Section A

Answer **all** questions.
Write your answers in the boxes provided at the end of the Section.

1 Which diagram shows diffusion?

A

B

C

D

2 The fluoride ion is added to toothpaste to prevent tooth decay. It has the symbol shown.

$$^{19}_{9}F^{-}$$

A student makes two statements about this ion.

Statement 1: It contains more electrons than protons.

Statement 2: It contains more neutrons than protons.

Which statements is/are correct?

A 1 only

B 2 only

C both 1 and 2

D neither 1 nor 2

3 Substance L melts at –7 °C and is a brown liquid at room temperature (25 °C).

Which value could be the boiling point of L?

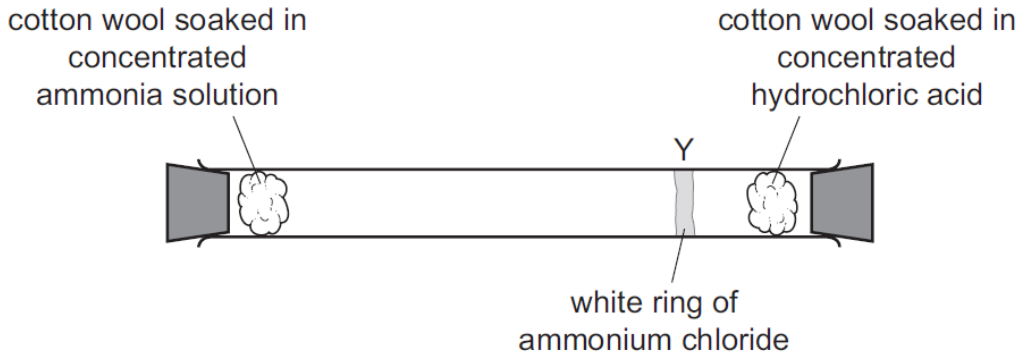
A –77 °C

B 0 °C

C 7 °C

D 59 °C

4 The apparatus shown is set up. Molecules of ammonia and hydrogen chloride react to form ammonium chloride. After 20 minutes, a white ring of ammonium chloride is seen at position Y.



Which statement best explains this observation?

A Molecules in ammonia diffuse more slowly because they have a larger mass than molecules of hydrogen chloride.

B Molecules in ammonia diffuse more quickly because they have a larger mass than molecules of hydrogen chloride.

C Molecules in ammonia diffuse more slowly because they have a smaller mass than molecules of hydrogen chloride.

D Molecules in ammonia diffuse more quickly because they have a smaller mass than molecules of hydrogen chloride.

5 Rubidium is in Group 1 of the Periodic Table and bromine is in Group 17.

Rubidium reacts with bromine to form an ionic compound.

What is the electron transfer taking place for rubidium, and the symbol of the rubidium ion?

	electron transfer	symbol of ion formed
A	electron gained	Rb^+
B	electron gained	Rb^-
C	electron lost	Rb^+
D	electron lost	Rb^-

Question	1	2	3	4	5
Answer					

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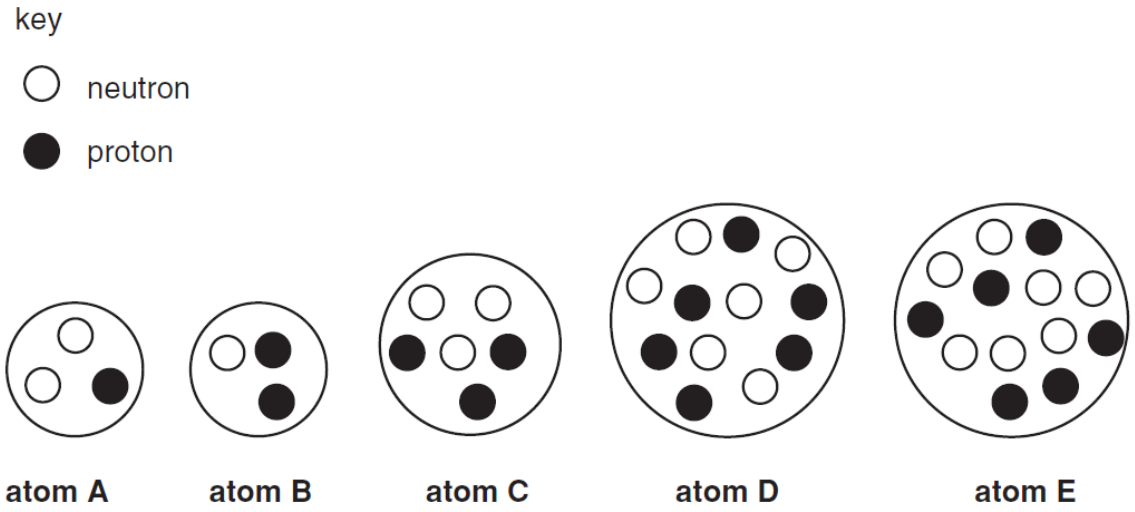
Section B
Answer **all** questions.
Write your answers in the spaces provided.

