

INERT METALS



Generally metals which are not affected by hydrochloric acid are called inert metals.

These metals are less active than hydrogen.

Bismuth (Bi), copper (Cu), mercury (Hg), silver (Ag), gold (Au), platinum (Pt), palladium (Pd), osmium (Os), iridium (Ir), rutenium (Ru) and rodium (Rh) are inert metals.

# General Properties

- They do not have a tendency to have an ionic structure so they are inert in chemical reactions.
- They have very high density, so they are called heavy metals.
- They are found in nature as pure metals.





# COPPER

The extensive use of copper makes it the second metal in commercial importance, after iron.

Electron configuration is  $[\text{Ar}]3d^{10}4s^1$

Density :  $8.92 \text{ g/cm}^3$

It melts at  $1084.6^\circ\text{C}$  and boils at  $2927^\circ\text{C}$

After silver, it is the second best conductor of electricity



■ **Copper is also used in the production of alloys. Some important alloys are:**

■ **brass (Cu, Zn),**

■ **bronze (Cu, Zn, Sn, or Al )**

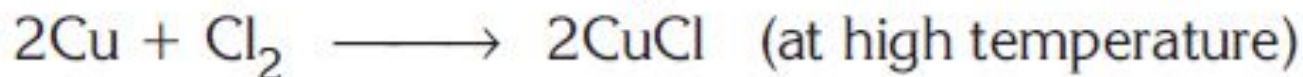
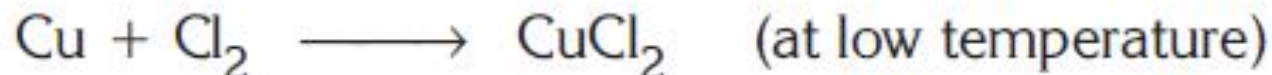
# OCCURRENCE

- In nature, it is found as compounds and in elemental form.
- The most important copper minerals are chalcopyrite (copper pyrite) ( $\text{Cu} \cdot \text{FeS}_2$ ), chalcocite ( $\text{Cu}_2\text{S}$ ), azurite ( $\text{CuCO}_3 - \text{Cu}(\text{OH})_2$ ), cuprite ( $\text{Cu}_2\text{O}$ ) and malachite ( $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ ).

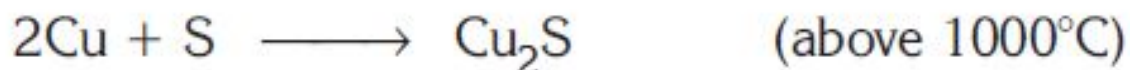
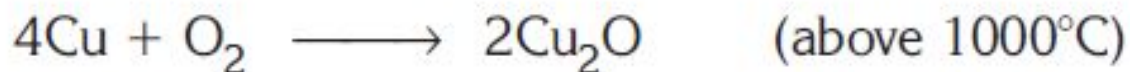
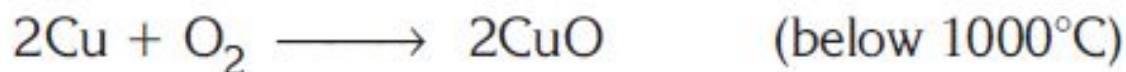
# Chemical properties

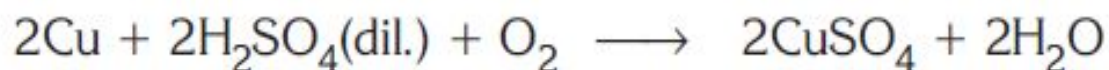
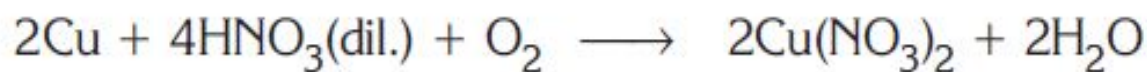
- Copper is a less active metal than hydrogen. That's why it doesn't react with water, HCl, diluted  $\text{H}_2\text{SO}_4$  or other acids.

