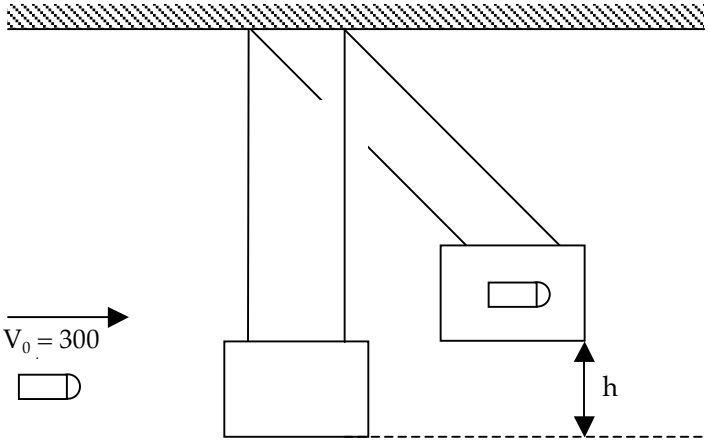
W7.07

MOMENTUM

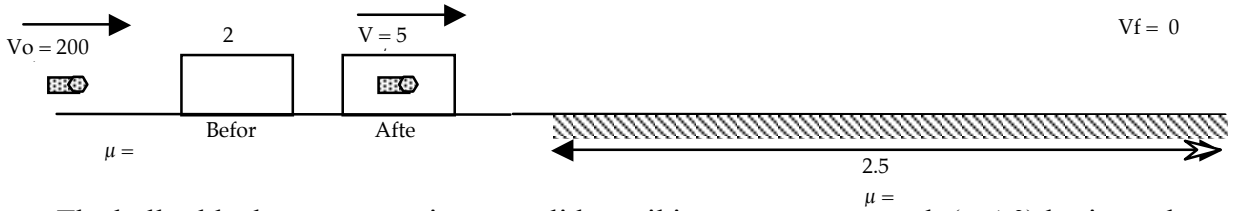
1. Venus Williams hits a 125 mph (57.9 m/s) serve at Lindsay Davenport. Davenport rockets a 100 mph (46.3 m/s) forehand past Williams for a clean winner. Assuming the ball has mass of 25 g and each impact lasts for 0.05 sec, calculate the average force exerted by
   a. Williams' racket during the serve and
   b. Davenport's racket during the return of serve.

2. A bullet with a mass of 0.050 kg and an initial velocity of 300 m/s is shot horizontally at a 5-kg block suspended as shown above. The bullet imbeds in the block.



   a. Calculate the velocity of the bullet-block system just after impact.
   b. Calculate the kinetic energy of the bullet-block system just after impact.
   c. Calculate the maximum height to which the bullet-block system swings.

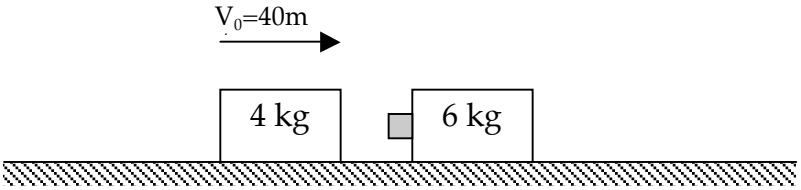
3. A bullet with a velocity of 200 m/s is shot at a 2-kg block resting on a horizontal frictionless surface. The bullet imbeds in the block and the bullet-block system slides across the surface with a speed of 5 m/s.
   a. Determine the mass of the bullet.

