

**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

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.

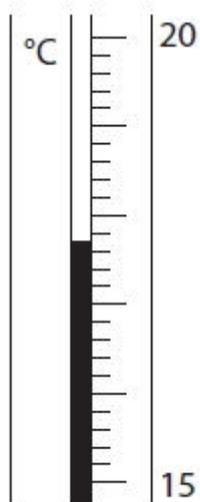
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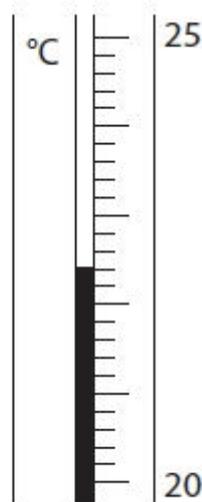
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(b) The student used a thermometer to measure the temperature rise. The diagrams show the thermometer readings before and after adding the metal.



before adding metal



after adding metal

Use the diagrams to complete the table.

(3)

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|---|--|
| 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?

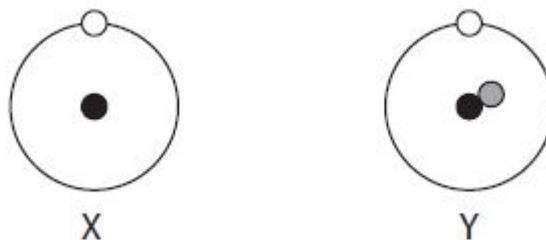
(1)

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3. This question is about the elements hydrogen and oxygen.
(a) The diagram below shows two different atoms of hydrogen.



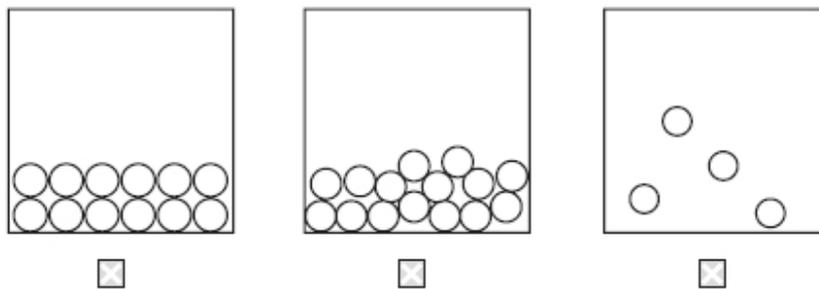
Place a cross in the appropriate box to indicate your choice of answer: A, B, C or D.

- (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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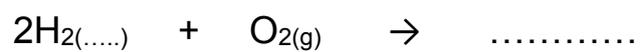
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(f) Hydrogen reacts with oxygen to form water.

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

(3)



