REDOX POTENTIALS AND SIMPLE TEST TUBE REACTIONS

1. a) Zinc has a more negative E^0 value than lead which means that it has a greater tendency to form its ions - the position of equilibrium lies further to the left. The electrons supplied by the ionisation of the zinc will force Pb^{2+} ions to form Pb atoms. So the two equilibria turn into one way reactions:

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

$$Pb^{2+} + 2e^- \longrightarrow Pb$$

You can add these two half-equations to give the ionic equation for the whole reaction:

$$Zn + Pb^{2+} \longrightarrow Zn^{2+} + Pb$$

b) Aluminium has a negative E^0 value showing that it releases electrons and forms its ions more easily than hydrogen does. It forces those electrons onto hydrogen ions by upsetting the hydrogen equilibrium to the right. So the two equilibria are turned into one way reactions:

$$Al \longrightarrow Al^{3+} + 3e^-$$

$$2H^+ + 2e^- \longrightarrow H_2$$

This time, the addition of the two half-equations is a bit more tricky. You would have to transfer 6 electrons as the simplest way to satisfy both half-equations. Multiply the aluminium equation by 2, and the hydrogen equation by 3, and then add them:

$$2Al + 6H^+ \longrightarrow 2Al^{3+} + 3H_2$$

c) The Cl_2/Cl^- equilibrium has a more positive E^0 value than the Fe^{3+}/Fe^{2+} one. That means that chlorine is relatively good at gaining electrons. It can take those from the Fe^{2+} ions by upsetting the Fe^{3+}/Fe^{2+} equilibrium to the left. So the two equilibria turn into one way reactions:

$$Cl_2 + 2e^- \longrightarrow 2Cl^-$$

$$Fe^{2+} \longrightarrow Fe^{3+} + e^-$$

This time, before you add the two half-equations, you have to remember to multiply the second one by two so that you are transferring the right number of electrons.

$$Cl_2 + 2Fe^{2+} \longrightarrow 2Cl^- + 2Fe^{3+}$$

(It is possible that you tried to do this reaction with the wrong iron equation, choosing the Fe^{2+}/Fe one by mistake. If you did this, it would be impossible for the chlorine to take electrons from Fe^{2+} to make Fe. You have to *give* electrons to Fe^{2+} to turn it into Fe, not take them away. The question actually talks about the formation of *iron(III)* chloride solution - so you shouldn't really have made this mistake. But I suspect lots of people will!)