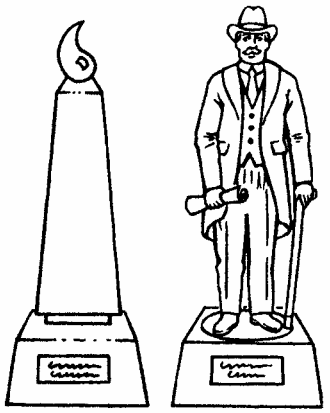
***(E. S. Indicator #13 –*** *Describe how landforms are created through a combination of destructive [e.g., weathering and erosion] and constructive [e.g., crustal deformation, volcanic eruptions and deposition of sediment] processes)*

Name _____ Date _____ Block _____

# Whether It Weathers (or Not)



It is the centennial of Rain Falls, New Hampshire, where the precipitation averages 111 cm a year and the temperatures range from -11$^{o}$ C in the winter to 33$^{o}$ C in the summer. In celebration of the centennial, the town council has voted to erect a new monument in the town square.

The council has asked you to select the most durable design and material for the new monument. The two designs have been submitted for your review. One is a very detailed statue of Claude Rain, the town's founder, and the other is a simple obelisk.

Several materials have been suggested, including marble, granite, limestone, and concrete. Keep in mind that the monument should last 100 years. The building material affects the monument's rate of weathering. Compare the effects of weathering on each material and design. Then, submit your recommendations to the town council.

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Your task it to determine which monument material and design will best withstand the severe weather in Rain Falls.

Factors to keep in mind:

- Rain Falls has a cold, wet climate. Because the town often freezes in winter and thaws in spring, you must find out how freezing and thawing affect the building materials.
- The monument will sit in a public area so it will be exposed to vandals, children and wear from periodic cleaning. How will the building materials resist the forces of human weathering?
- Snow and rain are slightly acidic in this area of the country. What are the effects of acidic precipitation on the building materials?
- Certain designs may weather differently because of the surface details. What is the relationship between exposed surface area and weathering?

1. Based on your own experience, which material do you expect to be best suited for the statue? Justify your reasoning.

Discuss with your team how you are going to determine which monument material and design will best withstand the severe weather in Rain Falls.
Components of experimental design:

- Materials needed
- Safety considerations
- Procedures used
- What data will you be collecting

Submit your plan to Mrs. Ewart for approval before proceeding.

2. Which design has more surface area, the statue or the obelisk? Justify your reasoning.

3. How did the amount of exposed surface area affect the rate of weathering?

4. Looking back at the drawings of the two potential designs, which monument would you recommend to the council, the statue of Claude Rain or the obelisk? Support your recommendation.

5. Carved into the face of Mt. Rushmore are giant sculptures of four American presidents. How are scientists using new technology to preserve Mt. Rushmore?

# Conduct an Experiment—Part 1: Testing Materials 

Investigate each environmental factor that will affect the weathering of the monument, and determine the best choice of material for your statue.

## The Effects of Freezing and Thawing

1. Rain Falls has a cold, wet climate. Because the town often freezes in winter and thaws in spring, you must find out how freezing and thawing affect the rocks.
2. **Day 1**: Examine a sample of each material with a magnifying glass. Can you find any cracks where water might enter?
3. Soak each rock sample in a bucket of water for 5 minutes. Remove the samples, and place them on the tray. Do not dry the samples. Place the tray in the freezer.
4. **Day 2**: Remove the tray from the freezer, and allow the rocks to warm to room temperature.
5. Examine the samples closely. Look for any changes with a magnifying glass. In the data table, describe any changes to your samples.

## The Effects of Weathering by Humans

Because the monument will sit in a public area, it will be exposed to vandals and children and wear from periodic cleaning. Test how the rocks on your list will resist the forces of human weathering.

6. Select 10 small rock pieces of a sample.
7. Measure their mass on a balance then place the rocks into a container.
8. Add 200 mL of water to the container. Place the lid on the container. Make sure the lid is on securely.
9. Steadily shake the container for 10 minutes.
10. Open the container. Drain the water **through the screen** so rock material does not go into the sink! Dry the rocks with a towel. Place the dried rocks on a balance. Measure and record the final mass in the data table.
11. Repeat for the other rock samples.

