Evidence from Ionisation 1.4

1. The table below lists the ionisation energies of some alkali metals.

Element	Ionisation Energy (kj mol^{-1})		
	1^{st}	2^{nd}	3^{rd}
Sodium	502	4560	
Potassium	425	3060	4440
Rubidium	409	2670	3880

(a) If 502kj of energy is used to convert **one mole** of gaseous sodium atoms into sodium ions calculate the energy needed to convert **one** gaseous sodium **atom** into a sodium ion.

(b) Explain why the first ionisation energies decrease as we descend group one.

(c) By considering where the electrons removed come from, suggest why the second ionisation energy of sodium is so much greater than the first.

2. Look at the table below which shows the ionisation energies (I.E.) in kJ mol^{-1} for selected elements.

Element	**1st I.E.**	**2nd I.E.**	**3rd I.E.**	**4th I.E.**
A	520	7,300	11,500	-
B	2,100	3,900	6,100	9,400
C	580	1,800	2,800	11,400
D	740	1,450	7,700	10,600

Identify the element(s)

(a) In group two of the periodic table.

(b) In group one of the periodic table.

(c)Which would require the least energy to convert an atom of the element into an ion with a three positive charge.

3. As we cross the third period from sodium to argon the trend is for the first ionisation energy to increase.

(a) Write an equation for the first ionisation energy for argon.

(b) Explain why the trend is for the first ionisation energies to increase as we cross the period.

(c) Identify the **two** elements which do not follow this trend. Explain why they do not.

EVIDENCE FROM IONISATION

(1) (a) $\frac{502}{6.02 \times 10^{23}}$ KJ/atom = 8.34×10^{-22} KJ

(b) Descending group 1, the more the outer electrons are 'shielded' from the pull of the nucleus. This is due to 'extra shells' of electrons.

(c) Removing a 2^{nd} electron from a sodium atom means it comes from the 2p subshell which (after the first electron has been removed from the 3s subshell) is full. Much more energy is needed to remove a 2p electron from a full 2p subshell than the single 3s electron. Stability is associated with the full 2p subshell.

(2) (a) Element D (b) Element A (c) Element C

(3) (a) $Ar(g) \rightarrow Ar^{+}(g) + e^{-}$

(b) Electrons being removed are from the same main shell. The atoms are also decreasing in size and the nuclear charge is increasing going across the Period. More energy in general is needed to remove the outer electron

(c) Mg and Al. Mg has a more stable electron arrangement than Al ($1s^2 2s^2 2p^6 3s^2$ for Mg) and ($1s^2 2s^2 2p^6 3s^2 3p^1$ for Al). Removing an electron from the 3s subshell in Mg needs more energy than that to remove the 3p electron from Al. The 3s is full, the 3p in Al is not.