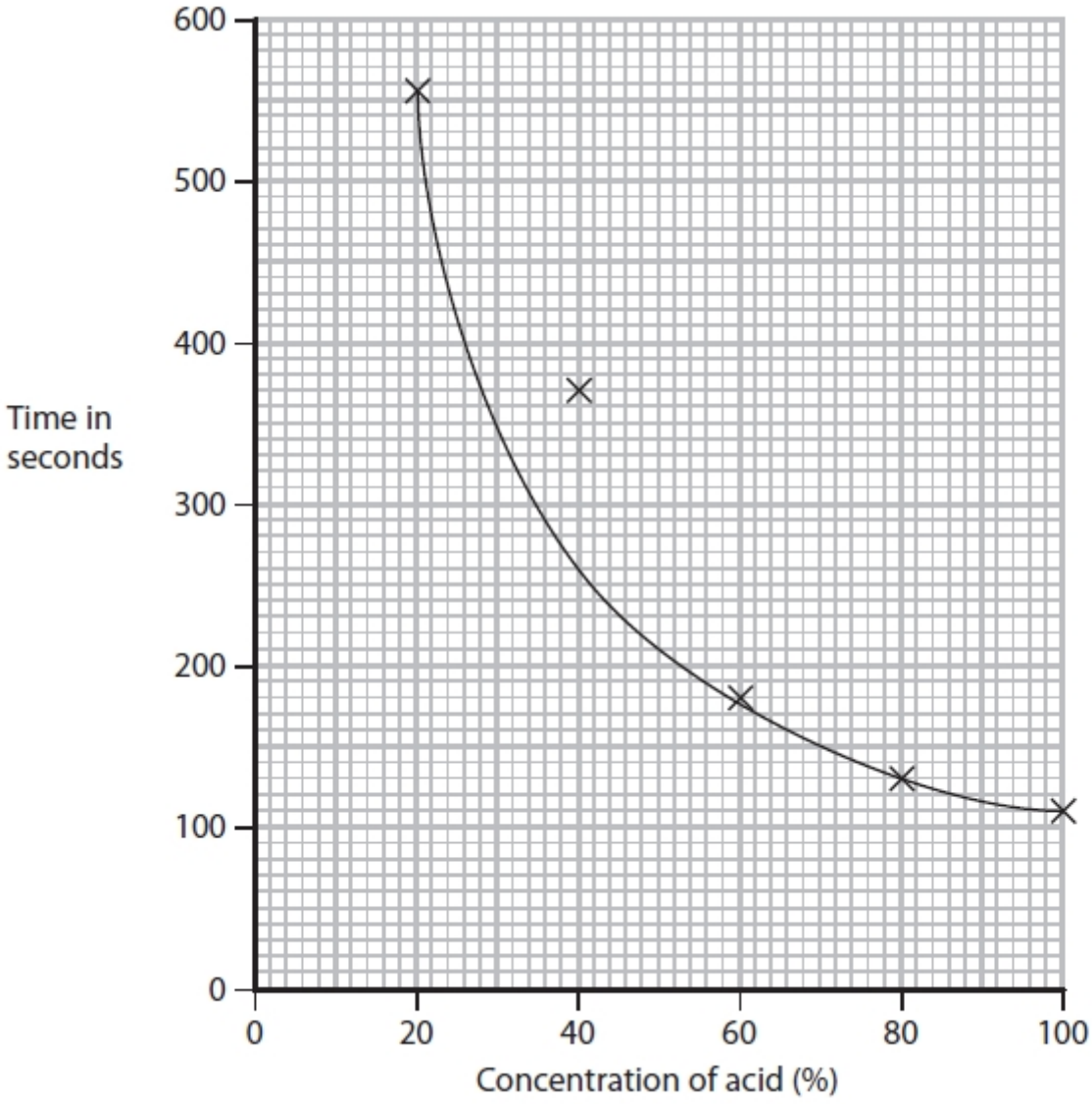
How would this improve the accuracy of the results?

(1)

.....

.....

