Teacher Created Resources®

STEM

Hands-On Challenges

Grade 4

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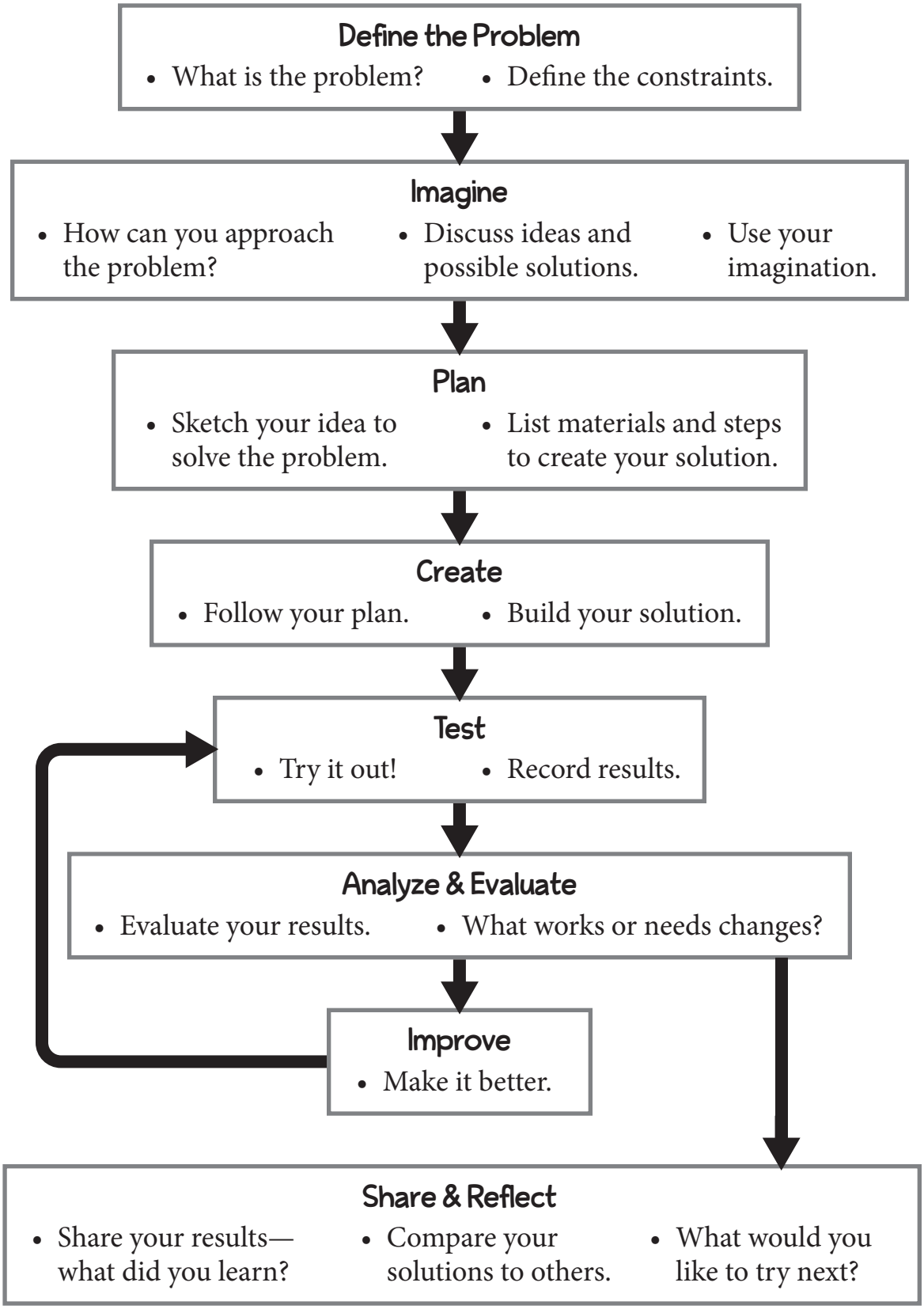
Engineering Design Process

–a series of steps used by engineers in order to solve a problem–



Save the Pond

Objectives

Students will learn about weathering through a hands-on activity. They will then record observations of a pond model and construct explanations for their observations.

STEM Focus

Earth and Space Science: Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Science Inquiry: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Science and Engineering Practices: Develop and use models; construct explanations and design solutions.

