

**Greenwood & Earnshaw**

**2<sup>nd</sup> Edition**

# **Chapter 28**

**Group 11**

**Copper, Silver & Gold**

# Copper, Silver & Gold

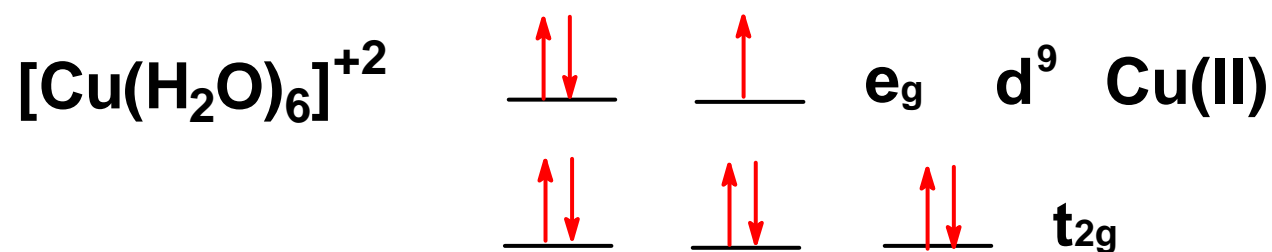
- The electron configurations in this group feature a  $d^{10} s^1$ .
- The first ionization energies are relatively high, much higher than Group 1 with which they were once grouped.
- Oxidation states are restricted, and even M(I) is somewhat oxidizing, hence the metals are sometimes found native.
- The electronegativity for Cu is slightly higher than Ni, Silver is somewhat lower than Pd, but gold is considerably higher than Pt.
- Melting points of the metals are considerably lower indicating significantly reduced metal-metal bonding, a fact reflected in the enthalpies of atomization.
- Densities of the 5<sup>th</sup> and 6<sup>th</sup> period metals is somewhat lower as well.
- The electrical resistivities for each of these metals is considerably lower than Group 10; Ag and Cu are the best electrical conductors.

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- The metals though sometimes grouped with the alkali metals the similarity ends with stoichiometry. The “coinage metals” have higher melting points, are harder, denser, less reactive, less soluble in liquid ammonia and their compounds more covalent than those of Group 1. The  $d^{10}$  being much poorer at shielding nuclear charge than the  $p^6$  electron configuration.
- Copper (68 ppm) is not rare and has been mined and smelted since antiquity as have silver (0.08 ppm) and gold (0.004 ppm). All have been prized for adornment and technology. The metals all have *fcc* lattices and form an extensive series of alloys with other metals.
- Copper and silver are considerably more reactive than gold, the former being readily attacked by sulfur and halogens.

# Copper (II) Complexes

Coordination number distinctions between 4, 5, 6 are difficult since Cu(II) exhibits strong tetragonal distortions arising from the Jahn-Teller effect. Simple halides dissolve in water to form the hexahydrates which tend to precipitate basic salts unless made slightly acidic.



The simple nitrate has been prepared and is monomeric in the vapor phase although the solids are polymeric chains with nitrate bridges. The concept of covalently bonded nitrate groups was novel in 1958.

