GROUP 1: ATOMIC AND PHYSICAL PROPERTIES

1. a) Sodium's nucleus has 11 protons, and there are 10 screening electrons between the nucleus and the single outer electron. The outer electron therefore feels a net attraction of +1 from the nucleus. Potassium has 19 protons and 18 screening electrons, also giving a net attraction of +1.

   b) Potassium has an extra layer of electrons, and these take up space.

2. a) First ionisation energy is the energy needed to remove the most loosely held electron from each of one mole of gaseous atoms to make one mole of singly charged gaseous ions.

   b) You have to consider the charge on the nucleus, the amount of screening, and the distance of the electron from the nucleus. As you go down the group, the extra charge on the nucleus is exactly offset by the extra screening electrons. The only factor affecting the ionisation energy is the distance from the nucleus. The further away the outer electrons get, the less strongly they are attracted, and the lower the ionisation energy.

3. a) Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons.

   b) It falls.

   c) When the atoms form bonds there will be a bonding pair of electrons – one from the Group 1 element and one from whatever it is bonding to. (This applies just as well to the formation of ionic bonds as to covalent ones. In the case of the ionic bond, the bonding pair ends up very close indeed to the more electronegative atom - so close that we consider that the electron from the Group 1 metal has been transferred entirely to the other element.)

   As the atoms get bigger, the bonding pair of electrons gets further from the nucleus of the Group 1 element, and so feels less attraction. Therefore the electronegativity decreases.

4. a) Both melting and boiling points fall.

   b) In a metallic bond, the outer (bonding) electrons become delocalised over the entire metal structure. The atoms are held together by attractions between the positively charged nuclei and the delocalised electrons.

   (It is probably better not to use the "an array of positive ions in a sea of electrons" way of thinking about metallic bonding. Personally I think it is easier to picture what is happening if you take a more accurate view.)

   c) As the atoms get bigger, the electrons in the bonding level, and therefore the delocalised electrons, are further away from the metal nuclei, and so are less strongly attracted. That means that the attractions are easier to break, and so less heat is needed to separate the atoms into a melt or a vapour.

5. a) lithium, sodium and potassium float (densities less than 1 g cm^{-3}); rubidium and caesium sink (densities greater than 1 g cm^{-3}).

b) (i) If the only difference between sodium and potassium was the mass of the atoms, potassium would be more dense than sodium. The atoms would be the same size, and so you could fit the same number into a given volume. But potassium atoms are heavier, and so the mass of that volume would be greater, meaning a greater density.

(ii) If the only difference between sodium and potassium was the radius of the atoms, potassium would be less dense than sodium. The atoms would have the same mass, but you would be able to fit fewer of the bigger potassium atoms into a given volume. A particular volume would therefore have a lower mass, and so the density would be less.

(Since you have two effects operating in different directions, how can you predict whether in the real world, where **both** the mass and the volume of a potassium atom are greater than a sodium atom, which has the greater density? You can't – at least without doing some calculations.

The point of asking this question is that you mustn't make unjustified assumptions. You can't just say that density increases because the mass of the atoms is increasing down the group. In fact, in this case, you would be entirely wrong, because the density of potassium is less than that of sodium – the change in volume is more important than the change in mass.)

I think it is very convenient that there is this fluctuation at potassium in the general trend for densities to rise down the group, because it forces you to think more clearly about what is going on! In all the other cases, the increase in mass *is* the more important factor, but it turns out that it isn't *always* the more important factor.)