PHYSICS 19-20

Name _____

Date _____ Per _____

Unit 3: Momentum & Impulse

Assignment #303

Practice 1: Conservation of Momentum

$$P_{before} = P_{after}$$
$$(m_1 v_{1i}) + (m_2 v_{2i}) = (m_1 v_{1f}) + (m_2 v_{2f})$$

1) Inelastic

A 15,000 kg (m_1) railroad car moving at 7.0 m/s (v_1) to the east collides with and sticks to another railroad car of the same mass (m_2) that is moving the same direction at 1.5 m/s (v_2). What is the velocity of the joined cars (v_f)?

$(15000)(7) + (15000)(1.5) = (15000)(?) + (15000)(?)$

$m_1 \quad v_1 \quad m_2 \quad v_2 \qquad\qquad m_1 \quad v_1 \quad m_2 \quad v_2$

$105{,}000 + 22{,}500 = (15000 + 15000)V$

$\frac{127{,}500}{30{,}000} = \frac{30{,}000V}{30{,}000}$

$4.25 \text{ m/s} = V$

$p = mV$

$p = (30{,}000)(4.25)$

P_{before} = 127,500 kg.m/s

P_{after} = 127,500 kg.m/s

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2) A 4.0 kg bowling ball sliding to the right at 8.0 m/s has an elastic head-on collision with another 4.0 kg bowling ball initially at rest. If the first ball stops after the collision, what is the velocity of the second bowling ball after the collision?

Elastic

$$(4)(8)+(4)(0) = (4)(0)+(4)(V_2)$$

$$32 + 0 = 0 + 4V_2$$

$$\frac{32}{4} = \frac{4V_2}{4}$$

$$8\ m/s = V_2$$

$p = mv$

$p = 4(8)$

P_{before} = 32 kg.m/s P_{after} = 32 kg.m/s

3) While filming "Gravity", Sandra Bullock & George Clooney are joined together in outer space (they are not moving). As a heroic measure, George Clooney pushed away from Sandra Bullock at 3 m/s. If George Clooney's mass is 93.5 kg, and Sandra Bullock moves away from him at -4.2 m/s, what is her mass?

Explosion

$$(m_1)(0)+(93.5)(0) = (m_1)(-4.2)+(93.5)(3)$$

$$0 + 0 = -4.2m_1 + 280.5$$

$$-280.5 \quad -280.5$$

$$\frac{-280.5}{-4.2} = \frac{-4.2m_1}{-4.2}$$

$$66.79\ kg = m_1$$

$p = (-4.2)(66.79)+280$

$p = 0$

P_{before} = 0 kg.m/s P_{after} = 0 kg.m/s

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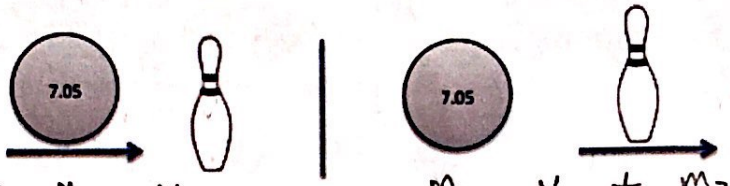
4) Mike is on the tenth frame of his recent bowling competition and he needs to pick up the last pin for a spare and the first place trophy. He rolls the 7.05-kg ball down the lane and it hits the 1.52-kg pin head-on. The ball was moving at 8.24 m/s before the collision. The pin went flying forward at 13.2 m/s. Determine the post-collision speed of the ball.

Elastic

$V_2 = ?$



$m_1 \quad v_1 + m_2 \quad v_2 = m_1 \quad v_1 + m_2 \quad v_2$

$(7.05)(8.24) + (1.52)(0) = (7.05)(V_1) + (1.52)(13.2)$

$58.092 + 0 = 7.05V_1 + 20.064$

$-20.064 \quad -20.064$

$\frac{38.028}{7.05} = \frac{7.05V_1}{7.05}$

$5.4 \text{ m/s} = V_1$

$P_{before} =$ 58.09 kg.m/s $\quad P_{after} =$ 58.07 kg.m/s

38.07 +

5) A 0.0562-kg tennis ball is loaded into a homemade cannon. The cannon is at rest when it is ignited. Immediately after the impulse of the explosion, a photogate timer measures the cannon to recoil backwards to be -0.280 m/s and the tennis ball was traveling 35 m/s. What is the mass of the cannon?

