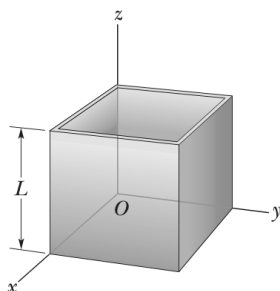• For material covering Ch. 9 (skipping Sect. 9-9)
• Due Friday, Oct. 24 at 5 pm

1. A cubical box that has been constructed from uniform metal plate of negligible thickness. The box is open at the top and has edge length L = 71 cm. Find **(a)** the x coordinate, **(b)** the y coordinate, and **(c)** the z coordinate of the center of mass of the box. [Answer: **(a)** 36 cm; **(b)** 36 cm; **(c)** 28 cm].

2. In the ammonia (NH3) molecule of the figure, three hydrogen (H) atoms form an equilateral triangle, with the center of the triangle at distance d = 94.0 pm (picometer) from each hydrogen atom. The nitrogen (N) atom is at the apex of a pyramid, with the three hydrogen atoms forming the base. The nitrogen-to-hydrogen atomic mass ratio is 13.9, and the nitrogen-to-hydrogen distance is L = 101.4 pm. What are the **(a)** x and **(b)** y coordinates of the molecule's center of mass? [Answer: **(a)** 0; **(b)** 31.3 pm].
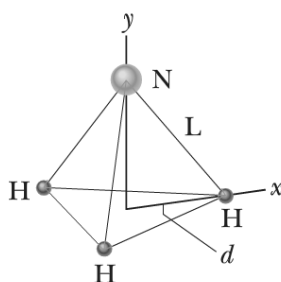

3. Ricardo, of mass 84 kg, and Carmelita, who is lighter, are enjoying Lake Merced at dusk in a 30 kg canoe. When the canoe is at rest in the placid water, they exchange seats, which are 3.3 m apart and symmetrically located with respect to the canoe's center. Ricardo notices that the canoe moves 43 cm horizontally relative to a pier post

during the exchange and calculates Carmelita's mass. What is it? [Answer: 61 kg].

4. A 1900 kg truck traveling north at 39 km/h turns east and accelerates to 60 km/h. **(a)** What is the change in the truck's kinetic energy? **(b)** What is the magnitude of the change in its momentum? [Answer: (a) 150. kJ; (b) 3.80×10^4 kg·m/s].

5. It is well known that bullets and other missiles fired at Superman simply bounce off his chest. Suppose that a gangster sprays Superman's chest with 5.6 g bullets at the rate of 98 bullets/min, and the speed of each bullet is 620 m/s. Suppose too that the bullets rebound straight back with no change in speed. What is the magnitude of the average force on Superman's chest from the stream of bullets? [Answer: 11 N].

6. The figure shows a 0.3 kg baseball just before and just after it collides with a bat. Just before, the ball has velocity of magnitude 10.7 m/s and angle $\theta_1 = 33.4°$. Just after, it is traveling directly upward with velocity of magnitude 8.80 m/s. The duration of the collision is 1.10 ms. What are the **(a)** magnitude and **(b)** direction (relative to the positive direction of the x axis) of the impulse on the ball from the bat? [Answer: **(a)** 5.16 kg·m/s; **(b)** 58.7°].
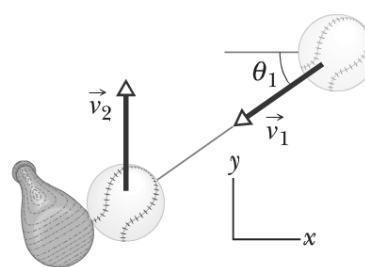
7. A space vehicle is traveling at 4730 km/h relative to Earth when the exhausted rocket motor is disengaged and sent backward with a speed of 95 km/h relative to the command module. The mass of the motor is four times the mass of the module. What is the speed of the command module relative to Earth just after the separation? [Answer: 4810 km/h].

8. A 3.0 kg mess kit sliding on a frictionless surface explodes into two 1.5 kg parts, one moving at 4.0 m/s, due north, and the other at 6.1 m/s, 15° north of east. What is the original speed of the mess kit? [Answer: 4.1 m/s].

9. A 3.50 g bullet is fired horizontally at two blocks at rest on a frictionless table. The bullet passes through block 1 (mass 1.39 kg) and embeds itself in block 2 (mass 1.89 kg). The blocks end up with speeds $v_1 = 0.660$ m/s and $v_2 = 1.45$ m/s. Neglecting the material removed from block 1 by the bullet, find the speed of the bullet as it **(a)** leaves and **(b)** enters block 1. [Answer: **(a)** 784 m/s; **(b)** 1050 m/s].

(*a*)
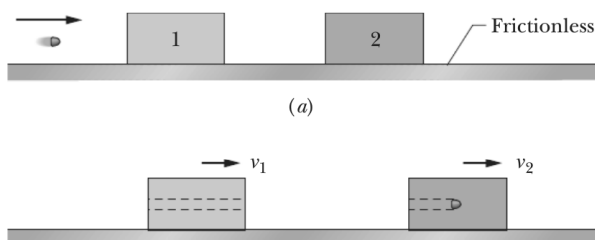
10. Block 1 of mass m_1 slides from rest along a frictionless ramp from height h and then collides with stationary block 2, which has mass $m_2 = 3m_1$. After the collision, block 2 slides into a region where the coefficient of kinetic friction is μ_k and comes to a stop in distance d within that region. What is the value of distance d if the collision is **(a)** elastic and **(b)** completely inelastic? Express your answer in terms of the variables given and g. [Answer: **(a)** $\dfrac{h}{4\mu_k}$; **(b)** $\dfrac{h}{16\mu_k}$].