Solutions, Molarity, and Dilutions Practice

Solutions

Unsaturated Solutions

<table>
<thead>
<tr>
<th>Beaker A</th>
<th>Beaker B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 g of solute added</td>
<td>2.0 g of solute added</td>
</tr>
</tbody>
</table>

| Number of dissolved particles | 5 | 10 |
| Number of solid particles | 0 | 0 |

Saturated Solutions

<table>
<thead>
<tr>
<th>Beaker C</th>
<th>Beaker D</th>
<th>Beaker E</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6 g of solute added</td>
<td>7.0 g of solute added</td>
<td>9.0 g of solute added</td>
</tr>
</tbody>
</table>

| 18 | 18 | 18 |
| 0 | 17 | ~26 |

1. Which illustration to the right represents:
   a. Solute particles in the solid state in water?
   b. Solute particles in the aqueous state?

2. Complete the table above by filling in the number of dissolved solute particles and the number of solid solute particles.

3. Which beaker(s) in the table above are saturated? Unsaturated? How can you tell?

Saturated: Beaker C, D, E (solids at bottom) for D & E only

Unsaturated: Beakers A, B
4. When a small amount of additional solute is added to an unsaturated solution, what happens to the number of dissolved particles? Provide a specific example from the table above to support your answer.

The # of dissolved particles increases.

- Adding a small amt. to Beaker A, you would ↑ the # of dissolved particles.

5. When a small amount of additional solute is added to a saturated solution, what happens to the number of dissolved particles? Provide a specific example from the table above to support your answer.

The # of dissolved particles stays the same.

If you added solute to beaker E they would not dissolve added to.

6. Predict what would happen if a small amount of additional solute were stirred into beaker E.

The solute would not dissolve.

7. Explain 3 ways you might help a solute dissolve in an unsaturated solution.

1. Stir
2. ↑ Temp.
3. ↓ particle size
Molarity

* Both pitchers were filled with enough water (solvent) to provide 2 liters of solution.
  Dissolved Lemonade Mix particle (solute) = .*

1. Using the image above, what is the solvent and what is the solute?

   \[
   \text{Solvent} = H_2O \\
   \text{Solute} = \text{Mix}
   \]

2. Circle the word that best completes each sentence below. Justify your answer based on the picture above.

   a. Lemonade Solution 1 has more/less/the same volume of solution as 2. How do you know?

   b. Lemonade Solution 1 has more/less/the same quantity of solute as 2. Describe how you know in terms of particles.

   There are fewer particles present

3. Lemonade Solution 2 is considered to be concentrated and Lemonade Solution 1 is considered to be dilute. List 2 ways to differentiate a concentrated solution from a dilute solution.

   - Concentrated solutions have a higher concentration and a larger # of dissolved particles.
   - The concentrated solution is darker and there are more solute particles.
4. A glass is filled with concentrated lemonade solution.

a. Is the solution in the glass the same concentration as the solution in the pitcher?

Yes

b. Does the solution in the glass contain the same number of solute particles as the solution in the pitcher? If no, explain how your answer to part a can be true. Hint: Consider both the amount of solute and the amount of solvent.

Concentration is a ratio of solute to solvent particles. The glass and the pitcher represent the same ratio of solute/solvent. The total # of particles doesn't matter.

5. Do the terms “dilute” and “concentrated” provide any specific information about the quantities of solute or solvent in a solution? Explain.

They do not provide quantitative information, a dilute soln has fewer dissolved particles whereas a concentrated soln has more dissolved particles.

6. What type of solution (dilute or concentrated) will have a larger molarity value?

Concentrated

7. A 0.5M KCl solution contains 74.55g of KCl (molar mass: 74.55g/mole) in 2000mL of solution

a. Does the ratio 74.55g KCl/2000mL give the correct molarity of this solution? Why or why not?

No - incorrect units

b. What units do the amount of solute and volume of solution need to be in order to calculate the correct molarity of 0.5M?

\[
\text{M} = \frac{\text{mol. of solute}}{\text{volume of solvent}} = \frac{\text{mol. of solute}}{\text{L}}
\]

8. Calculate the molarity of a solution containing 1.5 moles of NaCl in 0.50L of solution.

\[
\frac{1.5 \text{mol}}{0.5 \text{L}} = 3 \text{M} \rightarrow 3.0 \text{M}
\]

9. Calculate the molarity of a solution containing 0.40 moles of acetic acid in 0.250 liters of solution.

\[
\frac{0.40 \text{mol}}{0.250 \text{L}} = 1.6 \text{M}
\]

10. A student correctly determines that 17.1 grams of sucrose are needed to make 50mL of a 1M sucrose solution. When making this solution in lab, the student measured 50mL of water and masses 17.1 g of sucrose. The resulting solution was not 1M as the student intended. After the student mixed sucrose and water, the resulting solution was poured into a graduated cylinder and it read 62mL.

a. What part of the molarity equation did the student overlook when mixing the solution?