6 The diagram shows the nuclei of five different atoms.



(a) Which atom has a proton (atomic) number of 3?

..... [1]

(b) Which atom has a nucleon (mass) number of 12?

..... [1]

(c) Which **two** atoms are isotopes of the same element?

..... [1]

(d) Write the electronic arrangement of atom **E**.

..... [1]

[Total: 4]

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7 The table shows the percentages by mass of the elements in the Earth's crust and in the oceans.

element	percentage by mass in the Earth's crust	percentage by mass in the oceans
aluminium	8.20	0.00
calcium	3.60	0.05
chlorine	0.05	1.80
hydrogen	0.22	11.00
iron	5.00	0.00
oxygen	46.60	85.80
silicon	29.50	0.00
sodium	2.80	1.15
other elements	4.03	0.20
total	100.00	100.00

(a) Some elements found in the Earth's crust are not found in the oceans. Identify **two** such elements from the table.

…… [1]

(b) Some elements are found in a larger percentage by mass in the oceans than in the Earth's crust. Identify **two** such elements from the table.

…… [1]

(c) Many elements in the Earth's crust exist as compounds.

Showing outer electrons only, draw 'dot-and-cross' diagrams for the following compounds.

(i) calcium chloride

[3]

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(ii) sodium oxide

[3]

[Total: 8]

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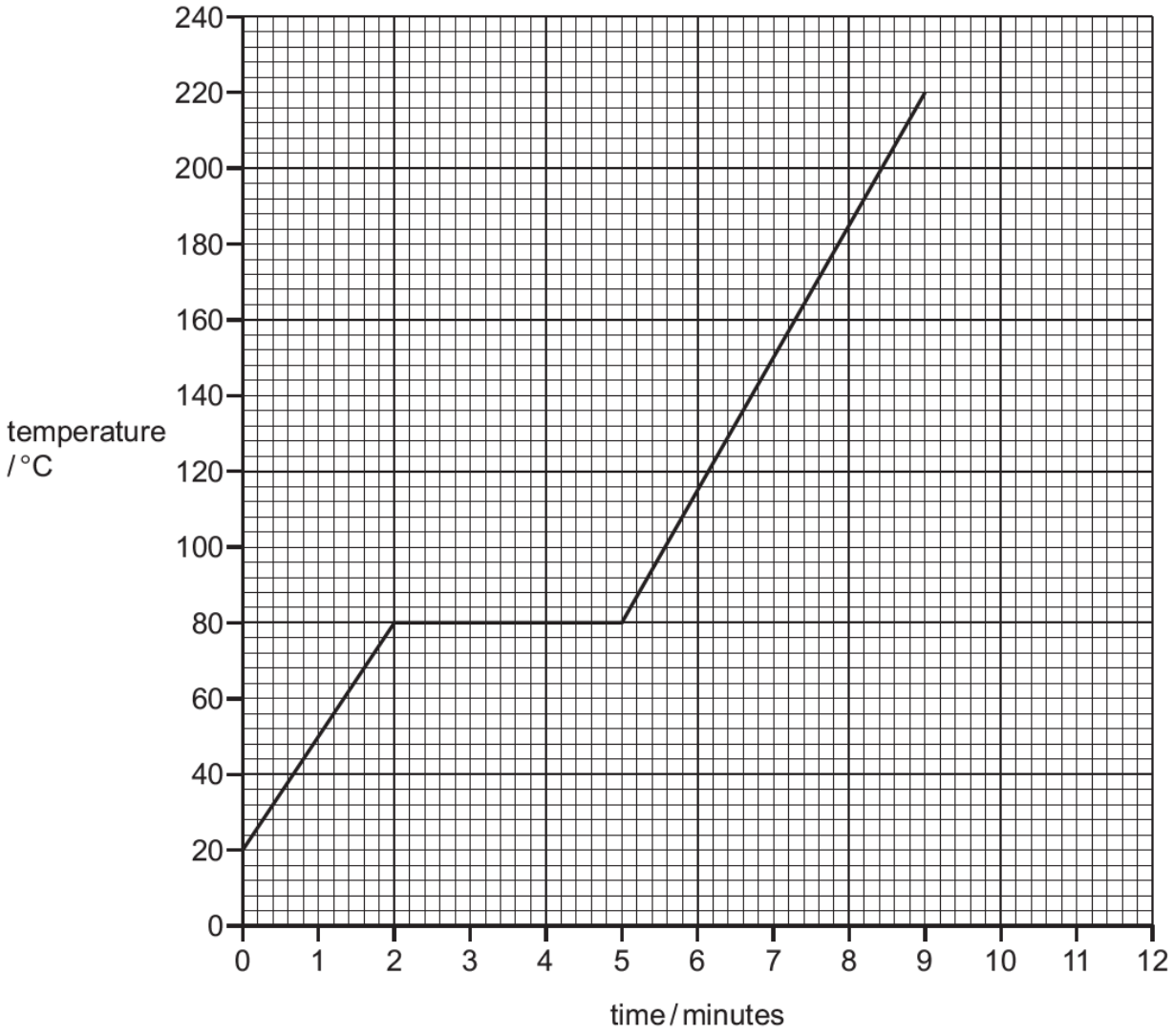
Section C

