

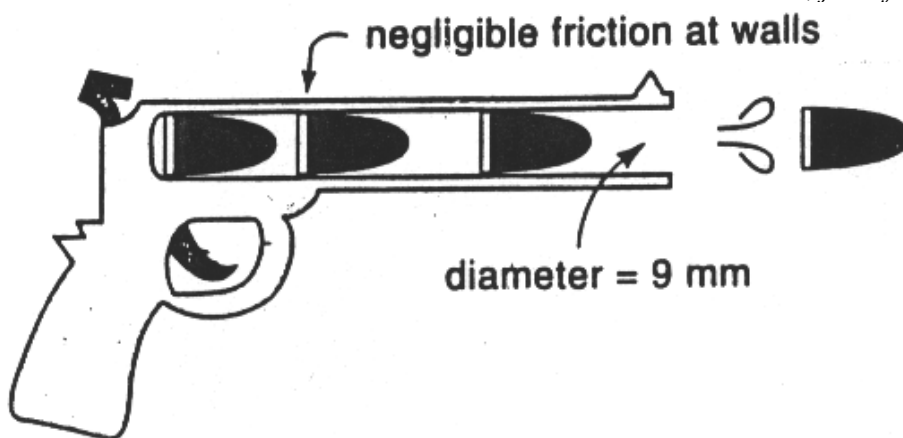
1. True story: an inventor has a new device to heat a room. It consists of a heater, a coil of electrically heated resistance wire, and a fan to force air across the heater coil. The heater and the fan are on separate circuits. The inventor is surprised to find that the air temperature passing through the device is increased even when the heater is shut off. Newspapers run the story and proclaim a new way to heat a room without the use of heating energy. A reporter finds out that you are a building energy expert, a graduate of 4.42. You are asked for your opinion.

2. One means proposed to conserve energy for space heating is the use of night setback; the interior temperature of a building is reduced during the evening. The heat transferred from the building to the outside air is proportional to the temperature of the building. Some people have questioned this strategy claiming that the total energy saved by night setback is reduced because of the additional energy needed to raise the interior temperature in the morning. Consider a 24-hour period for a building; assume the heat transferred from the exterior walls is directly proportional to the interior temperature. The internal energy of the building is proportional to the temperature. Be careful in defining the system and the heat and work interactions at the boundaries. What is the net energy change for the system over the 24-hour period? How much impact does the reheating energy in the morning have on the savings due to the night setback?

3. A 9 mm Xian short-barreled experimental pistol is fired, and the explosive gases push the bullet out the barrel of the gun. The pressure is carefully recorded as the bullet accelerates to the exit. Here is a sample of the data collected:

Position of bullet, Or distance down the barrel, cm	0	2	3	4	5	6	7	8
Pressure in gun chamber Behind the bullet, bar	23	25	24	22	17	10	6	4

*bullet at start, just after trigger is pulled*



What is the work done on the bullet?

4. 4. The door to an ordinary electric home refrigerator is left open by accident (with the power on) while the people are away for the weekend. If the kitchen doors are closed and the room is thermally well insulated, will the room be hotter than, colder than, or at the same temperature as the rest of the house when the unhappy people return? Why?

5. 5. An investigator suggests use of a heat pump to provide winter heating to a building. Instead of using the outside air as the low temperature heat source, she proposes to use the domestic water system which enters the house at a higher temperature than the outside air. This raises the heat pump average coefficient of performance  $Q_H/W$  from 2.5 to 3.0. As the heat pump operates,  $Q_W$  is transferred from the water, lowering  $T_I$ , the inlet water temperature to the house. To simplify the consideration assume the initial water temperature is  $T_H$  same as the interior temperature. The house temperature is constant at  $T_H$ . Evaluate the net energy electrical savings under two conditions:

- (a) The water quickly flows through the house and there is no heat transfer between the water and the interior of the house.  $T_D$  the water drain temperature equals  $T_I$  with or without the heat pump.
- (b) The water remains in the house for a long time. Heat transfer to the water in the house raises its temperature to the interior temperature  $T_H$ , so that  $T_D$  is equal to  $T_H$  no matter how much  $T_I$  changes.
- (c) Comment on the feasibility of such a system.