1. Hot copper reacts with all of the halogens.

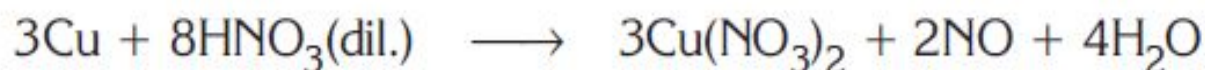


2. Oxygen and sulfur produce different oxides and sulfides at different temperatures.

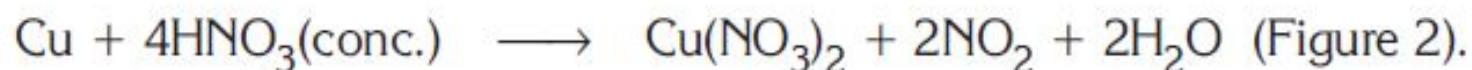




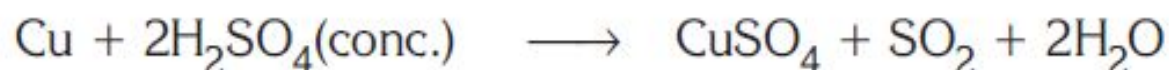
Copper reacts directly with diluted  $\text{HNO}_3$  by producing  $\text{NO}$  gas.



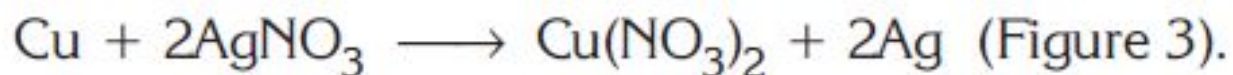
Reaction of copper with concentrated  $\text{HNO}_3$  produces  $\text{NO}_2$  gas.



Copper with concentrated  $\text{H}_2\text{SO}_4$  produces  $\text{SO}_2$  gas.



