Marking scheme for AHL Worksheet – Chapter 2

1 **a** $1s^2 2s^2 2p^6 3s^2 3p^4$ [1]

b $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$ [1]

c $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ [1]

d $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^2$ [1]

e $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2$ [1]

f $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$ [1]

g $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$ [1]

h $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ [1]

2 **a** $1s^2 2s^2 2p^6 3s^2 3p^6$ [1]

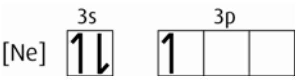
b $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$ [1]

c $1s^2 2s^2 2p^6 3s^2 3p^6$ [1]

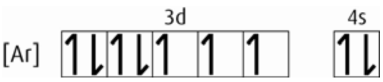
d $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10}$ [1]

e $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$ [1]

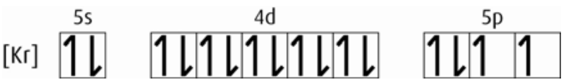
3 **a** Al [1]



b Co [1]



c Te [1]



4 **a** Se [1]

b Mn [1]

c Ba [1]

5 **a** $Na(g) \rightarrow Na^+(g) + e^-$ [1]

b $Cl^+(g) \rightarrow Cl^{2+}(g) + e^-$ [1]

c $Pb^{4+}(g) \rightarrow Pb^{5+}(g) + e^-$ [1]

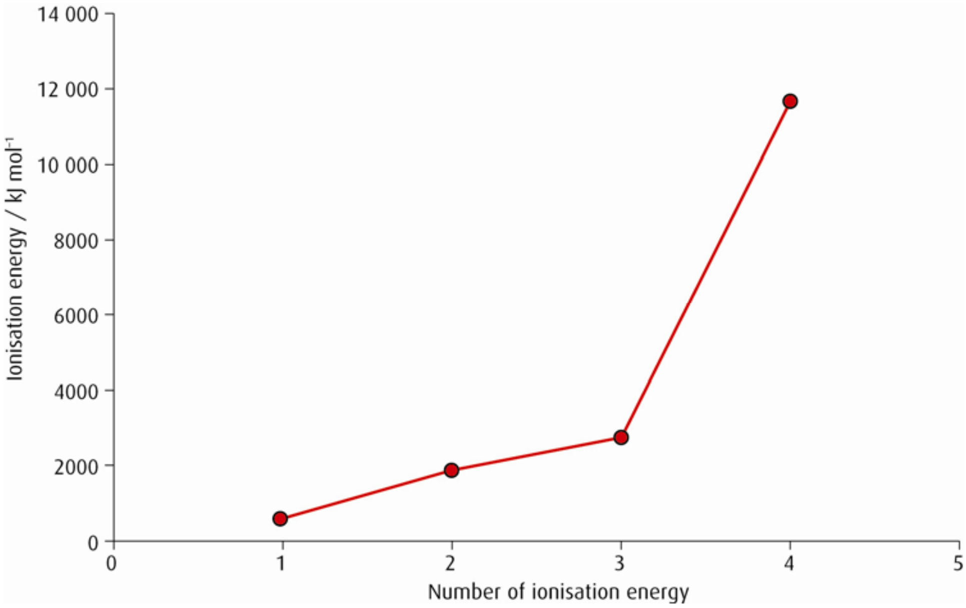
6 **Either**: once one electron has been removed the second electron must be removed from a positively charged ion; [1]

greater attraction between an electron and a positively charged ion. [1]

Or: once one electron has been removed there is less electron–electron repulsion in the ion; [1]

the electrons are pulled in closer to the nucleus and are more difficult to remove. [1]

7 Graph for aluminium:



[1]

Aluminium has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^1$. [1]

There is a slightly larger jump between the first and second ionisation energy than between the second and third. [1]

The first electron is removed from the 3p subshell but the second electron is removed from the 3s subshell [1]

