(a) An object moves a distance of 25 m in 3 s.

(b) A train travels 2 km, the first at an average speed of 50 km/h and the second at an average speed of 100 km/h. (*Note:* The average speed is not 75 km/h.)

(c) A runner runs 1 km in 3 min and a second kilometer in 4 min.

(d) An object dropped from a height of 75 m strikes the ground in 4 s.

9. Estimate the total force on the surface of your body due to the pressure of the atmosphere.

10. Calculate the kinetic energy of a 1500-kg automobile with a speed of 30 m/s. If it accelerates to this speed in 20 s, what average power has been developed?

11. An electric motor, rated at $\frac{1}{2}$ horsepower, requires 450 W of electrical power. Calculate its efficiency (power out divided by power in). What happens to the rest of the power?

12. Calculate the potential energy of:

(a) A 3-kg block of iron held 2 m above the ground;

(b) A spring with a spring constant $K = 10^3$ N/m stretched 10 cm from its equilibrium length;

(c) A 1-L bottle ($V = 1000$ cm^3) with a pressure 10^4 N/m^2 above atmospheric pressure ($P = 10^5$ N/m^2).

EXPERIMENTS FOR HOME, LABORATORY, AND CLASSROOM DEMONSTRATION

Home and Classroom Demonstration

1. *Longitudinal waves on a coiled spring (Slinky)* For best results, suspend a Slinky from a long horizontal stick or rod by attaching several strings (about a meter in length). However, a giant Slinky will work satisfactorily on a smooth polished floor in spite of a small amount of friction. Jerk one end of the Slinky in the direction to increase its length and observe the pulse wave that propagates. Produce a small pulse and a large pulse in rapid succession. Does the distance between the two pulses change as they travel down the spring? What does this indicate about the relationship between amplitude (pulse size) and wave speed? Generate a series of waves by smoothly increasing and decreasing its length.

Repeat the experiment with transverse rather than longitudinal pulses and waves.

2. *Siren disk* Blow air through a siren disk. If none is available, you can construct one by drilling regularly spaced holes in a wooden disk attached to a rotator. Note that the pitch of the tone depends upon the speed of rotation of the disk, whereas the loudness is determined by the rate of airflow.

3. *Moving object stroboscopically observed* In a partially or totally dark room, observe a white ball in stroboscopic light. (If none is available, a hand stroboscope can be constructed by cutting slots around the circumference of a disc mounted on a dowel rod with a finger hole for rotating it). Roll the ball on a table or other horizontal surface and compare what you see to Fig. 1.3(a). Roll the ball down an incline and compare what you see to Fig. 1.3(b).

Observe a mass oscillating on the end of a spring, and see if [illegible] make it appear to stand still by adjusting the rate of

4. *Moving-object video capture* Make a video recording of a moving object. Use a VCR with a single-frame player or a "frame grabber" to transfer single frames to a computer. Measure the distance the object has moved between successive frames.

5. *Falling object stroboscopically observed* Observe a falling object in stroboscopic light (or with video capture) and compare what you see to Fig. 1.8(a). Toss a ball upward at an angle and compare what you see to Fig. 1.8(b).

6. *U-tube manometer* Attach a length of rubber tubing to a U-shaped glass tube filled with colored water placed in front of a meter stick. The difference in heights of the water in the two sides of the U-tube represents the pressure in cm of water (a unit commonly used by organ builders). To convert cm of water to newtons/meter^2 or pascals (Pa), multiply by 100. Calibrate your lungs by blowing and sucking to obtain 100 cm of water (10^4 Pa) above and below atmospheric pressure. Which is easier to do?

7. *Deciding if pressure in a container depends upon the amount of water in the container* Place the end of the tubing attached to a manometer at various depths in a cylinder of water and show that the pressure (in cm of water) is equal to the depth of the tube below the surface. Repeat with containers of varying size and shape to show that the pressure depends only of the depth below the surface, regardless of the shape of the container or how much water it holds.

8. *Force on a container wall* Blowing a collapsed varnish can back to shape demonstrates the relationship of force to [illegible] the area of the large side of the can and

cated on the manometer) to obtain the net force on the collapsed side of the can.

9. *Lifting a concrete block by blowing into a beach ball* A concrete block can be lifted by blowing air into a beach ball. A manometer indicates the pressure in the ball during and after inflation. (How much blowing pressure would be required to inflate an air mattress if someone is already lying on in?)

10. *Air pressure on a newspaper* Cover most of a thin board on a table with a sheet of newspaper. Strike the end of the board with the fist and note that the inertia of the air mass inhibits movement of the newspaper.

11. *Sound waveforms* Connect a microphone to a cathode-ray oscilloscope or a PC with a sound-input card and display

Laboratory Experiments

Accelerated Motion (Experiment 1 in *Acoustics Laboratory Experiments*)

Graph Matching (Experiment 1 in *Physics with Computers*)

Picket Fence Free Fall (Experiment 5 in *Physics with Computers*)