PROPERTIES OF WATER
1. Define the following terms: polarity, surface tension, vapor pressure, specific heat, and capillary action.
   - **POLARITY:** Polarity is the separation of charges, positive and negative that can describe a bond or an entire molecule and is caused by differences in electronegativity.
   - **SURFACE TENSION:** The tendency for molecules at the surface of a liquid to be pulled inward resulting in a smooth surface.
   - **VAPOR PRESSURE:** The vapor pressure of a liquid is the equilibrium pressure of a vapor above its liquid (or solid).
   - **SPECIFIC HEAT:** The amount of energy needed to raise the temperature of 1g of substance by 1°C.
   - **CAPILLARY ACTION:** The rise of liquids up a narrow tube
2. Draw four water molecules. Label the types of bonds, oxygen atoms, hydrogen atoms, and respective charges on the atoms.

   ![Water Molecules Diagram]

   - H = Hydrogen atoms
   - O = Oxygen atoms

3. Is water polar or nonpolar? Explain. **Water is a polar molecule because the oxygen is more electronegative than the hydrogen so there is unequal sharing of the bonding electrons. Oxygen attracts the bonding electrons more than each hydrogen, and this causes the oxygen to be slightly negative and each hydrogen becomes slightly positive.**
4. What type of bond forms between individual molecules of water? **Hydrogen bonds**
5. What type of bond forms between each hydrogen and the oxygen within a water molecule? **Covalent**
6. Why is water considered the universal solvent? **Water is considered the universal solvent because it has the ability to dissolve many substances.**
7. What are the special properties of water and why do they occur? **High surface tension, high specific heat, low vapor pressure, capillarity, less dense in the solid state; these properties are due to the hydrogen bonds.**
8. Explain why solid ice is less than liquid water with regard to particle arrangement. **Ice actually has a very different structure than liquid water, in that the molecules align themselves in a regular lattice rather than more randomly as in the liquid form. It happens that the lattice arrangement allows water molecules to be more spread out than in a liquid, and, thus, ice is less dense than water.**
9. Why does sugar dissolve in water, but oil does not? **Water is a polar molecule and sugar is polar (like dissolves like). Oil is nonpolar so it will not dissolve.**

SOLUTIONS
10. Define the following terms: solution, solvent, solute, dilute, concentrated, dissociate, solubility, saturated, supersaturated and unsaturated.
   - **SOLUTION:** a homogeneous mixture where one substance is dissolved inside of another.
   - **SOLVENT:** the substance that does the dissolving
   - **SOLUTE:** the substance that is dissolved
   - **DILUTE:** a solution that has excess solvent; the solution has a lower concentration of solute per solvent
   - **CONCENTRATED:** a solution that contains more a higher concentration of solute per solvent
   - **DISSOCIATE:** when ionic compounds break into their respective ions completely
   - **SOLUBILITY:** the measure of the amount of solute that can be dissolved in a given amount of solvent
   - **SATURATED:** a solution where the maximum of solute is added to solvent
SUPERSATURATED: a solution where there are more solute particles than are needed to form a saturated solution
UNSATURATED: a solution where there are less solute particles than are needed to form a saturated solution

11. Give an example of solid, liquid, and gas solution. Identify the solute and solvent.
   Solid: Steel. Solute-carbon, Solvent-iron
   Liquid: Soda. Solute-sugar, CO₂, etc. Solvent-water
   Gas: Air. Solute-O₂, CO₂, etc. Solvent-N₂

12. What is a solution? Give an example of a solution, and an example of a mixture that is not a solution.
   Solution is a homogeneous mixture. Examples of solutions include steel, Kool-Aid, and air.
   A mixture that is not a solution is cereal and milk.

13. Describe how temperature and pressure affects the solubility of solid and gas solutes in water.
   As temperature increases, the solubility of solid solutes increase and the solubility of gas solutes decrease.
   As pressure increases, the solubility of gas solutes increase. Pressure does not affect the solubility of solid solutes.

14. A glass of water has 10g of sugar dissolved in it. If more sugar can be added to dissolve in the water, is the solution unsaturated, saturated, or supersaturated? unsaturated

15. How do intermolecular forces affect solvation? Like dissolves like: ionic and polar solutes dissolve in polar solvents, nonpolar solutes dissolve in nonpolar solvents. The energy released by forming intermolecular bonds between the solutes and solvent needs to be greater than the energy it takes to break apart the bonds.

