

SNC1D/1P Sustainable Ecosystems/ Sustainable Ecosystems and Human Activity

Student Activity: The Destructive Nature of Acid Rain

Topics	Timing
acid rain human impact	preparation: 5 min demonstration: 10 min (plus overnight to react)

Specific Expectations

SNC1D

- A1.6** gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams
- A1.8** analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty
- B2.4** plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality (e.g., leaching of organic or inorganic fertilizers or pesticides into water systems, changes to watersheds resulting from deforestation or land development, diversion of ground water for industrial uses), and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems [IP, PR, AI, C]
- B3.5** identify various factors related to human activity that have an impact on ecosystems (e.g., the introduction of invasive species; shoreline development; industrial emissions that result in acid rain), and explain how these factors affect the equilibrium and survival of ecosystems (e.g., invasive species push out native species and upset the equilibrium in an ecosystem; shoreline development affects the types of terrestrial and aquatic life that can live near lake shores or river banks; acid rain changes the pH of water, which affects the type of aquatic life that can survive in a lake)

SNC1P

- A1.6** gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams
- A1.8** analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty
- B2.4** plan and conduct an inquiry into how a factor related to human activity affects a terrestrial or aquatic ecosystem (e.g., how changes to soil composition from the use of different compostable materials or organic or inorganic fertilizers affect the types of plants that can be grown; how lower water levels resulting from water diversion affect waterfowl nesting areas and fish reproduction), and describe the consequences that this factor has for the sustainability of the ecosystem [IP, PR, AI, C]
- B3.5** identify some factors related to human activity that have an impact on ecosystems (e.g., the use of fertilizers and pesticides; altered shorelines; organic and conventional farming; urban

sprawl), and explain how these factors affect the equilibrium and survival of populations in terrestrial and aquatic ecosystems (e.g., fertilizers change the fertility of soil, affecting what types of plants can grow in it; pesticides leach into water systems, affecting water quality and aquatic life; shoreline development affects the types of aquatic life and terrestrial vegetation that can live by lake shores or river banks; urban sprawl wipes out fields and woods, destroying wildlife habitats)

Introduction

Burning fossil fuels releases carbon dioxide, $\text{CO}_2(\text{g})$, which contributes to the greenhouse effect and hence to climate change. Burning some fossil fuels also releases nitrogen oxides and sulfur dioxides. These gases react with moisture in the air to produce acid precipitation: rain or snow containing dilute nitric acid and sulfuric acid. Precipitation is naturally acidic with a pH of 5.6 because carbon dioxide reacts with water to form carbonic acid. Precipitation is defined as being acidic if its pH is less than 5.6.

Acid precipitation has many effects on the environment, including the following:

- Lowering the pH of aquatic ecosystems affects fish's gill's ability to absorb oxygen. This can result in a decrease in numbers of some fish species.
- Damage to trees' leaves leads to reduced resistance to disease and reduced ability to survive climate variation.
- Leaching of nutrients from soil results in poorer, less productive land.
- The toxicity of soils increases as the acid precipitation causes a release of toxic metals from rocks.

In aquatic ecosystems, the pH of surface water naturally ranges from 6 (slightly acidic) to 9 (slightly basic) depending on the biological activity and mineral content of rocks and sediment.

In this demonstration, students will compare the effects of acid on a number of objects to the effects of water. The beaker containing acid is a model of an environment exposed to acid precipitation.

Materials

chemical safety goggles
two 250 mL beakers
175 mL vinegar
175 mL distilled water

2 pieces of egg shell
2 green leaves (aquatic plants work well)
2 clean pennies

Safety Considerations

- Caution students not to taste the vinegar.

Procedure

Wear appropriate PPE: safety goggles.

1. **Predict/Explain**
Ask students, “How does acid rain affect plants, eggshells, and copper metal?” Invite students to justify their predictions.
2. **Observe**
Label one beaker “distilled water” and fill it about 2/3 full with distilled water.
3. Label the other beaker “acid” and fill it about 2/3 full with vinegar.
4. To each of the beakers add 1 leaf, 1 piece of eggshell, and 1 clean penny (Fig.1).

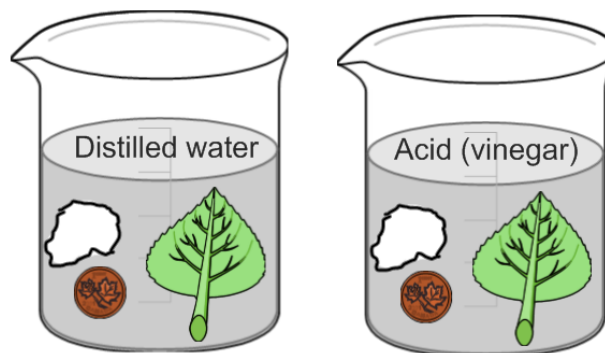


Fig.1 The “distilled water” beaker is the control.

5. Cover the beakers and leave them overnight.
6. The next day, invite students to observe and compare the contents of the beakers.
7. **Explain**
How did acid compare to the water in affecting the leaf, copper, and eggshells? Ask the students to revise their predictions, if necessary, based on what they have observed.

Disposal

Dispose of the leaves and egg shell in the municipal organic container or in the garbage. Pour the vinegar and water down the drain. Follow disposal procedures that are consistent with school board protocol and appropriate for your municipality.

What happens?

There should be no noticeable changes in the beaker containing distilled water. In the acid beaker the leaf, turns yellow with brown spots, the eggshell becomes soft and flexible, and the copper penny becomes brighter.

How does it work?

The acetic acid in vinegar breaks down the waxy layer on the outside of the leaf and kills the exposed cells, causing them to turn brown. The acetic acid reacts with the carbonate compounds in the shell, removing them and leaving the shell soft. The acid will likely react with some of the dark oxides of copper coating the penny, leaving the penny looking shinier and newer. However, vinegar does not react with copper directly because copper is a relatively unreactive metal. More reactive metals like magnesium and zinc would react if stored in vinegar.

Teaching Suggestions/Hints

1. Set up the activity the day before observations to ensure that the effects of the acid are noticeable. The beakers do not need to be illuminated overnight.
2. Use an older, dull penny with a dark, oxidized outer layer to most clearly show the effect of acid rain.
3. Depending on the chemistry knowledge of the students, the activity could be extended to include the chemical reactions that result in acid precipitation.
4. To promote collaboration, set up the demo using more beakers so that each student compares one item: student 1 has a penny in acid and a penny in distilled water; student 2 has a leaf in acid and a leaf in distilled water; student 3 has an eggshell in acid and an eggshell in distilled water. Encourage students to share and compare their observations.

Next Steps

Students could design and investigate the effects of acid rain on aquatic ecosystems. Samples of pond water could be collected or *Daphnia* ordered from a lab supply company.

Additional Resources

1. Environment Canada: Acid Rain - <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1>
2. U.S. Environmental Protection Agency: What is Acid Rain? <http://www.epa.gov/acidrain/what/index.html>