CONVECTION QUESTIONS

Answer the following on separate sheet(s) of paper.

1. Define:

a) convection

b) convection current

2. How does convection help heat your favourite room? Sketch the room. Show where the heat vents are located and label the diagram to show how the room is heated.

3. Why do basements usually feel cooler than the rest of the building?

4. Find the location of your dwelling's thermostat control. Why was it installed in this location? Think about convection and use what you have learned in your answer.

5. Explain the process of heating soup on the stove. Start with the heat given off by the stove's element and proceed from there, step by step, until the soup itself is boiling. Use a precise written description and include diagrams to illustrate your explanation.

6. What happens to the temperature of the soup when you turn off the stove's element? Explain why this happens.

CONVECTION (teacher answers)

I. Define:

a) convection
Convection is the transfer of heat energy which occurs when heated liquid or gas particles travel from one place to another.
b) convection current
Convection current is the circular pattern created when heat energy is transferred between particles.

2. How does convection help to heat your favourite room? Sketch the room. Show where the heat sources are located. Explain how the room is heated.

Example of heating from heat vent:
Hot air is blown out of the furnace duct. If it is hotter than the air in the room, it rises until it reaches the ceiling. It travels across the ceiling, mixing with the cooler air in the room. As this air cools, it falls and travels across the floor. It ends up near the furnace vent which is still blowing out hot air. The hot air being blown out of the vent begins to heat up the cooler air. The warm air rises and the whole process starts over again. This process of circulation (convection) continues until the room (the sensor in the room) reaches the temperature set on the thermostat.
SKETCHES WILL VARY BUT THE CONVECTION CURRENT SHOULD BE LABELLED.

3. Why are basements usually cooler than the rest of the building?

Hot air rises and cooler air falls. As well, basements are usually constructed out of cement and are not necessarily insulated as well as other parts of the building.

4. Find the location of your dwelling's thermostat control. Why was it installed in this location? Think about convection and use what you have learned in your answer.

It is probably located on the main floor of the building in a central location. If you set the thermostat at 20 degrees Celsius , the furnace will turn off when the temperature on the main floor reaches 20 degrees. There may be a slight variation in temperature in rooms some distance away from the thermostat, but the average temperature on the main floor would be about 20 degrees Celsius.

5. Explain the process of heating soup on the stove. Start with the heat given off by the stove's element and proceed from there, step-by-step, until the soup is boiling. Use a precise written description and include diagrams to illustrate your explanation.
Heat energy is transferred from the stove's element to the bottom of the pot by conduction. As the bottom of the pot gets hotter, it warms up the soup (by conduction). Because the soup particles

are warming up, they begin to expand and spread out across the bottom of the pan. Since this "bottom" layer of soup is hotter, it is less dense and rises. Once it rises, it comes in contact with pockets of cooler soup and the cooler soup pockets are pushed to the sides of the pot. Because they're cooler, they end up falling to the bottom of the pot where they mix with the warm soup which is being heated by conduction. The warmer soup gets pushed to the centre of the pot and rises to the surface. A convection current of soup is created. The process continues as long as there is heat being transferred from the element to the pot, or until all the soup (liquid) evaporates and there is no soup left in the pot.

SKETCHES MAY VARY BUT SHOULD INCLUDE THE CONTINUOUS CONVECTION CURRENT LABELLED WITH APPROPRIATE ARROWS.

6. What happens to the temperature of the soup when you turn off the stove's element? Explain why this happens.

Once the element is turned off, there is not heat energy being conducted to the bottom of the pot. The convection current gradually gets cooler and cooler because no heat energy is being added. Eventually no heat energy is transferred at all and no convection occurs.

Heat Transfer: Convection

Safety Precautions

- Safety goggles must be worn.
- All work surfaces should be cleared.
- Students should be standing when working with heat sources.