Explosion

$(0.0562)(0) + (m_2)(0) = (0.0562)(35) + (m_2)(-.280)$

$0 + 0 = 1.967 + (-.280m_2)$

$-1.967 \quad -1.967$

$\frac{-1.967}{-.280} = \frac{-.280m_2}{-.280}$

$7.0 \text{ kg} = m_2$

$1.967 + [-.280(7)]$

$P_{before} =$ 0 kg.m/s $\quad P_{after} =$ 0 kg.m/s

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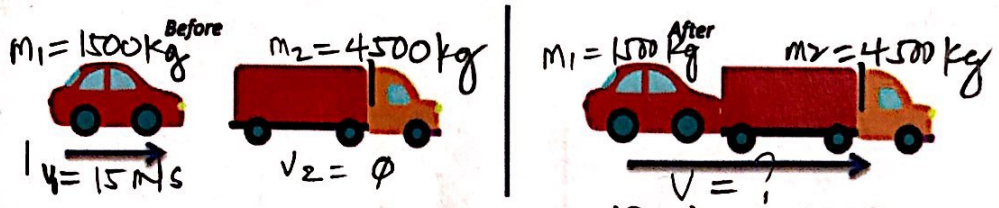
Inelastic

6) A 1,500 kg car traveling at 15.0 m/s to the east collides with a 4,500 kg truck that is initially at rest at a stoplight. The car and the truck stick together and move together after the collision. What is the final velocity of the two vehicle mass?



$(m_1)(v_1) + (m_2)(v_2) = (m_1)(v_1) + (m_2)(v_2)$

$(1500)(15) + (4500)(0) = (1500)(v_f) + (4500)(v_f)$

$22{,}500 + 0 = 1500v + 4500v$

$\frac{22{,}500}{6000} = \frac{6000v}{6000}$

$3.75 m/s = v$

50%

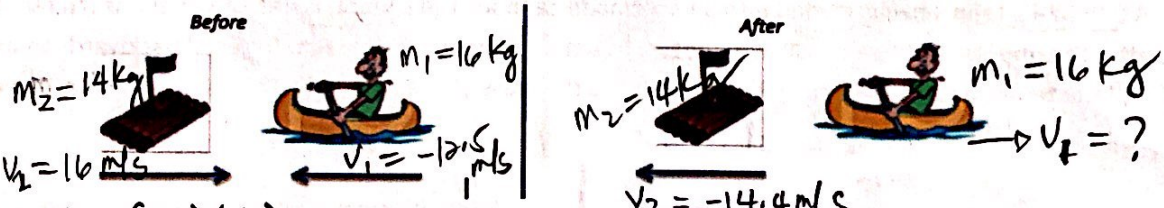
$p = 6000(3.75)$

P_{before} = 22,500 kg.m/s

P_{after} = 22,500 kg.m/s

Elastic

7) A 16.0 kg canoe moving to the left at -12.5 m/s makes an elastic head on collision with a 14.0 raft moving to the right at 16.0 m/s. After the collision the raft moves to the left at -14.4 m/s. Assuming water simulates a frictionless surface, what is the velocity of the canoe after the collision?



$(m_1)(v_1) + (m_2)(v_2) = (m_1)(v_1) + (m_2)(v_2)$

$(16)(-12.5) + (14)(16) = (16)(v_1) + (14)(-14.4)$

$-200 + 224 = 16v_1 + (-201.6)$

$24 + 201.6 = 16v_1$

$\frac{225.6}{16} = \frac{16v_1}{16}$

$14.1 m/s = v_2$

$16(14.1) + (-201.6)$

P_{before} = 24 kg.m/s

P_{after} = 24 kg.m/s