UNIT 6: Solutions

Lesson 1 : Solution Terminology & How and Why Solutions Form

Essential Questions: How do solids dissolve? How does the polarity of various solutes and solvents affect solution formation? How does one distinguish between electrolytic and non-electrolytic solutions?

Questions/ Vocab, etc.	Notes:

What is a Solution? *Example: Salt is dissolved in water*

A solution, also known as a _____ mixture is made up of 2 parts:

- _____ : the substance that is dissolved; usually in minority if both are in the same state; *salt is the solute*
- _____ : The substance that does the dissolving, usually in majority if both are in the same state; *water is the solvent*
- Substances are dissolved by a process called _____ . When the solvent is water, it is called *hydration.*

Properties of a Solution

1. The solute is evenly dispersed throughout the solvent
2. Solute particles are so small that they pass through the pores of filter paper
3. Solute particles are small enough to remain suspended in solvent all the time. (1 phase is observed)

Terminology

Solubility: the ability of a solute to dissolve in a solvent

- ✔ When ***2 substances*** dissolve in one another, they are considered SOLUBLE

  Example: _____
- ✔ If they cannot dissolve in one another, they are INSOLUBLE

  Example: _____
- ✔ When ***2 liquids*** dissolve in one another, they are considered MISCIBLE

  Example: _____
- ✔ If ***2 liquids*** cannot dissolve in one another, they are IMMISCIBLE

  Example: _____

Energetics of Dissolving Substances

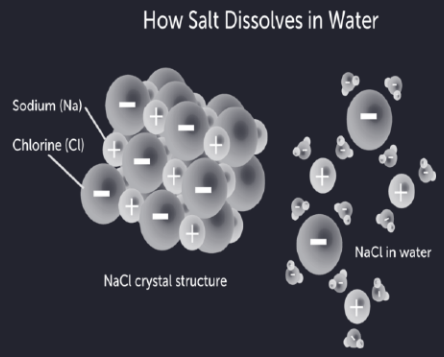
- The solvent and solute need to break intermolecular forces within themselves- This requires ENERGY (ENDOTHERMIC Process)
- New intermolecular forces are formed between the solvent and solute as the mix together.- This releases ENERGY(EXOTHERMIC Process)
- **If the energy released is more than the energy absorbed, the solvent "carries off" the solute and**
- **it dissolves. IT IS "SOLUBLE"**

Why do certain Ionic Compounds Dissolve in Water & Others Don't?

- When the forces of attraction between the ions with water are **GREATER** than the forces of attraction between the positive & negative ions, the compound will dissolve-SOLUBLE!
- When the forces of attraction between the ions with water are **SMALLER** than the forces of attraction between the positive & negative ions, the compound WILL NOT dissolve - INSOLUBLE!

Dissolving Ionic Compounds in Water

- Water molecules are _____ and their opposite ends of partial charge are attracted to the charges of the ions in an ionic compound.
- When the intermolecular forces are _____ between the water and the ion than the intramolecular forces between the ions, the water carries away the ion.



- These free-floating ions in the solution allow _____ to be conducted
- Substances that produce free-floating charges when dissolved in water are called **ELECTROLYTES**
- Strong Electrolytes conduct electricity better than weak electrolytes due to more ions being present.
  - Strong Electrolytes: 100% dissociation
  - Soluble ionic compounds, strong acids (HCl, HBr, HI, HNO_3, H_2SO_4,) and strong bases (any group 1 A hydroxide or these group 2 hydroxides: $Ca(OH)_2$, $Ba(OH)_2$ $Sr(OH)_2$
  - Weak Electrolytes: partial dissociation
  - Insoluble ionic compounds, weak acids or weak bases (NH_3)

Dissolving Polar Molecules

Polar covalent molecules are dissolved in the same way as Ionic Compounds—POLAR water forms intermolecular forces with the POLAR solute and "carries" the solute particles away.

- However, the polar covalent molecules stay together and just separate from other solute molecules.
- ***No charged ions form.***
- When molecules separate from other molecules but free-floating charges are not produced, the solution CANNOT conduct electricity. These are called **NONELECTROLYTES**.

