Worksheet- Momentum - Impulse & Momentum 1 Name: Key

1. If an object is not moving, what is its momentum?

0 !

2. A football punter accelerates a 0.55 kg football from rest to a speed of 28 m/s. The time his foot is in contact wi the ball is 0.25 seconds. What force does the punter exert on the ball?

$\Delta p = p_f - p_i$

$p_i = (0.55kg)(0) = 0$

$p_f = (0.55kg)(28) = 15.4 \frac{kg \cdot m}{s}$

$15.4 \frac{kg \cdot m}{s} = F \cdot 0.25$

$F = 61.6N$

3. A tennis ball may leave the racket of a top player on the serve with a speed of 65 m/s (consider the ball at rest before it hits the racket.) If the ball's mass is 0.02 kg and it is in contact with the racket for 0.03 seconds, what is t average force on the ball? $\Delta p = p_f - p_i$

$p_i = 0 \frac{kg \cdot m}{s}$

$p_f = (0.02kg)(65\frac{m}{s}) = 1.3 \frac{kg \cdot m}{s}$

$1.3 \frac{kg \cdot m}{s} = F \cdot t$

$1.3 \frac{kg \cdot m}{s} = F(0.03)$

$F = 43.3N$

4. A freight train moves due north with a speed of 8 m/s. The mass of the train is 6×10^6 kg. How fast would a 150 kg automobile have to be moving due north to have the same momentum as the train?

$p_T = (6 \times 10^6 kg)(\frac{8m}{s}) = 48000000 \frac{kg \cdot m}{s} = (1500kg)(v_c)$

$v_c = 32000 \frac{m}{s}$

5. Two men pushing a stalled car generate a net force of 840 N for 5 seconds. What is the final momentum of the car? $\Delta p = F \cdot t$

$p_i = 0 \quad p_f = ?$

$p_f = (840N)(5s) = 4200 \frac{kg \cdot m}{s}$

6. A woman, driving a golf ball off a tee gives the ball a speed of 38 m/s. The mass of the ball is 0.045 kg, and the duration of the impact with the golf club is 6×10^{-3} seconds.

a. What is the change in momentum of the ball?

$\Delta p = p_f - p_i \quad p_i = 0$

$p_f = (0.045kg)(38\frac{m}{s}) = 1.71 \frac{kg \cdot m}{s}$

b. Determine the force applied by the club.

$\Delta p = Ft$

$1.71 \frac{kg \cdot m}{s} = F \cdot 0.006s$

$F = 285N$

7. A 0.145 kg baseball pitched at 35 m/s is hit on a horizontal line drive straight back toward the pitcher at 50 m/s. the contact time between the bat and ball is 5×10^{-3} seconds, calculate the force between the ball and bat during contact.

$p_i = (-35\frac{m}{s})(0.145kg) = -5.075 \frac{kg \cdot m}{s}$

$p_f = (50\frac{m}{s})(0.145kg) = 7.25 \frac{kg \cdot m}{s}$

$\Delta p = p_f - p_i = 7.25 - -5.075 = 12.325 \frac{kg \cdot m}{s} = F \cdot (5 \times 10^{-3}s)$

$F = 2465N$

Worksheet- Momentum - Impulse & Momentum 1 Name:

8. A car with a mass of 1000 kg moves at 20 m/s. What average braking force is needed to bring the car to a halt in 10 seconds? $p_i = (1000\ kg)(20\ m/s) = 20{,}000\ kg\cdot m/s$ $p_f = 0$

$\Delta p = -20{,}000\ kg\cdot m/s = F \cdot 10$ $\boxed{F = -2000\ N}$

9. A 1500 kg car moving at 30 m/s slams into a building and comes to a halt. Consider questions A and B below. Which question can be answered using the given information and which can not? Explain

A. How much impulse acts on the car?

$I = \Delta p = p_f - p_i$ $p_i = (1500\ kg)(30\ m/s)$ $\boxed{p_i = 45{,}000\ kg\cdot m/s}$ $\Delta p = I = -45000\ kg\cdot m/s$

B. How much force acts on the car?

Can't answer - no time

10. An 8 kg bowling ball moving at 2 m/s bounces off a spring at 2 m/s, but it is now traveling in the opposite direction. $2\ m/s \rightarrow$ $\leftarrow -2\ m/s$

$\boxed{\Delta p = 16 - -16 = 32\ kg\cdot m/s}$

a. What is the change in momentum?

$\Delta p = p_f - p_i$ $p_f = 8kg \cdot (2\ m/s) = 16\ kg\cdot m/s$

$p_i = 8kg \cdot (-2\ m/s) = -16\ kg\cdot m/s$

b. If the interaction with the spring lasts 0.5 seconds, calculate the average force the spring exerts on it.

$\Delta p = 32\ kg\cdot m/s = F \cdot (0.5s)$

$\boxed{F = 64\ N}$

11. A 90 kg fullback is running at 5 m/s and is stopped by a tackler. The tackle lasts for 0.5 second.

a. What is the original momentum of the fullback?

