

UNIT 10 - TOPIC 1

Name: _____

WATER & SOLUTIONS - REVIEW

ESSENTIALS: Know, Understand, and Be Able To...

- A solution is a homogeneous mixture of a solute dissolved in a solvent.
- Use particle models/diagrams to show a solution.
- Distinguish between the behavior of ionic and covalent (molecular) solutes when dissolving in water.
- Distinguish between a physical change and a chemical change, in terms of particle arrangement.
- Determine whether a bond type is ionic, polar covalent or nonpolar covalent.
- Distinguish between “polar bonds” and “polar molecules”
- Use Lewis electron dot diagrams of molecules to determine if they are polar or nonpolar.
- The strength of intermolecular forces of attraction increases due to increasing molecular polarity and/or increasing molar mass. Hydrogen bonding is an unusually strong form of intermolecular attraction.
- Stronger intermolecular forces will result in higher boiling and freezing points, and lower vapor pressures.
- Use Table I to determine whether dissolving a solid will result in an increase or decrease in the temperature of the water solution.
- An electrolyte is a substance which, when dissolved in water, forms ions in the solution, and is therefore capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.
- Determine if a given formula represents an electrolyte (dissolves to form ions) or a nonelectrolyte (dissolves as molecules)
- Determine if a substance that is categorized as an electrolyte is an acid, a base or a salt
- Water molecules have a particular composition and polarity. The arrangement of and attractions between water molecules causes water to have unique properties.

EXCAVATE

Activity: Properties of Water

Assignments

ENVISION

Moodle Assignment

EVALUATE

Quiz

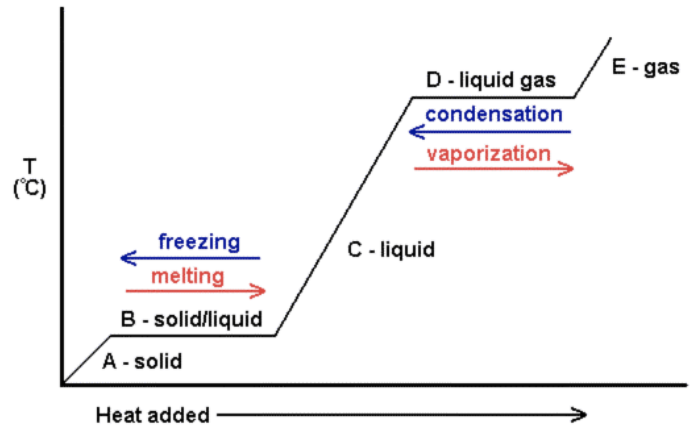
Quiz Corrections

Activity: Properties of Water



Thinking Questions:

1. What is the name of the intermolecular force that holds water molecules together? _____
2. Is this force strong or weak? _____
3. List 3 unique properties of liquid water: _____, _____, _____
4. Does water have a higher or lower melting point than other substances with similar structure? _____ Why? _____
5. For the following changes, fill in the blanks with *increases, decreases, or stays the same*:
 - a. water heats from 27°C to 36°C
PE _____ and KE _____
 - b. ice cools from 0°C to -45°C ...
PE _____ and KE _____
 - c. ice changes to water at 0°C ...
PE _____ and KE _____
 - d. water changes to vapor at 100°C ..
PE _____ and KE _____



Activity:

1. Fill a beaker with water and try to float a paper clip on the water. What happens?
2. Try to float a flat piece of metal on the water. What happens?
3. Add one drop of soap to the water. What happens?
4. Explain why it was easier to float the flat piece of metal than the paper clip. (hint: think about your body trying to float on water – what do you do to help yourself float?)
5. Now, put a small drop of soap on a piece of wax paper. Spread the soap to a circle of about 1 inch in diameter. Now put a drop of water on an area of unsoaped wax paper and put a drop of water on the soaped portion. What do you observe?
6. What unique property of water caused it to “bead up” on the waxed paper?
7. Why didn't the water “bead up” on the soapy part of the waxed paper?