### SAFETY ALERT!

Vinegar is a weak acid. Wear safety goggles and an apron while using vinegar. Wash your hands with soap and water when finished.

## The Effects of Acid Rain

Because snow and rain are slightly acidic, you must test the effects of acidic precipitation on different materials.

12. Place 10 pieces of rock on a balance. Measure the initial mass, and record it in the data table. Place the small pieces of rock in an empty beaker.
13. Pour 50 mL of vinegar into the beaker of rocks. Observe and listen to the reaction in the beaker. After 10 minutes, dispose of the vinegar **through the screen** so rock material does not go into the sink!
14. Dry the rocks with a towel. Measure the final mass of the small rocks, and record the results in the data table. Calculate and record the percentage of rock lost. Record this value in the data table.

# Part 2: Testing Designs

Keep in mind that the monument should last 100 years. The building material affects the monument's rate of weathering. Certain designs may weather differently because of the surface details. Now examine the relationship between exposed surface area and weathering.

15. Repeat the same steps for the Effects of Humans and the Effects of Acid Rain using one large rock instead of the 10 small rock pieces.
16. Share all results with the class.

Name _____ Date _____ Block _____

Lab Partners _____

# Rock Weathering Results

Lab #_____

| Weathering Process | Marble | Limestone | Granite | Concrete |
|---|---|---|---|---|
| Effect of freezing and thawing the rock | | | | |
| | | | | |
| Initial mass of small rocks before shaking (g) | | | | |
| Final mass of small rocks after shaking (g) | | | | |
| Percentage of mass lost | | | | |
| | | | | |
| Initial mass of large rocks before shaking (g) | | | | |
| Final mass of large rocks after shaking (g) | | | | |
| Percentage of mass lost | | | | |
| | | | | |
| Initial mass of small rocks before vinegar (g) | | | | |
| Final mass of small rocks after vinegar (g) | | | | |
| Percentage of mass lost | | | | |
| | | | | |
| Initial mass of large rocks before vinegar (g) | | | | |
| Final mass of large rocks after vinegar (g) | | | | |
| Percentage of mass lost | | | | |
| | | | | |
| Rank the building materials from best (least amount of weathering) to worst (greatest amount of weathering) | | | | |

Rock Weathering Results by Lab Group

| | Material | Small rocks initial mass shaking | Small rocks final mass shaking | Large rocks initial mass shaking | Large rocks final mass shaking | Small rocks initial mass vinegar | Small rocks final mass vinegar | Large rocks initial mass vinegar | Large rocks final mass vinegar |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Marble | 8.5 | 8.0 | 66.5 | 66.1 | 11.0 | 10.7 | 66.0 | 65.8 |
| 2 | Limestone | 12.0 | 11.8 | 61.0 | 60.6 | 13.0 | 12.5 | 60.5 | 59.9 |
| 3 | Granite | 10.5 | 10.1 | 39.4 | 39.1 | 9.1 | 8.9 | 28.4 | 28.4 |
| | | | | | | | | | |
| 4 | Marble | 16.0 | 15.4 | 54.7 | 54.2 | 14.7 | 14.3 | 53.6 | 53.1 |
| 5 | Limestone | 13.0 | 12.5 | 47.5 | 46.5 | 12.8 | 11.3 | 72.8 | 71.0 |
| 6 | Granite | 9.5 | 9.5 | 36.5 | 36.4 | 11.0 | 11.0 | 35.5 | 35.5 |
| | | | | | | | | | |
| 7 | Marble | 10.5 | 10.3 | 33.7 | 33.6 | 7.5 | 7.1 | 33.6 | 32.1 |
| 8 | Limestone | 14.4 | 14.2 | 53.6 | 52.2 | 14.4 | 12.8 | 52.2 | 50.8 |
| 9 | Granite | 6.2 | 6.1 | 52.6 | 52.2 | 7.2 | 7.1 | 48.7 | 48.5 |
| | | | | | | | | | |
| 10 | Concrete | 54.9 | 50.9 | 125.7 | 121.7 | 38.3 | 37.1 | 44.0 | 43.6 |