John Muir Study Guide
Science Lesson Plan
Grade Eight

Avalanche!

Avalanches are deadly down slope movements of earth, ice, rock, or snow, although the term is most often associated with snow. Avalanches occur in mountain areas and are most often triggered by rainfall or strong winds. Every year people are killed in these destructive events.

Throughout his life, John Muir had many thrilling and even dangerous adventures as he studied the natural world. In his attempt to study the nature of avalanches in the High Sierra Mountains of California, he had the opportunity to experience an avalanche firsthand. John Muir, it seems, was one of the world's earliest "extreme sports" enthusiasts!

Objective:

Students will be able to:

- explain that when forces on an object are balanced, the motion of the object does not change.
- identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
- describe how an object will change its motion when forces on it are unbalanced.
- plan and conduct a scientific investigation to test a hypothesis.

California Science Standard Grade 8, Physical Science - Forces:

Students know:

2c. when the forces on an object are balanced, the motion of the object does not change.

d. how to identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.

e. when the forces on an object are unbalanced the object will change its motion (that is, it will speed up, slow down, or change direction).

California Science Standard Grade 8, Investigation and Experimentation:

9. Scientific progress is made by asking meaningful questions and conducting careful investigations.

Students will:

a. plan and conduct a scientific investigation to test a hypothesis.

Materials:

John Muir on Avalanches Reading Handout (also provided below)
Thick poster board approximately 16" x 20", (1 board per student group)
1 lb. granulated sugar (1 cup per student group)
1 box of potato flakes (1 cup per student group)
1 lb. flour (1 cup per student group)
Measuring cups (1 cup per student group)
Protractor (1 per student group)
Plastic sheets or garbage bags (1 per student group)

Preparation:

Read the excerpt about John Muir's wild ride on an avalanche from his book *The Yosemite:*

"Few Yosemite visitors ever see snow avalanches and fewer still know the exhilaration of riding on them. In all my mountaineering I have enjoyed only one avalanche ride, and the start was so sudden and the end came so soon I had but little time to think of the danger that attends this sort of travel, though at such times one thinks fast. One fine Yosemite morning after a heavy snowfall, being eager to see as many avalanches as possible and wide views of the forest and summit peaks in their new white robes before the sunshine had time to change them, I set out early to climb by a side cañon to the top of a commanding ridge a little over three thousand feet above the Valley. On account of the looseness of the snow that blocked the cañon I knew the climb would require a long time, some three or four hours as I estimated; but it proved far more difficult than I had anticipated. Most of the way I sank waist

deep, almost out of sight in some places. After spending the whole day to within half an hour or so of sundown, I was still several hundred feet below the summit. Then my hopes were reduced to getting up in time to see the sunset. But I was not to get summit views of any sort that day, for deep trampling near the cañon head, where the snow was strained, started an avalanche, and I was swished down to the foot of the cañon as if by enchantment. The wallowing ascent had taken nearly all day, the descent only about a minute. When the avalanche started I threw myself on my back and spread my arms to try to keep from sinking. Fortunately, though the grade of the cañon is very steep, it is not interrupted by precipices large enough to cause outbounding or free plunging. On no part of the rush was I buried. I was only moderately imbedded on the surface or at times a little below it, and covered with a veil of back-streaming dust particles; and as the whole mass beneath and about me joined in the flight there was no friction, though I was tossed here and there and lurched from side to side. When the avalanche came to rest I found myself on top of the crumpled pile without bruise or scar. This was a fine experience. Hawthorne says somewhere that steam has spiritualized travel; though unspiritual smells, smoke, etc., still attend steam travel. This flight in what might be called a milky way of snow-stars was the most spiritual and exhilarating of all the modes of motion I have ever experienced. Elijah's flight in a chariot of fire could hardly have been more gloriously exciting. "

Activity:

Ask students if they know the definition of the term avalanche and if they can describe the process that causes one to occur. Explain to them that avalanches are common in mountain areas where deep snow accumulates on inclines of 30 degrees or more. Avalanche conditions form when a weak bonding layer forms between the underlying layer of snow and and the layer over it. Weakness can be caused by melting or the presence of fragile ice crystals that form at the interface between the layers. Most snow avalanches are small but can be dangerous, especially when the inclination of a slab of snow is at an angle of 30 to 45 degrees.

Explain to students that under these conditions there are the competing forces

of gravity and friction at work, which can determine whether or not an avalanche may occur. When these forces are in balance, there is no movement of the snowpack. However when one of these forces becomes unbalanced, movement of the snowpack can occur.

Ask students what they think might trigger an avalanche. These causes should include deposits of fresh snow that has different consistency than the layer below, large chunks of snow falling from trees or overhanging cornices, disturbance of the snow by human or animal activity, and strong gusts of wind.

Have students conduct the following experiment.

Divide students into teams of 4 or 5. Give each team a set of the materials listed above. The flour, sugar, and potato flakes will represent various consistencies of snow. Place the plastic bag on the table or floor to collect material as it slides down the board. Before beginning the experiment, ask students to first predict at what angle the flour, granulated sugar, and potato flakes will begin to flow down the board. Suggest a range of angles beginning with about 5 degrees up to about 45 degrees. Have each team test their hypothesis by placing a thick layer of each material on the board then tilting the board until the material begins to flow downward. Using the protractor, have students record the angle at which each material began to flow down the board.

Next have students apply one layer of each material on top of the other to the board. Conduct the experiment first with the flour on the bottom layer, the granulated sugar on the middle layer, and the potato flakes on the top layer. Tilt the board and observe the behavior of materials as they begin to slide. Clean the board and conduct the experiment a second time with the potato flakes on the bottom layer, the flour on the middle layer and the sugar on the top layer. Finally, conduct the experiment with the sugar on the bottom layer, the flour in the middle layer, and the flakes on the top layer. Have students record their observations noting the flow pattern and identifying which of the combinations was the least stable and which was the most stable. Ask students to observe whether or not compression by the overlying material was a factor in the flow pattern.

Conclusion: Draw a table on the blackboard and record each team's findings. Have the students discuss how the slope of the board and the consistency of each material affected the stability of the material and the rate of flow. Discuss how these findings can correlate to those factors that may trigger an avalanche.

Extension:

Ask the students to suggest a reason why Muir was able to survive his ride on an avalanche.
