Mark schemes

Q1.

(a) non-metallic element

1

(b) compound

1

(c) noble gases

1

(d) the boiling points increase down the group

1

(e) atoms

1

(f) XO_2

1

(g) $(2.8)^2 \times 6$

1

= 47.04

1

= 47 (nm^2)

allow an answer correct to 2 significant figures resulting from an incorrect attempt at the calculation

1

(h) the surface area to volume ratio of the fine particle is 10 times greater

1

[10]

Q2.

(a) 2,8,8,1

1

(b) they have the same number of outer shell electrons

1

(c) metallic

1

(d) any **two** from:

- bubbles (very) quickly
- melts (into a ball)
- floats
- moves (very) quickly

allow flame

2

(e) (reactivity) increases (down the group)

1

(f) any **two** from:
- increasing speed of movement
- increasing rate of bubble production
- doesn't melt → melts
- no flame → flame
  or
  flame → explosion

2

(g) hydrogen

1

(h) sodium ion structure 2,8

1

fluoride ion structure 2,8

allow any combination of circles, dots, crosses or e(–)

1

+ charge on sodium ion **and**
– charge on fluoride ion

an answer of

sodium ion fluoride ion

scores **3** marks

1

[12]

Q3.

(a) (atoms with the) same number of protons

allow atoms with the same atomic number

allow atoms of the same element

ignore the same number of electrons

1

(but with) different numbers of neutrons

ignore (but with) different mass numbers

*do **not** accept (but with) different relative atomic mass*

1

(b) $(A_r =) \frac{(69 \times 60) + (71 \times 40)}{100}$

1

= 69.8

1

(c) (number of electrons) = 31

1

(number of neutrons) = 38

1

(d) Ga^{3+}

1

(e) (gallium) fitted in a gap (Mendeleev had left)

1

(gallium's) properties were predicted correctly (by Mendeleev)

allow (gallium's) properties matched the rest of the group

1

[9]

Q4.

(a) any **two** from:

- (potassium) floats
- (potassium) melts
- (potassium) moves around
- potassium becomes smaller

  allow potassium disappears
- (lilac) flame
- effervescence

  allow fizzing

2

(b) $2K + 2H_2O \rightarrow 2KOH + H_2$

allow multiples

*allow **1** mark for KOH **and** H_2*

2

(c) reactivity increases (going down the group)