Crosscutting Concepts: Systems and system models; structure and function

Setup

For Introduction and Mini Challenge

- Find a rock for the demonstration. One with cracks in it will help demonstrate erosion and weathering.
- Collect colored chalk, paper plates, and salt for each group.
- Gather clear plastic cups and vinegar.
- Make copies of *Weathering, Erosion, and Deposition* and *Chalk Weathering* as needed.

For Main Challenge

- Gather building materials. You can use anything you have on hand for this challenge. Try to include some materials that can anchor into the ground the way tree roots would, such as plastic forks, toothpicks, and craft sticks.

  Offer both waterproof and permeable materials, such as plastic bags, plastic lids, and cotton balls.
- Collect watering cans for each group, or make holes in the bottoms of paper cups. To make the holes, try using a skewer or a sharp pencil.

Materials

Introduction and Mini Challenge

- *Weathering, Erosion, and Deposition* (page 88)
- *Chalk Weathering* (page 89)
- rock with a crack, if possible
- paper plates with raised edges
- colored chalk, one stick per pair
- table salt
- vinegar
- clear glass jar with lid or cork
- clear plastic cups

Main Challenge

- *Save the Pond* (page 90)
- *Reflections—Save the Pond* (page 91)
- large plastic bins, one per group
- large spoons
- measuring cups
- water (5 cups per group)
- sand or soil (3 cups per group)
- building materials (See Setup.)
- watering cans or paper cups (See Setup.)

Time Frame

The Introduction and Mini Challenge can be completed in one class session of about 30 minutes.

The Main Challenge can be completed in about 45 minutes.

Follow up with the Writing Reflections as time allows.

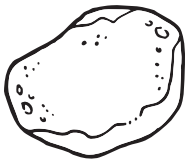
Vocabulary

abrasion
chemical weathering
deposition
divert
erosion
mechanical weathering
weathering

Save the Pond

Introduction

1. Hold up a rock. Ask, "How could this rock be broken into smaller rocks?" Have students discuss their ideas with a partner, and then have some students share with the class.
2. Give each student a copy of the *Weathering, Erosion, and Deposition* chart. Tell them that they will be filling in the definitions on this chart about what happens to rocks.
3. Tell students that this challenge is about what happens to rocks in nature. The first thing that can happen is **weathering**. Ask:
   —Can you explain what weathering is?



✏ Give them this definition and have them write it on their chart: *Weathering is the natural breaking down of rocks into smaller rocks, sand, or soil.*

4. Ask students if they know of any ways that rocks get broken in nature. Explain that they will learn about two different kinds of weathering in the Mini Challenge.
5. Ask students if they know what **erosion** is.

✏ Give them this definition, and have them write it on their chart:
Erosion is a natural process that moves or transports small rocks, sand, or soil to a different place.

6. Discuss the difference between weathering and erosion. (*Weathering breaks or dissolves the rocks. Erosion moves them to a different place.*) Ask:
   —What natural forces can cause erosion?

✏ Write *wind*, *water*, and *gravity* on the board or chart paper under *Erosion*.

7. Tell students that these are the natural forces that can cause erosion. Ask students to think about how each one could carry sand or small rocks from one place to another. Have volunteers explain their thinking.
   - ➜ ***Wind:*** Wind can blow sand—think of a dust storm. Wind can carry soil long distances, and it can create sand dunes.
   - ➜ ***Water:*** Moving water can carry sand and small rocks with it, as in a stream, a river, or an ocean.
   - ➜ ***Gravity:*** Rocks can fall and roll to a new place.
8. Introduce the word **deposition**. Point out to students that it has the word "deposit" in it and ask them to guess what it means.
9. Explain that, once rock has been weathered (*broken*) and eroded (*moved*), it gets deposited in a new place.

✏ Give students this definition and have them write it on their chart: *Deposition is the natural process in which small rocks, sand, or soil are dropped in a new place.*

10. Tell students that they can remember these three terms easily. Teach them this short chant and hand motions. Practice the chant a few times as a class.

> **Weathering** breaks it (make breaking motion with fists).
> **Erosion** takes it (move hands sideways while wiggling fingers).
> **Deposition** drops it (make hand motion of dropping).

Save the Pond

Mini Challenge

Chalk Weathering–Part 1

1. Group students in pairs, and give each pair a copy of the *Chalk Weathering* recording sheet.
2. Provide each pair with half a stick of colored chalk and a paper plate. Try to have each group use a different-colored chalk stick. (See #10 below.) Pour a couple of teaspoons of salt on each plate.
3. Explain that the chalk will represent a rock and that they are going to "weather" the rock (chalk).

