**VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE**

**http://studentorgs.vanderbilt.edu/vsvs**

# Convection Currents

**Fall 2011**

### Goal: To introduce students to convection in liquids and gases.

Fits Tennessee standards GLE  **0607.8.1**

1. **Introduction**

Ask students what they know about convection.

### 2. Introducing Liquid Crystal Thermometers

Students observe the temperature reading on a liquid crystal thermometer.

**3. Experiment: Convection Currents in Gases.**

Students use a chimney apparatus and dry ice to investigate the flow of warm and cold

air.

**4. Colliding Warm Air and Cold Air Masses.**

Students observe what happens when cold air meets warm air.

**5. Observing Convection Currents in Liquids.**

Students use a jar of rheoscopic fluid placed on a hot pack to watch the flow of rising

warm fluid. An ice cube is placed in the jar to create the flow of a cold mass.

**Complete teacher/school information on first page of manual.**

1. Make sure the teacher knows the VSVS Director’s (Pat Tellinghuisen) home and office numbers (in front of manual).
2. Exchange/agree on lesson dates and tell the teacher the lesson order (**any changes from the given schedule need to be given to Pat in writing (email)**).
3. Since this is your first visit to the class, take a few minutes to introduce yourselves. Mention you will be coming three more times to teach them a science lesson.
4. Do the experiment with the classroom, and leave 10 minutes at the end to discuss aspects of college life with them. Some topics that could be included are on page 4 of the manual.

**Pre-lesson set-up:**

1/3rd fill the Styrofoam cups with dry ice. Add a little water just before you pass them out (to increase the “fog”).

Assemble the chimney apparatus. DO NOT PASS OUT UNTIL PART 4.

### Materials

1. Chimney apparatus (1 per group)

8 small Styrofoam cups

2 large Styrofoam cups containing dry ice

5 boxes of matches (for VSVS use only) plus 1 lighter

9 Thermometer strips (1 per group plus 1 for VSVS members)

8 plates

8 jars containing rheoscopic fluid

8 recyclable heat packs

8 frozen ice cube packs

8 Styrofoam insulating pads

1 small bottle of water

**1.** **Introduction**

Ask students what they know about convection.

*It is the transfer of energy by a moving liquid or gas.*

*Heat moves by convection currents in liquids and gases.*

Ask students if they know how a hot air balloon stays up? How does the pilot know how to land it safely?

*From* [*www.eballoon.org/balloonn/how-it-works.html*](http://www.eballoon.org/balloonn/how-it-works.html) *“Hot hair is propelled towards to balloon. As it rises, it stays trapped in the balloon and causes the hot air balloon to rise. The pilot must keep firing the burner at regular intervals throughout the flight to ensure that the balloon continues to be stable. The hot air will not escape from the hole at the very bottom of the envelope because the hot air rises. The 'Parachute Valve' at the very top of the balloon is what is used to bring the balloon down towards the ground. It is essentially a circle of fabric cut out of the top of the envelope which is controlled by a long chord which runs down through the middle of the envelope to the basket. If the pilot wants to bring the balloon down he simply pulls on the chord which will open the valve, letting hot air escape, decreasing the inner air temperature. This cooling of air causes the balloon to slow its ascent.”*

**2. Introducing Liquid Crystal Thermometers**

Ask students if they have ever seen anything that changes color with temperature?

*Answers may include mood rings, strip thermometers. Students used the same thermometer strips last year in the 5th grade Conduction lesson.*

Show the students the strip thermometer and the degree markings (in F and C) on it.

Note the temperature where the **dark blue** color is.

Explain that this is room temperature, and all measurements will be compared to this

number.

Hand out 1 strip thermometer to each group.

Tell students to hold the strip gently at the top edge of the strip. Do NOT clasp in their hand.

Tell the students to place the strip on the desk top and record the temperature on their observation sheet.

The temperature of the strip may not be the same. Explain that these thermometers are not highly accurate but are good enough to measure changes in temperature

**Divide students into 8 groups**

**3. Experiment: Convection Currents in Gases.**

Draw a diagram of the chimney apparatus on the board. One VSVS member should write the temperature changes and air flow patterns on the diagram as the experiments are conducted.

Materials needed for this experiment for each group:

1 Chimney apparatus

1 Styrofoam cup containing dry ice

1 Thermometer strip

1 small bottle of water

**Instructions to VSVS members:**

1. Give each group a cup of dry ice in a small Styrofoam cup. Tell them that the dry ice is extremely cold and that they must not touch it with their hands. Tell students to hold the cup about 2-3 feet above the desk and to tilt it sideways so that the group can see dry ice “fog” flowing out of the cup. This is just to see the direction the fog will naturally flow
2. Explain that the “fog” is a very cold mixture of carbon dioxide gas, water vapor and air. The white color is from the condensed water vapor. (Carbon dioxide gas is colorless.)
3. The “fog” flows down towards the ground because it is colder and denser than the warm air surrounding it. Set the dry ice aside while steps 4-11 are completed.
4. Distribute chimneys to groups. (There are 8 chimneys per class. VSVS members need to be responsible for 2 groups.)
5. Place metal box on level surface. Keep away from combustibles. Place the chimney in the center of the groups table.
6. Insert chimneys. DO NOT LIGHT THE CANDLES UNTIL STEP 8.
7. Demonstrate this first and then tell students to use the thermometer strip to take the temperature of the air **2 inches** above each chimney. Students should hold the strip 2 inches above each chimney. Record these temperatures on their observation sheets. (The temperatures may not be the same for each measurement. Tell the students that these thermometers are not very accurate, but can be used to record changes in temperatures.)

