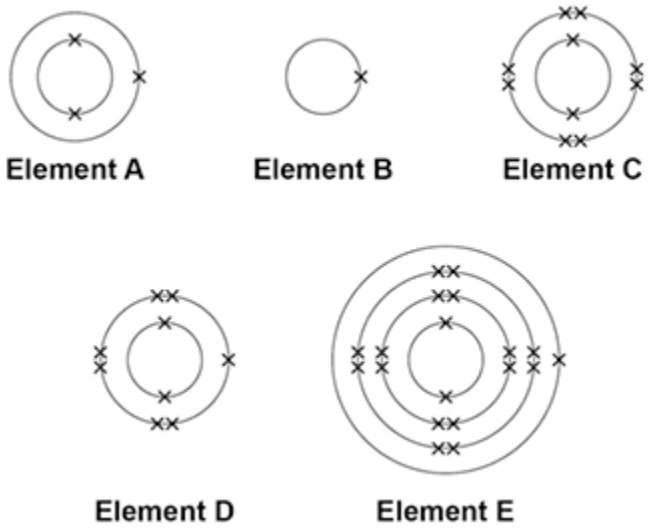
1 The electronic structure of the atoms of five elements are shown in the figure below.

The letters are **not** the symbols of the elements.



Choose the element to answer the question. Each element can be used once, more than once or not at all.

Use the periodic table to help you.

(a) Which element is hydrogen?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which element is a halogen?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which element is a metal in the same group of the periodic table as element **A**?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(d) Which element exists as single atoms?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(e) There are two isotopes of element **A**. Information about the two isotopes is shown in the table below.

Mass number of the isotope	6	7
Percentage abundance	92.5	7.5

Use the information in the table above above to calculate the relative atomic mass of element **A**.
Give your answer to 2 decimal places.

.....

.....

.....

.....

.....

.....

.....

Relative atomic mass = ...

(4)
(Total 8 marks)

2 This question is about atoms, molecules and nanoparticles.

(a) Different atoms have different numbers of sub-atomic particles.

(i) An oxygen atom can be represented as $^{16}_{8}O$

Explain why the mass number of this atom is 16.

You should refer to the numbers of sub-atomic particles in the nucleus of the atom.

.....

.....

.....

.....

.....

.....

(2)

(ii) Explain why $^{12}_{6}C$ and $^{14}_{6}C$ are isotopes of carbon.

You should refer to the numbers of sub-atomic particles in the nucleus of each isotope.

.....

.....

.....

.....

.....

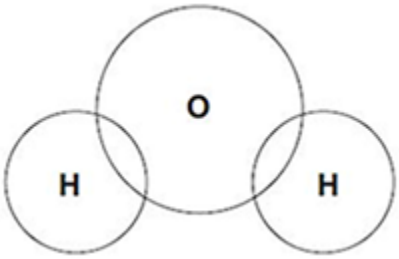
.....

(3)

(b) Hydrogen atoms and oxygen atoms chemically combine to produce water molecules.

(i) Complete the figure below to show the arrangement of the outer shell electrons of the hydrogen and oxygen atoms in a molecule of water.

Use dots (•) or crosses (×) to represent the electrons.



(2)

(ii) Name the type of bonding in a molecule of water.

.....

(1)

(iii) Why does pure water **not** conduct electricity?

.....

.....

(1)

(c) Nanoparticles of cobalt oxide can be used as catalysts in the production of hydrogen from water.

(i) How does the size of a nanoparticle compare with the size of an atom?

.....

.....

(1)

(ii) Suggest **one** reason why 1 g of cobalt oxide nanoparticles is a better catalyst than 1g of cobalt oxide powder.

.....

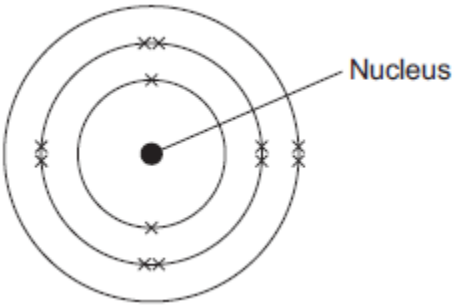
.....

(1)

(Total 11 marks)

3 This question is about magnesium.

(a) (i) The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

electrons	**neutrons**	**protons**	**shells**

The nucleus contains protons and .....

The particles with the smallest relative mass that move around the nucleus are called .....