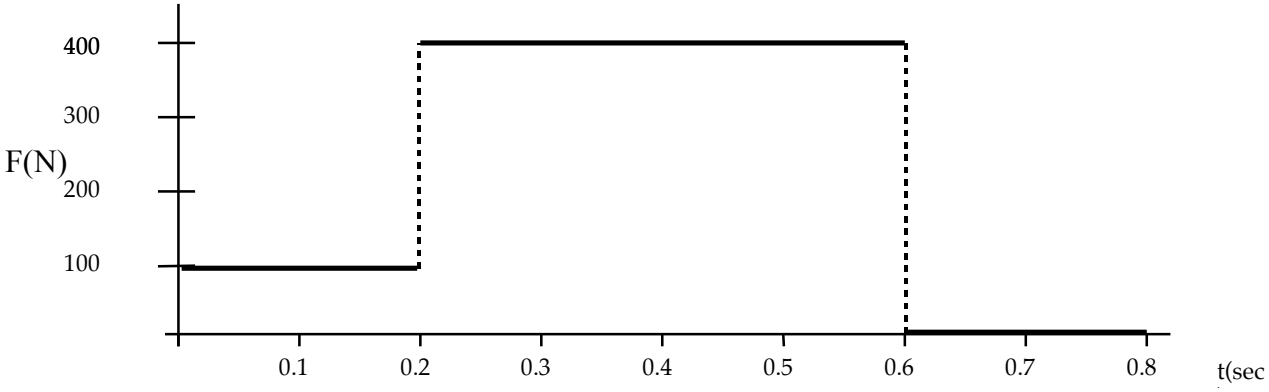


The bullet-block system continues to slide until it encounters a rough ($\mu \neq 0$) horizontal surface. If the bullet-block combination comes to rest after sliding an additional 2.5-m, determine

   b. the coefficient of friction between the rough surface and the block.
   c. the time it takes the bullet-block combination to come to rest (after it comes into contact with the rough surface).

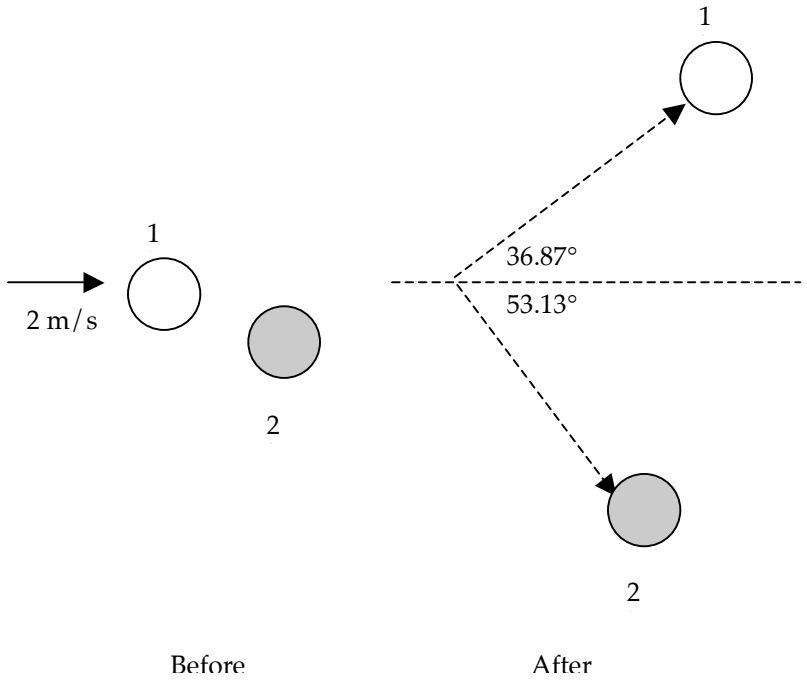
4. A 4-kg block slides on a frictionless surface at 40 m/s toward a 6-kg block (with a massless sponge attached) initially at rest. The force that the 4-kg block exerts on the 6-kg block is plotted below.





a. What is the total impulse of the 4-kg block on the 6-kg block?
b. Sketch the plot of the force of the 6-kg block on the 4-kg block (vs. time).
c. Find the speed of the 6-kg block after the collision.
d. Find the speed of the 4-kg block after the collision.
e. How much energy is lost or gained during the collision?

5. A 1-kg air hockey puck traveling at 2 m/s collides with a 2-kg puck. The two pucks move off after the collision as indicated in the diagram below. Determine the final velocity of each puck.



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1. a. 29 N
   b. 52.1 N

2. a. 2.97 m/s
   b. 22.3 J
   c. 0.44 m

3. a. 0.0513 kg
   b. $\mu = 0.5$
   c. t = 1 second

4. a. 180 N·s
   b. Equal and opposite to plot shown (by 3rd Law)
   c. 30 m/s
   d. –5 m/s
   e. –450 J

5. $V_{1\,kg} = 1.6$ m/s; $V_{2\,kg} = 0.6$ m/s