

1

This question is about atomic structure and elements.

(a) Complete the sentences.

(i) The atomic number of an atom is the number of

(1)

(ii) The mass number of an atom is the number of

.....

(1)

(b) Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

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.....

.....

(2)

(c) Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

.....

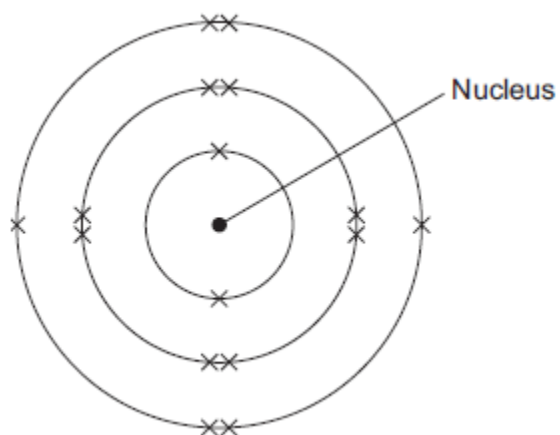
.....

.....

.....

(2)

- (d) The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick (✓) **one** box.

Ar

☐

O

☐

S

☐

Si

☐

(1)

- (e) When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

- (i) Compounds formed when non-metals react with metals consist of particles called

(1)

- (ii) Compounds formed from only non-metals consist of particles called

(1)

(Total 9 marks)

2

This question is about calcium.

- (a) What type of compound is calcium oxide?

Tick **one** box.

An acid

☐

A base

☐

A carbonate

☐

A salt

☐

(1)

- (b) Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

bonds

forces

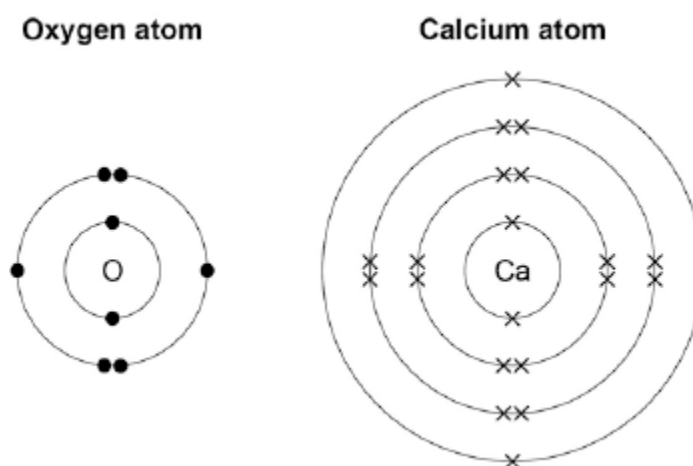
ions

layers

Calcium oxide has a giant ionic lattice in which there are strong electrostatic
..... of attraction in all directions.

(1)

- (c) The figure below shows the electronic structure of an oxygen atom and a calcium atom.



Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

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.....

.....

(4)
(Total 6 marks)

3

Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



- (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.

(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

- (i) Calculate the relative atomic mass (A_r) of metal M.

.....

.....

.....

Relative atomic mass (A_r) =

(2)

- (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

The name of metal M is

(1)

- (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

- (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

.....

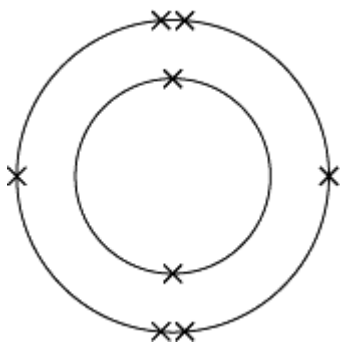
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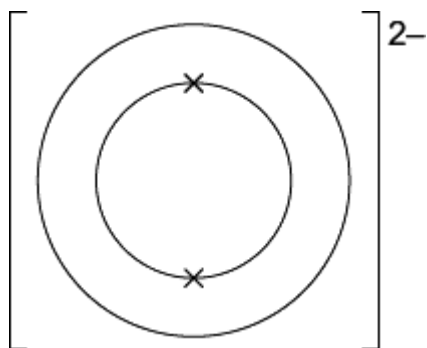
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(2)

