Walch Hands-on Science Series

Atmosphere and Weather

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illustrated by
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Contents

To the Teacher

This is one of a series of hands-on science activity books for middle school and early high school students. A recent national survey of middle school students conducted by the National Science Foundation (NSF) found that:

- more than half listed science as their favorite subject.
- more than half wanted more hands-on activities.
- 90 percent stated that the best way for them to learn science was to perform experiments themselves.

The books in this series seek to capitalize on these findings. These books are not texts but supplements. They offer hands-on, fun activities that will turn some students on to science. All of these activities can be done in school, and most of them can be done at home. The authors are teachers and have field-tested the activities in a public middle school and/or high school.

Students will need only basic equipment to carry out the experiments in this book. The activities range from the very simple to the difficult. There is something for every student.

THE ACTIVITIES CAN BE USED:

- to provide hands-on experiences relating to textbook content.
- to give verbally limited students a chance to succeed and gain extra credit.
- as the basis for class or school science fair projects or for other science competitions.
- to involve students in science club projects.
- as homework assignments.
- to involve parents in their children's science education and experiences.

Students can learn important scientific principles from carrying out these activities. For example:

- Negative experimental results are just as important as positive experimental results.
- Data may vary from what is expected.

Each activity has a Teacher Resource section that includes, besides helpful hints and suggestions, a scoring rubric, Internet connections for students who wish to carry out the follow-up activities, and a quiz. Instructional objectives and the National Science Standards that apply to each activity are provided to help you meet state and local expectations.

Air Masses and Fronts

TEACHER RESOURCE PAGE

INSTRUCTIONAL OBJECTIVES

Students will be able to

- define the concepts of air masses and fronts.
- recognize characteristics of different types of air masses and fronts.
- evaluate properties of data in a table.
- draw conclusions based on data.

NATIONAL SCIENCE STANDARDS ADDRESSED

Students demonstrate an understanding of

- energy in the earth's system: weather.
- properties of matter: density.

Students demonstrate scientific inquiry and problem-solving skills by

- framing questions.
- using relevant concepts to explain observed phenomena.
- working individually and in teams to collect and share information and ideas.

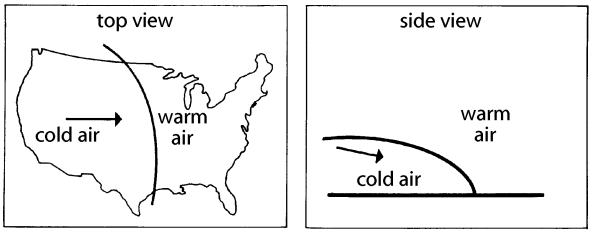
Students demonstrate effective scientific communication by

- arguing from evidence and data.

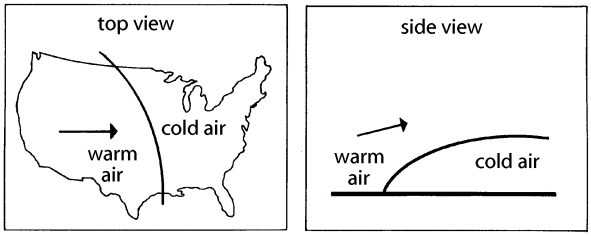
MATERIALS

- Pen or pencil
- 4 fl oz of dark corn syrup
- Rectangular clear plastic or glass open-top container, approximately 4 to 6 cm wide, 10 to 20 cm long, and 2 to 4 cm deep. A plastic drawer from a small, multi-drawer small-parts storage cabinet is ideal.

COLD FRONT



WARM FRONT



HELPFUL HINTS AND DISCUSSION

Time frame: 40 minutes, or one class period
Structure: Part A: individuals
Part B: pairs
Location: In class or at home

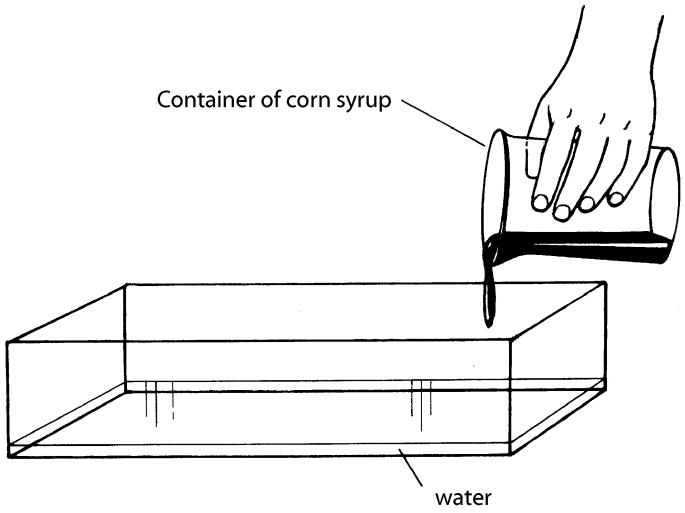
In Part A of this activity, students will identify and sketch the boundaries of warm, cool, and medium fronts based on temperature data in a table. In Part B, students will simulate one front overtaking another.