Material List (per group)

1 candle
matches
1 timing device (stopwatch)
1 sheet of white paper (letter size)
1 retort stand or suitable facsimile
1 clamp
10 to 30 centimetres of thread
scissors

Advanced Preparation

Your teacher will light the candle at the appropriate time.

Procedure

1. Begin at the centre of the paper and draw a spiral working your way to the outer edge.
2. Cut out the spiral.
3. Attach the centre of the spiral to the clamp.
4. Attach the clamp to the retort stand.
5. Observe the movement of the spiral cut-out. Make observations in your notebook.
6. Predict what will happen when you place heat below the spiral cut-out. Write the prediction in your notebook.
7. Light the candle provided.
8. Place the candle under the spiral cut-out.
9. Observe the movement of the spiral cut-out. Make observations in your notebook.

Analysis Questions

1. Did the spinner rotate in the direction you predicted? Define in your own words how the process of convection takes place.
2. What in particular governs the direction of the spiral?
3. Would the same results occur with other object shapes or object materials?
4. Could this information assist you in determining which materials would better meet the temperature control and energy efficiency of your tree house?

Relating Science and Technology to the World Outside

1. According to your knowledge of convection, determine the optimum location for air-return vents in home-heating systems.

2. You are contracted to design a heating and cooling system for your school gymnasium. The principal informs you that you are allowed to use separate vents for heating and air-conditioning. Generate a three-dimensional drawing of your gymnasium which will indicate the optimum placement of these vents.

3. Using the numbers 1-7, outline the development of a convection current.

_____air molecules move faster and farther apart, making this column of air less dense than the surrounding air

_____the temperature of the column of air rises as it approaches the heat source

_____the process is repeated

_____air above the heat source becomes warmer

_____surrounding air moves in to replace rising column of air

_____cooler, denser air descends

_____less dense air begins to rise

4. At what stage does convection take place in the water cycle?

Culminating Task Considerations

Select a material which will generate optimum heat transfer through convection. Consideration must be given to the placement of heating and cooling elements. Record all observations, skills, facts, and questions during the investigation. There is a direct connection between this subtask and the culminating task. Having a thorough notebook will assist you in the end. You may wish to consult with your group and/or teacher regarding verification or clarification.

Convection Connection

Name:_____

Date: _____

PROBLEM:

Can fluid motion and convection columns be visualized?

HYPOTHESIS:

_____

_____

_____

MATERIALS:

aluminum pie-pan, hot plate, dye (any colour), tap water, liquid hand soap or shampoo with a pearly or metallic appearance (look for glycol stearate or glycol distearate on the label), safety goggles.

PROCEDURE:

1. Fill the pie-pan between 1/2 to 3/4 full of tap water and add about 30 mL of hand soap.
2. Gently stir the soap and water solution so as not to create bubbles. Stir until the soap is mixed throughout the solution.
3. Add a few drops of dye to the solution to darken it.
4. Let your soap solution settle for 1 minute so that there is very little fluid motion.
5. Plug in the hot plate and place it on a low setting.
6. Carefully place the pie-pan on top of the heating element.
7. As the solution approaches the boiling point, carefully watch what happens to the pearly metallic luster of the solution.
8. Draw a diagram to demonstrate what you observed.
9. After a while, remove the pie-pan from the heat source and place it on a cool flat surface. Make careful observations as to what happens next.
10. Clean up all materials as per teacher instructions.

OBSERVATIONS:

1. Describe what happens to the pearly metallic luster of the solution as it approaches the boiling point. _____

_____

_____

2. Illustrate the convection columns you observed as the solution reached the boiling point.

CONCLUSION:

1. Describe how the convection cells travelled from the bottom of the solution to the top?

_____

_____

_____

2. Why do you think the dye was added to the solution?

_____

_____

APPLICATION:

1. Relate this movement of fluid to what you already know about the particle theory of matter?

_____

_____

_____

2. Where else have you seen fluid motion similar to this when heat is added to different substances?

_____

_____