Assignment: Review Ideas



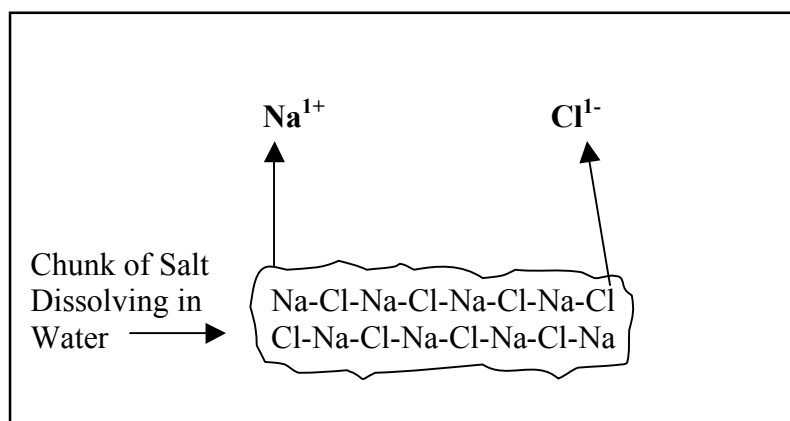
Idea #1: A solution is a homogeneous mixture of a solute dissolved in a solvent.

*****This is Important to Understand*****

Ionic bonds holding ions to each other tend to be stronger than intermolecular forces of attraction holding molecules to each other. So ionic compounds tend to be solids when we try to dissolve them, covalent compounds tend to be liquids or gases. When ionic solutes dissolve in water, the ions split up due to the action of water molecules. Molecules do NOT split up in water.

SKILL: Use particle models/diagrams to show a solution.

Show several water molecules, PROPERLY ORIENTED, around each ion. Remember it is a polar molecule with + and – ends.



SKILL: Distinguish between the behavior of ionic and covalent (molecular) solutes when dissolving in water.

- When CaCl_2 dissolves in water, how many ions form? _____
- When AlBr_3 dissolves in water, how many ions form? _____
- When $\text{Na}_2(\text{SO}_4)$ dissolves in water, how many ions form? _____
- Which substance (CaCl_2 , AlBr_3 , or $\text{Na}_2(\text{SO}_4)$) will better conduct electricity? Why?

- Compounds like CH_3OH and $\text{C}_6\text{H}_{12}\text{O}_6$ dissolve in water, but NOT by falling apart into ions. Why NOT?

Idea #2: A **physical change** results in the rearrangement of existing particles in a substance. No new types of particles are formed. A **chemical change** results in new types of particles being formed, with different bonding arrangements occurring in the products than were present in the reactants.

In terms of whether or not new types of particles are formed, explain whether making a solution is an example of a physical or chemical change:

Idea #3: **Bond polarity** can be determined by using comparing the electronegativity (“electron grabbing ability”) values of the two atoms making the bond. The greater the difference in the electronegativity values, the more polar the bond becomes.

SKILL: Determine whether a bond type is ionic, polar covalent or nonpolar covalent.

Rank the following in order from the least to the most polar bonds. Use Table S!!

C-F

H-F

C-S

C-Cl

Cl-Cl

H-O

Identify the type of bonding in each substance as ionic, polar covalent or non-polar covalent.

N_2

NO_3

Na_3N

$NaNO_3$

Idea #4: **Molecular polarity** can be determined by the shape of the molecule and distribution of electrons. Symmetrical (**nonpolar**) molecules include CO_2 , CH_4 , and the diatomic elements (“7-Up” or HOFBrINCl’s). Asymmetrical (**polar**) molecules include HCl , NH_3 , and H_2O .

SKILL: Distinguish between “polar bonds” and “polar molecules”

SKILL: Use Lewis electron dot diagrams of molecules to determine if they are polar or nonpolar.

Draw the Lewis electron dot diagrams for the following molecules:



Identify each molecule drawn above as a:

- Polar molecule with polar bonds, (P,PB)
- Nonpolar molecule with polar bonds (NP, PB)
- Nonpolar molecule with nonpolar bonds (NP, NPB)

Refer to your Lewis diagrams in the question above to help you!











Idea #5: The strength of **intermolecular forces of attraction** increases due to increasing molecular polarity and/or increasing molar mass. **Hydrogen bonding** is an unusually strong form of intermolecular attraction, and is used by water and a few other substances (NH₃, HF, alcohols).

Stronger forces of attraction will result in:

Higher boiling and freezing points, and lower vapor pressures.

SKILL: Given a pair of molecules, predict which will have the highest boiling point (or lowest vapor pressure, etc.) based on strength of forces of attraction.

