

Bridgeport Public Schools Science Department

Embedded Performance Task



Acid Rain

Laboratory Investigation Teacher Materials

Acid Rain

Teacher Materials

This curriculum-embedded science performance task is related to the content standards and expected performances for high school, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand III – Global Interdependence.

Targeted Content Standard

9.8 - The use of resources by human populations may affect the quality of the environment.

Targeted Scientific Inquiry, Literacy and Numeracy Standards

D INQ. 1 Identify questions that can be answered through scientific investigation.

D INQ. 3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

D INQ. 4 Design and conduct appropriate types of scientific investigations to answer different questions.

D INQ. 5 Identify independent and dependent variables, including those that are kept constant and those used as controls.

D INQ. 6 Use appropriate tools and techniques to make observations and gather data.

D INQ. 7 Assess the reliability of the data that was generated in the investigation.

D INQ. 9 Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

Learning objective:

Students will be able to identify building materials that are resistant to the effects of acid rain based on their data.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

Materials:

containers with lids
graduated cylinder
vinegar
pH paper/meter
safety goggles

limestone chips
marble chips
red sandstone chips
pea stone
access to a balance

Considerations:

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow about 60 minutes of instructional time for students to design and set up their experiments. Additional instructional time will be necessary for students to collect data for this activity as the change in the condition of the building materials will take several hours. If your schedule is such that class does not meet every day, then further adjustments for the activity will be necessary. Allow a minimum of 30 minutes for students to write about their results. As an alternative students can complete the lab report for homework. A sample scoring rubric is provided for your convenience or you may design your own.

Suggested materials for students to test have been listed in the laboratory activity. You can change these materials based on the supplies available to you or ask the students to bring in other building materials to test.

Any small container with a cover will work for this activity, including small jars or petri dishes. Vinegar with an approximate pH of 3 has been suggested as a substance to simulate acid rain. If the odor is too intense another weak acid may be substituted at the discretion of the teacher. Keep in mind safety considerations and the fact that average acid rain has a pH between 4.0 and 5.5.

The quantity of vinegar that is introduced to the building material is not specified in the student instructions. You can control the maximum amount of vinegar available to a team of students (20 ml per material tested) to conserve supplies or direct all students to use the same quantity of vinegar and building materials to pool data and compare results.

Some relevant information on acid rain is available at these and many other sites:

<http://www.epa.gov/highschool/air.htm>

<http://www.geocities.com/narilily/buildings.html>

<http://www.ec.gc.ca/acidrain/>

The task can be integrated into a unit on environmental science in any high-school physical or Earth science course. The curriculum-embedded task is intended to be used as a formative assessment during the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

Curriculum-Embedded Laboratory Investigation Scoring Rubric

Statement of Problem and Hypothesis

- 3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.
- 2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.
- 1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.
- 0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

Experimental Design

- 3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.
- 2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.
- 1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.
- 0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

Data Presentation

- 3 Data are well organized and presented in an appropriate manner.
- 2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.
- 1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.
- 0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

Conclusions

- 3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.
- 2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.
- 1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.
- 0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance	10-12 points
Proficient performance	7-9 points
Marginal performance	4-6 points
Unsatisfactory performance	0-3 points