Review the definitions of air masses and fronts. Also review the concept of density, and the fact that cold air is denser than warm air. Remind students that the second data table in Part A is for the same area as the first data table, but contains later measurements. Students should look for a change in the position of the fronts and air masses they are locating.

ADAPTATIONS FOR HIGH AND LOW ACHIEVERS

High Achievers: Encourage these students to do the Extension and Follow-up activities.

Low Achievers: Prior to the activity, review instructions on how to draw lines indicating boundaries between air masses. Make sure that students understand that they are looking for noticeable differences in temperature across the boundaries. For Part B, pair low achievers with high achievers who can help with the relevant concepts.



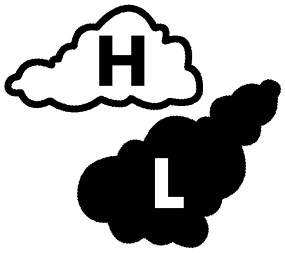
SCORING RUBRIC

For Part A, full credit should be given to students who have drawn the location of the fronts correctly on both data tables, and who correctly label the air masses and fronts. For Part B, full credit should be given if at least one of the sketches shows the syrup sliding under the water, if water and syrup are labeled, and if the direction of motion of the syrup is indicated. Extra credit should be given to students who do the Extension of Follow-up activities. The quiz can be scored from 1 to 5 correct.

INTERNET TIE-INS http://ww2010.atmos.uiuc.edu/(6h)/guides/mtr/af/arms/home.rxml
http://ww2010.atmos.uiuc.edu/(6h)/guides/mtr/af/frnts/home.rxml

QUIZ

1. What is an air mass?
2. What is the difference between a cold front and a warm front?
3. Does a warm air mass slide under or over a cold air mass it is overtaking?
4. Is a cold air mass denser or less dense than a warm air mass?
5. Why does a cold air mass slide under a warm air mass it is overtaking?



Name _____ Date _____

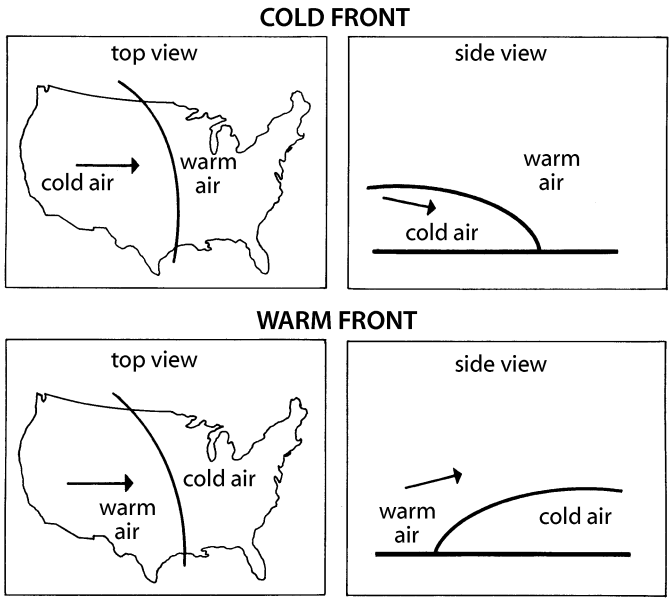
Air Masses and Fronts

STUDENT ACTIVITY PAGE

BEFORE YOU BEGIN

The properties of the air in the atmosphere are not the same everywhere. However, there are broad regions of air with relatively uniform temperature and/or humidity. These regions are known as **air masses**. Air masses move over the surface of the earth and can overtake, be overtaken by, or mix with, other air masses they encounter.

The boundaries between air masses are called **fronts**. Types of fronts are determined by the relative temperatures of the air masses involved. If a warmer air mass is overtaking a colder air mass, it will slide *over* the colder air mass because warm air is less dense than cold air. The boundary between the warm air mass and the cold air mass in a case like this is called a **warm front**. If colder air is overtaking warmer air, the colder air will slide *under* the warmer air, because cold air is denser. The boundary between the two air masses in a case like this is called a **cold front**. In this activity, you will identify and simulate air masses and fronts.



MATERIALS

- Pen or pencil
- 4 fl oz of dark corn syrup
- Rectangular clear plastic or glass open-top container, approximately 4 to 6 cm wide, 10 to 20 cm long, and 2 to 4 cm deep. A plastic drawer from a small, multi-drawer small-parts storage cabinet is ideal.

PROCEDURE

PART A

Data Tables 1 and 2 are grids that represent surface air temperatures in degrees Celsius over a 10-km- × 10-km square area. There are three air masses and two fronts in this area. Data Table 2 represents data taken about 10 minutes after the data in Data Table 1.

