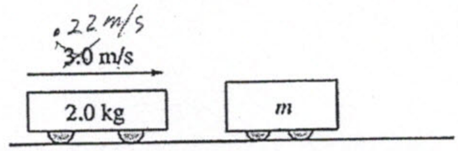
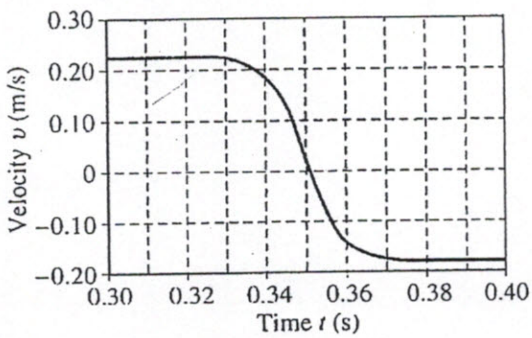
AP PHYSICS I
Chapter 9 Practice

KEY

Name: ____________________ Period: ________ Date: ____________

1. A 2.0 kg frictionless cart is moving at a constant speed of 0.22 m/s to the right on a horizontal surface, as shown below, when it collides with a second cart of undetermined mass m that is initially at rest. As a result of the collision, the second cart acquires a speed of 1.6 m/s to the right. The graph of the velocity of the cart as a function of time t is shown below. Assume that friction is negligible before, during, and after the collision. Assume that friction is negligible before, during, and after the collision.





a) Determine the cart's momentum before the collision.

$\vec{P}_i = m\vec{v}$

$P_i = 2kg(.22 m/s) = \boxed{.44 kg \cdot m/s}$

b) Determine the magnitude of the impulse during the collision.

$\vec{J} = \Delta\vec{p}$

$J = 2kg(-.18 m/s - .22 m/s)$

$J = \boxed{-.80 kg \cdot m/s}$

c) Determine the mass of the second cart.

$m_1 v_{1i} + \cancel{m_2 v_{2i}}^{0} = m_1 v_{1f} + m_2 v_{2f}$

$2kg(.22 m/s) = (2kg)(-.2 m/s) + m_2(1.6 m/s)$

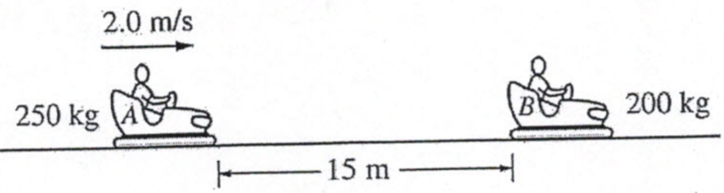
$.44 = -.40 + 1.6 m_2$

$\frac{.80}{1.6} = m_2$ $\boxed{m_2 = .5 kg}$

OR $J = \Delta p_2$

$.80 = m_2(1.6 - 0)$

$m_2 = .500 kg$



2. Several students are riding in bumper cars at an amusement park. The combined mass of car A and its occupants is 250 kg. The combined mass of car B and its occupants is 200 kg. Car A is 15 m away from car B and moving to the right at 2.0 m/s, as shown, when the driver decides to bump into car B, which is at rest.

(a) Car A accelerates at 1.5 m/s^2 to a speed of 5.0 m/s and then continues at constant velocity until it strikes car B. Calculate the total time for car A to travel the 15 m.

$v_f = v_i + at$

$5 m/s = 2 m/s + (1.5 m/s^2)t$

$t_1 = 2s$

$\Delta x = v_0 t + \frac{1}{2}at^2$

$\Delta x = 2(2) + \frac{1}{2}(1.5)(2)^2$

$\Delta x = 7m$

$\Delta x = vt$

$15 - 7 = 5 t_2$

$t_2 = 1.6s$

$t = 2s + 1.6s = \underline{\overline{3.6s}}$

(b) After the collision, car B moves to the right at a speed of 4.8 m/s.

i. Calculate the speed of car A after the collision.

$250 kg (5 m/s) + 0 = 250 kg V_A + 200 kg (4.8 m/s)$

$\frac{1250 - 960}{250} = V_A$

$\boxed{V_A = 1.2 m/s}$

ii. Indicate the direction of motion of car A after the collision.

____ To the left _______ To the right __✓__ None; car A is at rest.

(c) Is this an elastic collision?

____ Yes _______ No

Justify your answer.

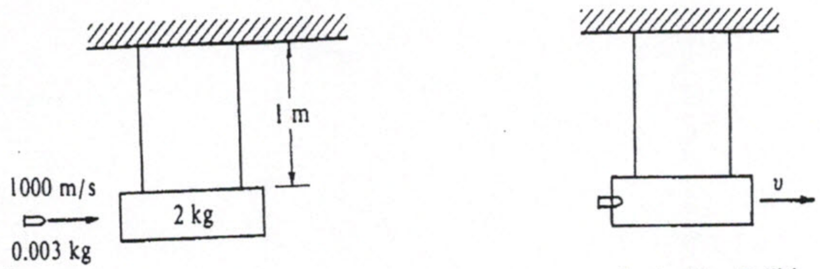
$K_i = \frac{1}{2}(250)(5)^2 = 3125J$

$K_f = \frac{1}{2}(250)(1.2)^2 + \frac{1}{2} 200 (4.8)^2$

$K_f = 180 + 2304 = 2484 J$

$K_f < K_i$

$K_i \neq K_f$



Before Collision

Immediately After Collision

3. A 2-kilogram block initially hangs at rest at the end of two 1-meter strings of negligible mass as shown on the left diagram above. A 0.003-kilogram bullet, moving horizontally with a speed of 1000 meters per second, strikes the block and becomes embedded in it. After the collision, the bullet/block combination swings upward, but does not rotate.

(a) Calculate the speed of the bullet/block combination just after the collision.

$$m_1 v_1 + \cancel{m_2 v_2}^{\,0} = (m_1 + m_2) v$$

$$\frac{.003(1000)}{2.003} = v$$

$$v = 1.50 \text{ m/s}$$

(b) Calculate the ratio of the initial kinetic energy of the bullet to the kinetic energy of the bullet/block combination immediately after the collision.

$$\frac{K_i}{K_f} = \frac{\cancel{\tfrac{1}{2}}(.003)(1000)^2}{\cancel{\tfrac{1}{2}}[.003+2](1.5)^2} = \frac{3000}{4.5} = 665.7$$

(c) Calculate the maximum vertical height above the initial rest position reached by the bullet/block combination.

$$K_i = U_f$$

$$\frac{1}{2} m v^2 = m g h$$

$$\frac{1}{2}(1.5)^2 = (9.8) h$$

$$h = .115 \text{ m} = 11.5 \text{ cm}$$