“Trojan Horse Battles Zebra Mussels: Particles packed with KCl get past mussels’ defenses to kill the invasive species” - Heather Janofski

- Zebra mussels cause billions of dollars worth of damage to pipelines, water intakes, and power-plants.
- Chlorine can be used to control the species, however chlorine also damages the environment.
- BioBullets are a combination of Chlorine and Potassium
- Other elements can be placed in BioBullets to control or feed other species.

http://pubs.acs.org/cen/news/84/i04/8404zebramussels.html

“Don’t Chuck that Teflon pan just yet” - Elizabeth Knappe

- Teflon, the material used to create non-stick cookware, and other consumer applications such as microwave popcorn bags and pizza boxes, contains a chemical compound called perfluorooctanoic acid (PFOA)
- Chemists are not sure what this acid is, but the U.S. Environmental Protection Agency has asked 8 companies to “substantially reduce and eventually eliminate the chemical from its products.”
- Why were they asked to do this?
  - PFOA is believed to be a synthetic industrial chemical that does not exist in nature
  - PFOA has been found at low levels in both the environment and in blood of humans
  - PFOA has caused developmental effects in laboratory animals


Concentrations: volumes instead of weights

- **Three ways to express concentration**
  - % (amount item/total amount) *100
  - Amount could be grams, ml, lbs, etc, as long as the type of amount is the same (w/w %)
  - ppm (amount item/total amount) *1,000,000
  - Molarity (moles solute/L of solution)

Solutions, mass and moles

- Red Dye #2 C_{20}H_{11}N_{2}Na_{3}O_{10}S_{3}
  - Molecular weight 604.5 g/mole
  - 0.2 grams is how many moles ??
Solutions, mass and moles

- Red Dye #2 \(\text{C}_2\text{H}_3\text{N}_3\text{Na}_3\text{O}_{10}\text{S}_3\)
  - Molecular weight 604.5 g/mole
  - 0.2 grams is \(3.31\times10^{-4}\) moles
- This amount of dye is added to water - a solution
- Solution is homogenous mixture of solute and solvent
- Solute is the smaller amount of dissolved material
- Solvent is the greater amount of material
- The amount of water (solvent) and amount of dye (solute) determine the concentration.
- Concentration is the ratio: 
  \[
  \frac{\text{amount dye}}{\text{amount of solution}}
  \]

Calculation of concentration

- Ratio of solute/solution
- If the solute and solution have the same units
  - Ratio \(x 100\) is %
  - Ratio \(x 1,000,000\) is parts per million (ppm)
- For dilute aqueous solutions, assume the mass of solution is due only to the water. The small error due to this assumption is not significant for most purposes (i.e., using 10.0 g for the solution weight instead of 10.2 g)

0.2 g dye in 10 mL water is what %

<table>
<thead>
<tr>
<th>% by wt</th>
<th>ppm by wt</th>
<th>Molarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>1.</td>
<td>0.02%</td>
</tr>
<tr>
<td>0%</td>
<td>2.</td>
<td>0.05%</td>
</tr>
<tr>
<td>1%</td>
<td>3.</td>
<td>0.2%</td>
</tr>
<tr>
<td>0%</td>
<td>4.</td>
<td>0.5%</td>
</tr>
<tr>
<td>81%</td>
<td>5.</td>
<td>2.0%</td>
</tr>
<tr>
<td>0%</td>
<td>6.</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

0.2 gram dye in 10 mL water, what is ppm

<table>
<thead>
<tr>
<th>ppm by wt</th>
<th>% by wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>200 ppm</td>
</tr>
<tr>
<td>0%</td>
<td>2.</td>
</tr>
<tr>
<td>0%</td>
<td>3.</td>
</tr>
<tr>
<td>0%</td>
<td>4.</td>
</tr>
<tr>
<td>82%</td>
<td>5.</td>
</tr>
<tr>
<td>0%</td>
<td>6.</td>
</tr>
</tbody>
</table>

Calculation of concentration

(A) Ratio when solute is moles and solution is L
- This ratio is called molarity (or M)
- \(3.31\times10^{-2}\) moles dye and 0.01 L solution
- \(3.31\times10^{-2}\) molar dye
- Important because balanced equations are written in terms of moles, not mass
- Three different ways to express the same thing

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<tbody>
<tr>
<td>A 0.2 g in 10 mL</td>
<td>2.0</td>
<td>20,000</td>
</tr>
</tbody>
</table>

Solutions and dilutions

<table>
<thead>
<tr>
<th>starting concentration (\times) (\frac{\text{starting volume}}{\text{final volume}}) = final concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take 5 mL of the 2.0 % solution and add it to 995 mL of water. What is new concentration (B) ?</td>
</tr>
<tr>
<td>For any type of dilution:</td>
</tr>
<tr>
<td>New % B (= 2.0 % \times \frac{5 \text{ mL}}{1000 \text{ mL}} = 0.010% )</td>
</tr>
<tr>
<td>New ppm B (= 20,000 \text{ ppm} \times \frac{5 \text{ mL}}{1000 \text{ mL}} = 100 \text{ ppm} )</td>
</tr>
<tr>
<td>New molarity B (= 3.31\times10^{-2} \text{ M} \times \frac{5 \text{ mL}}{1000 \text{ mL}} = 1.66\times10^{-4} \text{ M} )</td>
</tr>
</tbody>
</table>
Solutions and dilutions - again
• Take 2 mL of the this new solution B and add it to 298 mL of water. What is the resulting concentration (C)?
  • New % C
    – 0.01% x (2 mL/300 mL) = 0.000067%
  • New ppm C
    – 100 ppm x (2 mL/300 mL) = 0.67 ppm
  • New molarity C
    – 1.66 x 10⁻⁴ M x (2 mL/300 mL) = 1.11 x 10⁻⁶ M

Take 2 mL of the this new solution B and add it to 298 mL of water. What is the resulting concentration expressed as ppm?

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<tr>
<td>B 5 mL A to 1000 mL</td>
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<td>100 ppm</td>
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<td>100 ppm</td>
</tr>
<tr>
<td>C 2 mL B to 300 mL</td>
<td>0.67 ppm</td>
<td>1.11 x 10⁻⁶ M</td>
</tr>
</tbody>
</table>

• Which has more dye, 2 mL of B or 250 mL of C?
• (Solution volume) x (concentration) = amount solute

Can be answered in moles or mass - go with moles
• Molarity is moles/L, so want volume in L
  ✔ For B, 2 mL x 1 L/1000 mL = 0.002 L
  ✔ For C, 250 mL x 1 L/1000 mL = 0.250 L
• For B, 0.002 L x 1.66 x 10⁻⁴ M = 3.32 x 10⁻⁷ mole
• For C, 0.250 L x 1.11 x 10⁻⁶ M = 2.77 x 10⁻⁷ mole
To do this directly in terms of mass

- Recognize the ppm can be written as the ratio of mg/L.
- Thus, 100 ppm can be written as 100 mg/L and 0.67 ppm can be written as 0.67 mg/L.
- So still want volume in L.
  - For B, 2 mL is 0.002 L.
  - For C, 250 mL is 0.250 L.
- For B, 0.002 L x 100 mg/L = 0.2 mg.
- For C, 0.250 L x 0.67 mg/L = 0.168 mg.

Working with mass, moles and balanced equations

1. **Balanced Equation**
2. **Molecular weights of two related compounds**
3. Convert grams first compound to moles
4. Convert moles first compound to moles second compound
5. Convert moles second compound to grams second compound