Answer **all** questions.
Write your answers in the spaces provided.

8 In an experiment, a sample of a solid Z was continually heated for 11 minutes.

The graph shows how the temperature of the sample of Z changed during the first 9 minutes.



(a) What is the melting point of Z?

…… [2]

(b) The sample of Z began to boil at 9 minutes. It was boiled for 2 minutes.

Use this information to sketch on the grid how the temperature of the sample of pure Z changed between 9 minutes and 11 minutes. [1]

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(c) Describe the differences in the **movement** and the **forces of attraction** between the particles of Z at 20 °C and at 120°C.

……

……

……

……

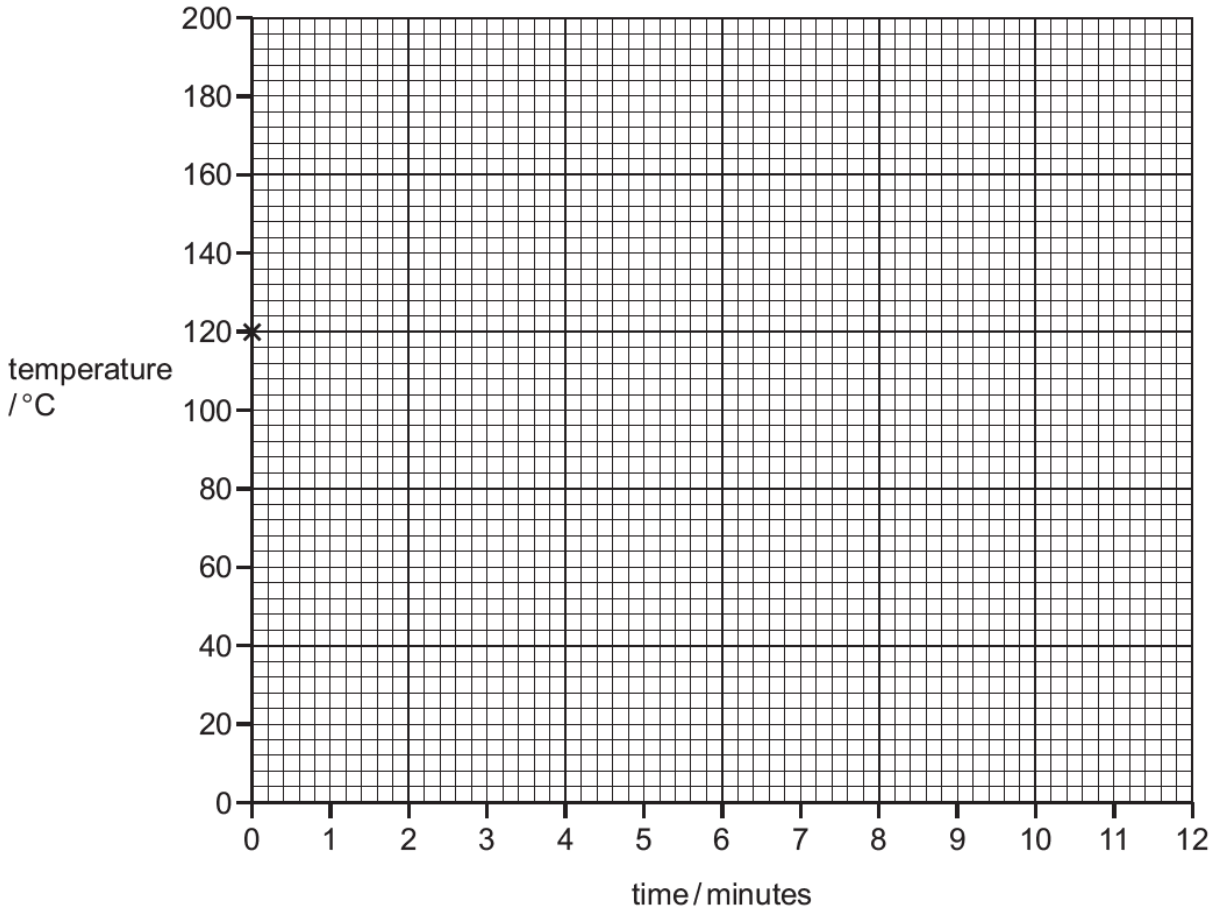
……

……

…… [3]

(d) A sample of Z was allowed to cool from 120 °C to 20 °C.
The total time taken was 8 minutes.

Starting from point ×, sketch on the grid how the temperature of the sample of Z changed between 0 minutes and 8 minutes. [3]



[Total: 9]

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9 Historical Development of the Atomic Structure

The first people to think about atoms more than 2000 years ago were the ancient Greeks. A man called Democritus proposed that if a piece of gold is cut into smaller and smaller pieces, it will finally become very small. This very small piece is so small that it will be impossible to cut it into even smaller pieces. This final small piece is called the atom. The word "atom" is derived from the Greek word "*atomos*", which means "indivisible". The idea of the atom was later taken up by a scientist called John Dalton. In 1808, he proposed the following ideas:

(a) Atoms cannot be divided into smaller particles (atoms are indivisible);
(b) Atoms of the same element have the same mass and properties;
(c) Atoms of different elements have different mass and properties;
(d) When chemical reactions take place, atoms of different elements join together to form compounds.

Later discoveries showed that Dalton's model was flawed and had to be modified. In 1897, J. J. Thomson discovered negatively-charged subatomic particles called electrons. This discovery destroyed the concept of atoms as being indivisible units. Since atoms are electrically neutral, Thomson proposed the presence of a positively-charged particle in the atom. As there were no known positively-charged particles at that time, he concluded that atoms consist of a positively-charged sphere in which electrons are embedded, just like a plum pudding.

