Solutions Introduction DCI Answers

Name _____	Section _____

1. Define the following terms:

solution

A solution is a mixture which contains two or more substances homogeneously (a single phase) dissolved in one another.

A homogeneous mixture.

solute

The solute is the component of a solution present in the smallest amount, or the non-aqueous component.

solvent

The solvent is the component whose phase is retained when the solution forms; if all components are the same phase, the one in the greatest amount is the solvent.

dissolution

The process of a solute dissolving in a solvent is called dissolution.

concentration

The concentration of the solution is the amount of solute in a given amount of solvent or solution.

2. Describe your observations of the following experiments performed by the instructor. **See Appendix III for recommended demonstration, video, or computer resources.**

a) Sodium chloride added to water

When sodium chloride, a white crystalline solid, is added to water the solid falls to the bottom of the beaker and slowly dissolves. The resulting solution is colorless. The mixing of sodium chloride and water is uneventful. The equation which describes the solution process is,

$$\mathbf{NaCl}\ \textit{(s)} \rightarrow \mathbf{Na^{+}}\textit{(aq)} + \mathbf{Cl^{-}}\textit{(aq)}$$

b) Sodium metal added to water

When sodium metal, a soft, silvery metallic solid, is added to water the piece of metal rapidly skids across the surface of the water. Occasionally flame can be seen emanating near the surface of the sodium metal. The addition of sodium metal to water result in a chemical reaction according to the equation,

$$\mathbf{Na}\textit{(s)} + \mathbf{H_2O}\textit{(l)} \rightarrow \mathbf{NaOH}\textit{(aq)} + \mathbf{H_2}\textit{(g)}$$

3. Complete the following table by providing physical examples of solute/solvent combinations.

Solute	Solvent	Example
Gas	Gas	**air**
Gas	Liquid	**oxygen in water**
Liquid		**ethanol in water**
Solid		**sodium chloride in water**
Gas	Solid	
Liquid		**mercury in gold**
Solid		**molybdenum in iron**

4. Based on the video viewed in the BCE describe what happens when the following pairs of liquids are mixed together.

   a) water and hexane

   A sample of water to which some blue food coloring had been added was poured into a large test tube containing a sample of hexane (clear and colorless). The two liquids would not mix together even on stirring. The bottom layer is water and the top layer is hexane because water is the denser liquid. When the two liquids are mixed, if they do not form a homogeneous mixture, they will form a heterogeneous mixture. This is because of the difference in intermolecular attractive forces. Water is a very polar molecule and it has hydrogen-bonding intermolecular attractive forces. Hexane is a nonpolar and has only London dispersion forces.

   b) hexane and carbon tetrachloride

   The sample of carbon tetrachloride (clear and colorless) was added to a sample of hexane. The resulting mixture appeared homogeneous. There was no separation of the two liquids. It was evident as only a single phase existed, and it was also clear and colorless. When these two liquids are mixed a solution is formed. This is because of the similarity in intermolecular attractive forces. Both carbon tetrachloride and hexane are nonpolar molecules and the most important intermolecular attractive forces are the London dispersion forces.

   c) water and ethanol

   The sample of water to which some blue food coloring had been added was added to a sample of ethanol. The resulting mixture appeared homogeneous. There was no separation of the two liquids. It was evident as only a single phase existed. When these two liquids are mixed a solution is formed. This is because of the similarity in intermolecular attractive forces. Both water and ethanol are polar molecules and due to the presence of the -OH functional group (H-OH and CH_3CH_2-OH) the most important intermolecular attractive force is hydrogen-bonding forces.

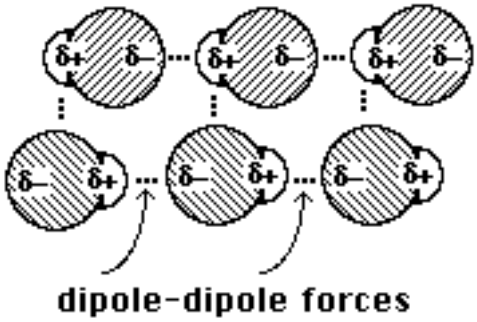
5. List the set of rules which can be used to predict the polarity of a covalent molecule.

   i) Draw a Lewis structure and determine the number of bonding groups and nonbonding pairs of electrons on the central atom.
   ii) If the central atom has only bonding groups of electrons and all terminal atoms are identical, the molecule is nonpolar.
   iii) If the central atom has only bonding groups of electrons and the terminal atoms are not identical, the molecule is polar.
   iv) If the central atom has at least one nonbonding pair of electrons, the molecule is polar.

6. Briefly describe each of the following types of intermolecular attractive forces. Sketch the orientations of molecules and/or ions involved in the following intermolecular attractive forces. Include at least one specific example where each attractive force is important. For each one, tell what causes the force and describe its strength relative to the others.

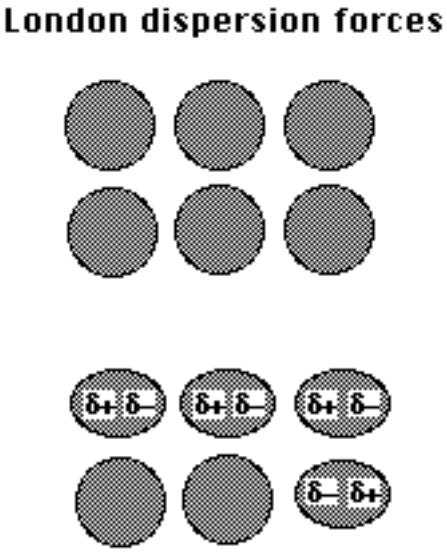
dipole-dipole forces

Dipole-dipole forces exist between hydrogen chloride molecules as shown to the right. The molecules align themselves such that the opposite charges resulting from the unequal sharing of electrons form an attractive interaction.



London dispersion forces

London dispersion forces exist between atoms and nonpolar covalent compounds. In the example on the right six atoms are shown in a form depicting the symmetric distribution of electrons. In the second group of six, some instantaneous dipoles are shown. The instantaneous dipoles result from a momentary unequal distribution of electrons. One atom with an instantaneous dipole will affect other atoms adjacent to it, producing a short range attractive interaction. These interactions are weak and are important for nonpolar molecules and single atoms



hydrogen-bonding forces

Hydrogen-bonding forces occur when a hydrogen atom covalently bonded to a very electronegative atom (O,N,F) is attracted to lone pair of electrons on an atom of an adjacent molecule.