Chapter 4

Oxidation numbers, Redox,
Moving electrons

What is the oxidation number of phosphorous in the phosphate ion?

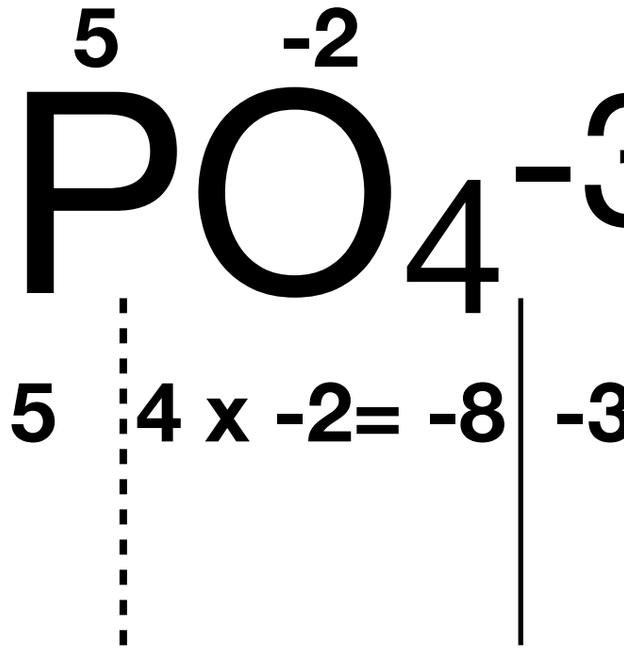
a. 6

b. 4

c. 3

d. 5

e. None of these



What is the charge on a magnesium ion?

a. 0
b. 1
c. 2
d. 3
e. One or more of these

What compounds could form from burning magnesium metal in air? Air is 20% O_2 and 80% N_2.

I. Mg_2O
II. MgO
III. MgN
IV. Mg_3N_2

A. I and III B. II and IV C. I, II and III D. IV only E. None of these

Strong vs Weak Electrolytes

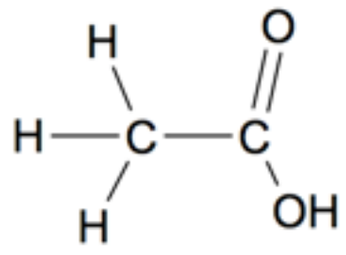
- Strong electrolytes completely dissociate into ions
- Weak electrolytes only partially dissociate, a few ions are formed, but most remain as a neutral molecules
- Non electrolytes= molecular compounds that do not dissociate

Substance	Light bulb	Strong Weak Non electrolyte
Sodium Chloride		
Sugar (sucrose)		
Vinegar		
Hydrochloric acid		
Sodium hydrogen carbonate		
Ethanol		
Electrosol		

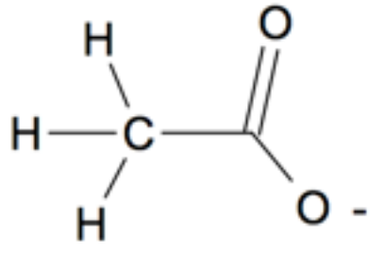
Lightbulb results

$NaCl(s) \longrightarrow Na^{+}(aq) + Cl^{-}(aq)$ **Strong**

$C_{12}H_{22}O_{11}(s) \text{ —} \text{—} > C_{12}H_{22}O_{11}(aq)$



$+ H_2O \rightleftharpoons$



$+ H_3O^{+}(aq)$

$HCl + H_2O \longrightarrow H_3O^{+}(aq) + Cl^{-}(aq)$

$NaHCO_3 \longrightarrow Na^{+}(aq) + HCO_3^{-1}(aq)$

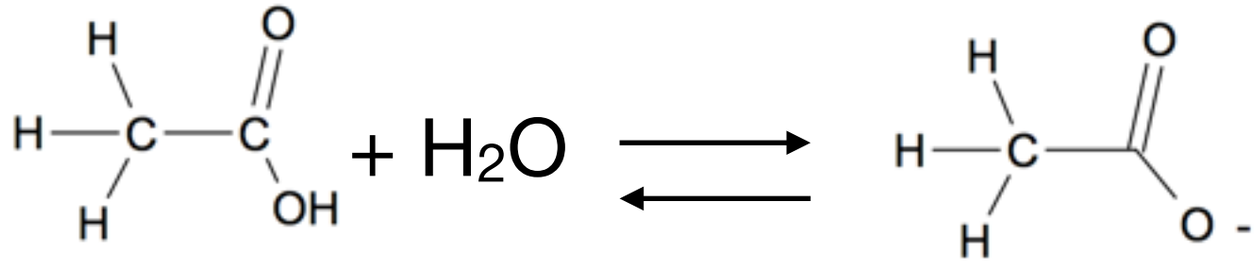
(Electrosol) $NaOH(aq) \longrightarrow Na^{+}(aq) + OH^{-}(aq)$