(d) The graph shows the student's results for the decrease in the mass of the flask and contents by 1.0 g.



(i) Use the graph to find the time taken for the loss of 1.0 g of mass from the flask when the concentration of acid is 50%.
Show on the graph how you obtained your answer.

(2)

.....

(ii) One of the points on the graph is anomalous.
What could have caused this anomalous result?

(1)

☒ **A** the concentration of acid was more than 40%

☒ **B** the loss of mass was greater than 1.0 g

☒ **C** the mass of marble chips was more than 10 g

☒ **D** the student started the timer too late

(e) The results of each experiment can be used to calculate the rate of reaction using the expression

$$\text{rate of reaction in grams per second} = \frac{1.0\ \text{g}}{\text{time to lose 1.0 g in seconds}}$$

Calculate the rate of reaction when the concentration of acid is 50%.

(2)

rate of reaction = ...g/s

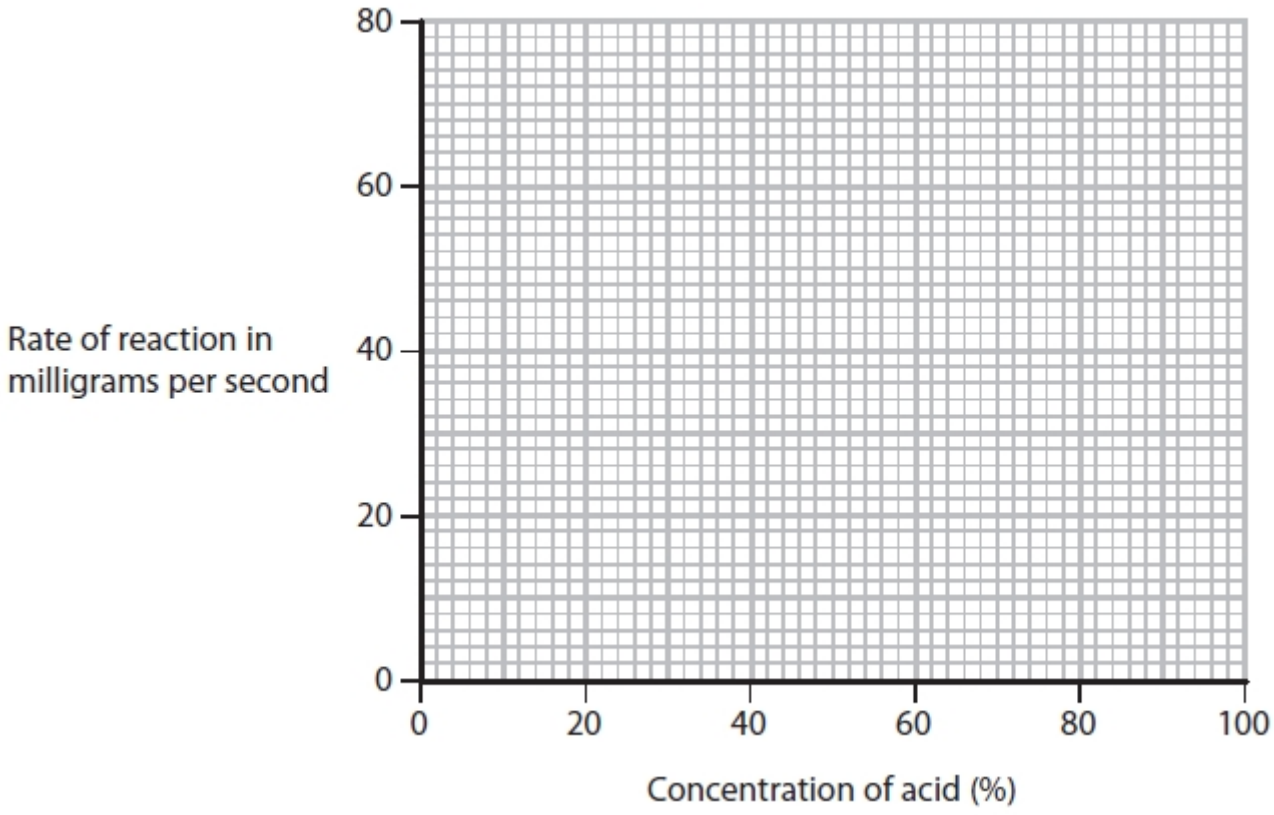
(f) The student is given a bottle of hydrochloric acid with a concentration different from that used in the previous experiments.
She repeats the investigation using different concentrations of hydrochloric acid.
She calculates the rate of reaction for each experiment.

