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

Group

	1	2											3	4	5	6	7	0

Period

1

1
H
Hydrogen
1

4
He
Helium
2

2

7	9												11	12	14	16	19	20
Li	Be												B	C	N	O	F	Ne
Lithium	Beryllium												Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
3	4												5	6	7	8	9	10

3

23	24												27	28	31	32	35.5	40
Na	Mg												Al	Si	P	S	Cl	Ar
Sodium	Magnesium												Aluminium	Silicon	Phosphorus	Sulfur	Chlorine	Argon
11	12												13	14	15	16	17	18

4

39	40	45	48	51	52	55	56	59	59	63.5	65	70	73	75	79	80	84
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

5

86	88	89	91	93	96	99	101	103	106	108	112	115	119	122	128	127	131
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	Xenon
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54

6

133	137	139	179	181	184	186	190	192	195	197	201	204	207	209	210	210	222
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Caesium	Barium	Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury	Thallium	Lead	Bismuth	Polonium	Astatine	Radon
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86

7

223	226	227
Fr	Ra	Ac
Francium	Radium	Actinium
87	88	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.
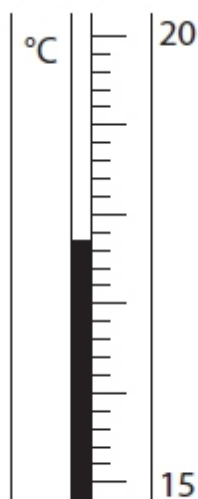
before adding metal   after adding metal
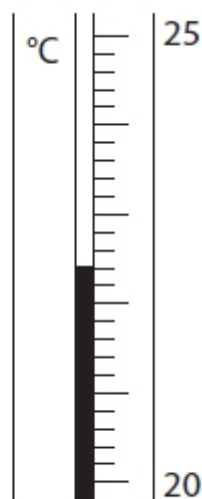
Use the diagrams to complete the table.

(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

....

Explanation

....

....

....

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

(2)

Metal

....

Explanation

....

....

....

(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

$$zinc + copper(II) \text{ sulfate} \rightarrow copper + zinc \text{ sulfate}$$
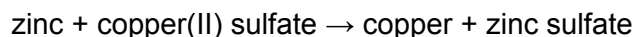
Write a chemical equation for this reaction.

(1)

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(Total for Question = 13 marks)

2. Part of the pH scale is shown.

pH   1 ----------------- 7 --------------- 14
     strongly acidic   neutral   strongly alkaline
        solution   solution
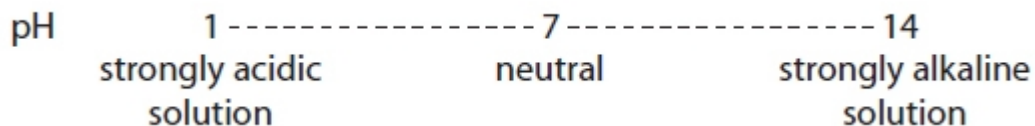
Some of these experiments involve a pH change.

     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.

X   Y

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)

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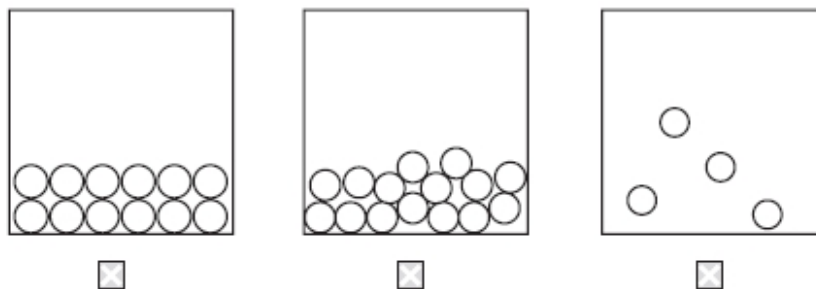
(c) The two hydrogen atoms in a molecule of hydrogen are joined by a strong covalent bond.

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

(2)

....

....

....

(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)

....

....

....

(f) Hydrogen reacts with oxygen to form water.

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

(3)

$$2H_{2(.....)} \quad + \quad O_{2(g)} \quad \rightarrow \quad \ldots\ldots\ldots$$
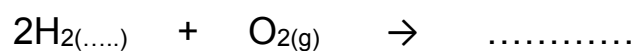
   (ii)   Draw a dot-and-cross diagram to represent a molecule of water.