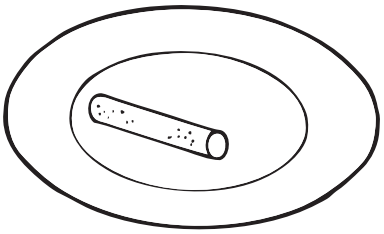
   ➜ Review the definition of *weathering*: Weathering is the natural breaking down of rocks into smaller rocks, sand, or soil. Ask:

   —Why are we using chalk instead of an actual rock? (*Because chalk is soft and will weather quickly. It would take much too long to weather a real rock!*)

4. Ask students to predict what will happen if they rub the chalk into the salt.

✏ Have them write their predictions on their *Chalk Weathering* recording sheets.

5. Have students lay the chalk on an empty section of the plate and have them use a pencil to trace around it. This will record the original size of the chalk.
6. Demonstrate for students how to "draw" circles in the salt with the chalk. Have students take turns running the chalk around in the salt. Tell students to observe both the chalk and the salt carefully as they work.
7. After about a minute, ask students to measure their chalk by laying it in the space where they traced it earlier.



✏ Have students record what they observe on their recording sheet. (*Students should see that the chalk is getting smaller and observe that the salt is taking on the color of the chalk.*)

8. Ask students to construct an explanation for what they observe and have them share it with their partners. Then, ask each pair to share what they think is happening.

✏ Have students record their explanations on their recording sheets.

9. Have students continue "weathering" their chalk until is approximately half the size of when they began.
10. Have each group take turns pouring their colored salt into a clear glass jar, one color layer at a time for some fun sand art. This will create a nice classroom decoration and a reminder of weathering!

Save the Pond

Mini Challenge *(cont.)*

Explain the Science

Point out to students that they created a model showing how rocks can be weathered when they rub against sand or other rocks. This kind of weathering is called **abrasion**. As they rubbed the chalk against the salt, small bits of the chalk rubbed off. These chalk particles mixed with the salt, changing the color of the chalk.

Abrasion can be caused by:

- ➜ Rocks tumbling down a mountain or a cliff.
- ➜ Rocks moving and rubbing against each other in water, such as a river or the ocean.
- ➜ Sand carried by strong wind rubbing off bits of rock, like sandblasting.

Abrasion is a form of **mechanical weathering**. Other forms of mechanical weathering include:

- ➜ Roots of plants growing in cracks of rocks and breaking them.
- ➜ Water freezing in the cracks of rocks and expanding to split them.
- ➜ Changes in temperature where the temperature gets very hot and very cold; the rocks themselves can expand in the heat and contract in the cold, causing them to crack.

Chalk Weathering–Part 2

1. Give each pair of students a clear cup with ¼ cup vinegar in it.
2. Ask students to predict what will happen if they put the chalk in the vinegar.

✏ Have them write their predictions on their recording sheets.

3. Have students drop their remaining ¼ stick of chalk in the vinegar and observe closely.
4. After about five minutes, have students record what they observe and then share their observations. (*Students should observe that the chalk sends up bubbles. The chalk may break up or start to dissolve.*)
5. Ask students to construct an explanation for what they observe and have them share it with their partners. Then, ask each pair to share what they think is happening.

✏ Have students record their explanations on their recording sheets.

Explain the Science

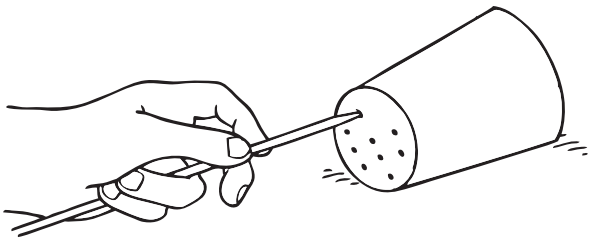
Explain to the students that they observed a model of **chemical weathering**. Chemical reactions break down the bonds holding the rocks together, causing them to fall apart and form smaller and smaller pieces. Different rocks react to different agents, including water, acid, and oxygen. In this model, the acid in the vinegar reacts with calcium carbonate in the chalk, producing carbon dioxide, which forms the bubbles.

