**Section 2:** Concentration and Solubility



In a given amount of solvent, concentration is the amount of solute actually dissolved and solubility is the maximum amount of solute that can dissolve.



#### Concentration

- A solution can be described as concentrated containing a large amount of solute, or dilute – containing a little amount of solute
- The **concentration** of a solution is the amount of solute actually dissolved in a given amount of solvent.
  - One way is to state the percentage by volume of the solute.

 $\frac{10 \text{ mL juice}}{10 \text{ mL juice} + 90 \text{ mL water}} \times 100 = 10\% \text{ by volume of juice}$ 



Concentration and Solubility

#### How much can dissolve?

**Comparing solubilities** 

- **Solubility** is the maximum amount of a solute that can be dissolved in a given amount of solvent at a given temperature.
- Often expressed as grams of solute per 100g of water (g/100 g water)
- Solubility can vary based on temperature, pressure, and other factors





3 g Solute B

## **Types of Solutions**

#### Saturated solutions

- Saturated solution is a solution that contains all of the solute that it can hold at a given temperature
- Generally, as the temperature of a liquid solvent increases, the amount of solid solute it can dissolve also increases.
- Solubility curves can be used to determine how much solute will dissolve at any temperature given on the graph





#### Low concentration = Few collisions

High concentration = More collisions



# **Types of Solutions**

#### **Unsaturated solutions**

- An **unsaturated solution** is any solution that can dissolve more solute at a given temperature.
- Each time a saturated solution is heated to a higher temperature, it becomes unsaturated.



#### Solubility

#### Types of Solutions

Supersaturated solutions

- A supersaturated solution is one that contains more solute than a saturated solution at the same temperature.
- Supersaturated solutions are unstable.

#### A Supersaturated Solution



#### Solution Energy

- The formation of some solutions are exothermic they give off energy
- Some substances need outside energy to dissolve, they are endothermic
- Reusable hot and cold packs are examples of exo- and endothermic solutions.

# Changes in Energy

- During a chemical reaction a change in energy occurs. Some reactions *absorb* energy, other reactions *release* energy.
  - <u>Endothermic Reactions</u>: happens when heat goes into (*absorbed* by) the reaction
    - i.e. cooking an egg.
    - Ammonium Nitrate & Water



- <u>Exothermic Reactions</u>: happens when heat comes out of (*released* from) a reaction.
  - i.e. Methane burning
  - Hot Hands hand warmer

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## **Solubility of Gases**

Pressure effects

- One way to increase the solubility of gases in liquid is to increase the pressure.
- Soft drinks are bottled so that the pressure inside the bottle is higher than the pressure outside this is why they bubble when opened.





### **Solubility of Gases**

#### **Temperature effects**

- Another way to increase the amount of gas that dissolves in a liquid is to cool the liquid.
- This is why soft drinks stay bubblier when kept cold

More molecules are in solution at the lower temperature





# Solubility of Gases

pH effects

- The pH of a solution is the measure of its acidity.
- If a gas forms an acid in solution, it will dissolve more easily in a base.
- If a gas forms a base in solution, it will dissolve more easily in an acid.

	Environmental Effects	pH Value	Examples	
ACIDIC	All fish die (4.2) Frog eggs, tadpoles, crayfish, and mayflies die (5.5) Rainbow trout begin to die (6.0)	pH value pH = 0 pH = 1 pH = 2 pH = 3 pH = 4 pH = 5 pH = 5 pH = 6 pH = 7 pH = 8	Examples Battery acid Sulfuric acid Lemon juice, Vinegar Orange juice, Soda Acid rain (4.2-4.4) Acidic lake (4.5) Bananas (5.0-5.3) Clean rain (5.6) Healthy lake (6.5) Milk (6.5-6.8) Pure water Sea water, Eggs	
BASIC		pH = 9 pH = 10 pH = 11 pH = 12 pH = 13 pH = 14	Baking soda Milk of Magnesia Ammonia Soapy water Bleach Liquid drain cleaner	
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