# Titration: quantitative analysis of an acid/base reaction

1. Obtain the following equipment: a 10 mL pipette, pipette filler, 50 mL burette, 125 mL Erlenmeyer flask, and two 50 mL beakers. Be careful when handling the burettes – they are very expensive.
2. Rinse all equipment with tap water. For the burette: a) close the stopcock, b) pour water into the end from a beaker, c) open the stopcock for a few seconds to rinse out the tip, d) rotate the burette as you dump out the remaining water (this rinses the sides of the burette), e) open and then close the stopcock to allow water in the tip to escape. For the pipette: a) use a pipette filler to fill the pipette part way with water, b) remove the filler, c) rotate the pipette as you dump the water, d) dry the end.
3. Dry the 50 mL beakers. Label one "base", and the other "acid". Fill the acid beaker with 0.175 M HCl. Half fill the base beaker with 0.60 M NaOH. To conserve chemicals, take only what you need.
4. Rinse the burette (see above) with a small amount of acid. Remember to rinse, & then drain, the tip.
5. Get a burette clamp from the front of the room. Using the clamp, attach the burette to your retort stand.
6. Fill the burette with acid to the 0 mL mark. Ensure that the tip of the burette is filled with acid – not air (to get rid of air bubbles, run some acid through the burette, then fill it back up to the 0 mark).
7. Rinse the pipette with base by taking up NaOH to the 0 mL mark and then emptying it into the sink.
8. Using a pipette, add 10 mL of base to the flask (i.e. fill pipette to 0 mL mark, then drain to 10 mL).
9. Get a dropper bottle of phenolphthalein. Add five drops of phenolphthalein to the NaOH in the flask.
10. Add 10 – 20 mL of distilled water to the flask (no need to measure it - just estimate). The extra water will not influence the reaction; it will increase the total volume, making the reaction easier to see.
11. With the tip of the burette in the neck of the flask, add acid – about 1 mL every 3-5 seconds. Swirl the contents of the flask constantly. To see the reaction better you can place a sheet of paper under the flask. Stop the acid flow immediately when you see the colour change (called the "endpoint"). This will happen very quickly so be careful not to "over-titrate". Note the volume of acid used.
12. You will now repeat step 11; to get a more accurate reading, you will be adding acid slower near the endpoint. Rinse out the flask. Add 10 mL of NaOH (using the pipette) & 5 drops phenolphthalein to the flask. Fill the burette back to the 0 mL mark with acid. Drain acid into the flask (from the burette) until the volume reads approximately 3 mL less than what was used in step 11. Now, add acid slowly (1 drop every 2-3 seconds) – stop when the endpoint is reached. Record the volume below.
13. Dump the acid and the contents of the flask. Rinse the burette, flask & acid beaker with tap water.
14. Dry the "acid" beaker with paper towel. Repeat steps 4 – 12 using 0.175 M $H_2SO_4$ in place of HCl.
15. Clean up. Rinse all equipment well with tap water (including burette & pipette). For burettes, remember to rinse and drain the tip. Return the burettes with the stopcock in the "open" position.

| Questions | NaOH + HCl | | NaOH + $H_2SO_4$ | |
|---|---|---|---|---|
| | NaOH | HCl | NaOH | $H_2SO_4$ |
| Volume used (mL) | | | | |
| Molarity (M) | | | | |

1. This kind of reaction (mixing an acid with a base) is called a _____ reaction.
2. Write balanced chemical equations for: a) NaOH(aq) + HCl(aq), and b) NaOH(aq) + $H_2SO_4$(aq).

3. How much $H_2SO_4$ was required relative to the amount of HCl required? Explain why this is so.

4. Calculate the volume of 0.175 M $H_2SO_4$ that should be required to neutralize 10 mL of 0.60 M NaOH. (Look back to your solutions stoichiometry handout if you need help with this calculation).

5. Fill in the blanks below to develop an equation that accounts for the data in the chart. Use the following variables: $M_A$ (molarity of acid), $M_B$ (molarity of base), $V_A$ (volume of acid), $V_B$ (volume of base), #H (number of hydrogens in acid formula), and #OH (number of OH groups in base formula).

_____ x _____ x _____ = _____ x _____ x _____