For each pair of molecules:

- Circle the molecule in each pair that would have the strongest intermolecular forces. Draw the molecules (if you need to) in order to figure out!
- Explain your choice in each case, either in terms of differences in molecular polarity or differences in molar mass.

Explanations

H₂O or H₂S

CH₄ or CH₃F

C₄H₁₀ or C₁₂H₂₆

NH₃ or CH₄

Between water and H₂S, which will have the higher boiling point?

Between CH₄ and CH₃F, which will have the lowest vapor pressure? (Review how Table H works if need be!)

Between C₄H₁₀ and C₁₂H₂₆, which will be evaporate most easily?

Idea #6: A solute will dissolve in water either exothermically or endothermically.

SKILL: Use Table I to determine whether dissolving a solid will result in an increase or decrease in the temperature of the water solution.

Look at the last 7 equation in Table I. Assume that equal numbers of moles of each of these salts are dissolved in the same amount of water in each case.

Which will raise the temperature of the water most? _____

Which will cool the water most? _____

Idea #7: An **electrolyte** is a substance which, when dissolved in water, forms ions in the solution, and is therefore capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.

SKILL: Determine if a given formula represents an electrolyte (dissolves to form ions) or a nonelectrolyte (dissolves as molecules)

SKILL: Determine if a substance that is categorized as an electrolyte is an acid, a base or a salt

Of the following, check off the ones that you would expect to conduct electricity because they are electrolyte solutions.

Electrolyte Category
(acid, base, or salt)

_____ Sea water – NaCl (aq)

_____ Sugar water – C₆H₁₂O₆ (aq)

_____ Distilled water – H₂O (l)

_____ Ammonium carbonate solution – (NH₄)₂CO₃

_____ Ice – H₂O (s)

_____ Nitric acid – HNO₃ (aq)

_____ Sodium Hydroxide – NaOH (aq)

_____ A solution of methanol – CH₃OH (aq)

_____ Copper metal – Cu (s)

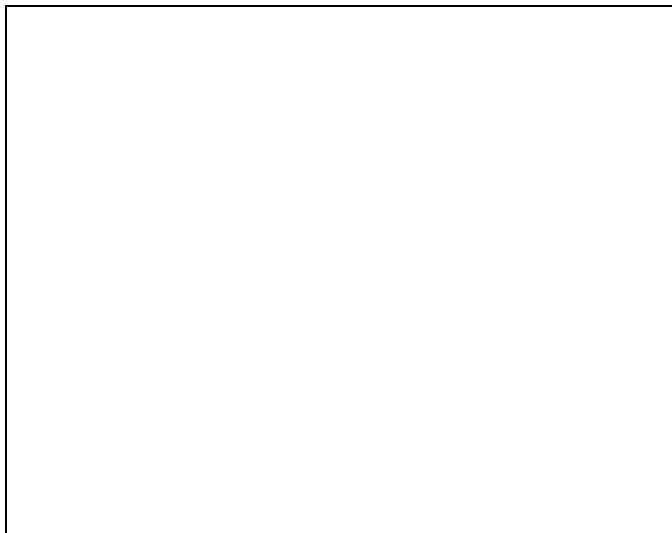
For the substances checked as electrolytes above, determine the electrolyte category.

Idea #8: Water is Unique

1. Water molecules have a particular composition and polarity.

SKILL: In the box, draw 3 water molecules, properly oriented:

- Label “polar covalent” bonds.
- Label “hydrogen” bonds.
- Show the + and – ends of the molecules.



2. The arrangement of and attractions between water molecules causes water to have unique properties.

Arrangement: Look at the arrangement of water molecules as seen on p. 446 and 449 of your text.

A) In which phase is...

... the arrangement of the molecules most orderly? _____

... the arrangement of the molecules most dense? _____

B) What is unique about the density of water as compared to all other substances on Earth?

Attractions: Water molecules attract each other with unusually strong attractions called “hydrogen bonds.”

Remember, these are NOT bonds, they are IMFs (intermolecular forces)

Match Cause

___ 1. High specific heat capacity

___ 2. High surface tension

___ 3. Strong hydrogen bonding between molecules.

___ 4. Ice is less dense than liquid water.

to Effect:

a) Doing belly floppers hurts.

b) Potholes tend to appear right after winter thaw.

c) Water evaporates slowly.

d) Lake Ontario has a moderating effect on local air temperatures.