Name: _____

Class: _____

Date: _____

Atomic Structure & Periodic Table part 3 AQA Triple Chemistry

Time: **86 minutes**

Marks: **84 marks**

Comments:

1. This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

(a) Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

_____

_____

_____

_____

(2)

(b) The table below shows the mass numbers and percentage abundances of the isotopes of gallium.

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

_____

_____

_____

_____

Relative atomic mass (1 decimal place) = _____

(2)

Gallium (Ga) is in Group 3 of the modern periodic table.

(c) Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}Ga$

Number of electrons _____

Number of neutrons _____

(2)

(d) What is the most likely formula of a gallium ion?

Tick (✓) **one** box.

Ga^{+} ☐

Ga^{-} ☐

Ga^{3+} ☐

Ga^{3-} ☐

(1)

(e) Gallium was discovered six years after Mendeleev published his periodic table.

Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

1 _____

_____

2 _____

_____

(2)

(Total 9 marks)

2. This question is about models of the atom.

(a) Atoms were first thought to be tiny spheres that could not be divided.

Which particle was discovered to change this model of the atom?

Tick (✓) **one** box.

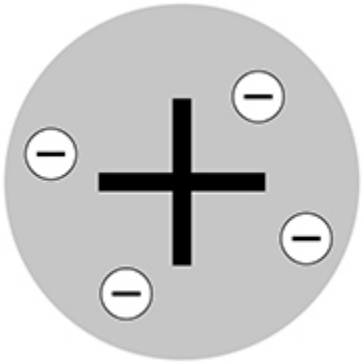
Electron ☐

Neutron ☐

Proton ☐

(1)

(b) The diagram below shows another model of the atom.



What is the name of this model of the atom?

_____

(1)

(c) A scientist fired particles at gold atoms.

Some of these particles were scattered.

The results led to a different model of the atom.

Which type of particle was fired at the gold atoms?

Tick (✓) **one** box.

Alpha ☐

Electron ☐

Neutron ☐

Proton ☐

(1)

(d) Which scientist first suggested that electrons orbit the nucleus at specific distances?

Tick (✓) **one** box.

Bohr ☐

Chadwick ☐

Mendeleev ☐

(1)

(e) The model of the atom used today has three subatomic particles:

- electrons
- neutrons
- protons.

Complete the sentences.

Atoms of the same element have the same atomic number because they have the same number of _____.

Atoms of the same element can have different mass numbers because they have different numbers of _____.

Atoms have no overall charge because they have the same number of _____ and _____.

(3)

(f) The radius of a nucleus is approximately 1×10^{-14} m

The radius of an atom is approximately 1×10^{-10} m

A teacher uses a ball of radius 1 cm to represent the nucleus.

What could represent the atom on the same scale?

Tick (✓) **one** box.

A ball of radius 10 cm ☐

A sports arena of radius 100 m ☐

An island of radius 10 km ☐

A planet of radius 1000 km ☐

(1)

(Total 8 marks)

3. This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

(a) What is the state of bromine at 100 °C?

Use **Table 1**.

Tick (✓) **one** box.

Gas ☐

Liquid ☐

Solid ☐

(1)

(b) What temperature does chlorine gas condense at to form a liquid?

Use **Table 1**.

Temperature = _____ °C

(1)

(c) Complete the sentences.

Going down Group 7 the melting points _____ .

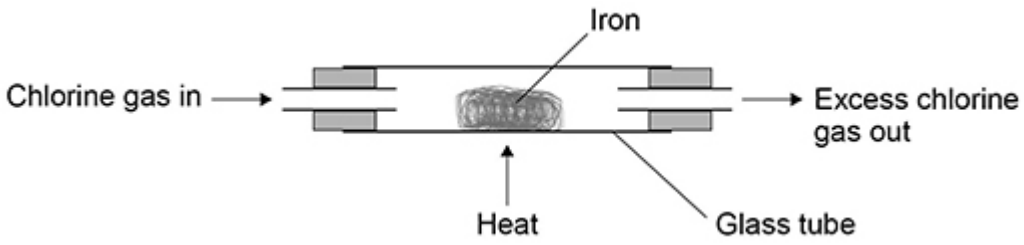
This is because the size of the molecules increases so the intermolecular forces

_____ .

(2)

A teacher investigated the reaction of iron with chlorine.

The diagram below shows the apparatus used.



(d) Why did the teacher do the investigation in a fume cupboard?

Tick (✓) **one** box.

