Preparing and mixing acid solutions for the use in the Cosmoegnic RadioNuclide (CRN) Target Preparation Facility - Bodo Bookhagen, UC Santa Barbara Geography Department

**Standard Concentrations and Normality of Acids:**

- Hydrochloric Acid, HCl conc. (36%): 12N ($\rho = 1.19 \text{ g/mL}$)
- Nitric Acid, HNO$_3$ conc. (69%): 15.8N ($\rho = 1.42 \text{ g/mL}$)
- Sulfuric Acid, H$_2$SO$_4$ (95.8%): 36N ($\rho = 1.84 \text{ g/mL}$)
- Ammonium Hydroxide, NH$_4$OH (29%): 14.8N ($\rho = 0.90 \text{ g/mL}$)
- Acetic Acid, CH$_3$CO$_2$H (99.8%): 17.4N ($\rho = 1.05 \text{ g/mL}$)

You use the following relation to calculate the volumes of acid mixtures with a given normality (N):

$$N_1 \times V_1 = N_2 \times V_2$$

$$V_1 = \frac{V_2 \times N_2}{N_1}$$

**Example:** Preparation of 6N Hydrochloric Acid (1:1 HCl)

- $N_1 = 12N$ (conc. HCl)
- $N_2 = 6N$
- $V_2 = 2000\text{mL}$
- $V_1 = 2000\text{mL} \times 6N / 12N$
- $V_1 = 1000\text{mL}$

To prepare a 2L 6N HCl solution, you mix 1L of conc. HCl with 1L of milliQ water.

<table>
<thead>
<tr>
<th>Acid</th>
<th>Normality</th>
<th>Mixture to make a 2000mL solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl</td>
<td>0.5N</td>
<td>83mL of conc. HCl (36%) + 1917mL of milliQ water</td>
</tr>
<tr>
<td>HCl</td>
<td>1N</td>
<td>167mL of conc. HCl (36%) + 1833mL of milliQ water</td>
</tr>
<tr>
<td>HCl</td>
<td>6N</td>
<td>1000mL of conc. HCl (36%) + 1000mL of milliQ water</td>
</tr>
<tr>
<td>HCl</td>
<td>8N</td>
<td>1333mL of conc. HCl (36%) + 667mL of milliQ water</td>
</tr>
</tbody>
</table>

**Making a 1% Hydrofluoric and 1% Nitric acid mixture**

For a 20 L solution, you use 49% HF: $0.2 / 0.49 = 0.41L$ and 69% HNO$_3$: $0.2 / 0.69 = 0.29L$ and 19.3L milliQ water.

**Making a 5% Hydrofluoric and 5% Nitric acid mixture**

For a 20 L solution, you use 49% HF: $1 / 0.49 = 2.04L$ and 69% HNO$_3$: $1 / 0.69 = 1.45L$ and 16.5L milliQ water.

**Mixing of 0.4M Oxalic acid (COOH)$_2$**

Molar weight of Oxalic acid, $M = 126.07 \text{ g/mol}$

Mixing a 2 liter 0.4M oxalic acid solution:

$126.07 \text{ g/mol} \times 0.4 \text{ mol/l} \times 2 = 100.9 \text{ g}$
Mixing a 1 liter 0.4M oxalic acid solution:
126.07 g/mol x 0.4 mol/l = 50.5 g
Put the weight of 100.9 g into the 2L LDPE bottle and add 2L of water. Close lid, shake well – it may take up to several hours until all crystals are dissolved.