EXTRACTION OF METALS: INTRODUCTION

1. A mineral is a pure naturally-occurring compound of the metal or other element you are interested in. An ore contains one or more minerals, and probably other rocky material, from which you can *economically* extract the metal you want.

2. The ore is crushed and treated with something which bonds to the particles of the metal compound you want, and makes those particles water-repellant. The mixture is placed in a large container with water and a foaming agent. The water-repelling mineral particles are picked up by the bubbles, float to the top and flow out over the sides.

3. a) $Al^{3+} + 3e^- \longrightarrow Al$

    Reduction is gain of electrons. Or, the aluminium is reduced from the +3 to the 0 oxidation state.

    b) The first three of these are trivial, and you can't afford to get them wrong. The fourth one is more tricky.

    (i) $WO_3 + 3H_2 \longrightarrow W + 3H_2O$

    This is most easily done simply in terms of oxygen transfer. The reducing agent, hydrogen, removes oxygen from the tungsten oxide, and is itself oxidised to water. You could also do it in terms of oxidation state. The tungsten is reduced from the +6 to the 0 oxidation state, and the hydrogen is oxidised from 0 to +1.

    (ii) $TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$

    This is most easily done in terms of oxidation state. The titanium is reduced from the +4 to the 0 oxidation state, while the sodium is oxidised from 0 to +1. The reducing agent is, of course, sodium.

    (iii) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

    This is most easily done simply in terms of oxygen transfer. The reducing agent, carbon monoxide, removes oxygen from the iron(III) oxide, and is itself oxidised to carbon dioxide. You could also do it in terms of oxidation state. The iron is reduced from the +3 to the 0 oxidation state., and the carbon is oxidised from the +2 to the +4 state.

    (iv) $Cu_2S + O_2 \longrightarrow 2Cu + SO_2$
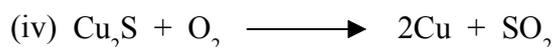
    This is much more tricky, and you need to look at the oxidation state changes of everything in the equation.

Chemguide – answers

You can think of the copper(I) sulphide as containing Cu^+ and S^{2-} ions. The copper goes from oxidation state +1 to 0, and so has clearly been reduced.

The oxygen goes from 0 to the -2 state that it has in nearly all of its compounds (apart from peroxides and in F_2O), and so has also been reduced.

What about the sulphur? This starts as -2 (it is present as a S^{2-} ion) and ends up as +4 in SO_2. This has therefore been oxidised, and is the only thing that has been oxidised in the equation. The reducing agent is therefore the S^{2-} ion in Cu_2S.

Well done if you got this right!

c)   (i) It is cheap, and also acts as the heat source for the reaction.

        (ii) For metals high in the electrochemical series (aluminium and above) the temperature needed for carbon reduction is too high to be economic. The metal produced may contain carbon as an impurity, which it may not be possible to remove.

d) Expense. Metals high in the electrochemical series, like sodium, can only be extracted themselves by expensive methods.

e)   (i) Expense.

        (ii) The metal can be produced very pure.