- (ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



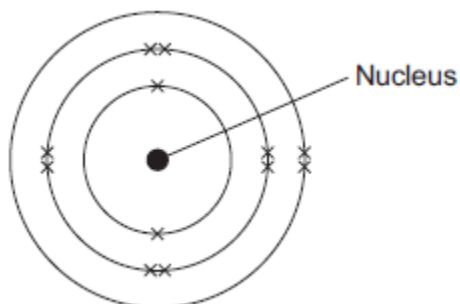
(1)

(Total 6 marks)

4

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

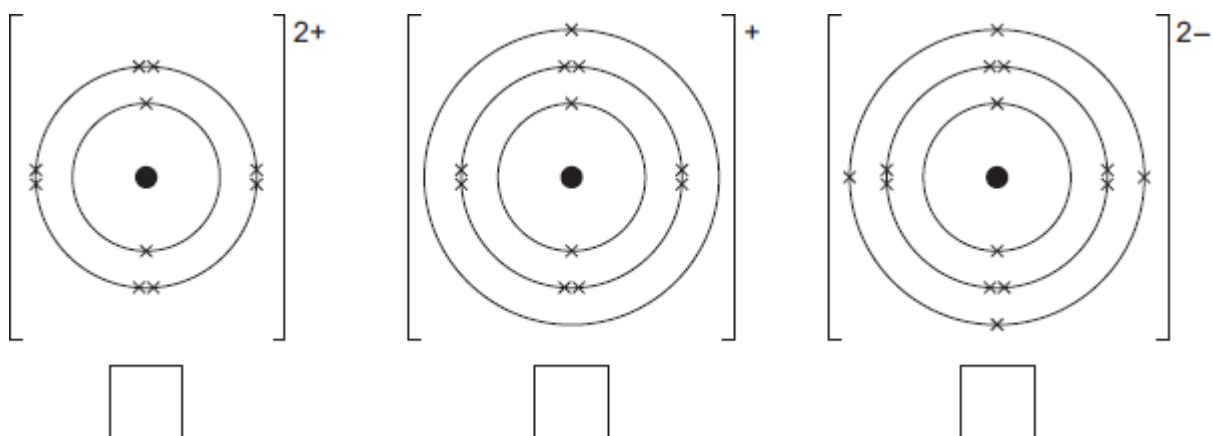
Atoms of magnesium are neutral because they contain the same number of electrons and

(3)

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

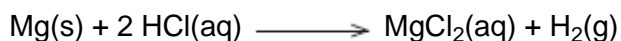
Which diagram shows a magnesium ion?

Tick (✓) **one** box.



(1)

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



- (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.

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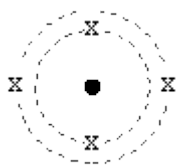
.....

(6)

(Total 12 marks)

5

- (a) The diagram shows the electronic structure of a particular element.



In a similar way, show the electronic structure of another element from the same group in the periodic table and name the element you select.

Name of element selected

(4)

- (b) The element lithium gives a moderate reaction with cold water, releasing hydrogen and forming a solution of lithium hydroxide.

Describe how sodium is similar to and how it is different from lithium in its chemical reaction with cold water.

Explain any similarity or difference in terms of their atomic structure.

Similarity.

Reason.

.....

.....

Difference.

Reason.

.....

.....

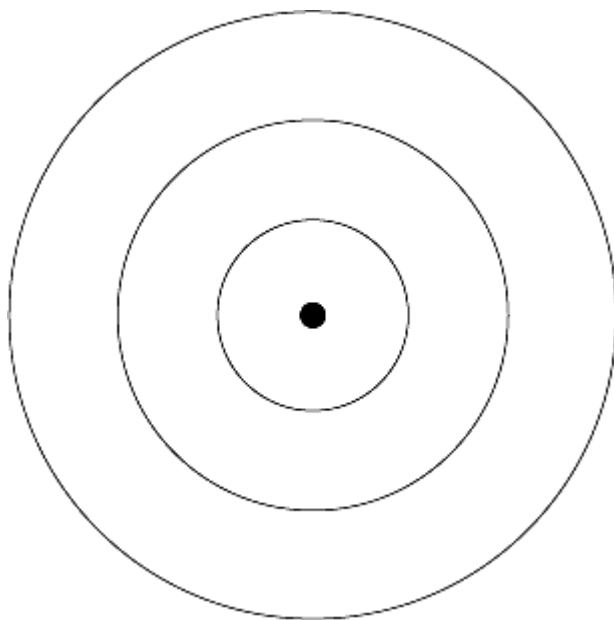
(5)

(Total 9 marks)

6

Sodium is a reactive element.