Types of Electrolytes

Electrolytes	Non-Electrolytes
Examples:	Examples:
Some or All ions are separated when dissolved in water	No molecules separate—there are NO ions when dissolved in water
Conducts electricity when dissolved in water The more ions present, the better it conducts	Does not conduct electricity at all when dissolved in water

Dissociation Equations: Breaking up Electrolytes of Ionic Compounds in water

1. Break the ionic compound apart into the positive and negative ions
2. Leave polyatomic ions intact (including the subscript within the polyatomic ion)
3. All subscripts not within a polyatomic ion become coefficients
4. Be sure to include charges on the dissociated ions!

Examples- Ionic Compounds

KNO_3 (s) →

$Ca(NO_3)_2$ (s) →

Na_2CO_3 (s) →

Examples- Special Covalent Compounds called Acids & Bases

HCl (g) →

NH_3 (g) →

H_2SO_4 (g) →

Examples- Covalent Compounds

$C_6H_{12}O_6$ (s) →

C_2H_5OH (l) →

Lesson 2 : Factors that Affect Solubility & Reading Solubility Curves

Essential Question: Why do some substances dissolve, while others settle out? How does temperature affect solubility?

Questions/ Vocab, etc.	Notes

Examples of Solutions

Solid-liquid	Liquid-Solid	Gas-Liquid	Solid-Solid	Liquid-Liquid	Gas-Gas

Types of Solutions

Unsaturated	Saturated	Super-Saturated
Visual: no solid at the bottom	Visual: solid can be seen at bottom	Has more solute dissolved than would make a saturated solution at room temperature NO VISUAL- need some background information

Supersaturated Solutions (Not very Common)

→ A supersaturated solution can be seeded. This is a solution at room temperature that has beyond the maximum amount of solid it can dissolve.

→ It will eventually become saturated when disturbed!

Solubility of a Solid in a Liquid

- In general, the higher the temperature of a solution, the more _____ can be dissolved.
- Usually a direct relationship: As temperature **increases**, the solubility of a solid **increases.**
- *Pressure does not affect the solubility of a solid in a liquid*

Solubility of a Gas in a Liquid

- In general, the higher the temperature of a solution, the _____ gas can dissolve. Think of thermal pollution and fish kills in the hot summer months!
- Usually an inverse relationship: As temperature **increases**, the solubility of a gas **decreases**
- *Pressure can also affect the solubility of a gas in a liquid.*
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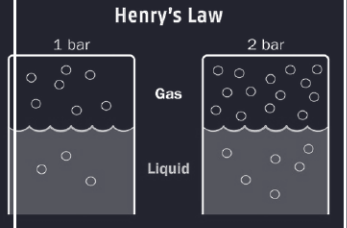
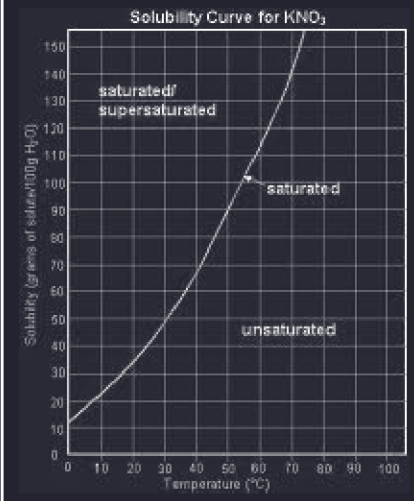


HENRY'S Law: As the pressure above a liquid increases, the solubility of a gas within a liquid will increase as well.

Solubility Curves

To determine the type of solution: find the data point on the graph of the temperature and solubility of solute in solvent.



→ *If it is below the line, it is UNSATURATED*

→ *IF it is on the line, it is SATURATED. It has reached its maximum amount that can dissolve.*

→ *If it is above the line and solute has been added but not dissolved, it is also SATURATED; the difference between the data point and the line is how much has not dissolved*

→ *If it is above the line and it's understood that the solute has been added **and it ALL dissolved**, it is SUPERSATURATED*

