

BC2001x Lab Lecture 3

Physical and Chemical Properties of Metals

The Copper Carousel



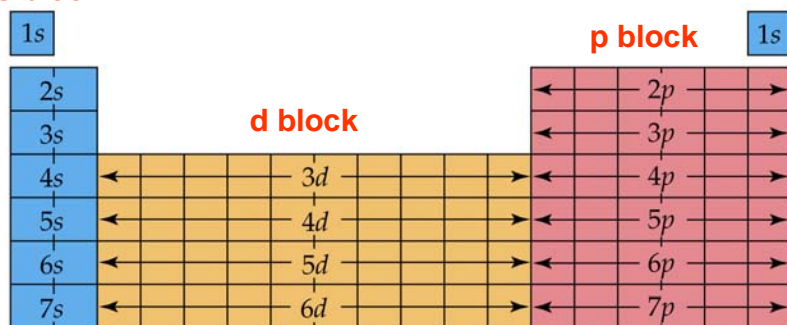
Some Properties of Metals

- Usually shiny, gray/silver
- Good electrical conductors
- Good thermal conductors
- Range in melting point, hardness, density, toxicity, and radioactivity

density: Os = 22.4 g/cm³ Li = 0.53 g/cm³
 melting point: Hg = -38.83 °C W = 3422 °C



s block



f block

Representative s-block elements
 Transition metals

Representative p-block elements
 f-Block metals

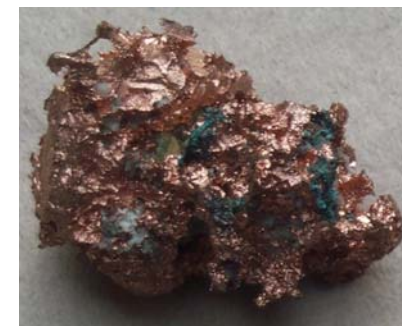
Copper

From the Latin *cuprum*, a highly versatile metal, important role in human history.

M.P. = 1358 K, B.P. = 2835 K, density δ = 8.96 g/cm³

Common formal oxidation states are +1 and +2, although others are known

Today you will examine the solution chemistry of this important element while practicing several laboratory techniques



Conservation of matter

- In each step of today's experiment, what should happen to the mass of copper?
- It remains **CONSTANT**
- Is it possible to create more copper?
- **NO!** This is a chemical impossibility!
- Even as the compounds of copper change, the number of copper atoms (or ions) in the reaction vessel is constant. This demonstrates the **Law of Conservation of Matter**.

Conservation of matter

The mass of copper in the experiment will not increase...but might it *decrease*?

Maybe...it depends on your lab technique!

What other assumptions does the Law of Conservation of Matter make?

Are these **reasonable**?

You will often be asked to make **reasoned** assumptions or approximations in your laboratory work – often these will reduce complex questions or calculations to more manageable problems!

Today's Experiment: Five Sections Lab Technique and Qualitative Observations

Lab Technique

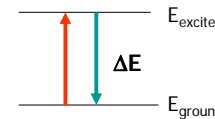
- **Continue to familiarize with lab equipment**
- **Practice new techniques**
Filtration, heating techniques, etc.

Chemical and Physical Properties

- **Colors of solids and solutions**
- **Aqueous solubility**
- **Precipitation Reactions**
- **Electron Transfer (redox) reactions:**
with H^+
with metal ions



How do atoms and molecules interact with light?



The color of light is related to its **wavelength λ**

When light at wavelength λ is absorbed/emitted by a molecule (or atom or ion) the molecule gains/loses energy

$$\Delta E = hc/\lambda$$

[h and c are constants].

In this visible and ultraviolet region, **electrons** in the molecule move to a different energy level:

$$\Delta E = E_{\text{excited}} - E_{\text{ground}}$$

If the molecule starts in an excited level and loses energy, light is **emitted**

If the molecule starts in the ground level and gains energy, light is **absorbed**

Will Precipitation Occur?

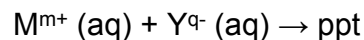
Consider possible outcomes:

Solution 1 contains $M^{m+}(aq)$ and $X^{n-}(aq)$



Solution 2 contains $A^{p+}(aq)$ and $Y^{q-}(aq)$

Possible products:

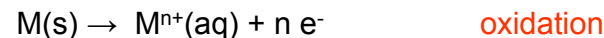


If the anion of solution 1 is $\text{NO}_3^-(aq)$ and the cation of solution 2 is $\text{Na}^+(aq)$, then the only precipitate that may form is between the metal ion M^{n+} and the anion Y^{q-} .

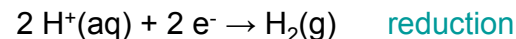
Electron Transfer (redox):

Some Metals react with $\text{H}_3\text{O}^+(aq)$ [= $\text{H}^+(aq)$]

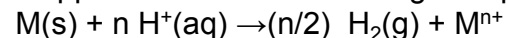
Metal M **loses** n electrons, becomes $n+$ cation:



Two H^+ 's each **gain** an electron; join to form $\text{H}_2(g)$:



This happens DIRECTLY in a single step:



Evidence that this happens:

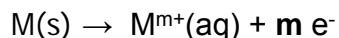
Bubbles! gas H_2 is formed

Solution may become colored if M^{n+} is colored

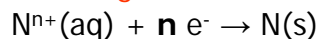
Electron Transfer (redox):

Metals reacting with ions of other metals

Metal M **loses** m electrons, becomes $m+$ cation:

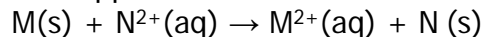


Metal **ion** N^{n+} **gains** n electrons, becomes metal N(s)



This happens DIRECTLY in a single step:

Suppose $m = n = 2$. Then



Evidence that this happens:

Metal N(s) is deposited (but not shiny rod or foil!)

Solution may change color.