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.

29
Cu
63.546

COPPER

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

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

Density : 8.92 g/cm^{3}

It melts at 1084.6°C and boils at 2927° 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) (Cu . FeS_2), chalcocite (Cu_2S), agurite ($CuCO_3$–$Cu(OH)_2$), cuprite (Cu_2O) and malachite ($CuCO_3$.$Cu(OH)_2$).

Chemical properties

- Copper is a less active metal than hydrogen. That's why it doesn't react with water, HCl, diluted H_2SO_4 or other acids.

1. Hot copper reacts with all of the halogens.

$$Cu + Cl_2 \longrightarrow CuCl_2 \quad \text{(at low temperature)}$$
$$2Cu + Cl_2 \longrightarrow 2CuCl \quad \text{(at high temperature)}$$

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

$$2Cu + O_2 \longrightarrow 2CuO \quad \text{(below 1000°C)}$$
$$4Cu + O_2 \longrightarrow 2Cu_2O \quad \text{(above 1000°C)}$$
$$Cu + S \longrightarrow CuS \quad \text{(below 1000°C)}$$
$$2Cu + S \longrightarrow Cu_2S \quad \text{(above 1000°C)}$$

$2Cu + 4HNO_3(dil.) + O_2 \longrightarrow 2Cu(NO_3)_2 + 2H_2O$

$2Cu + 2H_2SO_4(dil.) + O_2 \longrightarrow 2CuSO_4 + 2H_2O$

Copper reacts directly with diluted HNO_3 by producing NO gas.

$3Cu + 8HNO_3(dil.) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

Reaction of copper with concentrated HNO_3 produces NO_2 gas.

$Cu + 4HNO_3(conc.) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$ (Figure 2).

Copper with concentrated H_2SO_4 produces SO_2 gas.

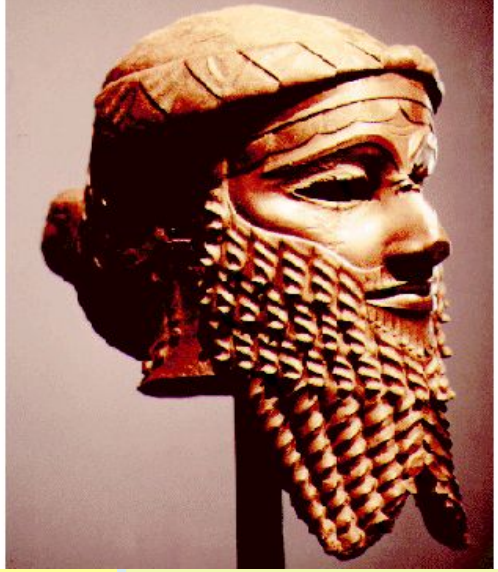
$Cu + 2H_2SO_4(conc.) \longrightarrow CuSO_4 + SO_2 + 2H_2O$

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

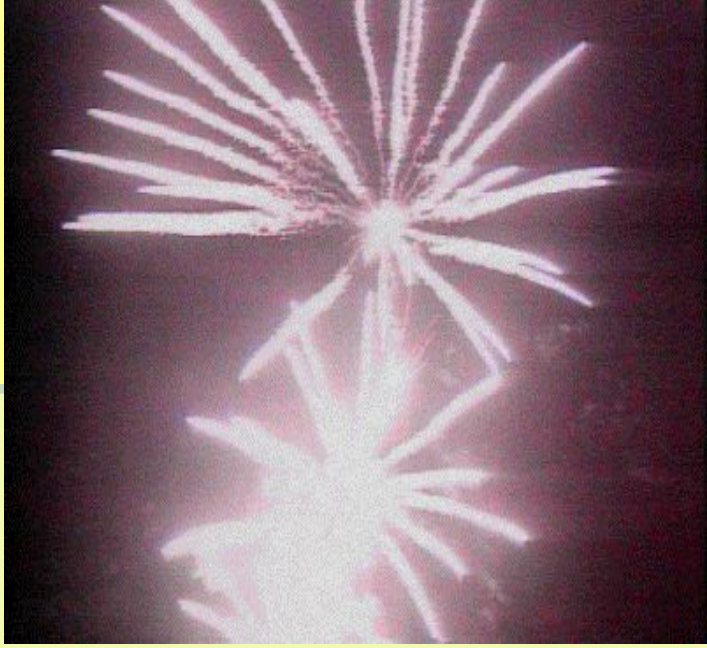
   $Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$ (Figure 3).