            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.
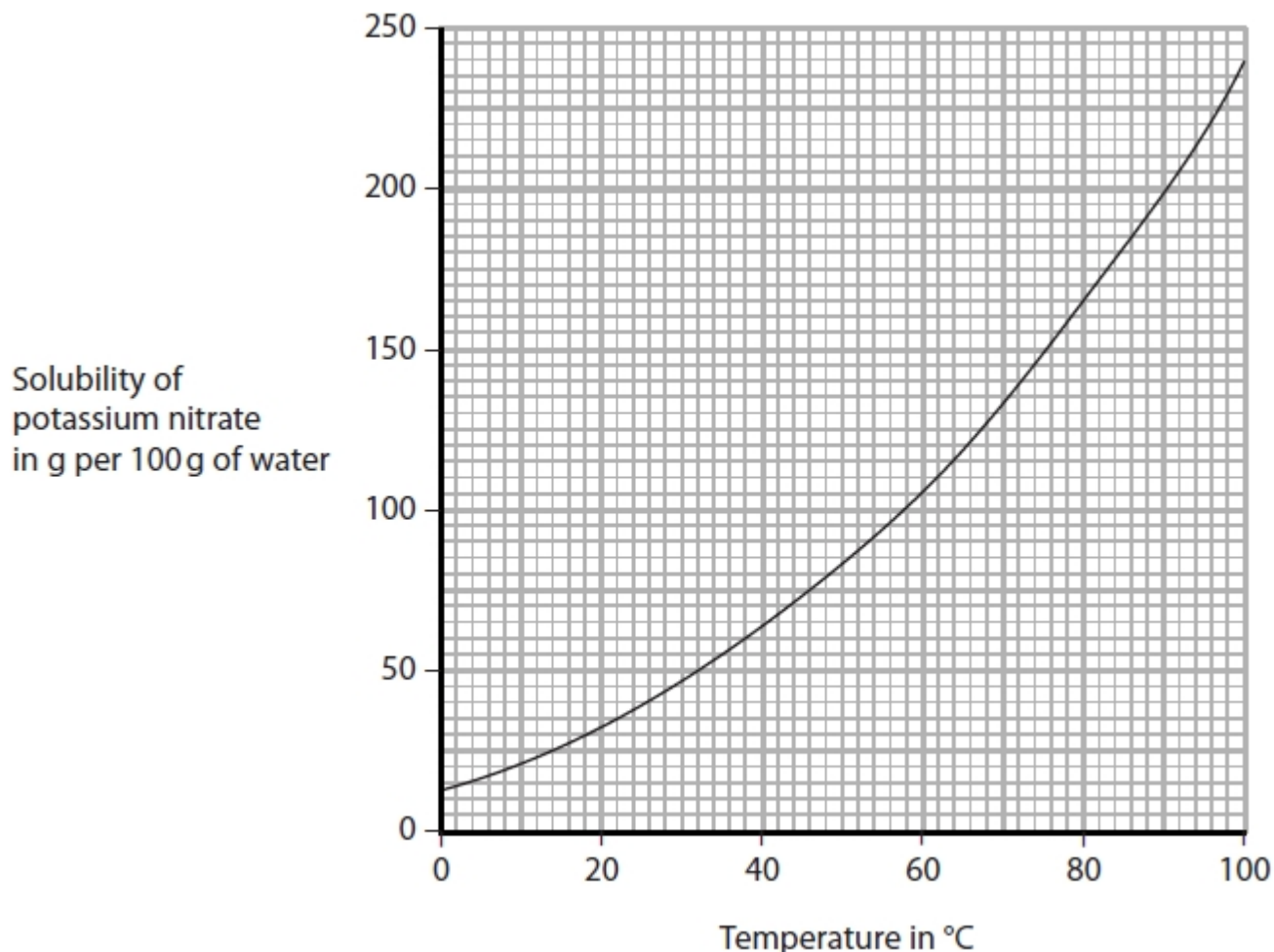
(a) The student decides to use a mass of 50 g of water at a temperature of 25 °C.

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)