16. Why do vinegar and oil not mix? Differences in polarity; vinegar is polar and oil is nonpolar

17. On the line at the left, write the letter of the definition that best matches each term.
   _f_ solution  a. measure of how much solute will dissolve in a solvent
   _c_ solute  b. solution with water as the solvent
   _g_ solvent  c. substance that is dissolved in a solution
   _i_ soluble  d. substance that dissolves in water to form a solution that conducts electricity
   _e_ alloy  e. solid solution containing two or more metals
   _b_ aqueous  f. homogeneous mixture of two or more substances in a single physical state
   _d_ electrolyte  g. substance that does the dissolving in a solution
   _a_ solubility  h. liquids that are insoluble in each other are considered this
   _h_ immiscible  i. capable of being dissolved

CALCULATING CONCENTRATION
18. If 8.7 g of Na₂CO₃ is dissolved in 800 mL of water, what is the molarity of the solution? (1 mL of water = 1 g of water) 0.103M

19. How many moles of MgCl₂ would be needed to make 1.5 L of a 0.40 M solution? 0.6 moles

20. What is the molarity of a bleach solution containing 9.5g of NaOCl per liter of bleach? 0.127M

21. What is the concentration in ppm of ethanol in a solution that contains 35 g of ethanol dissolved in 115 kg of water (1 kg = 1g)? 304.3 ppm

22. Calculate the molarity of a 1.60L of a solution containing 0.05 moles of dissolved KBr. 0.031M

23. If .5g of blood are added to 10.0 kg of water what is the concentration in PPM? (1 kg = 1g) 50 ppm

24. A solution is made up of 123 g NaOH and 289 g water. The total volume is 300.0 mL. Determine the following:
   a. Moles of NaOH 3.075 moles
d. PPM 4.26 x 10⁵ ppm
   b. Moles of H₂O 16.06 moles
e. Molarity 10.25M
   c. Molality 10.6m

25. What is the molality of a solution that contains 1 mole of HNO₃ in 0.500 kg H₂O? 2m

26. What volume of water is required to dissolve 4.5 moles of NaCl to prepare a [12.50 M] solution? 0.36 liters
SOLUBILITY
27. What factors affect solubility? Nature of solute/solvent, pressure, temperature
28. What does like dissolves like mean? Polar dissolves polar and nonpolar dissolves nonpolar
29. Why doesn’t pressure affect solids and liquids? The particles in solids and liquids are already close together
30. Whenever you are given a graph to analyze the first thing you should do is look at each axis to determine what information the graph is showing.
   X-axis – _____temperature________________
   Y-axis – _____solubility_________________

31. How many grams of KCl can dissolve in 100 g of water at 30°C? about 45 g
32. For most substances, solubility increases as temperature increases. What are the exceptions on the graph below? NH₃, Ce₂(SO₄)₃

Part One: Reading Solubility Curves
Use the graph to answer the following questions.
REMEMBER UNITS!
33. What mass of solute will dissolve in 100g of water at the following temperatures?
   a. KNO₃ at 70°C 130 g
   b. NaCl at 100°C 40 g
   c. NH₄Cl at 90°C 70 g
   d. Which of the above three substances is most soluble in water at 15°C. NH₄Cl

Part Two: Types of Solutions (saturated, unsaturated, supersaturated)
34. On a solubility curve, the lines indicate the concentration of a _____saturated_________ solution - the maximum amount of solute that will dissolve at that specific temperature.
35. Values on the graph _____below______ (below, above, on) a curve represent unsaturated solutions - more solute could be dissolved at that temperature.
36. Values on the graph _____above______ (below, above, on) a curve represent supersaturated solutions – no more solute could be dissolved at that temperature.
37. Using the solubility graph, determine if the following solutions are saturated, unsaturated or supersaturated. If they are anything but saturated, list two things you can do to make them saturated (include numbers).

<table>
<thead>
<tr>
<th>Solution (in 100g H₂O)</th>
<th>Sat, Unsat, Supersat</th>
<th>+/- how many °C to make saturated?</th>
<th>+/- how many g to make saturated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 g KClO₃ at 30°C</td>
<td>SATURATED</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>30 g NaCl at 40°C</td>
<td>UNSATURATED</td>
<td>CAN’T TELL/OFF THE CHART</td>
<td>48 – 40 = 8 g</td>
</tr>
<tr>
<td>60 g KNO₃ at 30°C</td>
<td>SUPERSATURATED</td>
<td>39 – 30 = 9 deg. C</td>
<td>60 – 46 = 14 g</td>
</tr>
<tr>
<td>40 g K₂Cr₂O₇ at 80°C</td>
<td>SKIP</td>
<td>SKIP</td>
<td>SKIP</td>
</tr>
</tbody>
</table>

COLLIGATIVE PROPERTIES
38. What are colligative properties? Give an example of a colligative property in real-life and explain why/how it is used. The properties that depend on the relative number of solute and solvent particles in a solution and not the chemical identity. Example of freezing point depression is salting the roads where it snows so that the freezing point of water is reduced.
39. What are three examples of colligative properties and how are they affected (do they increase/decrease)? ***NOTE TYPO: “FOUR EXAMPLES” SHOULD READ “THREE EXAMPLES”***
1. Boiling point elevation 2. Freezing point depression 3. Vapor pressure depression

THE LORAX
40. How did the production of Thneeds affect the Truffula trees, the animals, and the ecosystem in the movie? Give an example of a real-world scenario where human technology negatively impacts society/ecosystems.

Producing thneeds required the deforestation of Truffula trees. Animals that lived in the thneeds and needed them to survive no longer had them as an available habitat. The production of thneeds also released smog into the air and sludge into the waters as byproducts. This also caused animals to be negatively impacted. Real-life examples can vary (i.e., oil spills, deforestation, acidification of oceans).