In 1911, Ernest Rutherford discovered through an experiment that:

(a) a large part of the atom is made up of empty space;
(b) almost the entire mass of an atom is concentrated in a small volume called the nucleus;
(c) the nucleus contains positively-charged particles called protons;
(d) the number of protons equals the number of electrons;
(e) electrons move at high speeds at different distances from the nucleus.

In 1913, one of Rutherford's students, Niels Bohr proposed that electrons in an atom are arranged in circular paths (orbits) around the nucleus of the atom. He proposed that the electrons in a particular path possess a fixed energy, which prevents them from falling into the nucleus. He suggested that:

(a) electrons orbit the nucleus in fixed paths;
(b) electrons are arranged in shells, which contain electrons orbiting at the same distance from the nucleus;
(c) electrons in the same shell have the same energy level.

In 1932, James Chadwick discovered a third type of particles present in the nuclei of nearly all atoms. Chadwick called them neutrons.

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(a) Some ideas proposed by John Dalton are not correct. Use the information in the passage and your knowledge of atomic structure to explain **two** incorrect ideas of John Dalton.

……

……

……

……

……

…… [4]

(b) Suggest a reason why the mass of an atom calculated using Rutherford's model of an atom is always **less** than the true mass of the atom.

……

…… [1]

(c) Which scientist proposed the model of drawing the electronic arrangement of atoms that we use today?

…… [1]

(d) In 1932, James Chadwick discovered a third type of particles present in the nuclei of **nearly** all *atoms*. Chadwick called them neutrons.

Which element in the Periodic Table does **not** have a neutron?

…… [1]

(e) Neutrons have been used in nuclear reactions which results in the creation of artificial elements. In such processes, neutrons are accelerated to high speeds and are then fired like 'bullets' at the nucleus of an atom of another element.

Uranium-235 undergoes a similar reaction whereby a neutron is fired into its nucleus as shown below.

$^{235}_{92}U$ + 1 neutron → $^{89}_{36}X$ + $^{144}_{56}Y$ + 3 neutrons

Using the Periodic Table, deduce the identities of elements X and Y.

X is ……

Y is …… [2]

[Total: 9]

**********End of Paper**********