Chlorine gas is coloured. ☐

Chlorine gas is flammable. ☐

Chlorine gas is toxic. ☐

(1)

(e) The word equation for the reaction is:

iron + chlorine → iron chloride

Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

The mass of the glass tube and contents _____

Reason _____

_____

(2)

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	**Observation**
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

(f) Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use **Table 2**.

_____

_____

(1)

(g) Balance the equation for the reaction between iron and bromine.

$$2Fe + \_\_\_\_\_ Br_2 \rightarrow 2\ FeBr_3$$

(1)

(h) Calculate the relative formula mass (M_r) of $FeBr_3$

Relative atomic masses (A_r): Fe = 56 Br = 80

_____

_____

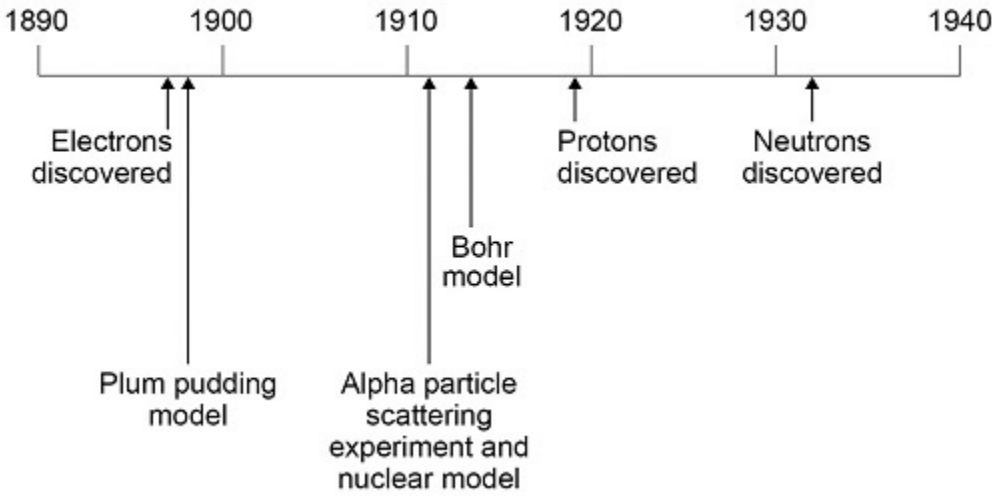
Relative formula mass (M_r) = _____

(2)

(Total 11 marks)

4. This question is about the development of scientific theories.

The diagram below shows a timeline of some important steps in the development of the model of the atom.



(a) The plum pudding model did not have a nucleus.

Describe **three** other differences between the nuclear model of the atom and the plum pudding model.

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

(3)

(b) Niels Bohr adapted the nuclear model.

Describe the change that Bohr made to the nuclear model.

_____

_____

_____

_____

(2)

(c) Mendeleev published his periodic table in 1869.

Mendeleev arranged the elements in order of atomic weight.

Mendeleev then reversed the order of some pairs of elements.

A student suggested Mendeleev's reason for reversing the order was to arrange the elements in order of atomic number.

Explain why the student's suggestion **cannot** be correct.

Use the diagram above.

_____

_____

_____

_____

(2)

(d) Give the correct reason why Mendeleev reversed the order of some pairs of elements.

_____

_____

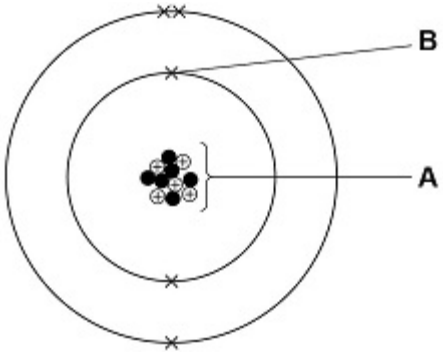
(1)

(Total 8 marks)

5. This question is about atomic structure.

Figure 1 represents an atom of element **Z**.

Figure 1



(a) Name the parts of the atom labelled **A** and **B**.

Choose answers from the box.

electron	**neutron**	**nucleus**	**proton**

A _____

B _____

(2)

(b) Which particle has the lowest mass?

Choose the answer from the box.

electron	**neutron**	**nucleus**	**proton**

_____

(1)

(c) Which group of the periodic table contains element **Z**?

Use **Figure 1**.

Group _____

(1)

(d) Give the atomic number and the mass number of element **Z**.

Use **Figure 1**.

Choose answers from the box.

1	**5**	**6**	**11**	**16**

Atomic number _____

Mass number _____

(2)

Bromine has two different types of atom.