4. Copper displaces less reactive metals from their compounds in aqueous solution.



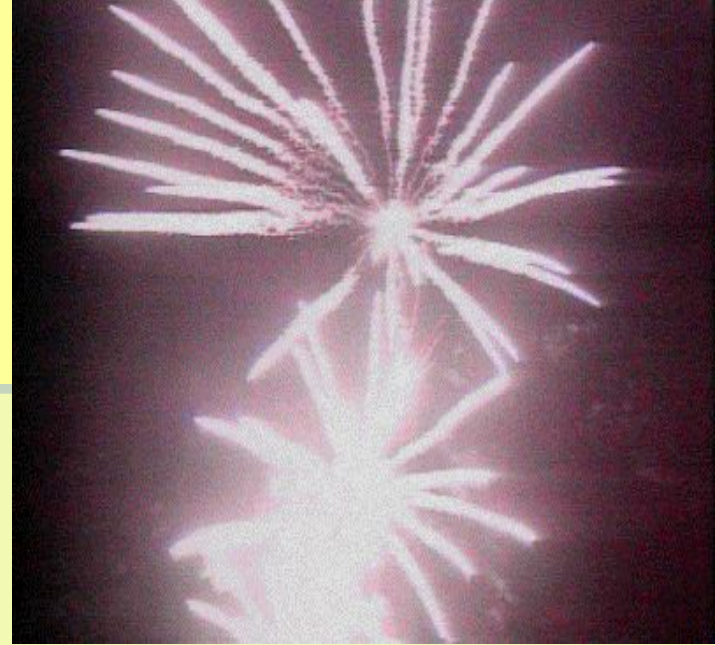


# Compounds of Copper

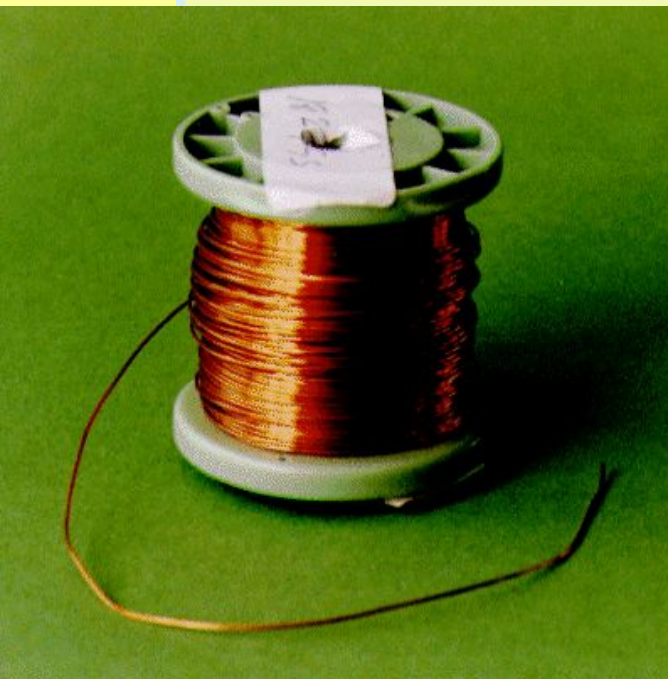
- Copper has +1 and +2 charges in its compounds. ***Ions with +1 are called copper (I) or cuprous, and ions with +2 are called copper (II) or cupric.***
- The most important cuprous compounds are: copper (I) oxide ( $\text{Cu}_2\text{O}$ ), and copper (I) chloride ( $\text{Cu}_2\text{Cl}_2$ ), and those of cupric compounds are copper (II) chloride ( $\text{CuCl}_2$ ), and copper (II) sulfate ( $\text{CuSO}_4$ ).



# Copper

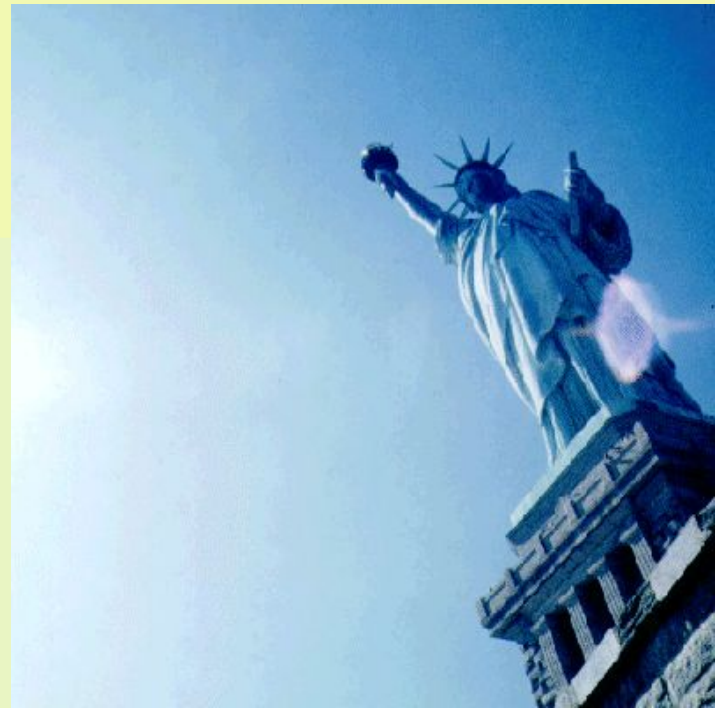


**BRONZE: Cu,Zn,Sn  
ALLOY**



# Cu

**COPPER  
WIRE**



# ZINC

- Zinc is the first member of group 2B.
- Zinc takes +2 oxidation state in its compounds.
- Zinc is a bluish-white metal
- The density of zinc is 7.14 g/cm<sup>3</sup>.
- Melting point is 419.5°C and boiling point is 907°C

# OCCURRENCE

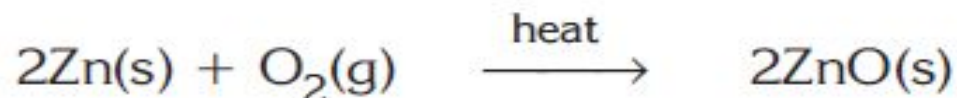
Zinc is not found in elemental form in nature. It is found as compounds, such as zincblende ( $\text{ZnS}$ ), willemite ( $\text{Zn}_2\text{SiO}_4 \cdot \text{H}_2\text{O}$ ), smithsonite or calamine ( $\text{ZnCO}_3$ ), and franklinite ( $\text{ZnO} \cdot \text{Fe}_2\text{O}_3$ ) in crustal rocks.