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

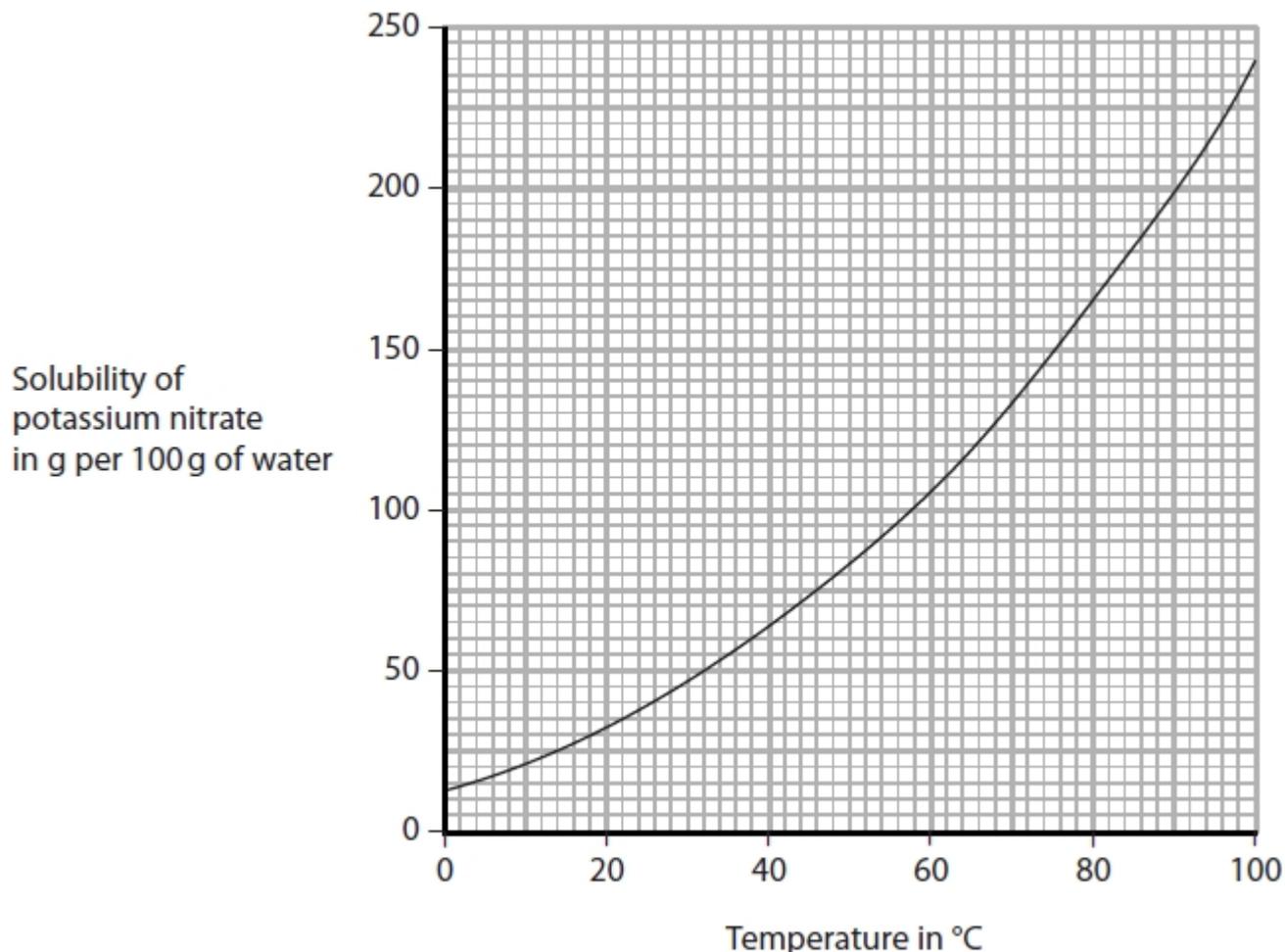
Show only the outer electrons of each atom.

(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 cm³ of water into a 100 cm³ 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.

