Dilution of H$_2$SO$_4$

**Description:** Concentrated H$_2$SO$_4$ is diluted by varying amounts and the temperature changes associated with dilution are measured.

**Materials:**

- H$_2$SO$_4$
- Beakers
- Deionized water
- Thermometer

**Procedure:**

In three separate beakers measure the temperature increase when 10, 20, and 30 mL of H$_2$SO$_4$ are diluted by addition TO 100 mL of water. Temperatures can rise up to 90 °C.

**Discussion:** The heat released in this demonstration is a result of the hydration of the various ions formed upon dissociation of the acid:

\[
\begin{align*}
H_2SO_4 & \rightarrow HSO_4^{1-} + H^+ \\
HSO_4^{1-} & \leftrightarrow SO_4^{2-} + H^+ \\
K_1 & >> 1 \\
K_2 & 0.012 \text{ (25 °C)}
\end{align*}
\]

The heats of reaction for the described dilutions have been calculated by Shakhashiri. The following table details the results from those calculations:

<table>
<thead>
<tr>
<th>H$_2$SO$_4$ (mL)</th>
<th>H$_2$O (mL)</th>
<th>$\Delta H_{rxn}$ (kJ)</th>
<th>$\Delta T$ (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>100</td>
<td>-11</td>
<td>25</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>-26</td>
<td>48</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>-30</td>
<td>70</td>
</tr>
</tbody>
</table>

**Safety:** Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Avoid contact with the beaker as reaction can create enough heat to cause burns. Concentrated solutions of acids and bases (>2 M) can irritate the skin and cause burns. When diluting concentrated acids, add acid to water to avoid spattering.

**Disposal:** Solutions should be diluted with sodium bicarbonate and flushed down the drain with plenty of water.

**References:**