*Smithsonite ( $\text{ZnCO}_3$ )*

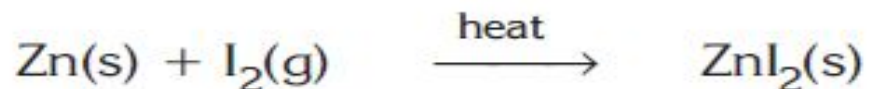


# CHEMICAL PROPERTIES

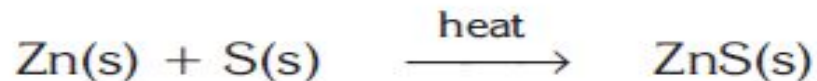
1. Zinc metal burns in air with a greenish-blue flame to form white zinc oxide.



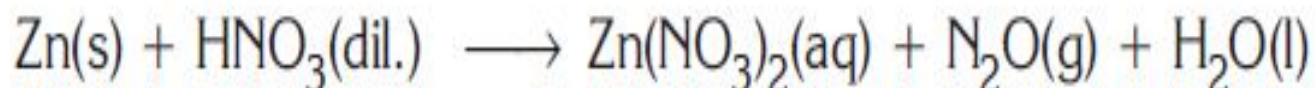
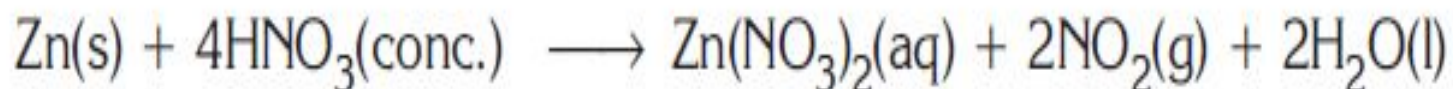
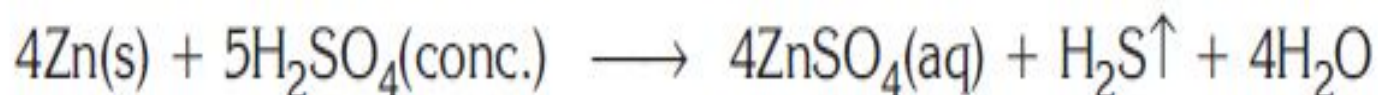
2. Zinc reacts with halogens to form white colored halides.



3. Zinc reacts with sulfur when heated, but no reaction of zinc with nitrogen is observed.



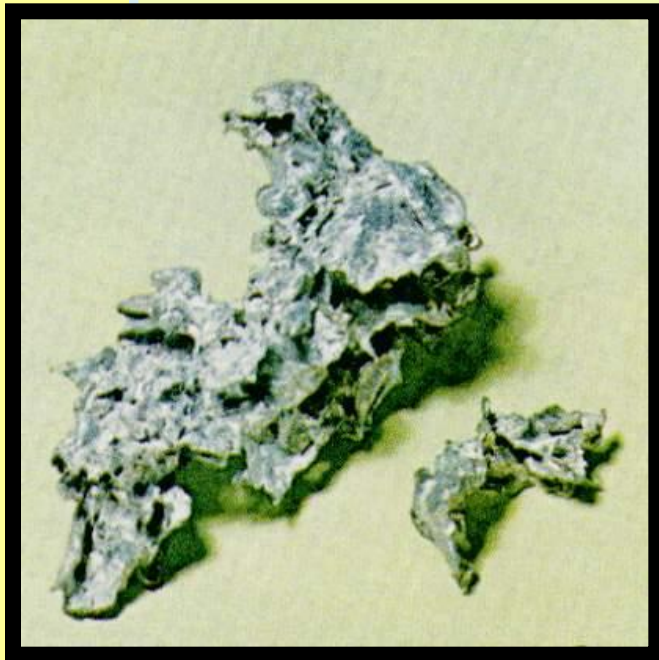
4. Zinc reacts with dilute acids, except  $\text{HNO}_3$ , to give hydrogen gas.



