Question 40 **(11 marks)**

To be used in wiring, copper must be at least 99.9% pure. To obtain 99.9% pure copper from its most common ore, chalcopyrite ($CuFeS_2$), two processes must take place.

(i) The first process occurs in a furnace where the chalcopyrite is converted to 'blister copper', which is approximately 98% pure due to impurities such as sand.

(ii) The second process occurs in an electrolytic cell where the 'blister copper' undergoes electrolysis to produce copper at or above 99.9% purity.

In the furnace, the ore is heated strongly with silica (silicon dioxide), calcium carbonate and air. The furnace reduces the copper(II) in the chalcopyrite first to copper(I) then to copper.

Below are the equations that represent the main processes occurring in the blast furnace.

Equation one: $2\ CuFeS_2 + 2\ SiO_2 + 4\ O_2 \rightarrow Cu_2S + 2\ FeSiO_3 + 3\ SO_2$

Equation two: $Cu_2S + O_2 \rightarrow 2\ Cu + SO_2$

(a) Equation two can be represented as half equations. Write the reduction half equation.
(1 mark)

Reduction: _____

Oxidation: $S^{2-} + O_2 \rightarrow SO_2 + 2\ e^-$

In the electrolytic cell, the copper produced from the blast furnace is purified.

(b) Explain the electrolytic process used to purify copper. Include:

- a brief overview of the process
- a labelled diagram of the electrolytic cell
- the relevant oxidation and reduction half equations
- a discussion of impurities and how they are separated from the copper. (10 marks)