The atoms have a different number of neutrons but the same number of protons.

(e) What is the name for this type of atom?

Tick (✓) **one** box.

Compound ☐

Ion ☐

Isotope ☐

Molecule ☐

(1)

(f) The different types of bromine atom can be represented as $^{79}_{35}Br$ and $^{81}_{35}Br$

The relative atomic mass (A_r) of bromine is 80

Which statement is true about the number of each type of atom in bromine?

Tick (✓) **one** box.

There are fewer $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are more $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms. ☐

(1)

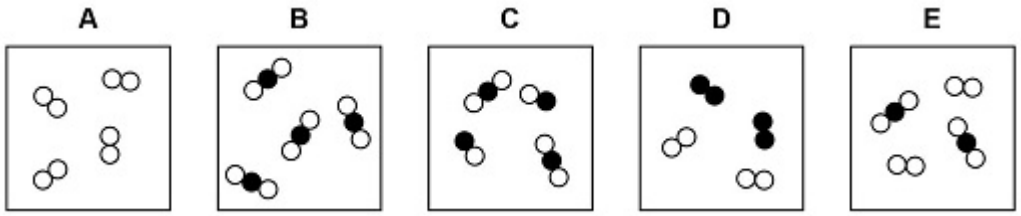
(Total 8 marks)

6. This question is about elements, compounds and mixtures.

Figure 1 shows five different substances, **A**, **B**, **C**, **D** and **E**.

○ and ● represent atoms of different elements.

Figure 1



Use **Figure 1** to answer parts (a) to (c)

(a) Which substance is only one compound?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which substance is a mixture of elements?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which substance is a mixture of an element and a compound?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

Substances are separated from a mixture using different methods.

(d) Draw **one** line from each method of separation to the substance and mixture it would separate.

Method of separation	Substance and mixture
chromatography	blue food colour from a mixture of food colours
	copper from an alloy of copper and zinc
crystallisation	copper sulfate from copper sulfate solution
	ethanol from a mixture of ethanol and water

(2)

(e) Sand does not dissolve in water. A student separates a mixture of sand and water by filtration.

Draw a diagram of the apparatus the student could use.

You should label:

- where the sand is collected
- where the water is collected.

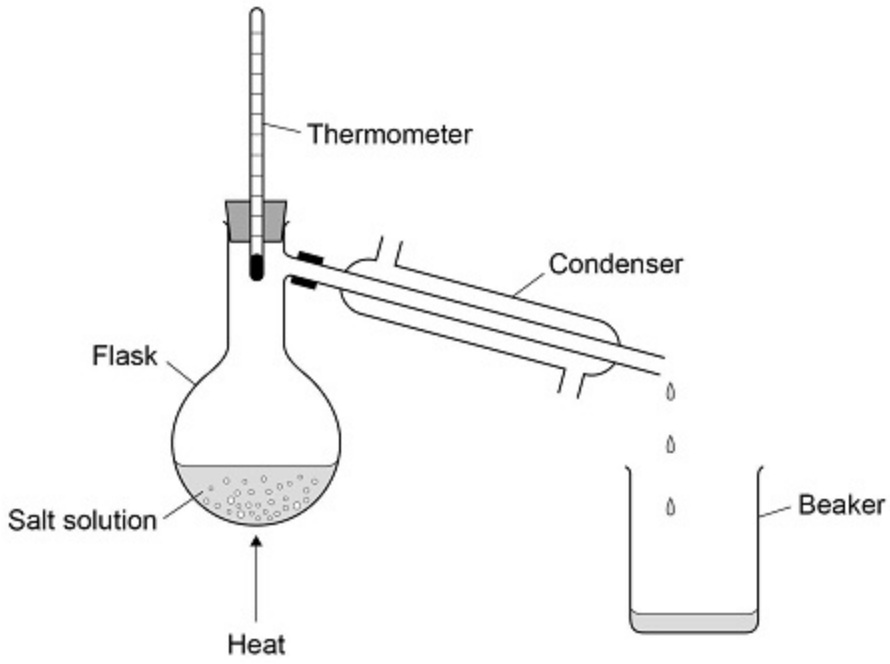
Diagram

(3)

(f) A student distils a sample of salt solution to produce pure water.

Figure 2 shows the apparatus.

Figure 2



What temperature would you expect the thermometer to show?

Tick (✓) **one** box.

0 °C ☐

10 °C ☐

50 °C ☐

100 °C ☐

(1)

(g) Describe how the process of distillation shown in **Figure 2** produces pure water from salt solution.

