Katabatic Winds

It's not necessarily the amount of new snow that is a weather severity on Antarctica, but it's sometimes the ferocity of the winds. The wind is responsible for displacing the loose snow and firn to create whiteout conditions and for creating severe wind-chill conditions. The katabatic winds on the continent exist due to the airflow from the high pressure, cold, elevated plains down slope to the relatively warmer lower elevations with less pressure. Looking at the katabatic winds offers an opportunity to explore air pressure and the properties of hot and cold air.

Activity Ideas

Demonstrating Hot and Cold Air Properties

Activity I

Materials:

2 quart size jars	matches
tea candle	paper squares
ice to fill jar	recording worksheet

Procedure:

Use two jars of the same or similar size. You will want the jars to be tall enough to keep the flame away from the top. Quart jars or larger work well. Cut squares of plain paper just larger than the top of the jar. Students can do this activity in teams of two or more.

Place a tea candle in the bottom of one jar. Fill the other about 2/3 full of ice. The jars can be set up before the observations so students can rotate through, or use multiple jars for partners.

Have the students place a square of paper first over the candle jar. Observe the reaction of the paper. Record observations on the worksheet. Remind students when a scientist observes "no change," that is indeed a valuable observation.

Repeat the procedure with the ice jar.

Notes:

**Do not use the same papers for repeated trials. The paper warps over the heat of the candle.

**The students will notice the edges of the paper "lifting" up over the heat. Discuss the idea of warmer air taking up more space due to the movement of the molecules. Some students might say they noticed the paper over ice being "pulled" down. Although it is unlikely that they could

see this, it can still lead to a discussion of cold air molecules taking up less space.

Activity II

**Make sure you try this before presenting it to a class. You need to try it with your materials to make sure you will see the intended response. The effect is good, but it can be tricky. Observing the response of the feathers led to a good discussion, but it did not present itself as an experiment suitable for recording like a typical lab write-up. It might best be done as a demonstration activity.

Materials:

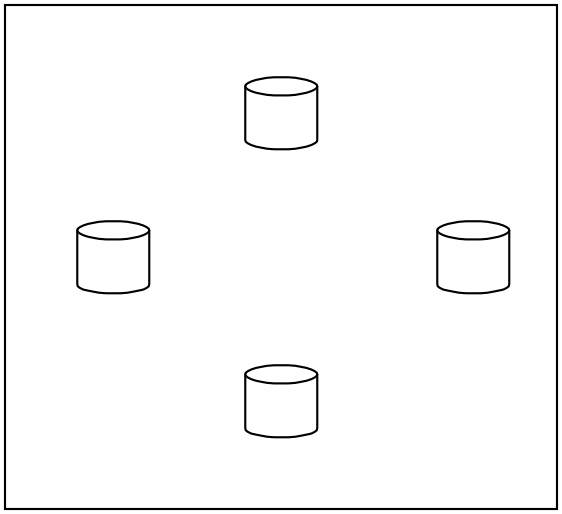
Ice slope (see below)	matches
4 votive candles	small feathers
foil	pair of tongs

Procedure:

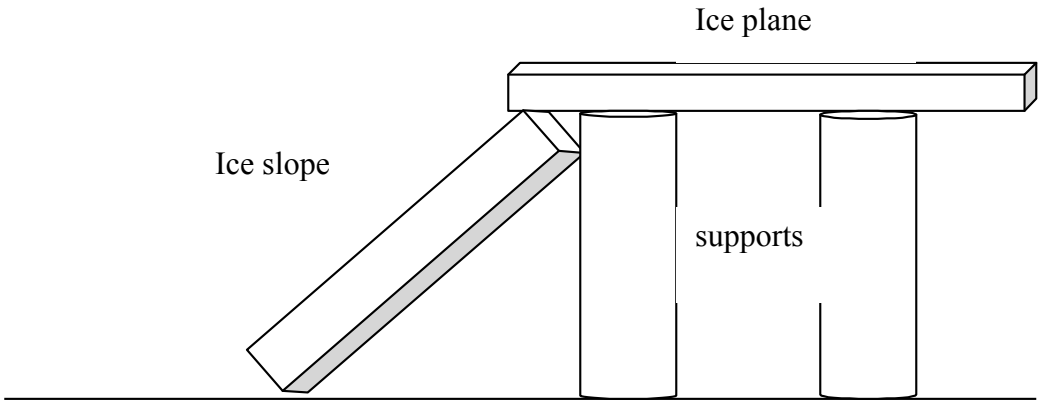
Prepare the ice for the slope at least a day before. Use 2 rectangular baking pans or plastic containers. A 7" X 11" or 9" X 13" works well for the "plane," and a smaller pan could be used for the "slope."