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 (Cu_2O), and copper (I) chloride (Cu_2Cl_2), and those of cupric compounds are copper (II) chloride ($CuCl_2$), and copper (II) sulfate ($CuSO_4$).

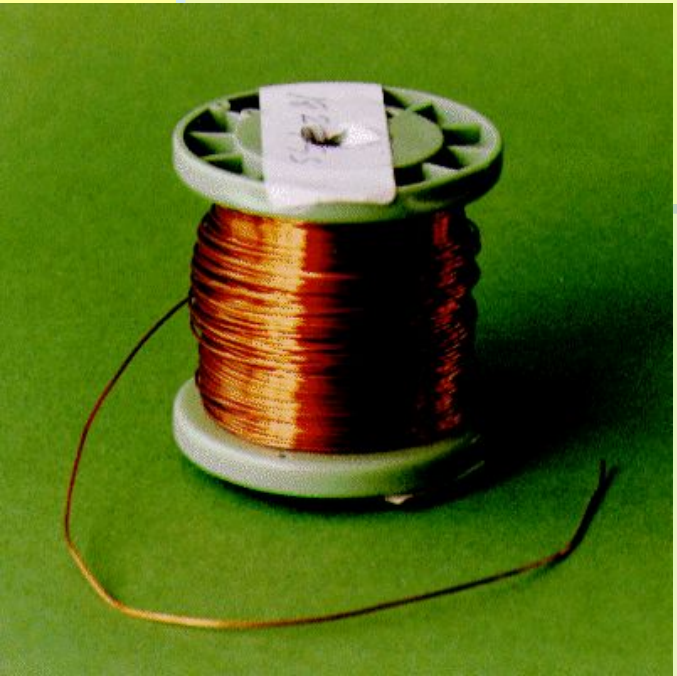


Copper

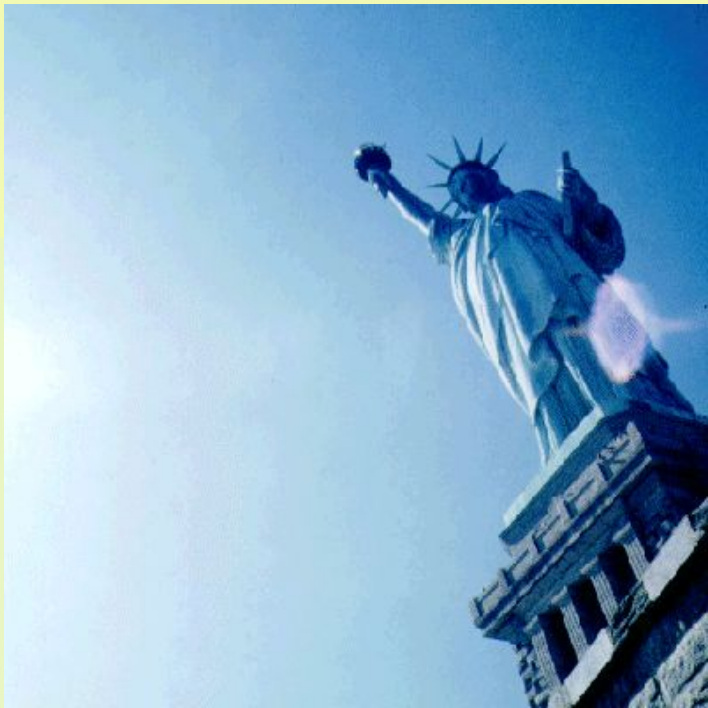


BRONZE: Cu,Zn,Sn ALLOY

Cu



COPPER WIRE

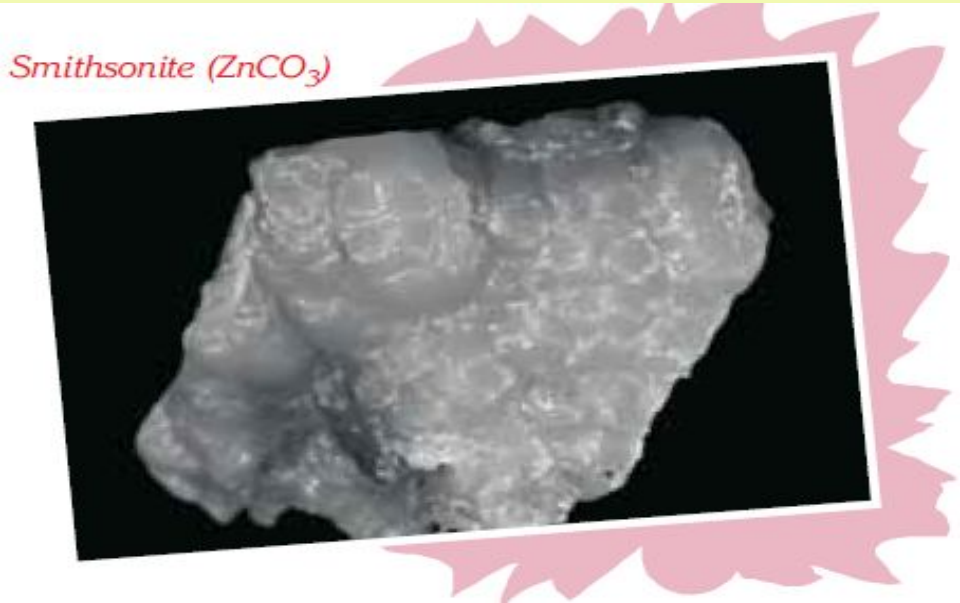


ZINC

- 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/cm3.
- 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 (ZnS), willemite (Zn2SiO4 . H2O), smithsonite or calamine (ZnCO3), and franklinite (ZnO .Fe2O3) in crustal rocks.



CHEMICAL PROPERTIES

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

$$2Zn(s) + O_2(g) \xrightarrow{\text{heat}} 2ZnO(s)$$

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