The table shows her results.

Rate of reaction in milligrams per second	15	29	40	56	70
Concentration of acid (%)	20	40	60	80	100

Plot these results on the grid and draw a straight line of best fit.

(3)



(g) The rate of reaction increases as the concentration of the acid increases.

Explain this relationship in terms of particles.

(3)

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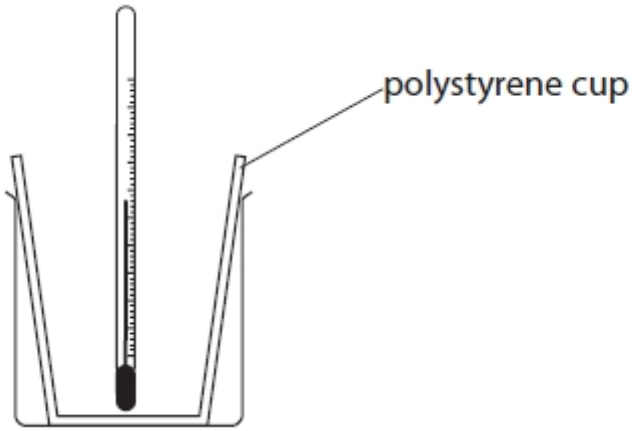
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(Total for question = 15 marks)

Q6.

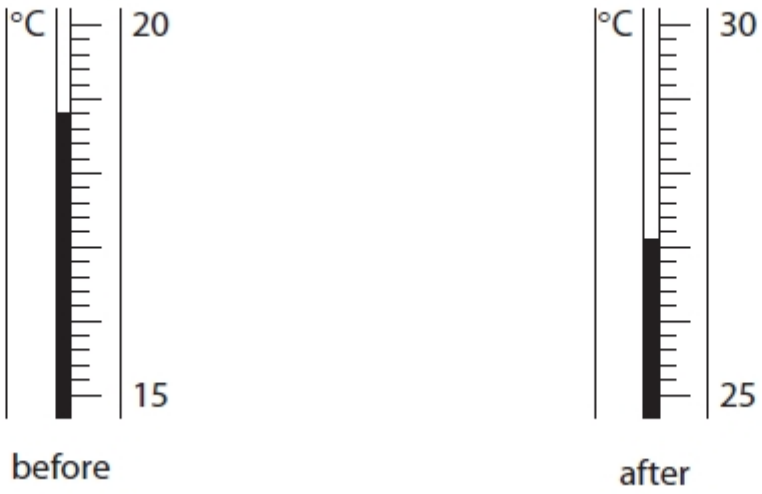
A student uses this apparatus to investigate the temperature change that occurs when potassium hydroxide is dissolved in water.



She uses this method.

- pour 50 cm^3 of water into the polystyrene cup and measure the temperature of the water
- add 3 g of potassium hydroxide and stir
- record the highest temperature of the solution

(a) These diagrams show the thermometer readings before and after the student added the potassium hydroxide.



Use the readings to complete the table.

(3)

temperature in °C after adding potassium hydroxide	
temperature in °C before adding potassium hydroxide	
temperature change in °C	

(b) The student uses her results to calculate the enthalpy change for dissolving potassium hydroxide in water.

She compares her value with a data book value.
Student's value = – 32kJ/mol.
Data book value = – 55kJ/mol.
There are no errors in the student's method or in the calculation.
Suggest two reasons why the student's value differs from the data book value.

(2)

1

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2

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(Total for question = 5 marks)