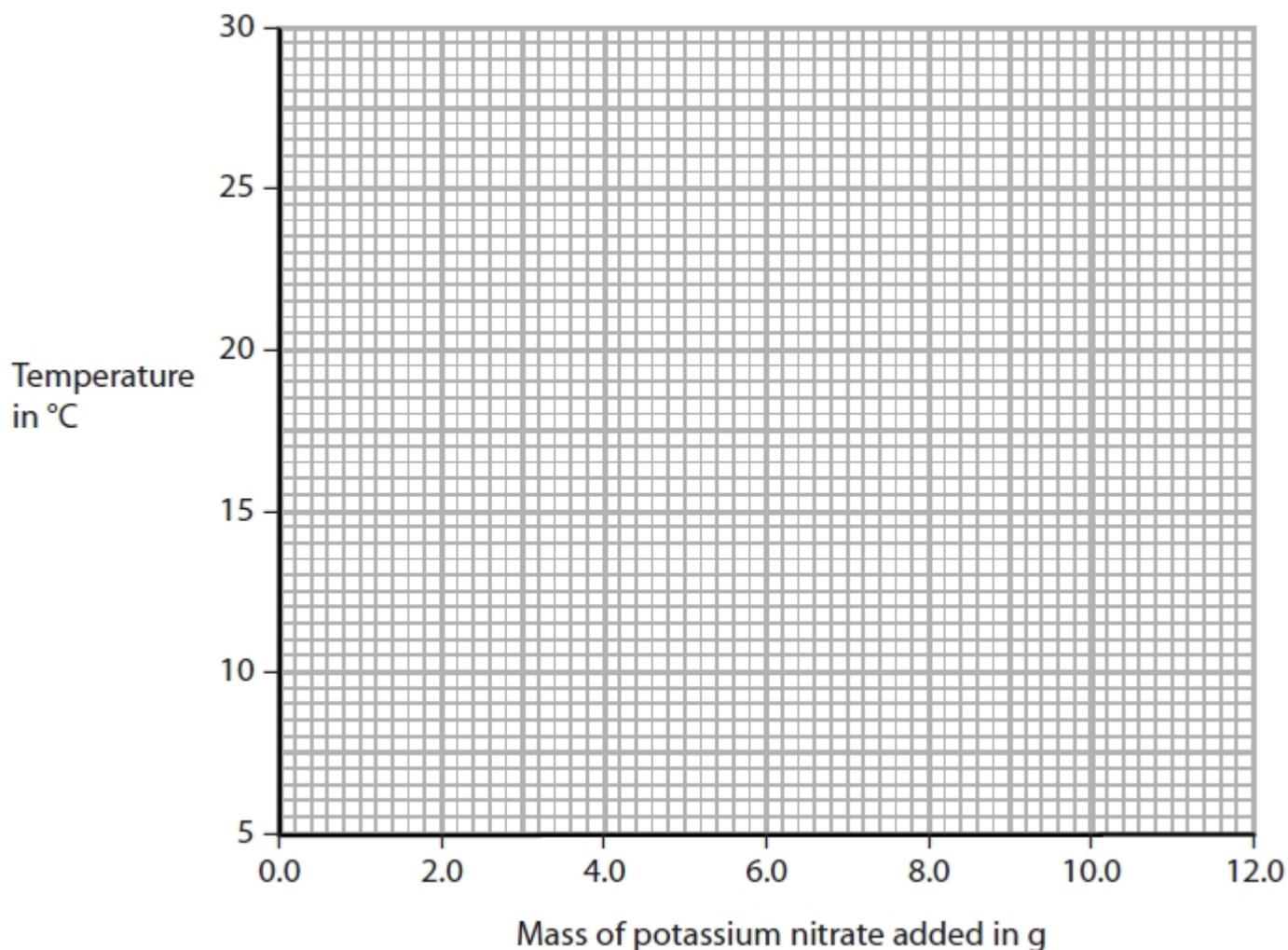
- add the first sample of potassium nitrate to the beaker and stir until the sample dissolves
- record the temperature of the solution
- add the second sample of potassium nitrate to the solution in the beaker and stir until the sample dissolves
- record the new temperature of the solution
- repeat until 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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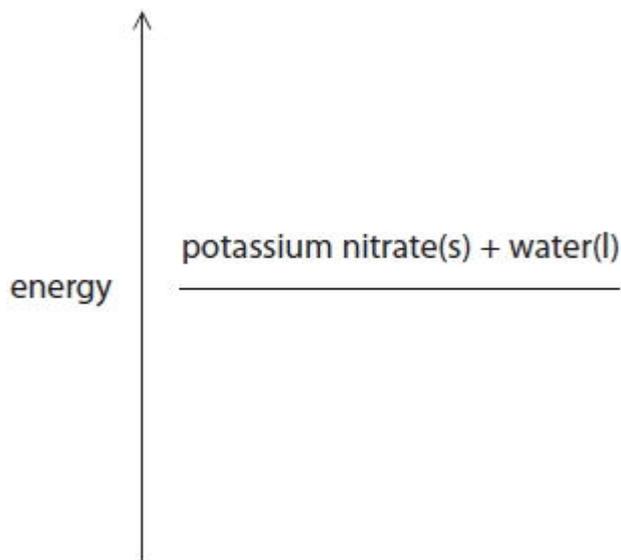
- (iii) Explain how the student's results show the type of heat change that occurs when potassium nitrate dissolves in water.

(2)

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

(1)



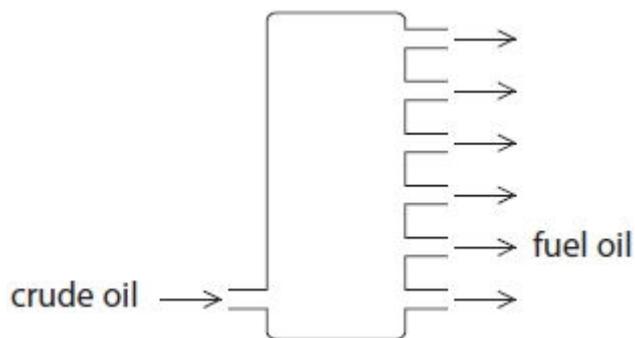
(Total for question = 8 marks)

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.



(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)



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

(2)

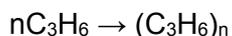
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- (iii) Explain which two compounds in this cracking reaction are described as saturated.

(2)

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(c) The conversion of propene into poly(propene) can be represented by this equation.



- (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

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Word equation
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(Total for Question = 8 marks)

END OF QUESTIONS