**Note: If the teacher has any misgivings about the use of a candle flame in the classroom, VSVS members must do the next steps as demonstrations with each group. In this case, divide the class into as many groups as there are VSVS members, and continue the lesson with the VSVS member demonstrating the steps.**

1. VSVS members should now light the candle and place it in metal box directly under left hand chimney.
2. Slide glass window in place to close box.
3. Tell students to hold the thermometer strip 2 inches above both the chimneys and record the temperature changes on the observation sheet. Students need to remove the temperature strip as soon as it reaches the maximum temperature.

Discuss results:

The temperature above the chimney above the candle increased dramatically. Why?

The temperature above the chimney without the candle did not change. Why?

**4. Colliding Warm Air and Cold Air Masses.**

1. Ask students what they think will happen when cold air meets warm air?
2. Tell students to hold the dry ice cup about 6 inches above **the hot** air chimney (the candle is still going) and tilt the cup so that the fog can be seen flowing out. Ask what is the direction of the flow of the fog?
3. Move the cup lower to 2 inches above the chimney and ask them to observe what happens now. Which air current wins out?

*The rising warm air moves the cold air to the side.*

1. Ask students what they think will happen when cold air is introduced to the RH chimney, away from the rising hot air?

*Cold air is denser than warm air and will sink to the bottom of the RH chimney.*

1. What will happen after the cold air reaches the bottom of the chimney? How will it move around in the box?
2. Using an empty cup, demonstrate how they will hold the dry ice cup over the RH chimney and “pour” the cold air out of it.
3. Tell students to “pour” cold “fog” out of their cup into the RH chimney.
   1. What do they observe? What path does the fog take?

*The fog flows straight down the right hand chimney.*

* 1. What happens to the candle flame? Why?

*It flickers, gets a little dimmer, and may go out.*

*The denser cold fog sinks to the bottom of the RH chimney. The warm above the candle is rising and the cold air flows to replace it. The fog contains carbon dioxide which does not support combustion (burning).*

Review results.

Ask students: What can we say about cold air versus warm air?

*Cold air sinks.*

*Warm air rises*.

Collect all chimney apparatus and pack into cardboard boxes. Close lid on box to prevent glass cover from breaking. Collect all cups of dry ice and return to original container.

**5. Observing Convection Currents in Liquids.**

Pass out the materials to each group:

1. container of rheoscopic fluid
2. recyclable heat pack
3. plate
4. frozen reusable ice cube

1 Styrofoam insulating pad

Tell students that convection currents in liquids follow the same patterns as those in gases. Hot liquids rise up and cold liquids sink to the bottom.

Tell the students that the liquid in the jar contains a silvery substance that makes the movement of liquids more obvious. Students will need to watch closely. The jar needs to be kept still once the experiment has started.

Ask students to predict the flow of the silver substance if an ice cube is put in the jar.

Remind students that the ice cube will float.

Ask students to predict what will happen to the flow if the bottom of the jar is heated?

Students will test their predictions:

Tell the students to

1. GENTLY shake the jar so that the silver solid is dispersed.
2. Open the jar and put the ice cube in. Screw the lid back on tightly. Ask students if they can see any motion in the liquid. *There will be some movement initially, but this will stop after a while.*
3. Show students how to activate the heat pack (snap the piece of metal in it).
4. Place the jar on top of the heat pack. Make sure the jar stays as still as possible and observe the motion of the liquid.
5. Draw the motion on their observation sheets (or VSVS members can draw the results on the board).

Review results:

Ask students if convection currents in liquids follow the same patterns that they saw in the gas experiment?

Collect all materials to return to the VSVS lab.

**Spend some time introducing yourselves to the class and facilitate the discussion on page 5 (why going to college is important).**

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Convection Currents Observation Sheet

**Convection Currents in Gases**

Room temperature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
|  | **Above LEFT Chimney** | **Above RIGHT Chimney** |
| **Initial Temperature** |  |  |
| **Temperature After Candle is Lit** |  |  |

1. What happens when the dry ice is held above the left chimney (over the lit candle)?

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1. What happens when the dry ice is held above the right chimney? (What path does the fog take? What happens to the candle?

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**Convection Currents in Liquids**

Draw the motion of the liquid in the diagram below:

**Ice Cube**

**Rheoscopic Fluid**

**Heat Pack**

**Styrofoam Block**

**Review**

Do convection currents in liquids follow the same pattern as convection currents in gases? What are these patterns?

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