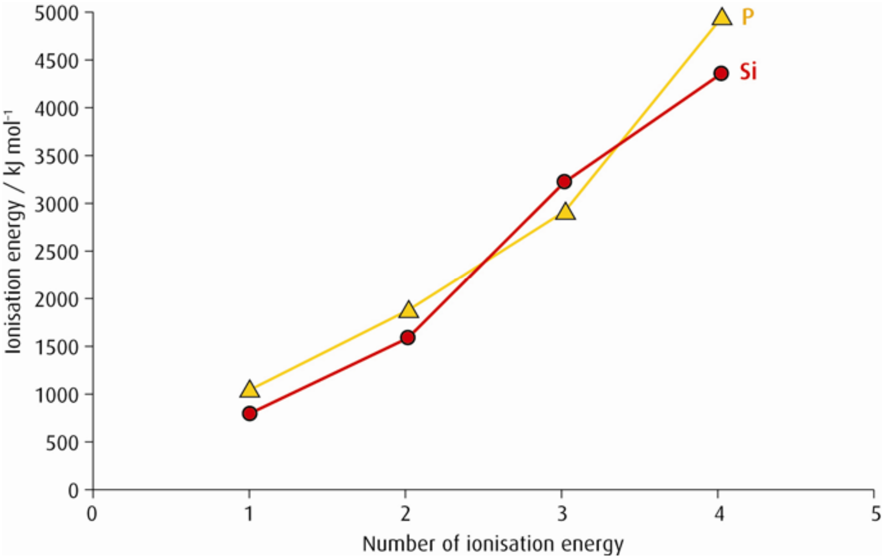
and more energy is required to remove an electron from the lower energy 3s subshell. [1]

There is a very large jump between the third and fourth ionisation energies [1]

as the third electron is removed from the third shell but the fourth electron is removed from the second shell [1]

and the electron in the second shell is closer to the nucleus and much more strongly attracted by the nucleus. [1]

Graph for silicon and phosphorus:



[2]

Si $1s^2 2s^2 2p^6 3s^2 3p^2$ P $1s^2 2s^2 2p^6 3s^2 3p^3$ [1]

Si has a slightly larger jump after the second ionisation energy while P has a slightly larger jump after the third ionisation energy [1]

in both cases this corresponds to the electron being removed from an s subshell rather than a p subshell. [1]

The s subshell is lower in energy and therefore more energy is required to remove an electron. [1]

8 **a** group 4 [1]

large jump in ionisation energy after fourth ionisation energy [1]

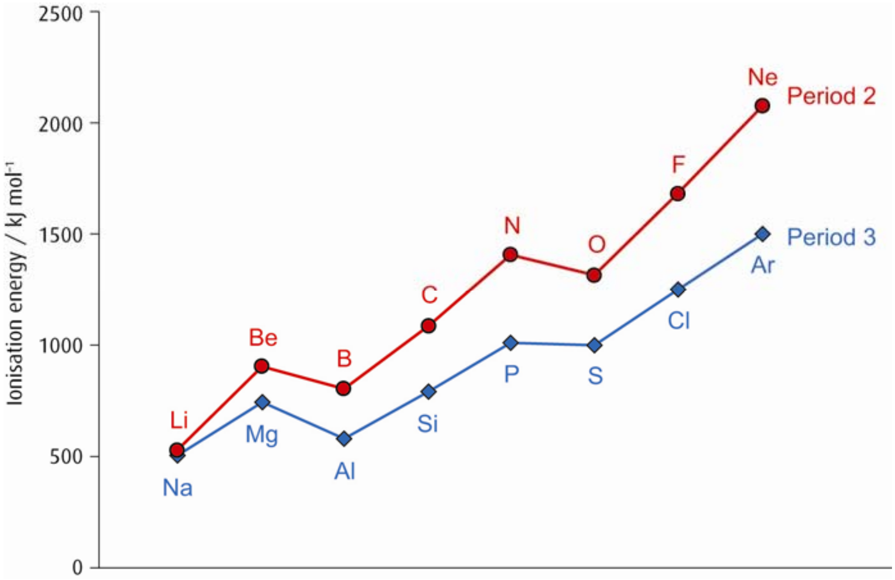
fifth electron removed from an inner shell [1]

b group 6 [1]

large jump in ionisation energy after sixth ionisation energy [1]

seventh electron removed from an inner shell [1]

9



Both graphs show a general increase in ionisation energy as atomic number increases [1]

this is due to an increase in nuclear charge with no significant increase in shielding (electrons added to the same shell). [1]

All the values for period 2 are higher than those for the corresponding element in period 3 [1]

because period 2 atoms are smaller than period 3 atoms (one fewer shell of electrons) [1]

therefore the outer electron is closer to the nucleus and more strongly held. [1]

The dips in the graphs occur at the same positions [1]

because the outer shell electronic configurations of elements in the same group are the same. [1]

The dip at B and Al is due to an electron being removed from a 3p subshell rather than a 3s subshell [1]

and the 3s subshell is lower in energy than the 3p subshell. [1]

The dip at O and S is due to two electrons being paired in the same p orbital and therefore greater repulsion. [1]