$$Zn(s) + Cl_2(g) \xrightarrow{\text{heat}} ZnCl_2(s)$$

$$Zn(s) + I_2(g) \xrightarrow{\text{heat}} ZnI_2(s)$$

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

$$Zn(s) + S(s) \xrightarrow{\text{heat}} ZnS(s)$$

$$Zn(s) + N_2(g) \longrightarrow \text{No reaction}$$

4. Zinc reacts with dilute acids, except HNO_3, to give hydrogen gas.

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

$$Zn(s) + H_2SO_4(dil.) \longrightarrow ZnSO_4(aq) + H_2(g)$$

$$4Zn(s) + 5H_2SO_4(conc.) \longrightarrow 4ZnSO_4(aq) + H_2S\uparrow + 4H_2O$$

$$Zn(s) + 4HNO_3(conc.) \longrightarrow Zn(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

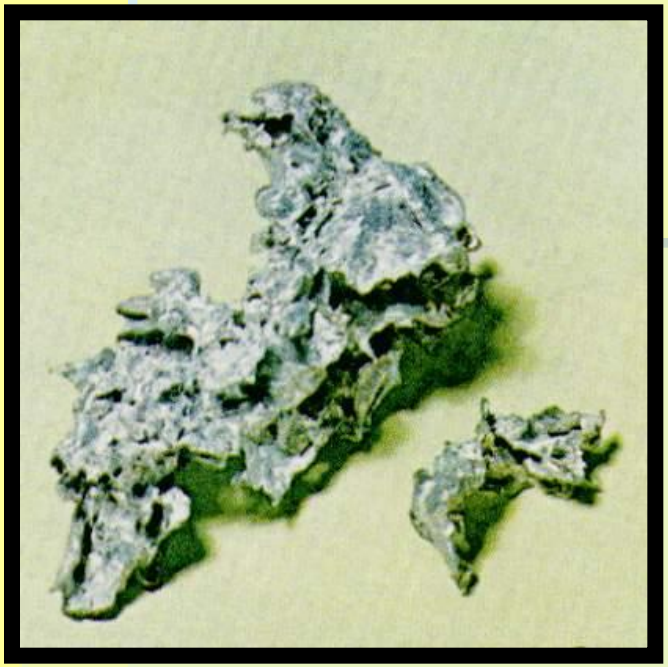
$$Zn(s) + HNO_3(dil.) \longrightarrow Zn(NO_3)_2(aq) + N_2O(g) + H_2O(l)$$