5. Reaction of Zn with strong bases.



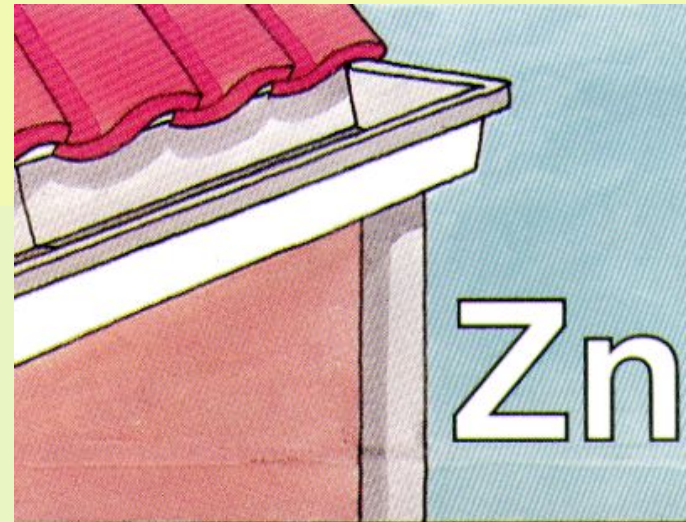
# Zinc



The metal is used principally as a protective coating, or galvanizer, for iron and steel; as an ingredient of various alloys, especially brass; as plates for dry electric cells; and for die castings. Zinc oxide, known as zinc white or Chinese white, is used as a paint pigment.



Zn



Zinc





# Chromium



- Chromium is the first member of group 6B.
- Pure chromium is grey in color, hard and bright like silver. The melting point is  $1907^{\circ}\text{C}$ , the boiling point is  $2671^{\circ}\text{C}$  and its density is  $7.19\text{ g/cm}^3$  at room temperature.

# OCCURRENCE

- The percentage of chromium is about 0.14% by mass in the earth's crust.
- The most important mineral of chromium is chromite ( $\text{FeO} \cdot \text{Cr}_2\text{O}_3$ ), which has a brownish-black color.

# CHEMICAL PROPERTIES

- The main oxidation states of chromium are +2, +3 and +6, but it may exist from +1 to +6 oxidation states.
- Powdered chromium is more active. It may be reacted easily with  $\text{NO}_3^-$  and  $\text{SO}_4^{2-}$  compounds, and with  $\text{O}_2$  gas.

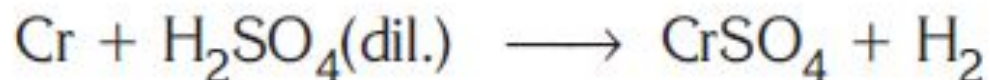
- 1. Chromium metal reacts with halo-acids, such as HCl and HBr, slowly.



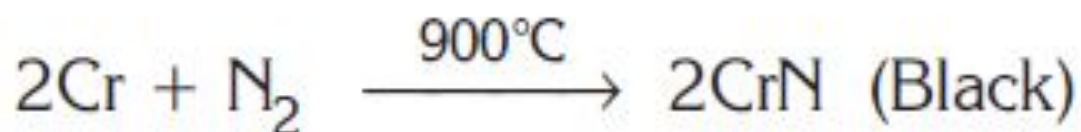
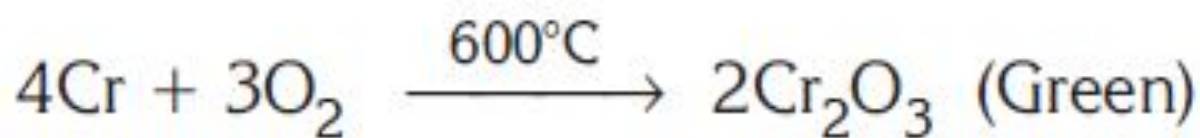
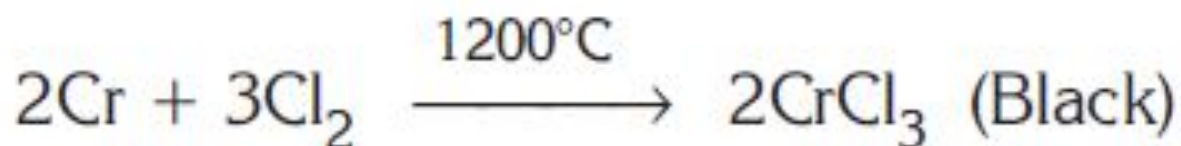
- 2. Hot and concentrated sulfuric acid reacts with chromium to form SO<sub>2</sub> gas.