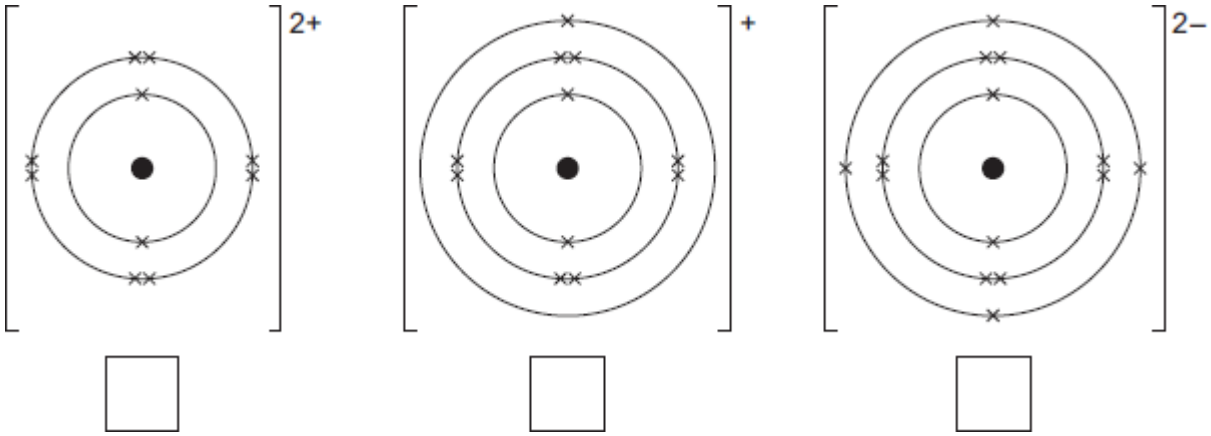
Atoms of magnesium are neutral because they contain the same number of electrons and .....

(3)

(ii) A magnesium atom reacts to produce a magnesium ion.

Which diagram shows a magnesium ion?

Tick (✓) **one** box.



(1)

(b) Magnesium and dilute hydrochloric acid react to produce magnesium chloride solution and hydrogen.

$$Mg(s) + 2\,HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

(i) State **two** observations that could be made during the reaction.

1 .....

.....

2 .....

.....

(2)

(ii) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe a method for making pure crystals of magnesium chloride from magnesium and dilute hydrochloric acid.

In your method you should name the apparatus you will use.

You do **not** need to mention safety.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)
(Total 12 marks)

Mark schemes

1

(a) **B**

1

(b) **D**

1

(c) **E**

1

(d) **C**

1

(e) 92.5 × 6 **and**
7× 7.5

1

$\frac{607.5}{100}$

1

6.075

1

6.08

1

*allow 6.08 with no working shown for **4** marks*

[8]

2

(a) (i) (mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus)

*accept mass number is total number of protons and neutrons for **1** mark*

2

(ii) same number of protons **or** both have 6 protons

accept same atomic number

1

^{12}C has 6 neutrons

1

^{14}C has 8 neutrons

1

*accept different number of neutrons for **1** mark*
numbers, if given, must be correct
*incorrect reference to electrons = **max 2** marks*

(b) (i) 2 bonding pairs

1

additional unbonded electrons negates this mark

4 unbonded electrons around oxygen

1

accept dot, cross or e or – or any combination

(ii) covalent

1

(iii) any **one** from:

- no delocalised / free electrons
  ignore mobile electrons
- no overall electric charge
  accept no charge (carriers)
- no ions

1

*do **not** accept any implications of the presence of ions*

(c) (i) larger

accept the size of a few hundred atoms

accept atoms are smaller (than nanoparticles)

allow up to 1000 atoms)

1

(ii) (nanoparticles have) large(r) surface area

1

[11]

3 (a) (i) neutrons

this order only

1

electrons

1

protons

1

(ii) box on the left ticked

1

(b) (i) effervescence / bubbling / fizzing / bubbles of gas

*do **not** accept just gas alone*

1

magnesium gets smaller / disappears

allow magnesium dissolves

*allow gets hotter **or** steam produced*

ignore references to magnesium moving and floating / sinking and incorrectly named gases.

1

(ii) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
There are simple statements of some of the steps in a procedure for obtaining magnesium chloride.

Level 2 (3−4 marks)
There is a description of a laboratory procedure for obtaining magnesium chloride from dilute hydrochloric acid and magnesium.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **or** a method of obtaining magnesium chloride crystals.

Level 3 (5−6 marks)
There is a well organised description of a laboratory procedure for obtaining magnesium chloride that can be followed by another person.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **and** a method of obtaining magnesium chloride crystals.

examples of the points made in the response:

- hydrochloric acid in beaker (or similar)
- add small pieces of magnesium ribbon
- until magnesium is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess magnesium
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper).

*Student may choose to use a named indicator until it turns a neutral colour, record the number of pieces of magnesium added then repeat without the indicator.

6

[12]