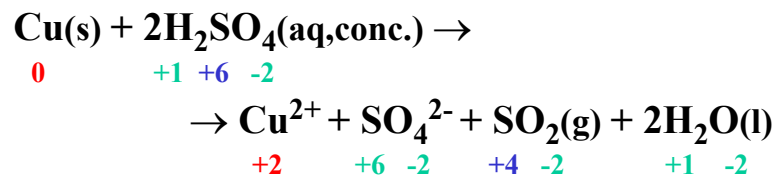
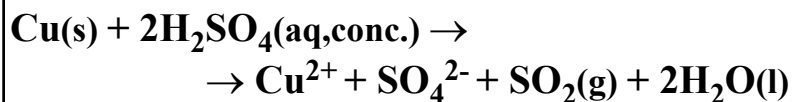


- Identification of Ox/Red agents – need to examine the Ox# of all elements in the reaction

Example:

Identify the Ox. and Red. agents in the reaction of Cu with hot, concentrated H₂SO₄.



⇒ Cu is oxidized ⇒ Cu is the reducing agent

⇒ S in H₂SO₄ is reduced ⇒ H₂SO₄ is the oxidizing agent

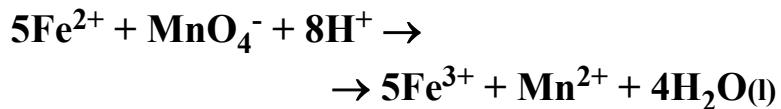
⇒ H₂SO₄ oxidizes Cu; Cu reduces H₂SO₄

Redox titrations

- Use redox reactions

Example:

A 0.202 g sample of iron ore is dissolved in HCl and all of its Fe content is converted to Fe²⁺. The resulting solution is titrated with 16.7 mL 0.0108 M KMnO₄ solution. Determine the mass% of Fe in the sample, if the equation of the redox reaction is:



⇒ mole ratio: [5 mol Fe²⁺/1 mol MnO₄⁻]

⇒ calculate the mass of Fe:

$$\begin{array}{l} 16.7 \times 10^{-3} \text{ L} \times \left(\frac{0.0108 \text{ mol MnO}_4^-}{1 \text{ L}} \right) \times \left(\frac{5 \text{ mol Fe}^{2+}}{1 \text{ mol MnO}_4^-} \right) \\ \times \left(\frac{55.85 \text{ g Fe}^{2+}}{1 \text{ mol Fe}^{2+}} \right) = 0.0504 \text{ g Fe}^{2+} \rightarrow 0.0504 \text{ g Fe} \end{array}$$

⇒ calculate the mass%:

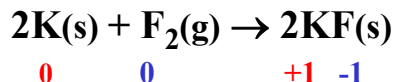
$$\text{Mass\% Fe} = \frac{0.0504 \text{ g Fe}}{0.202 \text{ g sample}} \times 100\% = 25.0\%$$

4.6 Free Elements in Redox Reactions

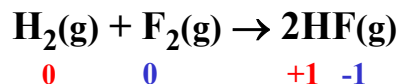
- If a reaction involves a free element as either reactant or product, it is a redox reaction

- Combining two elements**

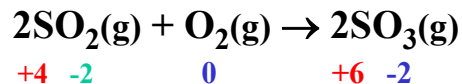
Metal + Nonmetal → Ionic compound



Nonmetal + Nonmetal → Covalent compound

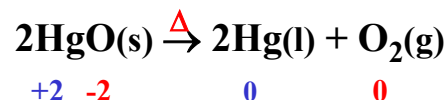


- Combining compounds and elements**

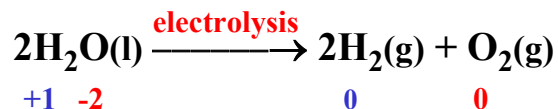


- Decomposing compounds into elements**

– Thermal decomposition



– Electrolytic decomposition

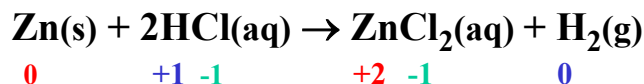


- Displacing one element by another**

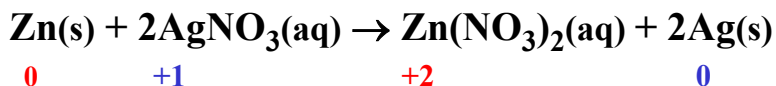
$A + BC \rightarrow AB + C$ (single displacement)

- The **activity series** of the metals – orders the metals by their ability to displace H or each other from compounds

– Metals displacing hydrogen from acids or H₂O

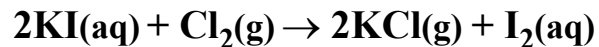


– Metals displacing each other

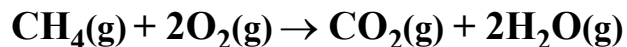


- Activity series** – metals higher in the list are stronger reducing agents and can displace (reduce) metals lower in the list from their aqueous solutions
- The most active metals are unstable in water

- The activity series of the halogens
 - Reactivity decreases down the group (halogens higher in the group are stronger oxidizing agents and can displace (oxidize) halogens lower in the group)

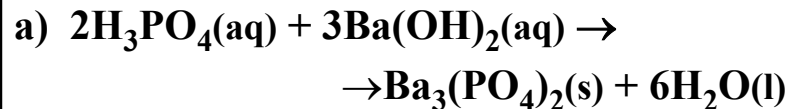


- **Combustion reactions** – combination of elements or compounds with oxygen



Example:

Classify the following reactions:



➤ H_3PO_4 is a weak acid; $\text{Ba}(\text{OH})_2$ is a strong base

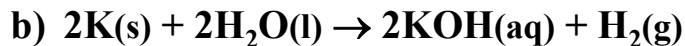
➤ Products are salt and water

⇒ **Neutralization reaction**

➤ The salt is insoluble → precipitate

⇒ **Precipitation reaction**

⇒ **Double displacement reaction**



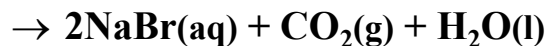
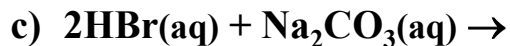
➤ Free elements involved in the reaction

➤ Change in Ox# of K and H

⇒ **Redox reaction**

➤ K displaces H from water

⇒ **Single displacement reaction**



➤ No change in Ox# of elements

➤ HBr is a strong acid, Na_2CO_3 is a salt of a weak acid

⇒ **Gas formation reaction**

⇒ **Neutralization reaction**