1

(because) the outer electron / shell is further from the nucleus

allow (because) there are more shells

allow (because) the atoms get larger

1

(so) there is less attraction between the nucleus and the outer electron / shell

allow (so) there is more shielding from the nucleus

*do **not** accept incorrect attractions*

1

(so) the atom loses an electron more easily

1

(d) (dot and cross diagram to show) sodium atom **and** oxygen atom

allow use of outer shells only

1

two sodium atoms to one oxygen atom

allow two sodium ions to one oxide ion

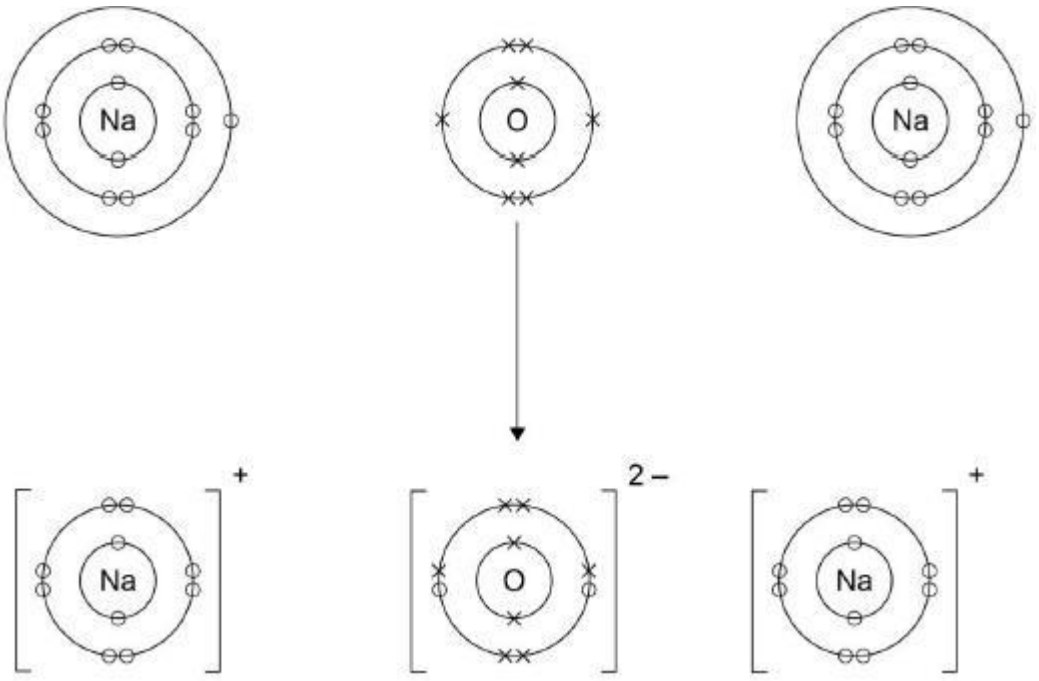
1

(to produce) sodium ion with a + charge

1

(to produce) oxide ion with a 2– charge

1



scores **4** marks

(e) (oxygen) gains electrons

1

(f) giant structure

allow (giant ionic) lattice

1

(with) strong (electrostatic) forces of attraction between (oppositely charged) ions

1

(so) large amounts of energy are needed to break the bonds / forces

allow (so) large amounts of energy are needed to separate the ions

1

[16]

Q5.

(a) any **three** from: (nuclear model)

- mostly empty space

  allow the plum pudding model has no empty space

  allow the plum pudding model is solid

- the positive charge is (all) in the nucleus

  allow in the plum pudding model the atom is a ball of positive charge (with embedded electrons)
  *do **not** accept reference to protons*

- the mass is concentrated in the nucleus

  allow in the plum pudding model the mass is spread out
  *do **not** accept reference to neutrons*

- the electrons and the nucleus are separate

  allow in the plum pudding model the electrons are embedded

  allow in the nuclear model the electrons are in orbits

3

(b) electrons orbit the nucleus

*do **not** accept reference to protons / neutrons*
allow electrons are in energy levels around the nucleus
or
allow electrons are in shells around the nucleus

1

electrons are at specific distances from the nucleus

1

(c) atomic number is the number of protons

1

(and) protons were not discovered until later

ignore electrons / neutrons were not discovered until later

1

(d) so their properties matched the rest of the group

allow converse

1

[8]

Q6.

(a) gas

1

(b) -35 (°C)

allow any value between -35 °C and -100 °C

1

(c) increase

1

increase

allow become stronger

1

(d) chlorine gas is toxic

1

(e) increased

1

chlorine (atoms) are now part of the solid (iron chloride)
or

the mass of the chlorine (atoms) is now also measured

1

(f) burns very vigorously

allow burns violently
allow brighter (orange) glow
allow (orange) flame
allow explodes

1

(g) $2\ Fe + 3\ Br_2 \rightarrow 2\ FeBr_3$

allow multiples

1

(h) $56 + (3 \times 80)$

1

$= 296$

ignore units

1

[11]

Q7.

(a) liquid gas

1

(b) (boiling point) increases (down the table / group)

1

(because) the relative formula / molecular mass increases
or
(because) the size of the molecule increases

1

(so) the intermolecular forces increase (in strength)

allow (so) the forces between molecules increase (in strength)

1

(so) more energy is needed to overcome the intermolecular forces

allow (so) more energy is needed to separate the molecules

*do **not** accept a reference to breaking bonds unless specifically between molecules*

1

(c) boiling point is a bulk property

allow boiling point is related to intermolecular forces (so more than one molecule is involved)

1

(d) the gas / halogen is toxic

allow the gas / halogen is poisonous / harmful allow to prevent inhalation of the gas / halogen

ignore deadly / lethal

1

(e) (going down the group) the outer electrons / shell become further from the nucleus

allow energy level for shell throughout

allow the atoms become larger

allow the number of shells increases

ignore the number of outer shells increases

1

(so) the nucleus has less attraction for the outer electrons / shell

allow (so) the nucleus has less attraction for the incoming electron

allow (so) increased shielding between the nucleus and the outer electrons / shell

allow (so) increased shielding between the nucleus and the incoming electron

1

(so) an electron is gained less easily

1

(f) 4.48 (g iron) **and** 8.52 (g chlorine)

1

(moles Fe = $\frac{4.48}{56}$ =) 0.08

allow correct calculation using incorrectly calculated mass of iron

1

(moles Cl = $\frac{8.52}{35.5}$ =) 0.24

allow correct calculation using incorrectly calculated mass of chlorine

allow (moles Cl_2 = $\frac{8.52}{71}$ =) 0.12

1

(Fe : Cl = 0.08 : 0.24 =) 1 : 3

allow correct calculation using incorrectly calculated moles of iron and / or chlorine

2 Fe + 3 Cl_2 → 2 $FeCl_3$

allow multiples / fractions

allow a correctly balanced equation including Fe and Cl_2 from an incorrect ratio of Fe : Cl

*allow **1** mark for Fe **and** Cl_2 (reactants) **and** $FeCl_3$ (product)*
or
*allow **1** mark for Fe **and** Cl_2 (reactants) **and** a formula for iron chloride correctly derived from an incorrect ratio of Fe : Cl (product)*

2

[16]

Q8.