$CH_3CH_2OH(l) \text{ —} \text{—} > CH_3CH_2OH(aq)$

Lightbulb results

$NaCl(s) \longrightarrow Na^{+}(aq) + Cl^{-}(aq)$ Strong

$C_{12}H_{22}O_{11}(s) \text{ —} \text{—}> C_{12}H_{22}O_{11}(aq)$ Non electrolyte



+ $H_3O^{+}(aq)$ Weak

$HCl + H_2O \longrightarrow H_3O^{+}(aq) + Cl^{-}(aq)$ Strong

$NaHCO_3 \longrightarrow Na^{+}(aq) + HCO_3^{-2}(aq)$ Strong

(Electrosol) $NaOH(aq) \longrightarrow Na^{+}(aq) + OH^{-}(aq)$ Strong

$CH_3CH_2OH(l) \text{ —} \text{—}> CH_3CH_2OH(aq)$ Non electrolyte

Acids and Bases

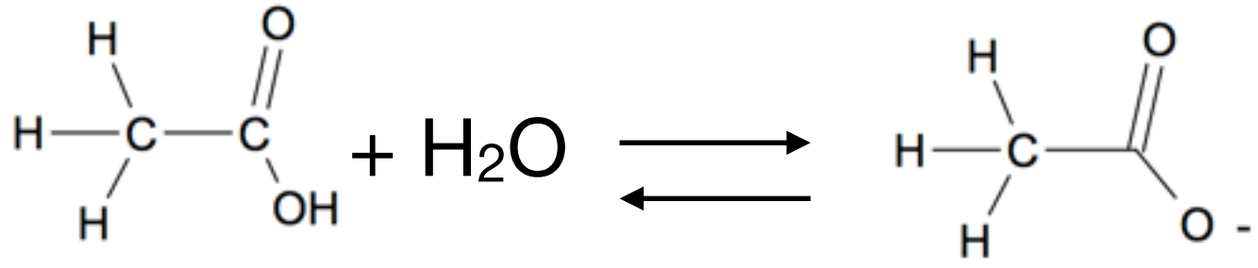
- Acids donate protons to water, turn litmus red, and taste sour.
- Bases accept protons, increase hydrogen oxide concentration, turn litmus blue, taste bitter and feel slippery.
- Strong acids and bases completely dissociate, Weak acids and bases only partially dissociate.

Substance	Cabbage Juice	Acid or Base? Strong or Weak? (light bulb)
Sodium Chloride		
Sugar (sucrose)		
Vinegar		
Hydrochloric acid		
Sodium hydrogen carbonate		
Ethanol		
Electrosol		

Cabbage Juice Results

$NaCl(s) \longrightarrow Na^{+}(aq) + Cl^{-}(aq)$ Salt

$C_{12}H_{22}O_{11}(s) \text{——>} C_{12}H_{22}O_{11}(aq)$ Molecule



+ $H_3O^{+}(aq)$ Weak acid

$HCl + H_2O \longrightarrow H_3O^{+}(aq) + Cl^{-}(aq)$ Strong acid

$HCO_3^{-} + H_2O \rightleftharpoons OH^{-}(aq) + H_2CO_3(aq)$ Weak base

(Electrosol) $NaOH(aq) \longrightarrow Na^{+}(aq) + OH^{-}(aq)$ Strong base

$CH_3CH_2OH(l) \text{——>} CH_3CH_2OH(aq)$ Molecule
(dissolving a solid molecule in water is a physical change)

In the dilution of 10.0 mL of a 0.10 *M* solution of HCl to a volume of 20.0 mL, what remains unchanged?

a. The moles of HCl in the solution

b. The concentration of the HCl solution

c. The volume of the HCl solution

d. The mass of the HCl solution

e. All of the above change.

