Acid-Base Titration: Interactive Simulation

Name: ____________________________ Date: ____________________

Discussion

- The molar concentration (Molarity) of a acid solution is determined by neutralization with a base of known concentration.
- A standard base solution is added to a known quantity of a acid solution until the reaction is complete, as shown by a sudden change in the color of an acid-base indicator. This sudden change is known as the endpoint.
- In general, and acid-base reaction (double displacement) produces a SALT + water. Note that “salt” can be a variety of compounds, depending on the reactants used. In the equation below, the “salt” is represented by the formula, “ZCl”, which is a chloride salt.
- Acid-base reaction: ZOH + HCl \( \rightarrow \) ZCl + H2O; (where Z = metal cation\(^+\): Na, K, Ca, etc.)

Go to the following site to complete the virtual experiment.

http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/acid_base.html

Use data table below to record observations.

1. Select Type of Reaction: Strong Acid vs. Strong Base
2. Fill the burette with: Base
3. Select the acid and base: HCl and NaOH. The burette will now automatically fill.
4. Select the indicator: phenolphthalein
5. Note the volume of the acid and the Molarity of the acid at the bottom of the screen; record these values in the data table.
6. Push the slider up to add a volume of base; if you use the red button you can add the base dropwise; which is especially important right before the acid and base have reached an endpoint (neutralization). You can use the dropwise button for the entire titration if you choose so that you do not miss the endpoint.
7. Watch the flask for a color change to a pale pink. The endpoint is reached when one drop of base changes the color of the solution in the flask from colorless to pale pink.
8. If you overshoot the endpoint by adding base too quickly or getting too dark a solution, you will have to repeat the experiment by clicking “Reset” and starting over at Step 1.
9. When you reach the endpoint by changing the color of the acid in the flask, calculate the molarity of the base by using stoichiometry.
   a. In the space provided in the Data Table, write the balanced chemical equation for the neutralization reaction.
   b. Use the Molarity and volume of the acid, as well as the volume of base added, to determine the Molarity of the base.
   c. Continue canceling units until you have moles of base in the numerator and liters of base in the denominator.
      (HINT: The last step will involve using the volume of the base from the titration.)
   Show work for your calculations on the Calculations page.
10. When you have determined a molarity for the base, enter this value into the box labeled ____M. If you are correct, the program will tell you so.
11. Click on the Graph button and view the graph of the titration. The end, or equivalence, point of the reaction can be read from the graph. Pick the midpoint of the vertical section of the graph. Record this value in the data table. Click “Return” to close the graph.
12. Repeat the above procedure, with the following changes:
    Acid = HNO\(_3\); base = KOH; indicator = Bromothymol Blue (color change from blue to light green); fill the burette with Acid.
## Data Table

<table>
<thead>
<tr>
<th>Titration</th>
<th>Acid Formula</th>
<th>Base Formula</th>
<th>Volume of Acid, $V_A$</th>
<th>Molarity of Acid, $M_A$</th>
<th>Volume of Base, $V_B$</th>
<th>Molarity of Base, $M_B$</th>
<th>End, or Equivalence Point, pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>HCl</td>
<td>NaOH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaction Equation</td>
<td>HCl + NaOH ---&gt; _____________ + _____________</td>
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<tr>
<td>#2</td>
<td>HNO₃</td>
<td>KOH</td>
<td></td>
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<tr>
<td>Reaction Equation</td>
<td>HNO₃ + KOH ---&gt; _____________ + _____________</td>
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</tbody>
</table>

## Calculations

Use the equation, Molarity acid x Volume acid = Molarity base x Volume base: $M_A \cdot V_A = M_B \cdot V_B$

**Titration #1:**

Molarity of Base, $M_B = \frac{M_A \cdot V_A}{V_B}$

**Titration #2:**

Molarity of Base, $M_A = \frac{M_B \cdot V_B}{V_A}$

Titration #1: $M_B =$ ________________ M  

Titration #2: $M_A =$ ________________ M
### Mr. John’s Results: Data Table

<table>
<thead>
<tr>
<th>Titration</th>
<th>Acid Formula</th>
<th>Base Formula</th>
<th>Volume of Acid, ( V_A )</th>
<th>Molarity of Acid, ( M_A )</th>
<th>Volume of Base, ( V_B )</th>
<th>End, or Equivalence Point, pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>HCl</td>
<td>NaOH</td>
<td>25.00</td>
<td>0.1353</td>
<td>18.50</td>
<td>7</td>
</tr>
<tr>
<td>Reaction Equation</td>
<td>HCl + NaOH ---&gt; ( \underline{\text{NaCl}} ) + ( \underline{\text{H}_2\text{O}} )</td>
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<td></td>
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</tr>
<tr>
<td>#2</td>
<td>HNO(_3)</td>
<td>KOH</td>
<td>25.00</td>
<td>0.1644</td>
<td>19.40</td>
<td>7</td>
</tr>
<tr>
<td>Reaction Equation</td>
<td>HNO(_3) + KOH ---&gt; ( \underline{\text{KNO}_3} ) + ( \underline{\text{H}_2\text{O}} )</td>
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</tbody>
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### Calculations

Use the equation, Molarity acid x Volume acid = Molarity base x Volume base: \( M_A \cdot V_A = M_B \cdot V_B \)

**Titration #1:**

Molarity of Base, \( M_B = \frac{M_A \cdot V_A}{V_B} \)

Titration #1: \( M_B = \underline{0.1828} \) M

**Titration #2:**

Molarity of Base, \( M_B = \frac{M_A \cdot V_B}{V_A} \)

Titration #2: \( M_A = \underline{0.2119} \) M
Titration Lab, Interactive Simulation

Quiz, Learning Check

1. When a strong base and a strong acid combine, what is the pH of the salt that is created?
   a. 1.0       b. 7.0       c. 10.0       d. Depends on the reactants

2. What two products are formed when an acid and a base combine?
   a. double displacement       c. acid & base
   b. base and salt       d. salt & water

3. What is the purpose of using an indicator for a titration?
   a. To be able to see when the reaction is complete       c. To be able to better focus the eyes on the reaction
   b. To determine when the reactants are fully ionized       d. To make the procedure more visually interesting

4. What advantages are there to doing a virtual titration as opposed to a titration in the lab?
   a. Lets students play on the computer       c. Safer, more efficient, lower cost
   b. None, would rather do the hands-on lab       d. To sharpen computer skills

5. Which of these is a strong acid?
   a. CH$_3$COOH       c. NH$_3$
   b. C$_6$H$_{12}$O$_{11}$       d. HCl

6. Which of these is a strong base?
   a. CH$_3$COOH       c. NH$_3$
   b. NaOH       d. HCl

7. Acid – base reactions are often ________________________.
   a. Double displacement       c. Combustion
   b. Redox       d. Synthesis

8. Which of these is an indicator?
   a. Ammonium sulfate       c. Lactose
   c. Ribonucleic Acid       d. Phenolphthalein

9. What is the purpose of a titration?
   a. To generate colorful reactions       c. To determine the concentrations of unknown solutions
   b. To help pass Chemistry course       d. To determine the identity of unknown compounds

10. What is another name for “endpoint”?
    a. Balance point       c. Stoichiometric point
    b. Equivalence point       d. Final point

Fill in answers here.

| 1.       | 6.       |
|------------------|
| 2.       | 7.       |
| 3.       | 8.       |
| 4.       | 9.       |
| 5.       | 10.      |
Quiz, Learning Check:

### KEY

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