Answer Key

09/29/25

Redox Reactions and Molarity

What happens when a carbonate reacts with acid? (CO_3^{2-})

Carbonate decomposes into $CO_{2(g)}$ + $H_2O_{(l)}$

$$CaCO_{3(s)} + 2\,HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

What is a redox reaction?

Rxn that involves the transfer of electrons from one reactant to another

Define oxidation and reduction and oxidizing agent and reducing agent.

Oxidation: Loss of e^- & reducing agent

Reduction: Gain of e^- & oxidizing agent

LEO says GER (Lose e^-, oxidation) (Gain e^-, reduction) or OIL RIG (oxidation is losing, reduction is gaining)

What type of reactions are redox reactions?

Combination (Synthesis)

Decomposition (analysis)

Single replacement ($\overline{A+BC} \rightarrow AC+B$)

Combustion

* Double replacement is NOT a redox rxn *

What are the rules for assigning oxidation numbers?

Atoms in elemental form: $\emptyset$ EX: $O_2^{\emptyset}$

Group 1 and 7: +1 or −1 (from periodic table) EX: $Li^+ + Cl^-$

Oxygen: −2 (periodic table) but −1 in peroxide EX: $H_2^{+}O_2^{-}$

Hydrogen: +1 when bonded to nonmetal + −1 when bonded to a metal

Sum of oxidation numbers:

Has to equal zero, except on ions

EX: $P_2^{+5}O_5^{-2}$

$+10 \quad -10$

$= 0$

$Cr_2^{+6}O_7^{-2\,2-}$

$+12 \quad -14$

$= -2$

What is the oxidation number of sulfur in H_2S, S_8, SCl_2, Na_2SO_3, and SO_4^{2-}?

H_2S: $+2 - 2 = 0$ → -2

S_8: $\emptyset$ → 0

SCl_2: $+2 - 2 = 0$ → $+2$

Na_2SO_3: $+2 + 4 - 6 = 0$ → $+4$

SO_4: $+6 - 8 = -2$ → $+6$

Determine which compounds are oxidized and reduced. Determine the oxidizing and reducing agent. LEO says GER

$2HCl(aq) + Mg(s) \longrightarrow H_2(g) + MgCl_2(aq)$

HCl = oxidizing agent

Mg = reducing agent

$H^+ \rightarrow H^\emptyset$ more negative → gained e⁻ Reduced

$Mg^\emptyset \rightarrow Mg^{+2}$ more positive → lost e⁻ Oxidized

$CH_4 + O_2 \longrightarrow CO_2 + H_2O$ (GER / LEO)

CH_4 = reducing agent

O_2 = oxidizing agent

$C^{-4} \rightarrow C^{+4}$ more + → lost e⁻ Oxidized

$O^\emptyset \rightarrow O^{-2}$ more − → gain e⁻ Reduced

$Mg + Cu(NO_3)_2 \longrightarrow Mg(NO_3)_2 + Cu$

$+2 + 10 - 12 = 0$ $\longrightarrow$ $+2 + 10 - 12 = 0$

Mg = reducing agent

$Cu(NO_3)_2$ = oxidizing agent

$Mg^\emptyset \rightarrow Mg^{+2}$ more + → lost e⁻ Oxidized

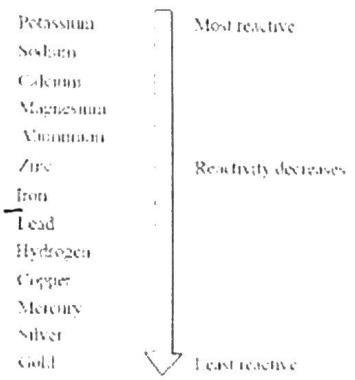
$Cu^{+2} \rightarrow Cu^\emptyset$ more − → gain e⁻ Reduced

Elements higher on the activity series are more reactive and more easily oxidized → easier to lose e⁻ than gain

Can $2AgNO_3(aq) + Cu(s)$ form a reaction.

