Activity: Calcium carbonate formation
Determine the effect of increasing acid concentration on the formation of calcium carbonate, the material that makes up shells and coral skeletons.

Materials
- 6 small vials or test tubes
- Permanent marker or pen and tape for labeling
- 10 mL vinegar
- 30 mL distilled water
- 2 small cups or beakers
- 4 plastic pipettes
- Concentrated calcium chloride ($CaCl_2$) solution
- Concentrated sodium carbonate (Na_2CO_3) solution
- Indicator solution or pH paper
- Optional: Small shells or pieces of coral skeleton

Procedure
1. Label one small cup "vinegar" and the other small cup "distilled water." Fill the cups with these liquids.

2. Label the six vials with the numbers 1 through 6.

3. Fill the vials with vinegar and distilled water following Table 1. Use separate pipettes for the distilled water and vinegar.

4. Based on what you know about solubility and the calcium carbonate formation reaction (see Fig. 1), predict what will happen when you add calcium chloride ($CaCl_2$) solution to each vial. Record your predictions in Table 1.

$$CaCl_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CaCO_3\ (s) + 2\ NaCl\ (aq)$$

Fig. 1. Calcium carbonate formation reaction

5. Add 0.5 mL $CaCl_2$ solution to each vial. Record your observations in Table 1.

6. Based on what you know about solubility and the calcium carbonate formation reaction, predict what will happen when you add sodium carbonate (Na_2CO_3) solution to vial 1.

7. Add 0.5 mL Na_2CO_3 to vial 1. Take time to make observations. Record your observations in Table 1.

8. Make a prediction about what will happen when you add Na_2CO_3 to vial 2. Add 0.5 mL Na_2CO_3 to vial 2. Take time to make observations. Record your observations in Table 1. Do this for the rest of the vials.

9. Predict the pH for each vial and then test your prediction using indicator solution or pH paper. Record your predictions and observations in Table 1.

10. Optional: Predict what will happen when you add a small shell or piece of coral to each vial. Add one small shell or piece of coral to each vial. Observe and record your observations.

Table 1. Filling of vials and data collection

Vial	1	2	3	4	5	6
Distilled Water	5 mL	5 mL	5 mL	4.5 mL	4 mL	3 mL
Vinegar	none	5 drops	10 drops	0.5 mL	1 mL	2 mL
Prediction for added $CaCl_2$						
Observation for added $CaCl_2$						
Prediction for added Na_2CO_3						
Observation for added Na_2CO_3						
Predicted pH						
Observed pH						
Prediction for shell addition						
Observation for shell addition						

Activity Questions

1. Rank the vials from most to least acidic.

2. How did the vinegar affect the pH in each vial?

2. How does the pH affect calcium carbonate formation in each vial?

3. What happened when you added the shell or piece of coral to each vial? What was the effect of pH on this process?

4. Shells and coral are made of calcium carbonate ($CaCO_3$). The acid in the solution was vinegar, or acetic acid ($C_2H_4O_2$). Acetic acid dissociates into H^+ and $C_2H_3O_2^-$. Predict the reaction between $CaCO_3$ and acetic acid.

5. Which vial most closely matches current ocean pH? Which, if any, vial most closely matches projected ocean pH?

6. Does this system accurately model what is happening in the environment? How is it similar? How is it different?

7. Based on your observations, what are potential effects of decreasing ocean pH on organisms that are made of calcium carbonate ($CaCO_3$)?

8. How do you think ocean acidification might affect organisms that are not made of calcium carbonate?