1.Aluminum hydroxide is the active ingredient in Maalox, a remedy for upset stomachs. The Aluminum hydroxide reacts with stomach acid (HCl) to produce water and aluminum ions. A 5.0 mL sample of aluminum hydroxide was reacted with 21.34 mL of 0.1850M hydrochloric acid (HCl) and then the unreacted (leftover) HCl was titrated with sodium hydroxide. It required 8.457 mL of 0.2000M sodium hydroxide to reach the endpoint.

a. Write the balanced equation for the reaction of aluminum hydroxide with hydrochloric acid.

b. Write the balanced equation for the reaction of sodium hydroxide with hydrochloric acid.

c. Determine the leftover moles of HCl that did not react with aluminum hydroxide.

d. Determine the moles of HCl that reacted with aluminum hydroxide

e. How many moles of Aluminum hydroxide were present in the 5.00 mL sample?

f. How many grams of aluminum hydroxide were present in the 5.00 sample?

g. Is Aluminum hydroxide soluble in water? Explain.

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a. Write the balanced equation for the reaction of aluminum hydroxide with hydrochloric acid.

$Al(OH)_3$ (s) + HCl(aq) ——> Al^{+3}(aq) + 3Cl^- (aq) + 3 H_20(l)

b. Write the balanced equation for the reaction of sodium hydroxide with hydrochloric acid.

NaOH(aq) + HCl(aq)——> Na^+(aq) + Cl^- (aq) + H_20(l)

c. Determine the leftover moles of HCl that did not react with aluminum hydroxide.
d. Determine the moles of HCl that reacted with aluminum hydroxide
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$NaOH(aq) + HCl(aq) \longrightarrow Na^{+}(aq) + Cl^{-}\ (aq) + H_20(l)$

c. Determine the leftover moles of HCl that did not react with aluminum hydroxide.

8.47×10^{-3} L sodium hydroxide x 0.2000mole/L = 1.694×10^{-3} moles OH^{-} = moles H^{+}

d. Determine the moles of HCl that reacted with aluminum hydroxide.
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d. Determine the moles of HCl that reacted with aluminum hydroxide.

Total HCl = 21.34 x 10^{-3} L x 0.1850mole/L = 3.948 x 10^{-3}moles H+

Total HCl - leftover HCl = HCl that reacted

3.948 x 10^{-3}moles H+ - 1.694 x 10^{-3} moles H+ = 2.254 10^{-3} moles H+ that reacted

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e. How many moles of Aluminum hydroxide were present in the 5.00 mL sample?

2.254 x10^{-3} moles H+ $\frac{\text{1 mole } Al(OH)_3}{\text{3 moles H+}}$ = 6.762 x10^{-3} moles $Al(OH)_3$

f. How many grams of aluminum hydroxide were present in the 5.00 sample?
g. Is Aluminum hydroxide soluble in water? Explain.

hydrochloric acid.

$Al(OH)_3$ (s) + 3HCl ——> Al^{+3}(aq) + 3Cl^- (aq) + 3 H_20(l)

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NaOH(aq) + HCl(aq)——> Na^+(aq) + Cl^- (aq) + H_20(l)

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$$2.254 \times 10^{-3} \text{ moles H+} \quad \frac{1 \text{ mole } Al(OH)_3}{3 \text{ moles H+}} = 6.762 \times 10^{-3} \text{ moles } Al(OH)_3$$

f. How many grams of aluminum hydroxide were present in the 5.00 sample?

6.762 x10^{-3} moles $Al(OH)_3$ x 78 g/mole = 5.204 x 10^{-1} grams

g. Is Aluminum hydroxide soluble in water? Explain.

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e. How many moles of Aluminum hydroxide were present in the 5.00 mL sample?

$$2.254 \times 10^{-3} \text{ moles H+} \quad \frac{1 \text{ mole } Al(OH)_3}{3 \text{ moles H+}} = 7.513 \times 10^{-4} \text{ moles } Al(OH)_3$$

f. How many grams of aluminum hydroxide were present in the 5.00 sample?

7.513 x10^{-4} moles $Al(OH)_3$ x 78 g/mole = 5.860 x 10^{-2} grams

g. Is Aluminum hydroxide soluble in water? Explain.

No, hydroxides are insoluble in water, aluminum is not one of the exceptions. They do dissolve in acid.