Name: _____

Lab 8. Physics of Air

1: Expanding and contracting

Purpose

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

Materials

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

Overview

You will observe how the volume of a gas changes with temperature. An inflated round balloon connected to a jug will serve as a convenient sample of air. You will keep track of its volume as the jug is placed in hot water and ice water.

Procedure

1. Predict: Will the volume of air in the rubber balloon change if it is heated or chilled? If so, how?

2. 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.

3. 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.

4. Place the jug and the thermometer in ice 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.

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

2. 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, four clear glass quart 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.

1. 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.

2. Repeat the process with the other pair of jars, but with the jar of cold water inverted atop the jar of hot water.

3. 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.

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

5. Observe the Lava Lamp. Describe the motion of the "lava."

Questions

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

2. Why does the "lava" in the Lava Lamp move as it does?

3. 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 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 useful 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. Predict: If air is pumped into a bottle, how does its temperature respond? What if compressed air is released from a bottle?

3. Read the temperature of the thermometer inside the bottle. Record it here. _____

4. 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.

5. Pump a few strokes of air into the bottle until you feel resistance. Wait 30 seconds for the thermometer to equilibrate and read its temperature. Record it here. _____

6. Pump more air into the bottle until it is noticeably pressurized. Wait 30 seconds for the thermometer to equilibrate and read its temperature. Record it here. _____

7. Pump still more air into the bottle, until it feels about as pressurized as a soda bottle on the grocery store shelf. Wait 30 seconds for the thermometer to equilibrate and read its temperature. Record it here. _____

8. Now *gradually* vent the air from the bottle by *gently* releasing the stopper. Wait 30 seconds for the thermometer to equilibrate and read its temperature.
Record it here. _____

Questions

1. What happens to the temperature of a gas as its pressure is increased?

2. What happens to the temperature of a gas as its pressure is decreased?

3. How does the temperature of a gas change when the gas *does* work?

4. How does the temperature of a gas change when work is *done on* the gas?

5. Doing work *on* a gas *raises* its energy. When a gas *does* work, its energy is *depleted*. How is the gas's temperature related to its energy?