3.6A: Factors Affecting the Rate of a Reaction: Lab Activity

Part A: Nature of the Reactants

1. Add 20 drops of 3.0 mol/L hydrochloric acid solution to each of five wells of a 24-well test plate.
2. Place a small piece of magnesium in the first well, a small piece of aluminum in the second, a small piece of zinc in the third, a piece of iron in the fourth, and a piece of copper in the fifth.
3. Observe and record your observations.

   Questions

   - What gas is produced? How do you know?
   - Write a balanced equation to represent the reaction.
   - Do all the metals take the same time to react?
   - Rank the metals in order of reactivity.

4. Add 13 drops of water and 7 drops of 3.0 mol/L hydrochloric acid solution to one well of a 24-well test plate. Stir with a glass capillary tube (sealed at one end) to mix the solution.
5. Add 13 drops of water and 7 drops of 3.0 mol/L acetic acid solution to a second well of a 24-well test plate. Stir with a glass capillary tube to mix the solution.
6. Add 20 drops of 1.0 mol/L aqueous zinc(II) nitrate solution to a third well, 20 drops of 1.0 mol/L iron(III) nitrate solution to a fourth well, and 20 drops of 1.0 mol/L copper(II) nitrate solution to a fifth well of the 24-well test plate.
7. Place a small piece of magnesium in each of the five solutions.
8. Observe and record your observations.

   Questions

   - What happened in each well? Identify the products in each case.
   - Write a balanced equation to represent each reaction.
   - How much time does the magnesium take to react in each solution?

Part B: Surface Area (degree of subdivision of a solid)

1. Add 30 drops of 3.0 mol/L hydrochloric acid solution to each of four wells of a 24-well test plate.
2. To the first well, add a piece (a marble chip is suitable) of calcium carbonate ($CaCO_3$). To the second well, add a similar amount of finely ground (powdered) calcium carbonate.
3. To the third well, add a pice of "mossy" zinc. To the fourth well, add a similar amount of finely divided zinc (20-mesh) or powdered zinc.
4. Observe and record your observations.

Questions

- What happened in each well? Identify the products in each case.
- Write a balanced equation to represent each reaction.
- How much time do the solids take to react in each solution?

Part C: Temperature

1. Prepare a hot water bath by heating about 150 mL of water in a 250 mL beaker to boiling. Set aside.
2. Add 2 mL of 0.01 mol/L aqueous potassium permanganate ($KMnO_4$) solution (made acidic with sulphuric acid) to each of two 13 × 100 mm test tubes.
3. Place one of the test tubes of potassium permanganate solution into the hot water bath. While it is coming up to temperature, proceed to the next step.
4. Add 5 mL of 0.02 mol/L oxalic acid solution to the second test tube (at room temperature). Stir with a stirring rod.
5. Add 5 mL of 0.02 mol/L oxalic acid solution to the test tube in the hot water bath. Stir.
6. Reheat the water in your water bath to boiling, and set it aside again. Prepare a cold water bath by adding ice cubes to 50 mL of water in a 250 mL beaker.
7. Add 3 mL of water and 1 mL of 3.0 mol/L hydrochloric acid solution to each of three 13 × 100 mm test tubes. Place one of the test tubes in the hot water bath, place one in the cold water bath, and leave one at room temperature. Wait about 2 minutes for the solutions to come to temperature.

8. Cut three 0.5 cm long pieces of magnesium ribbon. Add one piece to each of the three test tubes. Observe the time required for each piece to disappear completely.

Question

- Does the reaction take the same time at each temperature? Explain.

Part D: Catalyst

1. Add 2 mL of 0.01 mol/L aqueous potassium permanganate ($KMnO_4$) solution (made acidic with sulphuric acid) to each of two 13 × 100 mm test tubes.
2. To one of the test tubes, add 5 drops of 0.01 mol/L manganese(II) sulphate solution.
3. Add 5 mL of 0.02 mol/L oxalic acid solution to each of the test tubes, stopper the tubes, and shake.
4. Observe and record your observations.

Question

- Does the reaction take the same time in each test tube? Explain.