5. Reaction of Zn with strong bases.

$$Zn + 2NaOH(conc.) + 2H_2O \longrightarrow Na_2[Zn(OH)_4](aq) + H_2(g)$$

Zinc

30
Zn
65.39

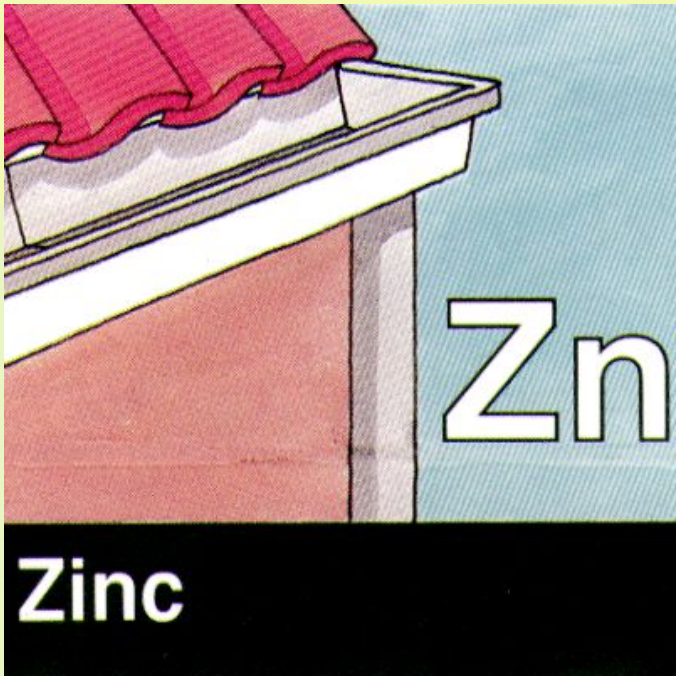


The metal is used principally as a protective coating, or galvanizer, for iron and steel; as an ingredient of various alloys, especially brass; as plates for dry electric cells; and for die castings. Zinc oxide, known as zinc white or Chinese white, is used as a paint pigment.


WINSOR & NEWTON
DESIGNERS
GOUACHE
ZINC WHITE
DESIGNERS

Zn


DURACELL
DURACELL
DURACELL
DURACELL


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°C, the boiling point is 2671°C and its density is 7.19 g/cm3 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 ($FeO \cdot Cr_2O_3$), 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 NO_3^- and SO_4^{2-} compounds, and with O_2 gas.

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

$$Cr + 2HCl(dil.) \longrightarrow \underset{\text{pale blue}}{CrCl_2} + H_2$$

2. Hot and concentrated sulfuric acid reacts with chromium to form SO_2 gas.

$$2Cr + 6H_2SO_4(conc.) \rightarrow Cr_2(SO_4)_3 + 3SO_2 + 6H_2O$$

Chromium reacts with dilute H_2SO_4 to give $CrSO_4$ salt and H_2 gas.

$$Cr + H_2SO_4(dil.) \longrightarrow CrSO_4 + H_2$$

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

$$2Cr + 3Cl_2 \xrightarrow{1200^\circ C} 2CrCl_3 \text{ (Black)}$$

$$4Cr + 3O_2 \xrightarrow{600^\circ C} 2Cr_2O_3 \text{ (Green)}$$

$$2Cr + N_2 \xrightarrow{900^\circ C} 2CrN \text{ (Black)}$$

COMPOUNDS

1)Chromium (III) Oxide, Cr_2O_3

Chromium (III) oxide is a green colored powder.

$$2Cr(OH)_3 \xrightarrow{heat} Cr_2O_3 + 3H_2O \quad \text{or}$$

$$(NH_4)_2Cr_2O_7 \xrightarrow{heat} Cr_2O_3 + N_2 + 4H_2O$$

2) Chromium (VI) Oxide, CrO_3

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

$$K_2Cr_2O_7(s) + H_2SO_4(conc.) \longrightarrow 2CrO_3(s) + K_2SO_4(aq) + H_2O(l)$$

$$K_2CrO_4(s) + H_2SO_4(conc.) \longrightarrow CrO_3(s) + K_2SO_4(aq) + H_2O(l)$$

3. Chromates (CrO_4^{2-}) and dichromates ($Cr_2O_7^{2-}$)

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

$$Na_2CrO_4 + Pb(NO_3)_2 \longrightarrow PbCrO_4\downarrow + 2NaNO_3$$

Chromates react with acids and turn to orange colored dichromates.

$$2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$$