Set up the 2 test areas several feet apart: a heated surface and the ice plain/slope.

Heated surface: Place the votive candles in a closely arranged diamond shape on a sheet of foil. Make sure this is in a draft free location. The idea is to create a heated air space above the candles. Light the candles a few minutes before experimenting to allow the space to heat up.



Ice plain and slope: If there is a difference in pan size, use the larger pan as the plain. Elevate the ice plane on a box or other object and rest the other pan of ice so it is sloping away from the plane at about a 45 degree angle. (It is not important to be precise with this.) Set this up a few minutes before testing to allow the air space to cool.



Experiment: One at a time, release a feather above the air space, whether it is the cold or hot space. Above the heat, release the feather in the middle of the diamond. Above the ice, release the feather above the point where the slope meets the plain. The feathers should be released at about the same height above each to compare the results. Observe the way the feather moves in the air. Repeat the procedure to find a consistent pattern.

Notes:

**Have the tongs handy in case the feather does drop into the candles.

**Do not re-use a feather if it falls into the candle or onto the ice. The weight of the feather changes significantly in either case.

**The students will likely say that the feather tries to get away from the heat. Guide the discussion to emphasize that the feather only demonstrates what is happening in the air. In fact, the feather "floats" in the warmer air, but "sinks" when it is controlled by the cooler air. Therefore, the feather falls outside of the heated air space because that is where the cooler air is.

**The feather will occasionally fall into the candles. Usually this is because a draft has been caused by people moving the heated air space. Hold your hand above the candles or ice a moment before releasing to let the air settle.

**Experiment with holding the feather over different areas of the ice. The best place seems to be where the slope drops away since the air has room to "fall" there.

**Refer to this site for some good explanations to use during discussions with the Pull-it-all-together questions on the worksheet.
http://hpccsun.unl.edu/nebraska/stuproj/ametf99/wenzl/katabatic.html

Resources and internet links

katabatic wind (gravity wind)

Downslope wind caused by greater air density on the slope than at some distance, horizontally, from it. The wind is associated with surface cooling of the slope.

http://kazan.inf.fu-berlin.de/euromet-zeam/courses/glossary/katabat2.htm


Photo – US ITASE

http://hpccsun.unl.edu/nebraska/stuproj/ametf99/wenzl/katabatic.html
Explanation of katabatic winds with illustrations

Firn snow and katabatic wind explanations:

http://www.xrefer.com/entry/614400
http://www.alexski.co.uk/mountainsafety/Weather.htm

The word firn is derived from the German language. Literally translated means "of last year". Although frequently used in the alps to denote a snow condition frequently found in spring, it actually refers to a snow condition in glaciers.

This condition occurs when overlying snow layers continually melt, re-freeze and recrystallize the snowflakes. It is currently thought that this process takes approximately one year to create the firn condition.

During the spring and summer months the 'firn' layer is often detected by a thin dusting of frost in the early morning.

After several years and further pressure exacted by the many layers of snow and ice (45 - 60m), the firn layer will turn to glacial ice

See next page for student worksheet

Name _____

Exploring the conditions for Katabatic Winds

What are **katabatic winds**? They are downslope winds that are caused by greater air density on the slope than at some distance, horizontally, from it. The winds are associated with the surface cooling of the slope.

What is density?

Which air is more dense, warm or cold?

Record your observations for the following experiments.

Experiment 1: Paper Covers

Place a paper over the jar with a candle burning inside. Observe. What did you notice about the paper?

Place a paper over the jar with ice inside. Observe. What did you notice about the paper?

Experiment 2: Falling Feathers

Hold a feather a set distance above the cold slope. As you let the feather drop, what do you notice about the way the feather falls? Look at the way the feather moves. How would you describe the path that it takes?

Hold a feather about the same set distance above the warmed area.
What do you notice about the way this feather falls?

Pull-it-all-together questions:

Everything is pulled to earth by gravity. Which air do you think gravity would pull down faster, cold or hot? Why?

We used a feather in our experiment so that we could see what the air was doing. How does what you observed in these experiments help us explain what might happen on a glacial slope?

Would the same thing happen on a desert sand dune? (Why or why not?)

Knowing what you do about the geography of Antarctica, why are there katabatic winds on West Antarctica?