The Periodic Table

Mark Scheme

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.1 Atomic Structure and the Periodic Table
Sub-Topic	The Periodic Table
Difficulty Level	Gold Level
Booklet	Mark Scheme

Time Allowed: **59 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

M1.(a) 1×10^{-10} m

1

(b) 1 / one

allow alkali metals

1

(c) R and S

1

because they have the same number of protons

allow same atomic number, different mass number

1

and a different numbers of neutrons

1

(d) **Level 3 (5–6 marks):**
A relevant and coherent explanation of the trend in reactivity. The response makes logical links between the points raised and considers both the number of energy levels
and the distance between the nucleus and the outer energy level.

Level 2 (3–4 marks):
Statements that are linked to provide a simple explanation of the trend in reactivity using either the number of energy levels or the distance between the nucleus and the outer energy level.

Level 1 (1–2 marks):
Simple statements made about the halogens or the trend in reactivity.

0 marks:
No relevant comment

Indicative content

Simple statements / descriptions

- have 7 electrons in the outer shell

- need to gain an electron
- form ions with a -1 charge
- halogens further down the group are less reactive (or vice versa)
- halogens further down the group have more shells or energy levels (or vice versa)

Linked statements / explanations

- have 7 electrons in the outer shell so need to gain an electron to have the electronic structure of a noble gas
- halogens further down the group are less reactive because they have more shells or energy levels (or vice versa)
- halogens further down the group have more shells or energy levels so less attractive force on the incoming electron (or vice versa)
- halogens further down the group have more shells or energy levels so more 'shielding' against the incoming electron (or vice versa)
- outer electrons of halogens further down group are further away from the attractive force of the nucleus (or vice versa)
- an electron is less easily gained because there are more shells or energy
  levels (or vice versa)
- an electron is less easily gained because the outer electrons are further from
  the attractive force of the nucleus (or vice versa)

6

[11]

M2.(a) did not appear because they had not been discovered **or** they are unreactive **or** they did not form compounds

1

(b) arranged in order of atomic / proton number

1

elements in the same group have the same number of electrons in the outer shell

1

(c) chlorine>bromine>iodine

table shows that chlorine displaces bromine and iodine

1

and bromine displaces iodine

1

(d) $Cl_2(aq) + 2\ Br^-(aq) \rightarrow Br_2(aq) + 2\ Cl^-(aq)$

correct formulae

1

correct balancing

1

correct state symbol

1

(e) the further down the group, the halogen becomes less reactive because outer electrons
are further from the nucleus

1

so less attractive force on an incoming electron

1

[10]

M3.(a) (i) any **one** from:

- one electron in the outer shell / energy level
- form ions with a 1+ charge

1

(ii) any **one** from:

- hydrogen is a non-metal
- (at RTP) hydrogen is a gas
- hydrogen does not react with water
- hydrogen has only one electron shell / energy level
- hydrogen can gain an electron **or** hydrogen can form a negative / hydride / H^- ion
- hydrogen forms covalent bonds **or** shares electrons

accept answers in terms of the Group 1 elements

1

(b) (i) (bromine) gains electrons

it = bromine

*do **not** accept bromide ion gains electrons*

ignore loss of oxygen

1

(ii) I_2

must both be on the right hand side of the equation

1

+ $2e^-$

*$2I^- - 2e^- \rightarrow I_2$ for **2** marks*

1

(iii) fluorine is the smallest atom in Group 7 **or** has the fewest energy levels in Group 7 **or** has the smallest distance between outer shell and nucleus

*the outer shell **must** be mentioned to score 3 marks*

1

fluorine has the least shielding **or** the greatest attraction between the nucleus and the outer shell

1

therefore fluorine can gain an electron (into the outer shell) more easily

1

[8]

M4.(a) if placed consecutively, then elements would be in wrong group / have wrong properties

allow some elements didn't fit pattern

1

left gaps

1

(b) (elements placed in) atomic / proton number order

1

(elements in) same group have same number of outer electrons

1

any **one** from:

- number of protons = number of electrons
- reactions/(chemical) properties depend on the (outer) electrons
- number of shells gives the period

allow number of shells increases down the group

1

(c) (i) (transition elements usually) have same / similar number of outer / 4th shell electrons

allow 2 electrons in outer shell

1

(because) inner (3rd) shell / energy level is being filled

ignore shells overlap

1

(ii) 2nd shell / energy level can (only) have maximum of 8 electrons

accept no d-orbitals

or 2nd shell / energy level cannot have 18 electrons

1

[8]

M5. (a) (i) *incorrect or no element = **0** marks*

hydrogen

allow H / H_2

1

all the other elements are metals

allow hydrogen is a not an (alkali / group 1) metal

ignore hydrogen is a gas

OR

copper (1)

allow Cu

(copper) is not an alkali metal (1)

allow Cu is a transition element / metal

allow any valid specific chemical property eg Cu does not react with water

ignore references to electronic structure

ignore physical properties

1

(ii) Group 0 / noble gases

ignore Group 8

1

(b) (i) scandium / gallium / germanium

accept Sc / Ga / Ge

allow Krypton / Kr

1

(ii) predicted they were metals

allow atomic mass / weight

ignore atomic structure

1

predicted their (chemical/physical) properties / reactivity

accept any chemical / physical property
allow similar properties if mentioned in context of a group

1

(c) (i) (both) have one / an electron in the outer energy level / shell
ignore form single plus ions

1

(ii) *accept shell for energy level*
accept converse explanation for lithium
if 'outer' not mentioned, max 2 marks
ignore sodium reacts more easily

sodium loses one outer electron more easily (than lithium)

1

because outer electrons/energy level further from the nucleus in sodium **or** because sodium has more shells (than lithium)
*do **not** accept 'more outer shells'*
allow sodium (atom) is larger

1

because forces/attraction to hold outer electron are weaker in sodium (than lithium)
accept more shielding in sodium (than lithium)

1

[10]

M6. (a) because the nitrogen from dry air contained noble/Group 0 gases
ignore other gases

or

(because the nitrogen from dry air) contained argon / krypton / xenon
ignore helium and neon

1

and three / some of these gases, (argon, krypton, xenon) have a greater density than nitrogen

ignore helium and neon

or

and argon / krypton / xenon has a greater density than nitrogen

1

(b) (i) carbon dioxide would form / is a solid

accept carbon dioxide freezes or its freezing point is > –200°C

ignore melting point

or

(solid) carbon dioxide would block pipes

1

(ii) helium **(and)** neon

*both needed for **1** mark*

accept He and Ne

1

(iii) argon **(and)** oxygen

accept Ar and O_2

1

because there is only a difference of 3°C in their boiling points

accept because they have boiling points that are almost the same

1

[6]

M7. (a) all have seven electrons in their outer shell / energy level

1

(b) *must be comparative in all points or converse*

chlorine atom is smaller than bromine atom

or
chlorine atom has fewer shells than bromine atom

1

outer shell / energy level of chlorine has stronger (electrostatic) attraction to the nucleus than bromine

or
outer shell of chlorine is less shielded from the nucleus than bromine

1

so chlorine more readily gains an extra electron

1

[4]