Name: _____
(1 point)

Lab 3: Physics of Air

Using everyday materials, you will demonstrate some of the fundamental principles of the thermal physics of air. There are four activities in this lab, each worth 6 points. You may do them in any order.

1. Molecular transport

Purpose

Indirectly observe the difference in molecular speeds at different temperatures.

Materials

Food coloring, hot water, cool water, two beakers

Overview

You will observe how food color spreads out in still water when the water is warm and when it is cool.

Procedure

1. Fill one beaker with cool water and another with warm water. Allow both to rest for at least five minutes to allow any motion or circulation to stop.
2. Holding the squeeze bottle of food coloring close to the surface of the cool water, gently squeeze a drop of coloring into the water. Try not to make a splash. Repeat with the warm water.
3. Watch the food coloring plumes as they spread through the water. Compare the progress of the two plumes.

2. Expanding and contracting

Purpose

In this activity you will observe how a gas behaves when its temperature changes.

Materials

Hot water, ice water, balloon, glass jug, string, length measuring device (ruler, meter stick, tape measure), thermometers

Overview

You will observe how the volume of a gas changes with temperature. You will use an inflated round balloon as a convenient sample of air and keep track of its volume as it is placed in hot water and ice water.

Procedure

1. Blow up a balloon, not too full. Pinch its neck to keep the air in and stretch the mouth of the balloon around the mouth of the gallon jug. Measure the size of the balloon somehow. Record it here.

2. Place the jug and the thermometer in hot water. Try to keep the jug as completely submerged as possible. After it has been there for at least five minutes, measure the size of the balloon. Record the temperature and the balloon's size here.

3. Place the jug and the thermometer in cold water. After the jug has been there for at least five minutes, measure the size of the balloon. Record the temperature and the balloon's size here.

4. Clean up any water or other mess from the table.

3. Convection

Purpose

In this activity you will observe the principal way that heat moves through liquids and gases.

Materials

Cold water, hot water, food coloring, 4 clear glass jars, funnel, cardboard pieces, bucket, Lava Lamp

Overview

In this activity you will observe the vertical mixing of hot and cold water between two pairs of quart jars.

Procedure

1. Completely fill two jars with hot colored water and two jars with clear cold water.
2. Hold a card over the mouth of a jar of hot water and invert the jar. Place it atop a jar of cold water. Carefully remove the card so that the hot-water jar sits inverted atop the cold-water jar, mouth-to-mouth.
3. Repeat the process with the other pair of jars, but with the jar of cold water inverted atop the jar of hot water.

4. Observe the water in both jars for a few minutes. What happens to the colored water in each case? If any water moves, describe its motion.

5. Carefully empty the four jars. Clean up all spills from the area.

Questions

1. Why is the movement of water different in the two situations?

2. What causes the water to move, or to remain where it is?

4. Adiabatic Compression and Expansion

Purpose

You will observe how changing the pressure of a gas affects its temperature.

Materials

basketball pump, hose, rubber stopper, 2-L PETE bottle with LC thermometer strip inside

Overview

Gases change temperature when they do work or when work is done on them. **Work** occurs when a force is applied to a moving object: it is the change wrought by the force. Static forces do not do work. It takes energy to do work. In fact, one of the more popular definitions of **energy** is the ability to do work.

When a sample of gas expands, such as blowing up a balloon, it does work on its surroundings. Conversely, when the surroundings push on a sample of gas, causing it to contract, the surroundings do work on the gas.

In this activity you will add air to a 2-L bottle already full of air. The added air takes up space in the bottle, compressing the air that already was there. When the bottle is vented, air escaping from it does work on the air outside the bottle.

Procedure

1. Because this activity involves gases under pressure and small objects that may fly through the air, *all members* of a group working on this activity MUST WEAR SAFETY GOGGLES. True, goggles are neither comfortable nor stylish. However, neither is a black eye or worse. So, put on a pair of safety goggles.
2. Read the temperature of the thermometer inside the bottle. To read an LC Strip thermometer, find the number with the colored background. Record the temperature here. _____
3. If it is not already assembled, connect the hose to both the pump and the rubber stopper so that air expelled from the pump comes out through the narrow end of the stopper. Place the stopper securely in the mouth of the bottle. It is best if one person holds the stopper in the mouth of the bottle and another operates the pump.
4. Pump a few strokes of air into the bottle until you feel resistance. Wait a few seconds for the thermometer to equilibrate and read its temperature. Record it here. _____
5. Pump more air into the bottle until it is noticeably pressurized. Wait a few seconds for the thermometer to equilibrate and read its temperature. Record it here. _____
6. Pump still more air into the bottle, until it feels about as pressurized as a soda bottle on the grocery store shelf. Wait a few seconds for the thermometer to equilibrate and read its temperature. Record it here. _____
7. Now *gradually* vent the air from the bottle by *gently* releasing the stopper. Wait a few seconds for the thermometer to equilibrate and read its temperature. Record it here._____

Questions

1. How does the temperature of a gas change when the gas *expands*?
2. How does the temperature of a gas change when the gas *contracts*?