Objective 3. Identify the chemical forces in ionic and molecular solutions.

1. Water is called the universal solvent.
a. Draw the Lewis structure of water. Is water polar or non-polar? Identify the intermolecular forces between water molecules. If H bonds exist, use a dotted line to represent H bonds between water molecules.
b. Acetic acid (CH_3COOH) is soluble in water. Draw the Lewis structure of water. Identify the intermolecular forces between acetic acid molecules. Draw a picture that shows the intermolecular forces between acetic acid and water.
c. One way to soften water (remove Ca^{2+} and Mg^{2+} ions) is to use lime, $Ca(OH)_2$. The lattice energy between $Ca(OH)_2$ is greater than the hydration energy. Is lime soluble in water?
d. Motor oil is an alkane with a chemical formula, C_{20} H_{42}. Draw the skeletal structure of motor oil. Identify the intermolecular forces between motor oil molecules. Use chemical forces to explain why oil doesn't mix with water.
e. In Lab 1, Part C, you made crude (impure) banana ester. Isoamy alcohol and sulfuric acid are the impurities. You purified the ester by doing a liquid-liquid extraction. The Isoamy alcohol and sulfuric acid are ____ soluble in water than in the ester because _____.
f. When drug companies make drugs, the drug is usually soluble in water. If the drug is not soluble enough in water, bonding –OH groups to the drug makes it more soluble. Explain why bonding –OH groups to the drug makes it more soluble.

2. Is gasoline (C_8H_{18}) soluble in motor oil? Draw a picture that shows the intermolecular forces between motor oil and gasoline.

3. a. In general, solids are more soluble in water as temperature increases. When temperature increases, atoms/molecules move faster. Use chemical forces to explain why NaCl is more soluble in hot water than cold water.
b. Caffeine is moderately soluble in room temperature water (2 g caffeine in 100 ml water) but very soluble in boiling water (66 g caffeine in 100 ml water) (https://en.wikipedia.org/wiki/Caffeine). Draw the structure of caffeine. Use chemical forces to explain why caffeine is soluble in water. If H bonds exist, use a dotted line to represent H bonds between water molecules.
c. As Pepsi is heated, it loses mass. Explain this observation.
d. When a can of soda is opened, gas escapes. Explain this observation. Draw a picture that shows how pressure affects the gas dissolved in soda.

4. Concentration
a. Wine is approximately 13% ethanol by volume. The Molar concentration of this solution is 2.2 M. Show how to convert from % by volume to Molarity.
b. 25 g of salt (sodium chloride) is dissolved in enough water to make 250 ml of solution. The concentration of this solution is 1.7 M. Show how this concentration is calculated.
c. Sea water is 0.6 M or 3.5% NaCl (mass/volume). Starting from 0.6 M, convert to % (m/V).
d. Sea water (0.6 M NaCl) has an average density of 1.027 g/ml. In 1 liter of sea water, there 992 g of water and 35 g NaCl. Show how these masses were determined. Then, calculate the molality of seat water.

5. a. 25 g of sugar (sucrose, $C_{12}H_{22}O_{11}$) is dissolved in enough water to make 250 ml of solution. Useful information: density of this sugar-water solution is 1.04 g/ml.
Calculate the concentration in:
(i) Molarity
(ii) % (mass/volume)
(iii) molality
b. The physiological concentration of NaCl and glucose is 0.9% (m/V) and 5% (m/V), respectively. 0.9% (m/V) NaCl has a _____ (higher/lower/same) ***Molarity*** than 5% (m/V) glucose. Calculate the Molarity of each solution to support your answer.