1. Examine Data Table 1. Locate and sketch in the boundaries of the three air masses (you may draw directly on the Table). Remember, you are looking for boundaries between areas with noticeably different temperatures.
2. Estimate the average temperature of each of the three air masses and label them in increasing order of temperature: *cool*, *medium*, and *warm*. Remember that these terms are only relative.

(continued)

Name _____ Date _____

Air Masses and Fronts *(continued)*

STUDENT ACTIVITY PAGE

3. At this point you know which air masses are which, but you don't know what kind of fronts are present. To determine which fronts are present, repeat step 1 for Data Table 2. Notice that the fronts have moved.

Data Table 1

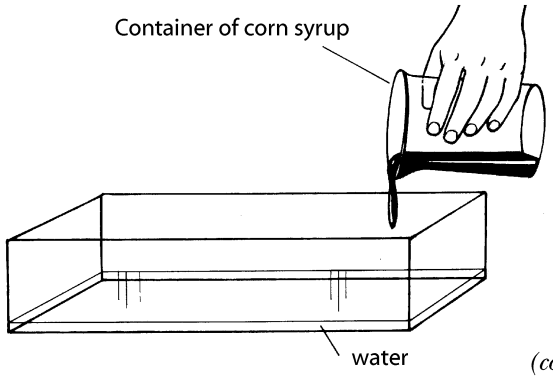
14	13	13	15	13	13	15	14	19	19
13	15	14	14	13	14	15	15	20	20
15	14	14	14	15	15	13	18	19	20
15	15	15	14	15	15	21	20	19	20
14	14	15	15	14	20	19	20	20	19
15	16	14	23	23	24	19	20	19	18
23	23	24	22	22	23	24	21	20	20
22	23	24	23	24	23	23	23	20	19
23	24	23	25	25	24	24	24	23	18
22	24	24	24	25	24	23	23	22	17

Data Table 2

14	13	13	15	13	13	15	14	15	19
13	15	14	14	13	14	15	15	14	20
15	14	14	14	15	15	13	14	19	20
15	15	15	14	15	15	15	20	19	20
14	14	15	15	14	15	23	20	20	19
15	16	14	14	15	24	24	24	19	18
14	15	15	14	22	23	24	21	23	20
15	23	24	23	24	23	23	23	24	24
23	24	23	25	25	24	24	24	23	24
26	25	26	24	23	25	25	23	24	24

PART B

1. Fill the clear container with water to a depth of 3 to 5 millimeters (no deeper!).
2. Work in teams of two. One of you, the *observer*, should position yourself to view the container from the long side, with the water at eye level. Be prepared to sketch what you see.
3. Your partner, the *pourer*, should now begin to pour a steady stream of dark corn syrup into the water at one end of the open container. The pouring should be at a steady rate so that it takes about 20 to 30 seconds to pour out the entire 4 fluid ounces. As this is being done, the observer should observe and sketch the appearance of the boundary between the water and the corn syrup, including its position in the clear container. Try to observe and sketch quickly enough to make two sketches: once early during the pour, and once after the corn syrup is half way poured out of the container. Be sure to note the direction of movement of the corn syrup.
4. About a minute after all the corn syrup has been poured, the observer and the pourer change places. The pourer should now observe and sketch the water–corn syrup boundary.



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Name _____ Date _____

Air Masses and Fronts *(continued)*

STUDENT ACTIVITY PAGE

DATA COLLECTION AND ANALYSIS

PART A

Indicate your answers directly in the data tables.

PART B

Sketch your observations in the following boxes. Each box represents the side view of the container through which you viewed the experiment. Be sure to label the water, the corn syrup, and the direction of movement of the corn syrup.

Early in pour

Late in pour

After the pour

CONCLUDING QUESTIONS

1. From the movement of the fronts in Part A and the type of air masses behind them, determine the type of each front (warm or cold). Label it directly in Data Table 2.
2. From its behavior in the experiment, does the corn syrup behave like a warmer or colder air mass than the water? _____
3. Based on your answer to question 2, what kind of front did you make with the water and the corn syrup: warm or cold? _____
4. Why did the corn syrup slide under the water? _____

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(continued)

Name _____ Date _____

Air Masses and Fronts *(continued)*

STUDENT ACTIVITY PAGE

EXTENSION In addition to cold fronts and warm fronts, there are two other kinds of fronts indicated on weather maps: **stationary fronts** and **occluded fronts**. Research the descriptions of these kinds of fronts, and the symbols meteorologists use to indicate the different kinds of fronts on weather maps.

FOLLOW-UP ACTIVITIES

1. Look at the weather map in today's newspaper (or at a Web site). Notice the fronts indicated on the map. What kind of front is currently closest to your location? What fronts might pass over your location in the next few days?
2. Try Part B with liquids other than corn syrup, such as shampoo and dishwashing liquid. Do they behave in the same way as the corn syrup? Why or why not?