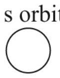
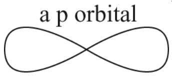
Chapter 3: Atomic structure (shared Homework sheet with Chapter 2)

Homework marking scheme

1 **a** Element I is magnesium (Mg) [1]
large jump from the 2nd ionisation energy to the 3rd ionisation energy. [1]
Element II is sulfur (S) [1]
large jump from the 6th ionisation energy to 7th ionisation energy. [1]
Element III is aluminium (Al) [1]
large jump from the 3rd ionisation energy to the 4th ionisation energy. [1]
Element IV is chlorine (Cl) [1]
large jump from the 7th ionisation energy to the 8th ionisation energy. [1]
Element V is sodium (Na) [1]
large jump from the 1st ionisation energy to the 2nd ionisation energy. [1]

b Element (Mg)I: $1s^2\ 2s^2\ 2p^6\ 3s^2$ [1]
Element II (S): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ [1]

c **i** spherical shape because it is taken from an s orbital
an s orbital

[1]

ii dumb-bell shape because it is taken from a p orbital.
a p orbital

[1]

d **i** $S(g) \rightarrow S^{+}(g) + e^{-}$
1 mark for correct use of state symbols and 1 mark for correct equation. [2]

ii $Al^{7+}(g) \rightarrow Al^{8+}(g) + e^{-}$
1 mark for correct use of state symbols and 1 mark for correct equation. [2]

e ^{33}S has 16 electrons, 16 protons and 17 neutrons [1]

f $A_r = \dfrac{(32\times 95)+(33\times 0.76)+(34\times 4.22)+(36\times 0.01)}{100}$
= 32.1
1 mark for 32, 1 mark for 1 decimal place, 1 mark for showing working. [3]

g **i**

Element	Sulfur	Fluorine
number of moles	$\dfrac{29.7}{32.1} = 0.925$	$\dfrac{70.3}{19} = 3.7$
relative number of atoms	$\dfrac{0.925}{0.925} = 1$	$\dfrac{3.7}{0.925} = 4$

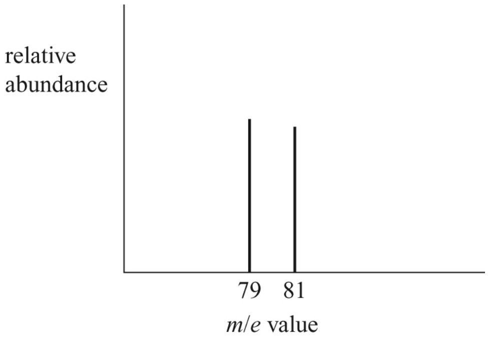
empirical formula is SF_4 [3]

ii $\dfrac{\text{molecular formula}}{\text{empirical formula}} = \dfrac{\text{relative molecular mass}}{\text{mass of empirical formula}}$ [1]

$= \dfrac{108.1}{108.1} = 1$ [1]

Therefore, molecular formula = empirical formula = SF_4

2 a i



1 mark for horizontal axis and label, 1 mark for vertical axis and label, 1 mark for two lines, 1 mark the for the ^{81}Br value being slightly (but obviously) shorter than the ^{79}Br value [4]

ii The more abundant isotope is the bromine-79 isotope [1]

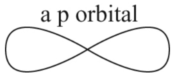
because the relative atomic mass is calculated using the weighted average [1]

b i Br^- is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$ [2]

ii F is $1s^2\ 2s^2\ 2p^5$ [1]

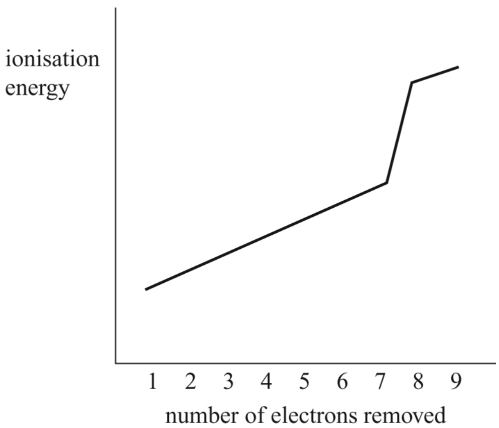
iii Their outer electron arrangement is np^5 [1]

iv



[1]

v



both axes labelled correctly [1]

steady rise from 1 to 7 electrons removed [1]

jump in values between 7 and 8 electrons removed [1]

c i $Br_2 + 5F_2 \rightarrow 2BrF_5$

1 mark for correct symbols and formulae, 1 mark for balancing [2]

ii $n(\text{fluorine}) = \frac{5}{2}\,n(BrF_5) = \frac{5}{2} \times 0.0500 = 0.125$ mol [1]

volume of $F_2 = n(\text{fluorine}) \times 24\ dm^3 = 0.125 \times 24\ dm^3$ [1]

$= 3\ dm^3$ [1]

d i $2KBr + 6F_2 \rightarrow 2BrF_5 + 2KF$

1 mark for correct symbols and formulae, 1 mark for balancing [2]

ii $n(\text{fluorine}) = 3n(BrF_5) = 3 \times 0.0500 = 0.150$ mol [1]

volume of $F_2 = n(\text{fluorine}) \times 24\ dm^3 = 0.150 \times 24\ dm^3$ [1]

$= 3.6\ dm^3$ [1]

3 **a** **i** II and X [1]
II has the highest value of first ionisation energy. [1]
X is eight elements further on/also at peak in ionisation energy. [1]

ii neon [1]
$1s^2\ 2s^2\ 2p^6$ [1]
argon [1]
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ [1]

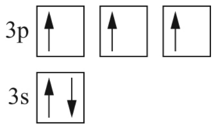
b **i** The electron added goes into the same sub-shell/orbital, but there is an increased number of protons in the nucleus [1]
therefore, there is an increased attractive force and more energy is required to remove the electron. [1]

ii The electron added goes into a p orbital [1]
Electrons into p orbitals are less tightly held and therefore easier to remove. [1]

iii Extra protons are being added to the nuclei [1]
but electrons are being added in the same energy level and therefore have an extra attractive force, so more energy is required to remove the electrons. [1]

c **i** Phosphorus [1]

ii



1 mark for 3s and 3p levels, 1 mark for two electrons in 3s and three electrons in 3p, 1 mark for the three electrons in the 3p energy level all having the same ‘spin’. [3]

iii The electron being added is going into an already occupied orbital [1]
therefore, feels repulsion from the electron present [1]
therefore, requires less energy to remove it. [1]