METALLIC STRUCTURES

1. a) Sodium is 8-co-ordinated, and magnesium is 12-co-ordinated. (Don't forget to make it clear which is which.) In the 8-co-ordinated structure each sodium atom is touching 8 others – four above it and four below it. In magnesium each atom is touching 12 others – 6 in the plane around it, 3 above and 3 below.

   (If you can see from your syllabus or past exam papers that you are expected to draw diagrams, make sure that you can draw those as well.)

   b) *electronic structure:* Sodium has one outer electron which it can delocalise to form the metallic bond; magnesium has two. So with magnesium there will be a higher electron density in the bond. Magnesium also has an extra proton. There will therefore be stronger attractions between the nuclei and the delocalised electrons, making the bond harder to break, and so more energy is needed to melt or boil the magnesium. (This is more detailed than what I have said on the page you have just read, and depends on you remembering how a metallic bond works. Whether you would need this amount of detail if you answered this question in an exam would depend on the number of marks and the amount of space available. If in doubt, always give the maximum amount of information – provided, of course, that you get it right!)

   packing: Each magnesium atom is in close contact with 12 others, whereas sodium only has 8 near-neighbours. This creates more bonding in the magnesium.

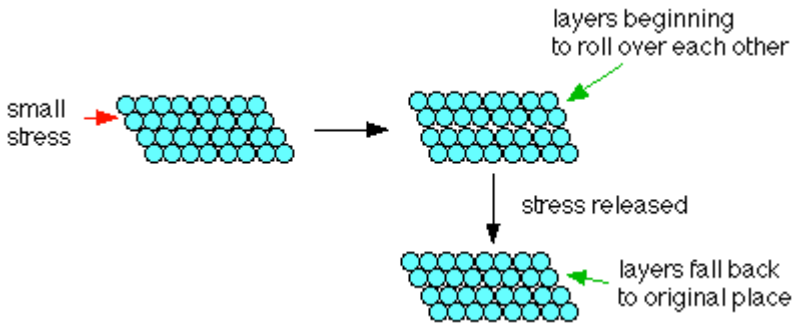
   atomic radii: Magnesium atoms are smaller than sodium atoms because of the extra proton in the magnesium. Magnesium nuclei are therefore closer to the bonding electrons, strengthening the bond.

2. a) The delocalised electrons are free to move throughout the structure.

   b) The bonding electrons gain kinetic energy when the metal is heated, and this energy is carried throughout the structure as the electrons move around.

3. a) *malleable* – can be beaten into sheets; *ductile* – can be drawn into wires.

   b) Give a mixture of words and diagrams such as these diagrams from the Chemguide page.



c) Heating a piece of metal tends to shake the atoms into a more regular arrangement with fewer grain boundaries (breaks in the regular pattern). Grain boundaries stop the layers of atoms from rolling over each other easily, and so removing them makes the metal softer.

Hitting the metal breaks up the regular structure again, producing lots of small crystal grains, and so increasing the number of grain boundaries. That makes it more difficult for the layers of atoms to roll over each other, and so hardens the metal.

d) Copper and zinc atoms aren't the same size. A structure containing both of them will be much more irregular than one containing identically sized atoms. This will make it more difficult for the layers to slide over each other, and so the alloy is harder than the individual metals.