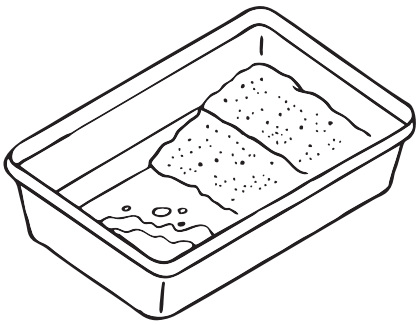
Save the Pond

Main Challenge

Define the Problem

1. Divide the class into groups of three to five. Give each student or group the following materials:
   - *Save the Pond* recording sheet
   - large plastic bin
   - 3–4 cups of sand
   - large spoon
   - measuring cup
   - container with 5 cups of water
   - watering can or a paper cup with holes cut in the bottom





2. Have each group place the sand in the plastic bin and use the spoon to move the sand towards one end, making a slope.
3. Tell students to measure and pour four cups of water into the other end. This will form the model pond.
4. Read the following scenario to students:

> People like to use this pond for fishing and swimming. Fish live in it, and animals drink from it. It used to have trees growing all around it, but someone cut them all down. Let's make it rain on the slope leading to the pond and watch carefully to see what happens to the pond.

5. Have students sprinkle about ½ cup of water on the sand in their bin by using a watering can or a paper cup that has many small holes poked in the bottom.
6. Begin recording information on the *Save the Pond* recording sheet.

✏ Have students sketch the pond and slope as they look at this stage. Consider the following:

—Where was the sand *eroded*?

—Where was it *deposited*?

—What changes do you see in the water?

7. Tell students that they have been hired as engineers to slow down the erosion around the pond and to reduce the amount of sand being deposited into the pond. The goal is to improve the water quality.
8. With students, decide on the criteria for success.

—How will you know if the solutions worked? *Note:* The criteria for success will be fairly subjective for this challenge.

Example: The water stays clear, and very little sand falls down the slope.

Save the Pond

Main Challenge *(cont.)*

Imagine & Plan

1. Show students the building materials and provide ample time to handle and inspect the materials.
2. Share the constraints of this challenge with students. If appropriate, add budget information.

Challenge Constraints

- Choose only four materials from the materials provided.
- You may have as much of your four chosen materials as you need.
- You may not attach any building materials to the bin.

3. Have student groups brainstorm how they could reduce erosion and deposition around the pond.

✏ Direct groups to draw and label their planned solution and to list materials on their recording sheets.

4. Once the plans are finalized, have one or two students from each group gather the needed materials.

Build & Test

1. Provide time for student engineers to build their solutions. As they are working, circulate to observe and prompt with questions as needed. Ask:

   —Where will the water go after you build your solution?

   —Are you trying to stop the water or **divert** it? Divert means to make it run in a different direction.

2. Once students are confident in their solution, let them test it by sprinkling water (rain) again.

✏ Have students add information to the recording sheets and sketch the pond and slope as they looked after the second flood.

3. Ask them to answer these questions and to pinpoint the areas on the sketches.

   —Where was the sand eroded? Where was the sand deposited?

   —How do they think their solution worked? How could they improve it?

4. Let students revise and improve their design and test again until they are happy with the results or until time runs out. Add an additional recording sheet if necessary.