Chromium reacts with dilute H<sub>2</sub>SO<sub>4</sub> to give CrSO<sub>4</sub> salt and H<sub>2</sub> gas.



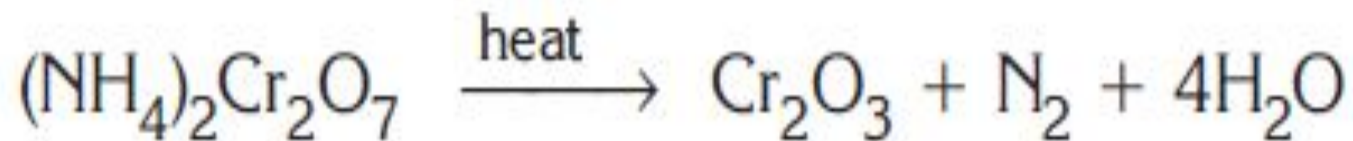
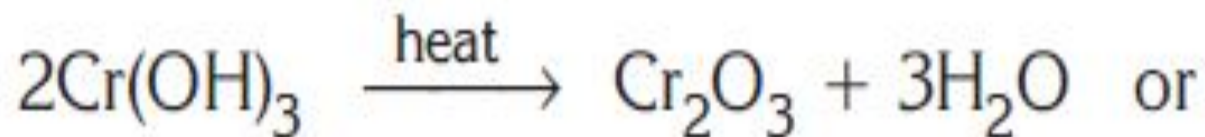
Heated chromium metal reacts with some nonmetals to produce the following Cr(III) compounds:



# COMPOUNDS

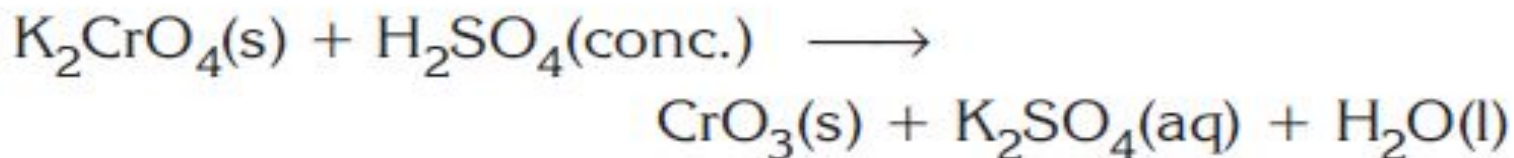
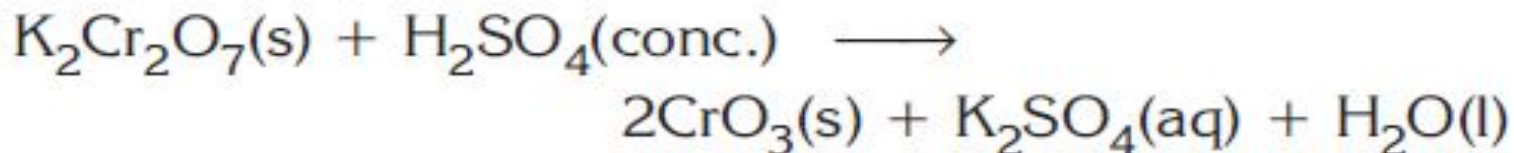
1) Chromium (III) Oxide,  $\text{Cr}_2\text{O}_3$

Chromium (III) oxide is a green colored powder.



## 2) Chromium (VI) Oxide, CrO<sub>3</sub>

- Chromium (VI) oxide is a red colored solid that melts at 197°C. It is a powerful oxidizing agent



### 3. Chromates ( $\text{CrO}_4^{2-}$ ) and dichromates ( $\text{Cr}_2\text{O}_7^{2-}$ )

- Chromates of alkali metals, magnesium and calcium are soluble in water. Soluble chromates have usually yellow color.



Chromates react with acids and turn to orange colored dichromates.