(a)

ignore reference to atomic structure
ignore references to Cr, Mn and Mo

any **one** from:

- so elements / iodine / tellurium were in groups with similar properties
- iodine has similar properties to Br / Cl / F / Group 7
  allow corresponding argument in terms of tellurium
- iodine has different properties to Se / S / O / Group 6
  allow corresponding argument in terms

of tellurium

1

(b)

ignore reference to atomic structure

Mendeleev had predicted properties of missing elements

1

elements were discovered (that filled the spaces / gaps)

1

properties (of these elements) matched Mendeleev's predictions

allow atomic weights (of these elements) fitted in the spaces / gaps

1

*if no other mark awarded, allow **1** mark for in previous versions of the periodic table the pattern of similar properties broke down*

1

(c) relative atomic mass

1

(d) (increasing) atomic / proton number

ignore (increasing) electron number

*do **not** accept relative atomic / proton number*

1

(e) (formula) At_2

ignore incorrect state symbol

1

(state) solid

allow (s)

ignore s

1

(f) any **two** from:

- flame
  allow burns
- (white) solid forms
  allow (white) smoke forms
- colour of gas / chlorine disappears / fades

2

[10]

Q9.

(a) 7

1

(b) small molecule

1

(c) F_2

1

(d) the reactivity decreases (going down Group 7)

allow the reactivity decreases from chlorine to iodine

1

(because) chlorine displaces bromine and iodine

allow (because) chlorine has two reactions

allow (because) neither bromine nor iodine can displace chlorine

1

(and) bromine displaces iodine **or** iodine does not react

allow (and) bromine has one reaction ***or*** *iodine has no reactions*

allow (and) iodine cannot displace bromine

1

(e) 80

1

(f) (1.2 kg =) 1200 (g)
or (900 g =) 0.9 (kg)

1

$$(\frac{900}{1200} \times 100) = 75(\%)$$

or

$$(\frac{0.9}{1.2} \times 100) = 75(\%)$$

allow an answer correctly calculated from:

$$(\frac{900}{\text{incorrect attempt at conversion of 1.2}} \times 100)$$

or

$$(\frac{\text{conversion of 900}}{1.2} \times 100)$$

1

*an answer of 75 (%) scores **2** marks*

[9]

Q10.

(a) sodium oxide

allow Na_2O

1

(b) oxidation

1

(c) 13

1

(d) sodium hydroxide

1

(e) OH^-

1

(f) $(\text{volume} =) \frac{250}{1000}$ or ¼

or 0.25 (dm^3)

1

or

$(\text{mass per } cm^3 =) \frac{40}{1000}$ (g)

or 0.04 (g)

$(\frac{250}{1000} \times 40 =)$ 10 (g)

1

*an answer of 10 (g) scores **2** marks*

(g) all points correct

allow a tolerance of ±½ a small square
*allow **1** mark for 3 points correct*
ignore any attempt at a line of best fit

2

(h) 39 °C

allow any value from 34 to 46 (°C)

1

[10]

Q11.

(a) FeS_2

*do **not** accept equations*

1

(b) 26

1

30

1

26

1

must be this order

(c) any **two** from:

- iron has a high(er) melting / boiling point
- iron is dense(r)
- iron is hard(er)

allow iron is less malleable / ductile

- iron is strong(er)
- iron is less reactive

allow specific reactions showing difference in reactivity

- iron has ions with different charges
- iron forms coloured compounds
- iron can be a catalyst

allow iron is magnetic

allow the converse statements for sodium
allow transition metal for iron
allow Group 1 metal for sodium

ignore references to atomic structure

ignore iron rusts

2

(d) carbon is more reactive (than nickel)

allow converse

1

(so) carbon will displace / replace nickel (from nickel oxide)

allow (so) nickel ions gain electrons

or

(so) carbon will remove oxygen (from nickel oxide)

allow (so) carbon transfers electrons to nickel (ions)

1

(e) (total M_r of reactants =) 87

1

(percentage atom economy)

$$= \frac{59}{87} \times 100$$

allow (percentage atom economy)

$$= \frac{59}{\text{incorrectly calculated } M_r} \times 100$$

1

= 67.8 (%)

allow an answer from an incorrect

calculation to 3 sig figs

1

*an answer of 67.8 (%) scores **3** marks*

*an answer of 67.8160919 (%) or correctly rounded answer to 2, 4 or more sig figs scores **2** marks*

an incorrect answer for one step does not prevent allocation of marks for subsequent steps

[11]

Q12.