The student overlooked the "liters of soln" part of the eqn. The student measured the volume of solvent used in a beaker, dissolve 17.1g of sucrose in less than 50mL of water. Transfer the dissolved sucrose to a graduated cylinder and add H2O until the total volume is 50mL.

b. What steps should the student take in lab to correctly prepare the 1M solution?

and not the final volume of the prepared solution.
Molarity Practice

11. How many grams of potassium chloride are needed to make 200 mL of a 2.5 M solution? (Answer: 37.9 g)

\[
2.5 \text{ M} = \frac{X}{0.200 \text{ L}} \quad X = 0.5 \text{ mol} \times \frac{74.5 \text{ g}}{1 \text{ mol}} = 37.9 \text{ g}
\]

12. What is the molarity of a 5.00 x 10^2 mL solution containing 249 g of calcium iodide? (Answer: 1.69 M)

\[
249 \text{ g} \times \frac{1 \text{ mol}}{294 \text{ g}} = 0.850 \text{ mol} \quad \frac{0.850 \text{ mol}}{0.5 \text{ L}} = 1.7 \text{ M}
\]

1.69 M or 1.70 M

13. How many moles of LiF would be required to produce a 2.5 M solution with a volume of 1.5 L? (Answer: 3.75 moles)

\[
2.5 \text{ M} = \frac{X}{1.5 \text{ L}} \quad X = 3.75 \text{ mol}
\]

14. Describe how you would prepare 100.0 mL of a 3.45 M solution of NaOH.

\[
3.45 \text{ M} = \frac{X}{0.1 \text{ L}} \quad X = 0.345 \text{ mol} \times \frac{40.0 \text{ g}}{1 \text{ mol}} = 13.8 \text{ g NaOH}
\]

Mass out 13.8g of NaOH and dissolve it in a small amount of H2O (less than 100mL).

Transfer the soln to a beaker and fill the beaker w/ H2O to a final volume of 100 mL.

15. Challenge Problem (Yes, you should still attempt this!) The lethal dose of potassium cyanide, KCN, is 50 mg per 1000 g of body mass. Assuming the average human is 7000 g and there are about 6.0 L of blood in the human body, what is the molarity in the blood of a lethal dose of potassium cyanide? (Answer: 9.6 x 10^-4 M)

\[
\frac{7000 \text{ g}}{1000 \text{ g}} = 7 \quad 50 \text{ mg} \times 7 = 350 \text{ mg} = 0.35 \text{ g}
\]

\[
0.35 \text{ g} \times \frac{1 \text{ mol}}{65 \text{ g}} = \frac{0.0054 \text{ mol}}{6 \text{ L}} = 9 \times 10^{-4} \text{ M}
\]
DILUTION PRACTICE

1. 5.00 mL of a solution of 6.00 M HCl is diluted to a total volume 14.00 mL. What is the concentration of the new solution? (Answer: 2.14 M HCl)

\[
\frac{M_1 V_1}{M_2 V_2} = \frac{(6.00 \text{ M})(5 \text{ mL})}{M_2 (14.00 \text{ mL})} = 2 \Rightarrow M_2 = 2.14 \text{ M}
\]

2. 50.00 mL of concentrated nitric acid (16 M HNO₃) is diluted to 1.000 L. What is the concentration of the new solution? (Answer: 0.80 M HNO₃)

\[
\frac{M_1 V_1}{M_2 V_2} = \frac{(16 \text{ M})(0.05 \text{ L})}{M_2 (1 \text{ L})} = 0.8 \Rightarrow M_2 = 0.80 \text{ M}
\]

3. 30.00 mL of water is added to 20.00 mL of 0.0500 M sodium carbonate. What is the molarity of sodium carbonate in the new solution? (Answer: 0.0200 M)

\[
(0.0500 \text{ M})(20.00 \text{ mL}) = M_2 (35.00 \text{ mL})
\]

4. What volume of 0.100 M NaCl is needed to make 5.00 mL of 0.200 M solution? (Answer: 0.01 mL)

\[
(0.100 \text{ M}) V_1 = (0.200 \text{ M})(5.00 \text{ mL})
\]

5. We need a 0.60 M NaCl solution. Starting with 50.00 mL of 0.300 M NaCl, what must you do?

\[
(50.00 \text{ mL})(0.300 \text{ M}) = (0.600 \text{ M}) V_2
\]

5 mL = V₂

6. Challenge Problem (Yes, you should still attempt this!) A solution is prepared by dissolving 10.8 g ammonium sulfate in enough water to make 100.0 mL stock solution. A 10.00-mL sample of this stock solution is then placed in a 50.00-mL volumetric flask and diluted to the mark with water. What is the molarity of the new solution? Answer 0.164 M (NH₄)₂SO₄

\[
10.8 \text{ g} \text{ NH}_₃ \times \frac{1 \text{ mol}}{132 \text{ g}} = \frac{0.0818 \text{ mol}}{0.1 \text{ L}} = (0.818 \text{ M})(10.00 \text{ mL}) = (50 \text{ mL}) \text{ N}_₂
\]

\[
M_2 = 0.164 \text{ M}
\]