$2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

Yes, copper is higher on the reactivity series than silver



$Ni(s) + Fe(NO_3)_3(aq) \rightarrow$ No reaction

- Ni not higher than Fe

What is the equation for molarity?

$$\text{molarity } (M) = \frac{\text{moles of solute}}{\text{volume of solution in liters}} = \frac{\text{mol}}{\text{L}}$$

Calculate the molarity by dissolving 23.4g of Na_2SO_4 in 125mL of water.

$M = \frac{\text{mol}}{\text{L}}$ g → mol mL → L

$$\frac{125\text{mL}}{1000} \left| \frac{1\ \text{L}}{\text{mL}} \right. = 0.125\text{L}$$

$$\frac{23.4\text{g } Na_2SO_4}{142.041\text{g } Na_2SO_4} \left| \frac{1\text{ mol } Na_2SO_4}{} \right. = 0.165\text{ mol } Na_2SO_4$$

$$\frac{0.165\text{mol}}{0.125\text{L}} = 1.32\text{ mol/L or } 1.32\text{ M}$$

How many grams of Na_2SO_4 are required to make 0.350L of 0.500M Na_2SO_4 ?

$$\frac{0.500\text{ mol}}{\text{L}} \times 0.350\text{L} = 0.175\text{mol } Na_2SO_4$$

$$\frac{0.175\text{ mol } Na_2SO_4}{1\text{ mol } Na_2SO_4} \left| \frac{141.041\text{ g } Na_2SO_4}{} \right. = 24.8\text{g } Na_2SO_4$$

What is the equation for making dilutions?

$$M_1V_1 = M_2V_2$$

M = molarity

V = volume

How many milliliters of 3.0M H_2SO_4 are needed to make 450mL of 0.10M H_2SO_4 ?

M_1 V_2 M_2

$$\frac{M_1V_1}{M_1} = \frac{M_2V_2}{M_1}$$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{(0.10\text{M})(450\text{mL})}{(3.0\text{M})}$$

$$\frac{(3.0\text{M})(V_1)}{3.0\text{M}} = \frac{(0.10\text{M})(450\text{mL})}{3.0\text{M}}$$

$V_1 = 15\text{mL}$

* For dilutions, must have the same compound to use $M_1V_1 = M_2V_2$

350.mL of water was added to 225mL of a 4.5M NaOH solution. What is the concentration of the 350.mL solution?

$$M_1V_1 = M_2V_2$$

$$\frac{(350.\text{mL})(M_1)}{350.\text{mL}} = \frac{(225\text{mL})(4.5\text{M})}{350.\text{mL}}$$

$$M_1 = \boxed{2.9\ \text{M}}$$

What is the difference between the equivalence point and the end point in titrations?

Equivalence point: when moles acid = moles base

End point = color change in titration

If it takes 54 mL of 0.1 M NaOH to neutralize 125 mL of an HCl solution, what is the concentration of the HCl?

V_1

$M = \frac{\text{mol}}{\text{L}}$

$$\frac{54\text{mL} \mid 1\ \text{L}}{1000\ \text{mL}} = 0.054\text{L}$$

$$\frac{0.1\text{mol NaOH}}{\text{L}} \times 0.054\text{L} = 0.0054\text{mol NaOH}$$

$$\frac{125\text{mL} \mid 1\text{L}}{1000\text{mL}} = 0.125\text{L}$$

$$\frac{0.0054\text{mol NaOH} \mid 1\text{ mol HCl}}{1\text{ mol NaOH}} = 0.0054\text{ mol HCl}$$

$$\frac{0.0054\text{ mol}}{0.125\text{L}} = \boxed{4 \times 10^{-2}\ \text{M HCl}}$$

0.0432 ↑

$Na^+ Cl^-$

$$NaOH + HCl \rightarrow NaCl + H_2O$$