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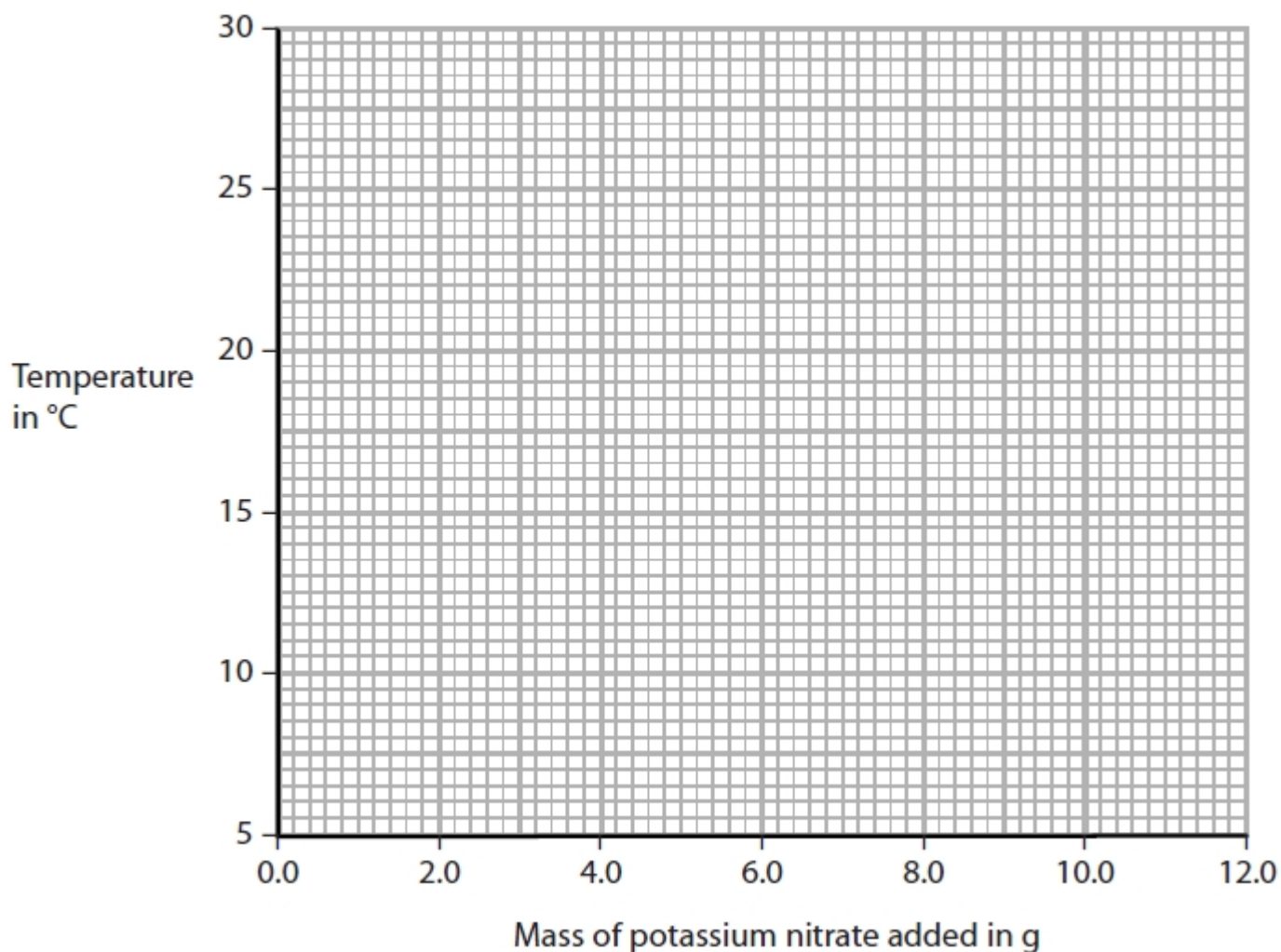
(ii) From the graph, find the mass of potassium nitrate that would be needed to produce a temperature change of 10.0 °C.

(1)

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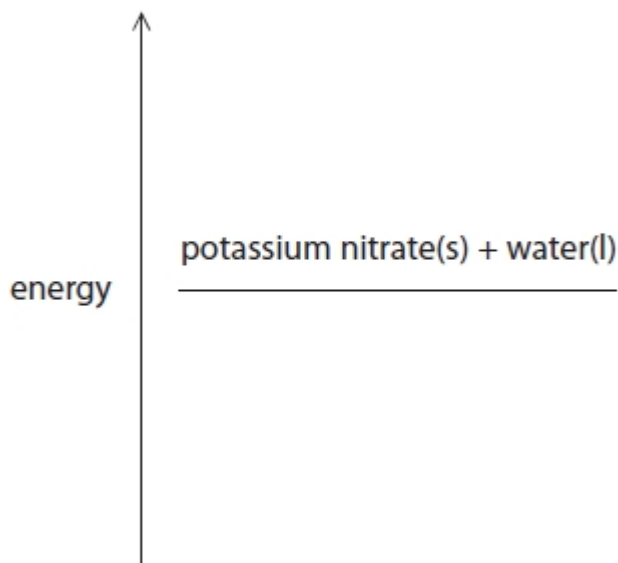
(iii) Explain how the student's results show the type of heat change that occurs when potassium nitrate dissolves in water.

(2)

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....

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

(1)

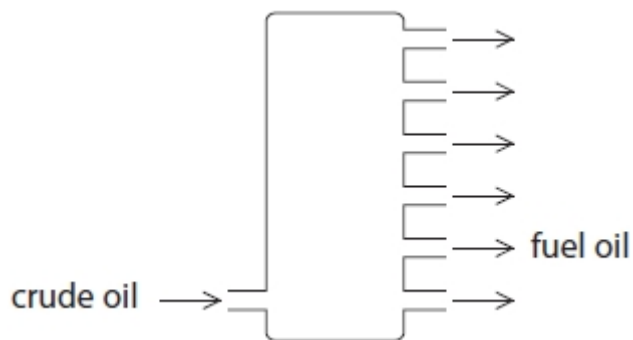energy | potassium nitrate(s) + water(l)
————————————————

(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)

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

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

(2)

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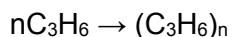...

(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)

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

(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)

……………………………………………………………………………………………..

(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