Analyze & Evaluate

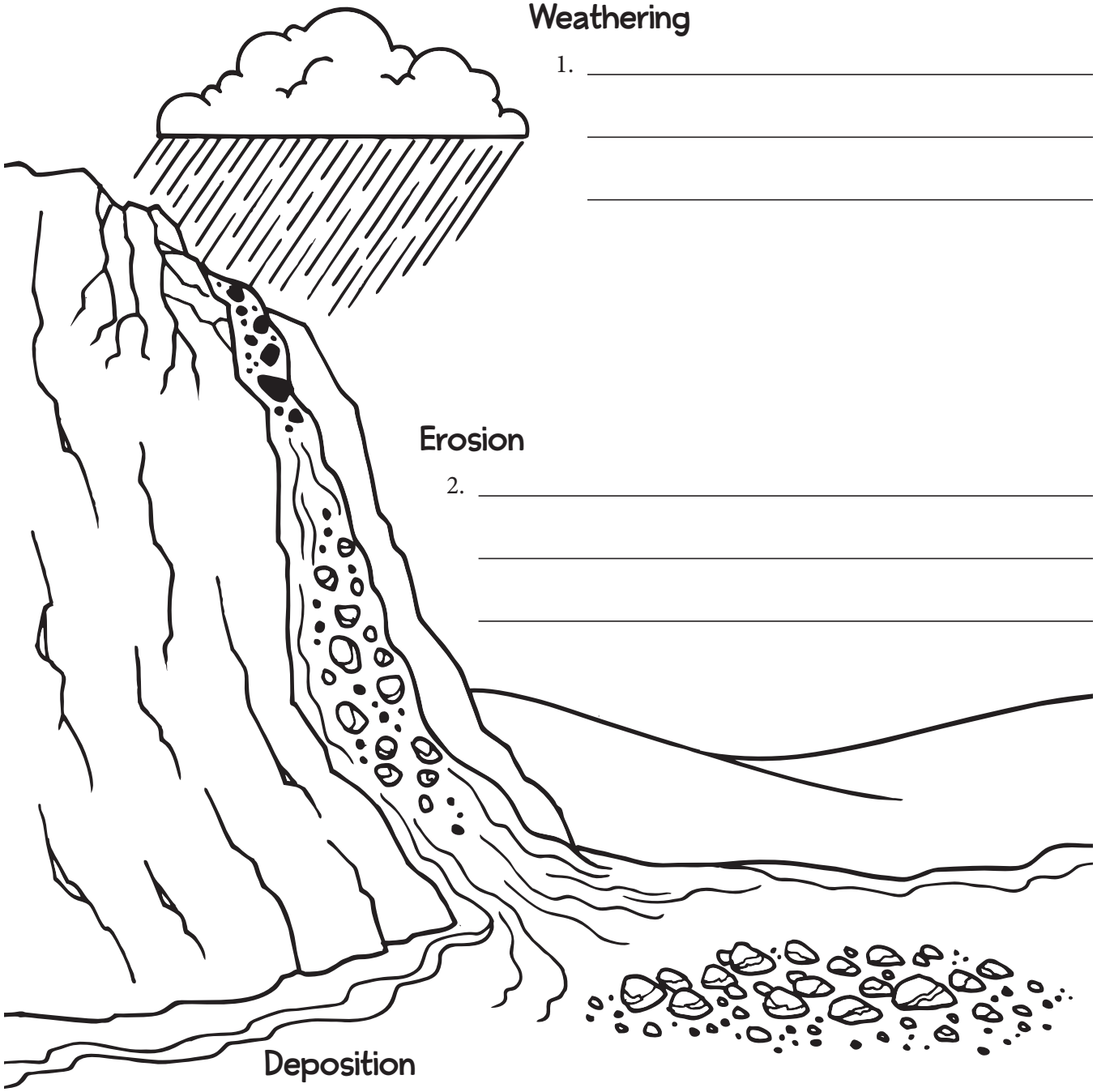
1. Have each group share the results of its solution. Ask them to describe how they built their solution, how it worked, and any improvements they made.
2. As a class, analyze each solution and talk about its strengths and weaknesses. Encourage students to cite evidence in their answers, such as, "Our water got really cloudy, so ours didn't work very well" or "They kept most of the sand from going into the water, so I think their solution was good."
3. Have students discuss how this model might translate to the real world. What materials could they use that are similar to the materials they used in the model to protect a real pond?

Writing Reflection

✏ Have each student complete the *Reflections—Save the Pond* writing reflection individually.

Name _____ Date _____

Weathering, Erosion, and Deposition



Weathering

1. _____

_____

_____

Erosion

2. _____

_____

_____

Deposition

3. _____

_____

Name _____ Date _____

Chalk Weathering

Directions: Observe each model carefully and record what you see.

Part 1: Chalk in Salt

1. What do you predict will happen when you rub chalk in salt?

2. What did you observe?

3. What is your explanation for what you observed?

Part 2: Chalk in Vinegar

1. What do you predict will happen when you put chalk in vinegar?

2. What did you observe?

3. What is your explanation for what you observed?

Name _____ Date _____

Save the Pond

1. Sketch your slope and pond as they looked when you first built them.

2. Sketch your slope and pond as they looked after the rain. Mark where there are signs of *erosion* and *deposition*.

3. Describe what happened when the rain fell around the pond. What changes did you see in the water?

_____

4. Sketch your idea to protect the pond from the negative effects of erosion and deposition.

5. Sketch the pond as it looks after the rain with your solution in place.

6. What worked? _____

_____

7. What didn't? _____

_____

8. Make improvements to your solution. Describe the improvements, and test it again.

9. What worked? _____

What is your evidence? _____

10. What didn't work? _____

What is your evidence? _____

Name _____ Date _____

Reflections—Save the Pond

1. What was the problem you needed to solve?

2. What was your plan to solve the problem?

3. How did your first try at a solution work?

   What is your evidence?

4. What did you do to improve your solution?

5. How did your improved solution work?

   What is your evidence?

6. What would you do differently if you attempted this challenge again?

7. What was the hardest part?

8. What was your favorite part?