(a) potassium chloride **and** iodine

either order

allow KCl for potassium chloride and I_2 for iodine

1

(b) (chlorine's) outer electrons / shell closer to the nucleus

allow chlorine has fewer shells

allow chlorine atom is smaller than iodine atom

ignore chlorine has fewer outer shells

1

(so) the chlorine nucleus has greater attraction for outer electrons / shell

allow chlorine has less shielding

*do **not** accept incorrect types of attraction*

1

(so) chlorine gains an electron more easily

1

***max 2** marks can be awarded if the answer refers to chloride / iodide instead of chlorine / iodine*

allow converse statements

allow energy levels for shells throughout

(c) hydrogen chloride is made of small molecules

allow hydrogen chloride is simple molecular

1

(so hydrogen chloride) has weak intermolecular forces*

1

(intermolecular forces) require little energy to overcome*

1

do **not accept reference to bonds breaking unless applied to*

intermolecular bonds

(d) (bonds broken = 4(412) + 193 =)1841

1

(bonds formed = 3(412) + 366 + **X** =) 1602 + **X**

1

−51 = 1841 − (1602 + **X**)

allow use of incorrectly calculated values of bonds broken and / or bonds formed from steps 1 and 2 for steps 3 and 4

1

(**X** =) 290 (kJ/mol)

allow a correctly calculated answer from use of −51 = bonds formed − bonds broken

1

OR

alternative method ignoring the 3 unchanged C−H bonds

(412 + 193 =) 605 (1)

366 + **X** (1)

−51 = 605 − (366 + **X**) (1)

(**X** =) 290 (kJ/mol) (1)

*an answer of 290 (kJ/mol) scores **4** marks*

*an answer of 188 (kJ/mol) scores **3** marks*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[11]

Q13.

(a) **J**

1

(b) **M** and **Q**

either order

1

(c) **Q**

1

(d) **M**

1

(e) **L**

1

(f) **Level 3 (5-6 marks):**
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

Level 2 (3-4 marks):
Some logically linked reasons are given. There may also be a simple judgement.

Level 1 (1-2 marks):
Relevant points are made. They are not logically linked.

Level 0
No relevant content

Indicative content

comparative points
- both tables have more than one element in a box
- both have similar elements in the same column
- both are missing the noble gases
- both arranged elements in order of atomic weight

advantages of Mendeleev / disadvantages of Newlands
- Newlands did not leave gaps for undiscovered elements
- Newlands had many more dissimilar elements in a column
- Mendeleev left gaps for undiscovered elements
- Mendeleev changed the order of some elements (e.g. Te and I)

points which led to the acceptance of Mendeleev's table
- Mendeleev predicted properties of missing elements
- elements with properties predicted by Mendeleev were discovered
- Mendeleev's predictions turned out to be correct
- elements were discovered which fitted the gaps

6

[11]

Q14.

(a) The forces between iodine molecules are stronger

1

(b) anything in range +30 to +120

1

(c) Brown

1

(d) $2\ I^- + Cl_2 \rightarrow I_2 + 2\ Cl^-$

1

(e) It contains ions which can move

1

(f) hydrogen iodine

1

[6]

Q15.

(a) atomic weights

must be in this order

1

electrons

1

proton numbers

1

(b) (i) H/hydrogen

allow H_2 or h

1

(ii) one / 1

allow alkali metals

1

(iii) Potassium (K)

1

(iv) Iron has a higher density than potassium

1

Iron forms ions that have different charges

1

(c) any **three** from:

- melts
- fizzes / bubbles / effervesces

  allow gas produced
- sodium floats
- size of the sodium decreases

  allow dissolves / disappears
- sodium moves

  allow two marks for moves around on the surface of the water

3

[11]

Q16.

(a) (i) atomic weights

allow atomic masses

1

(ii) proton

allow proton number

1

(b) (i) F/fluorine

allow F_2

1

(ii) any **one** from:

- copper has a higher density
- copper is stronger
- copper is harder
- copper is less reactive

allow named property

ignore colour, conductivity, melting point and boiling point

allow converse for potassium

1

(iii) relative distance from nucleus

allow more / fewer energy levels / shells or larger / smaller atom

1

relative attraction to nucleus

allow more / less shielding

1

relative ease of gain or loss of electron

1

opposite explanation of ease of gain or loss of electron for other group

1

max 3 marks if 'outer' not mentioned

[8]