A 3.0 kg gun initially at rest is free to move. A 0.010 kg bullet leaves the gun with a speed of 300 m/s.

1. Which object has more momentum after the collision?

2. After firing, how fast does the gun move?

Questions 3 and 4: A 0.2 kg ball moving at 30 m/s is stopped by a catcher in 0.010 s.

3. What is the impulse experienced by the ball during the collision with the catcher?

4. If the catcher instead uses a different glove which doubles the time of collision, what will happen to the force experienced by the ball in the collision?

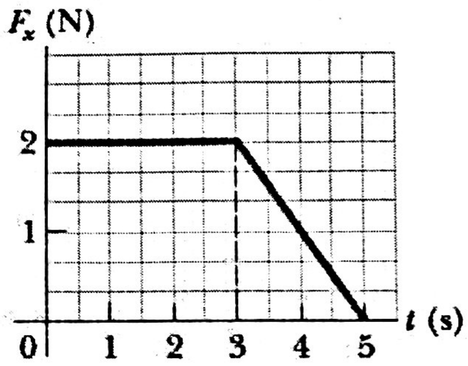
Questions 5 and 6: Car C, of mass 1000 kg, moves to the right at 30 m/s. Car D, also of mass 1000 kg, moves to the left at 10 m/s.

5. What is the total momentum of the two cars?

6. The cars collide and stick together. What is the combined speed of the two carts after collision?

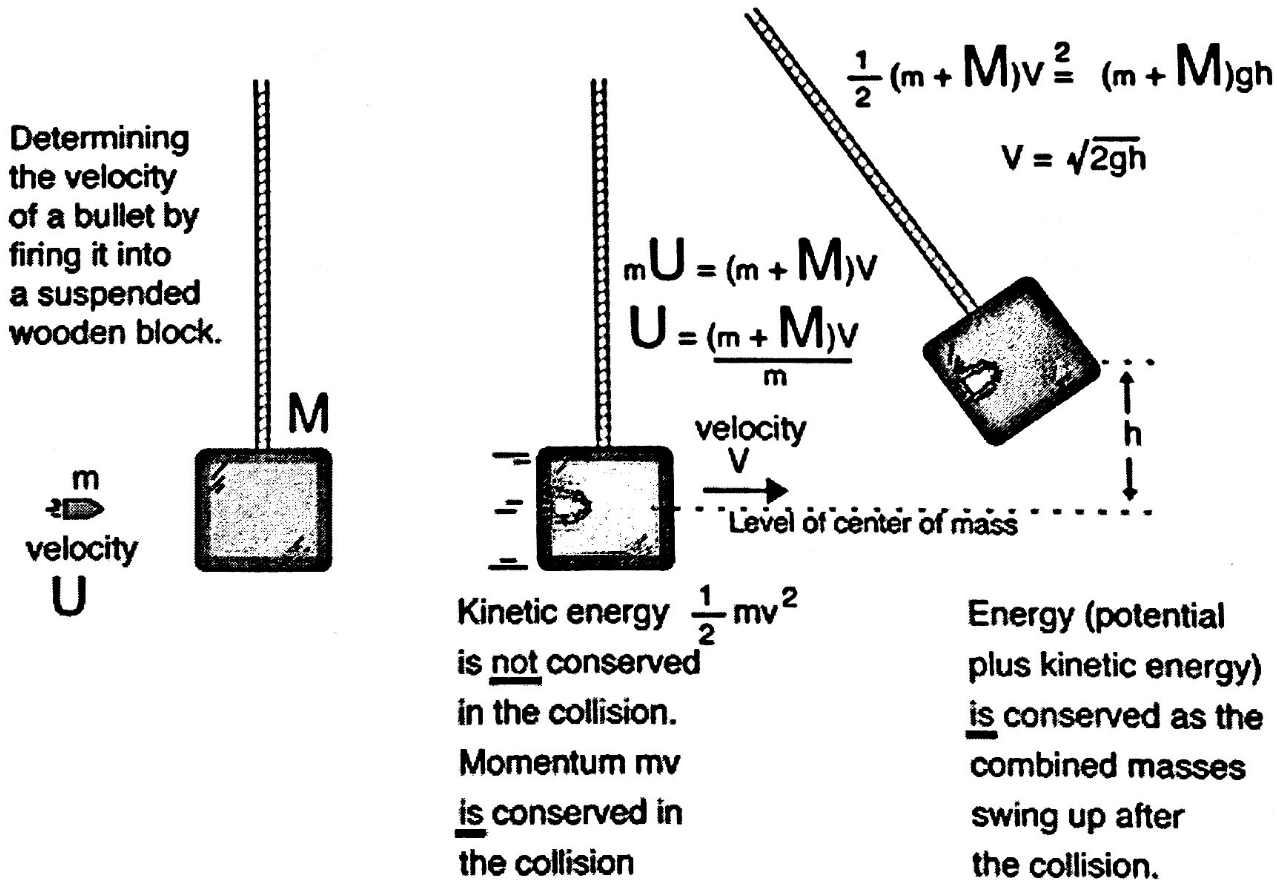
An 8.0 g bullet is fired into a 2.5 kg pendulum bob,which is initially at rest and becomes embedded in the bob.The pendulum then rises a vertical distance of 6.0cm.

