Copper and its Compounds.

Ores: Copper pyrites (chalcopyrite) $CuFeS_2$, Cuprite (ruby copper) Cu_2O, Copper glance (Cu_2S), Malachite $[Cu(OH)_2.CuCO_3]$, Azurite $[Cu(OH)_2.2CuCO_3]$

Extraction: Most of copper (about 75%) is extracted from its sulphide ore, copper pyrites.

Concentration of ore: Froth floatation process.

Roasting: Main reaction: $2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2$.

Side reaction: $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$; $2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$.

Smelting: $FeO + SiO_2 \rightarrow FeSiO_3(\text{slag})$; $Cu_2O + FeS \rightarrow FeO + Cu_2S$

Note: The mixture of copper and iron sulphides melt together to form 'matte' and the slag floats on its surface.

Conversion of matte into Blister copper (Bessemerisation): Silica is added to matte and a hot blast of air is passed $FeO + SiO_2 \rightarrow FeSiO_3(\text{slag})$. Slag is removed. By this time most of iron sulphide is removed. $Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$

Note: Blister copper: Which contain about 98% pure copper and 2% impurities (Ag, Au, Ni, Zn etc.)
Properties of copper: It has reddish brown colour. It is highly malleable and ductile. It has high electrical conductivity and high thermal conductivity. In presence of CO_2 and moisture Cu is covered with a green layer of $CuCO_3.Cu(OH)_2$. $2Cu + H_2O + CO_2 + O_2 \rightarrow CuCO_3.Cu(OH)_2$.

It undergoes displacement reactions with lesser reactive metals e.g. with Ag. It can displace Ag from $AgNO_3$. The finally divided Ag so obtained is black in color.

Compounds of copper

Cuprous oxide Cu_2O: It is a reddish brown powder insoluble in water but soluble in ammonia solution, where it forms diammine copper (I) ion. $Cu^+ + 2NH_3 \rightarrow [Cu(NH_3)_2]^+$. It is used to impart red colour to glass in glass industry.

Cupric oxide CuO : It is dark black, hygroscopic powder which is reduced to Cu by hydrogen, CO etc. It is used to impart light blue color to glass. It is prepared by heating copper nitrate.

$2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$

Copper sulphate $CuSO_4.5H_2O$ (Blue vitriol): It is prepared by action of dil H_2SO_4 on copper scrap in presence of air. $2Cu + 2H_2SO_4 + \underset{(air)}{O_2} \rightarrow CuSO_4 + 2H_2O$

(i) On heating this blue salt becomes white due to loss of water of crystallization.

$$\underset{\text{Blue}}{CuSO_4.5H_2O} \xrightarrow{503\ K} \underset{\text{White}}{CuSO_4} + 5H_2O$$

At about 1000 K, $CuSO_4$ decomposes to give CuO and SO_3.

$$CuSO_4 \xrightarrow{1000\ K} CuO + SO_3$$

(ii) It gives a deep blue solution of tetrammine copper (II) sulphate with NH_4OH.

$$Cu_2SO_4 + 4NH_4OH, \rightarrow \underset{\text{Blue colour}}{[Cu(NH_3)_4]SO_4} + 4H_2O$$

(iii) With KCN it first gives yellow precipitate of $CuCN$ which decomposes of give $Cu_2(CN)_2$.

$Cu_2(CN)_2$ dissolves in excess of KCN to give $K_3[Cu(CN)_4]$

$$2CuSO_4 + 4KCN \rightarrow Cu_2(CN)_2 + 2K_2SO_4 + (CN)_2$$

(iv) With KI it gives white ppt. of Cu_2I_2

$$4KI + 2CuSO_4 \rightarrow 2K_2SO_4 + \underset{\text{White ppt.}}{Cu_2I_2} + I_2$$

(v) With $K_4[Fe(CN)_6], CuSO_4$ gives a reddish brown ppt. of $Cu_2[Fe(CN)_6]$

$$2CuSO_4 + K_4[Fe(CN)_6] \rightarrow \underset{\text{Reddish brown ppt.}}{Cu_2[Fe(CN)_6]} + 2K_2SO_4$$

Uses: For electroplating and electro refining of copper. As a mordant in dyeing. For making Bordeaux mixture (11 parts lime as milk of lime + 16 parts copper sulphate in 1,000 parts of water). It is an excellent fungicide. For making green pigments containing copper carbonate and other compounds of copper. As a fungicide in starch paste for book binding work.

Cupric sulphide CuS : It is prepared as follows: $Cu(NO_3)_2 + H_2S \rightarrow \underset{\text{Black ppt.}}{CuS} + 2HNO_3$.

Cupric chloride $CuCl_2$: It is a dark brown solid soluble in water and its aqueous solution first changes to green and then to blue on dilution.

Cuprous chloride Cu_2Cl_2 : It is a white solid insoluble in water and dissolves in conc. HCl due to formation of $H[CuCl_2]$ complex.