

LAB 9

Fluids

OBJECTIVES

- (1) Use Archimedes' Principle to determine the density of solid objects.
- (2) Observe the behavior of fluid pressure due to the atmosphere, to the temperature, and to the speed of a moving fluid.
- (3) Compare observations with the behavior expected from Bernoulli's Principle.

EQUIPMENT

Balances, masses, water cans, empty soda cans, Magdeburg hemispheres, barometer, liquid nitrogen, light bulbs, ball in air stream, and a ball in a funnel.

PROCEDURE

Part 1: Atmospheric Pressure

Atmospheric pressure surrounds us everywhere, but we rarely appreciate how much power it has.

- (a) Boil a small amount of water in a can to flush the air out of it (why does this work?), then let the atmosphere crush it. *Explain physically what occurred.*
- (b) Use a vacuum pump on a barometer and *explain why the level of mercury either goes up or down when air is withdrawn or let in.*
- (c) Study the suction cups and see if you can understand how they work. With a partner, see if you can lift up one of the movable tables with a pair of suction cups.
- (d) Explain why the Magdeburg hemispheres are hard to pull apart after partial evacuation with the hand pump. *Measure the diameter of the hemispheres and predict how big a force would be required to separate them if there were a perfect vacuum inside and an air pressure of 100 kPa outside.*
- (e) Clearly, air at room temperature exerts a considerable pressure on everything—about 15 pounds per square inch or “one atmosphere.” If we cool the air, however, the bouncing molecules, moving more slowly, exert ever-so-much less pressure. At liquid nitrogen temperature (77 K), our air becomes *liquid*. Blow-up a balloon and stick it into the liquid nitrogen and *explain physically what occurred.*

Part 2: Archimedes' Principle

- (a) Weigh an object first in air, W_{air} , and then completely submerged in water, W_{water} . Determine its density from these measurements. *Can you identify the substance from its density and appearance alone?*
- (b) Measure the weight of the water displaced by a floating object. *Does it equal the weight of the object itself?*

Part 3: Bernoulli's Principle

Bernoulli's Principle tells us that fast-moving air has a lower pressure than slow-moving air. *Explain how this principle applies to each of the experimental situations below.*

- (a) Blow between two light bulbs.
- (b) Hang a ball in the fast-moving stream of air from a blower, and observe how air pressure resists its attempts to escape.
- (c) Blow a ball out of a funnel, and notice that the way it works is not what we might originally expect.
- (d) Place a dime on a table and blow really hard over top of it. With practice, you can get the dime to jump into a cup. This makes a good bar room bet 😊.