- (a) Complete the diagram to show the electronic structure of a sodium atom.



(2)

- (b) Sodium reacts with chlorine to form sodium chloride.

Explain how in terms of electrons, atoms and ions.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(Total 6 marks)

Mark schemes

1

- (a) (i) protons

allow "protons or electrons", but do not allow "protons and electrons"

1

- (ii) protons plus / and neutrons

1

- (b) (because the relative electrical charges are) $-(1)$ for an electron and $+(1)$ for a proton

allow electrons are negative and protons are positive

1

and the number of electrons is equal to the number of protons

if no other mark awarded, allow 1 mark for the charges cancel out

1

- (c) (the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7

allow diagrams for the first marking point

1

(so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell

if no other mark awarded, allow 1 mark for have the same / similar properties

1

- (d) S

1

- (e) (i) ions

1

- (ii) molecules

1

[9]

2

- (a) A base

1

- (b) forces

1

- (c) calcium loses electrons and oxygen gains electrons

max 3 for incorrect reference to atom / ion or to oxygen / oxide

1

two electrons are transferred

1

calcium has a 2^+ charge

1

oxide has a 2⁻ charge

1
[6]

3

(a) (i) 65

correct answer with or without working = 2 marks

if answer incorrect

evidence of (81 - 16) for 1 mark

ignore units

2

(ii) zinc

accept error carried forward from (a)(i)

allow correct symbol

answer given should be element / metal closest to their answer

*do **not** allow compounds*

1

(b) (i) • it loses electrons

sharing / covalency = max 1 mark

1

• three electrons

1

(ii) 8 electrons shown in second shell.

accept dots / crosses / mixture of dots and crosses / e

electrons do not need to be paired

*do **not** allow extra electrons in first shell*

1

[6]

4

(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]

5

- (a) 2.8.2. magnesium or 2.8.8.2. calcium
inner shell (2)
outer shell (2)
intermediate shell/s correct
element named to match structure

each for 1 mark

(Structure correct for element name but not in group 2, award 2 marks)

4

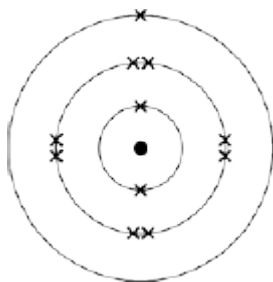
- (b) Similar hydrogen and/or an alkali/hydroxide produced
for 1 mark
- Reasons: chemical reaction involves loss of an electron
Na + Li have the same number of electrons in the outer shell
(do not allow same group of p.table)
each for 1 mark
- Different rate of reaction faster for sodium*
for 1 mark
- Reason: outer electron more easily lost from the sodium atom
[* allow sodium hydroxide produced]
for 1 mark

5

[9]

6

(a)



1 mark for 11 electrons shown

1

1 mark for 2:8:1 arrangement
accept any symbol for electrons

1

(b) max 3 marks if reference to covalent bonding or sharing electrons

a sodium atom loses one electron
do **not** accept gains 7 electrons

1

to become sodium / positive ion(s)

1

a chlorine atom gains one electron
do **not** accept loses 7 electrons
allow 1 mark for sodium loses electrons **and** chlorine gains electrons

1

to become chloride / negative ion(s)

allow chlorine ion

*for **2** marks accept:*

chlorine gains an electron from sodium

or

chlorine and sodium become ions

*if no other marks scored allow **2** marks for sodium loses electrons
and chlorine gains electrons to form ionic bonds*

*if no other marks scored allow **1** mark for:*

both sodium and chlorine get full outer shells

or

reference to ionic bonding

1

[6]