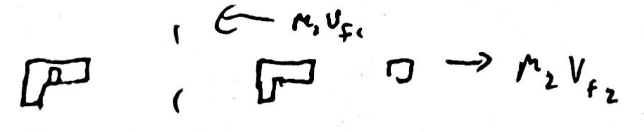
7. What was the initial speed of the bullet? Show your work.



8. Based on the force vs time graph, what is the net impulse acting on the object? (from t=0 sec to t=5 sec)

9. Based on the force vs time graph, if the object had a mass of 2 kg and an initial velocity of 3 m/s. What would be the final velocity after 5 sec?





3.0 kg gun   0.01 kg bullet

1. they have the __same__ momentum
   - law of conservation of momentum

2. $m_1 v_{f1} = m_2 v_{f2}$ $(3\text{ kg}) v_{f1} = (0.01\text{ kg})(300\ \text{m/s})$

   $(3\text{ kg}) v_{f1} = 3\ \text{kg m/s}$

   $v_{f1} = 1\ \text{m/s}$ to the left

3. Impulse-momentum theorem $\Delta p = F\Delta t$

   $\Delta p = m\Delta v$ $v_o = 30\ \text{m/s}$ ball slows down to a stop

   $\Delta p = (0.2\text{ kg})(30\ \text{m/s})$ $v_f = 0\ \text{m/s}$ $\Delta v = 30\ \text{m/s}$

   $= 6\ \text{kg m/s} = F\Delta t$

   $F = \frac{\Delta p}{\Delta t} = \frac{6\ \text{kg m/s}}{0.01\ \text{sec}} =$ **600 N**

4. $\Delta p = F\Delta t$ double the collision time

   same ↓ f   Force is __decreased__ by a factor of 2

   __halved__

5. 1000 kg → 30 m/s   ← 10 m/s 1000 kg

   $m_1 v_{o1} = (1000)(30) = +30{,}000$ $m_2 v_{o2} = (1000\text{ kg})(-10\ \text{m/s})$

   $= -10{,}000\ \text{kg m/s}$

   total momentum

   $p_o = +30{,}000\ \text{kg m/s} + (-10{,}000\ \text{kg m/s})$

   $=$ **20,000 kg m/s**

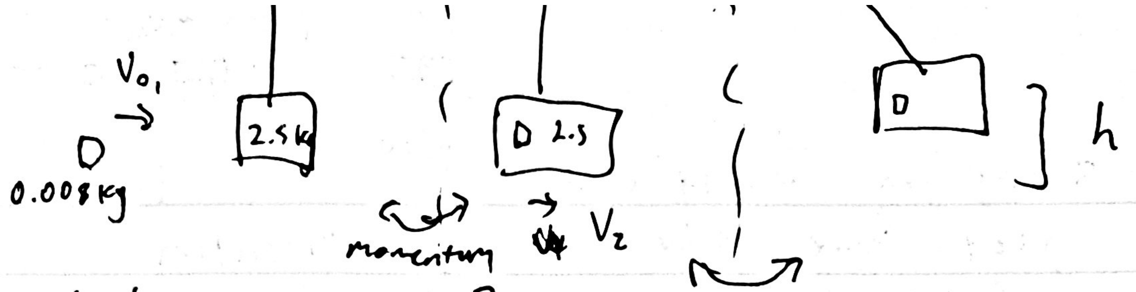
6. perfectly inelastic collision $p_o = m_1 v_{o1} + m_2 v_{o2} = (m_1 + m_2) v_f$

   1000 | 1000

   → 10 m/s

   $p_f = 20{,}000\ \text{kg m/s} = (1000 + 1000) v_f$

   $v_f = \frac{20{,}000}{2000} =$ **10 m/s to the right**



Velocity of bullet = ? energy

6 cm = 0.06 m

$\frac{1}{2} \cancel{M_{total}} V_2^2 = \cancel{M_{total}} gh$ $\frac{1}{2} V_2^2 = gh$

$V_2^2 = 2gh$

$V_2 = \sqrt{2(9.8)(0.06)} = \underline{1.08 \text{ m/s}}$ $V_2 = \sqrt{2gh}$

Android Wabbit mu free Calculator

$M_{bullet} V_{bullet} = (M_{bullet} + M_{bob}) V_2$

$(0.008)(V_{bullet}) = (0.008 + 2.5)(1.08)$

$\boxed{V_{bullet} = 338.6 \text{ m/s}}$

8. impulse = area under curve = $6 + 2 = \underline{8 \text{ N}\cdot\text{s}}$

$= \Delta p$ Force-time graph

9. $8 \text{ N}\cdot\text{s} = \Delta p =$ $p_0 = (2\text{kg})(3 \text{ m/s}) = 6 \text{ kg m/s}$

$\Delta p = 8$ $p_0 = 6$ $p_f = 14 \text{ kg m/s}$

$p_f - p_0 = 8$ $p_f - 6 = 8$ $= m V_f$

$V_f = \frac{14 \text{ kg m/s}}{2 \text{kg}} = \boxed{7 \text{ m/s}}$