(4)

(Total 13 marks)

7. This question is about atomic structure.

(a) Atoms contain subatomic particles.

The table below shows properties of two subatomic particles.

Complete the table.

Name of particle	Relative mass	Relative charge
neutron		
		+1

(2)

An element **X** has two isotopes.

The isotopes have different mass numbers.

(b) Define mass number.

(1)

(c) Why is the mass number different in the two isotopes?

(1)

(d) The model of the atom changed as new evidence was discovered.

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.

Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how.

(4)

(Total 8 marks)

8. This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

The figure below shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

(a) The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

_____

_____

(1)

(b) Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

_____

_____

_____

_____

_____

_____

(3)

(c) Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

Tick (✓) **one** box.

Atomic number	☐
Mass number	☐
Relative atomic mass	☐
Relative formula mass	☐

(1)

(d) Complete the sentence.

In the modern periodic table, the elements are arranged in order of

_____

(1)

Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

(e) Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

Formula of astatine molecule _____

State at room temperature _____

(2)

(f) Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

_____

_____

_____

_____

(2)

(Total 10 marks)

9. The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

_____

(1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

(c) What is the formula for fluorine gas?

Tick **one** box.

F ☐

F_2 ☐

F^2 ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7.

Use the results in the table above.

(3)

A company uses chlorine to produce titanium chloride from titanium dioxide.

(e) What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

(1)

(f) The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

_____

_____

_____

_____

Percentage yield = _____ %

(2)

(Total 9 marks)

Mark schemes

1.

(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]

2.

(a) electron

1

(b) plum pudding

1

(c) alpha

1

(d) Bohr

1

(e) protons

1

neutrons

1

protons (and) electrons

either order

1

(f) a sports arena of radius 100 m

1

[8]

3. (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 × 80)

1

= 296

ignore units

1

[11]

4. (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]

5. (a) **A** nucleus

1

B electron

1

(b) electron

1

(c) 3 / three

1

(d) (atomic number) 5

1

(mass number) 11

1

(e) isotope

1

(f) there are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms

1

[8]

6. (a) B

1

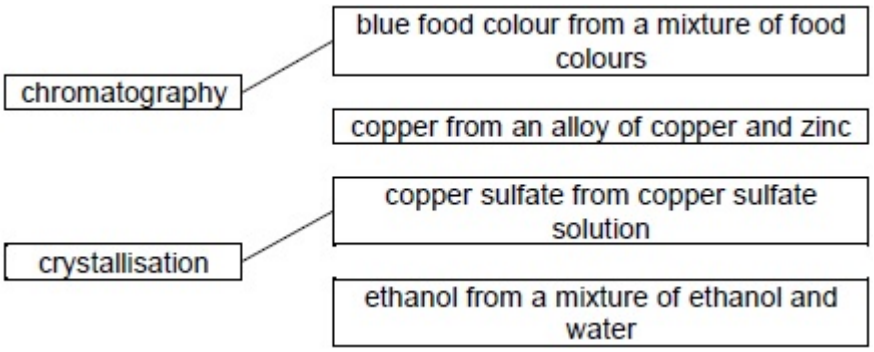
(b) D

1

(c) E

1

(d)



additional line from a box negates the mark for that box

2

(e) (filter) funnel containing filter paper

1

suitable vessel for collecting filtrate

1

sand **and** water labelled in correct place

1

(f) 100 °C

1

(g) any **four** from:

- solution is heated
- water evaporates
  allow water boils / vaporises
- the vapour cools in the condenser
- the vapour condenses
  or
  the vapour turns to a liquid
- (pure) water collects in the beaker

4

[13]

7. (a) (neutron) 1 0

both needed
allow (neutron) 1 neutral

1

proton 1 (+1)

both needed

1

(b) number of protons plus neutrons

allow number of protons and neutrons
ignore protons and neutrons unqualified
*do **not** accept references to mass or relative mass of protons and / or neutrons*

1

(c) (the isotopes contain) different numbers of neutrons

1

(d) most (alpha) particles passed (straight) through (the gold foil)

1

(so) the mass of the atom is concentrated in the nucleus / centre
or
(so) most of the atom is empty space

1

some (alpha) particles were deflected / reflected

1

(so) the atom has a (positively) charged nucleus / centre

if not awarded for MP2 allow (so) the mass of the atom is concentrated in the nucleus / centre.

1

[8]

8. (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]

9. (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

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

or

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

allow an answer correctly calculated from:

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

or

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

1

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

[9]