Examples

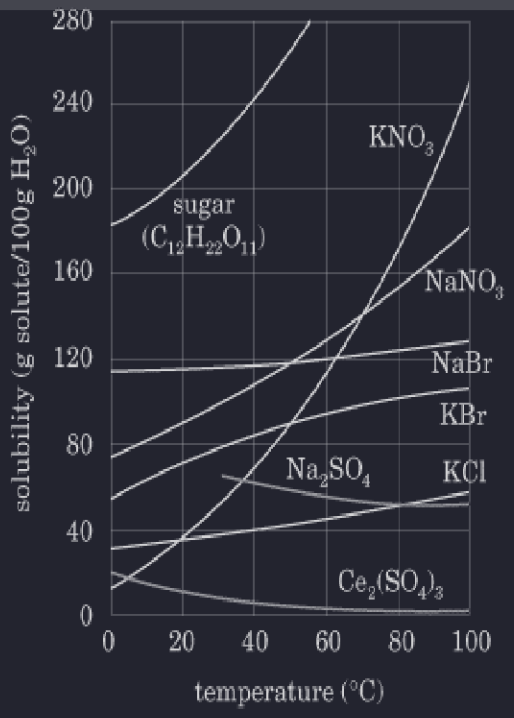
1. What kind of solution occurs when 40g of KCl is dissolved in 100 g H_2O at 60°C?

2. What kind of solution occurs when 40g of KCl is dissolved in 100 g H_2O at 40°C?

3. What is the maximum amount of NaBr that can be dissolved in 100 g H_2O at 60°C?

4. What is the maximum amount of KNO_3 that can be dissolved at 70°C?

5. According to the diamond mark, how much of the KNO_3 has been added to the water at 70°C?



6. How much extra KNO_3 is sitting at the bottom of the container at this temperature of 70°C?

3 Factors that Affect the Rate of Dissolving

1.

2.

3.

Lesson 3: Molarity Calculations

Essential Question: What equations are used to perform calculations involving the molarity of a solution, including dilutions?

Questions/ Vocab, etc.	Notes
	Molarity & Concentration of Solutions Concentration: A measure of the amount of solute in a given amount of solution • Qualitative Description: *Dilute*: small amount of _____compared to solvent *Concentrated*: _____ amount of solute compared to solvent **Molarity: quantitative description of concentration** → Molarity (M) is a concentration unit that uses moles of the solute instead of the mass of the solute → A 2.0M solution is 2.0 moles of solute dissolved in 1.0 L of solution. → A 8.0M solution is ***more*** concentrated than a 4.0M solution. $M = \frac{\text{moles solute}}{\text{L of solution}}$ **Examples : *Don't forget to change mL into L!*** 1. If you dissolve 5.0 moles of NaCl in 300.0 mL of solution, what is the molarity? 2. If you dissolve 12.0 g of NaCl in 150.0 mL of solution, what is the molarity? 3. How many grams of $CaCl_2$ would be needed to make 25.0 ml of a 2.5M solution?

Lesson 4 : How to make a Solution and Dilution Calculations

Essential Question: How can you dilute a stock, concentrated solution using the dilution equation?

Questions/ Vocab, etc.	Notes

How to Describe in Words How to make a Solution?

Complete the calculation to determine the amount of mass needed to make the solution.

State the following:

Add _____ g of _____ (solute) to a volumetric flask. Then add small amounts of water while stirring until _____ ml of solution has been reached.

Example

In words, explain how you would make a 500.0 ml solution of a 0.12 M $CoCl_2$ solution

Math:

Description:

How to Dilute a Solution?

A Dilution is a technique designed to make a concentrated solution into a more dilute solution

- ✔ The <u>moles of the solute never changes</u> during the process of the dilution
- ✔ You <u>do not need to change the volume into liters.</u> DO make sure that both volume amounts are in the same unit.
- ✔ Look for the "OF": The molarity and volume connected by this preposition MUST stay together!

$$M_1V_1 = M_2V_2$$

M_1V_1 = original concentration & volume

M_2V_2 = new concentration and volume

Examples:

1. What is the molarity of a new solution if you diluted 100.0ml of 3.0M HCl to 250.0 ml ?

2. What is the final volume of a solution if 375 ml of a 5.0 M solution is diluted to 1.5 M?

How to Describe in Words How to make a Solution?

Using a pipette, draw up _____ ml of _____ M stock solution and transfer to a volumetric flask. Then add water to the flask while stirring until _____ ml of the diluted solution has been reached.

Example:Using a 4.0M $MgSO_4$ solution, describe how to make a 300.0 ml of a 1.7 M solution.

Be Careful about the wording!

Look out for the word "ADDS _____", this must be added to the original volume to get the correct final volume BEFORE calculations**

Example: If Shanice has 620.0 mL of a 0.50 M NaBr solution, what will the concentration be if she ***adds 240.0 mL more*** water to it?