$p_i = (90kg)(5\ m/s) = 450\ kg\cdot m/s$

b. What is the impulse imparted on the fullback?

$I = \Delta p = -450\ kg\cdot m/s$ $\Delta p = p_f - p_i$ (0, 450)

c. What is the force exerted on the fullback?

$-450 kg\cdot m/s = F \cdot t$ $-450\ kg\cdot m/s = F \cdot 0.5$ $\boxed{F = -900\ N}$

d. What is the force exerted on the *tackler*?

Equal and opposite -

$\boxed{900\ N}$

Worksheet- Momentum - Impulse & Momentum 1 Name:

12. Alter the following statements so that they are true statements.

a. Impulse is equal to momentum.

The change in

b. The units for impulse are ~~Newton's per second.~~

$\frac{kg \cdot m}{s}$

c. Momentum is the product of mass times ~~speed.~~

velocity

13. A 0.5 kg football is thrown with a velocity of 15 m/s to the right. A stationary receiver catches the ball and br it to rest in 0.02 seconds. What is the force exerted on the receiver?

$p_i = (0.5kg)(15\frac{m}{s}) = 7.5\frac{kg \cdot m}{s}$

$p_f = 0$ $\quad \Delta p = F \cdot t$ $\quad$ **F = -375N**

$\Delta p = -7.5\frac{kg \cdot m}{s}$ $\quad -7.5\frac{kg \cdot m}{s} = F \cdot (0.02s)$

14. A 0.40 kg soccer ball approaches a player horizontally with a velocity of 18 m/s to the north. The player strik the ball and causes it to move in the **opposite** direction with a velocity of 22 m/s.

a. What is the change in velocity of the ball? (careful!) $-18\frac{m}{s} \rightarrow$ $\leftarrow 22\frac{m}{s}$

$\Delta v = v_f - v_i$

$22 - -18 =$ **$40\frac{m}{s}$**

b. What impulse was delivered to the ball by the player?

$I = \Delta p =$ $p_i = (-18\frac{m}{s})(0.4kg) = -7.2\frac{kg \cdot m}{s}$

$p_f = (22\frac{m}{s})(0.4kg) = 8.8$

$\Delta p = 8.8 - -7.2 =$ **$16\frac{kg \cdot m}{s}$**

15. A 3.0 N force to the right acts on a 0.5 kg object at rest during a time interval of 1.5 seconds.

a. What is the velocity of the object at the end of this interval? $p_i = 0\frac{kg \cdot m}{s}$

$\Delta p = F \cdot t$ $\quad (3N)(1.5s) = 4.5\frac{kg \cdot m}{s} = p_f - p_i$ $\quad 4.5\frac{kg \cdot m}{s} = m \cdot v$

$4.5\frac{kg \cdot m}{s} = (0.5kg)(v$

$v = 9\frac{m}{s}$

b. **At the end of this interval**, a new constant force of 2.0 N **to the left** is applied for 1.5 sec. What is the velocit at the end of the 1.5 sec? neg.

$p_i = 4.5\frac{kg \cdot m}{s}$ $\quad p_f = ?$

$\Delta p = F \cdot t$ $\quad -2N \cdot 1.5 = -3\frac{kg \cdot m}{s}$ $\quad \Delta p = p_f - p_i$ $\quad -3 = p_f - 4.5\frac{kg \cdot m}{s}$

$p_f = 1.5\frac{kg \cdot m}{s} = m \cdot v$ $\quad 1.5\frac{kg \cdot m}{s} = 0.5 \cdot v$ $\quad$ **$v = 3\frac{m}{s}$**

16. A 2250 kg car traveling to the west slows down uniformly from 20.0 m/s to the west to a stop. The force on car is 8450 N to the east. How much time does it take for the car to stop?

$\Delta p = p_f - p_i$

$p_i = (2250kg)(20\frac{m}{s}) = 45000\frac{kg \cdot m}{s}$

$p_f = 0$

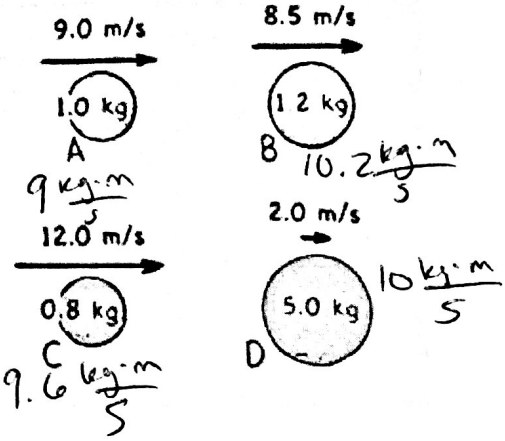
$\Delta p = -45000\frac{kg \cdot m}{s} = F \cdot t$

$-45000\frac{kg \cdot m}{s} = -8450N \cdot t$

$t = 5.33s$

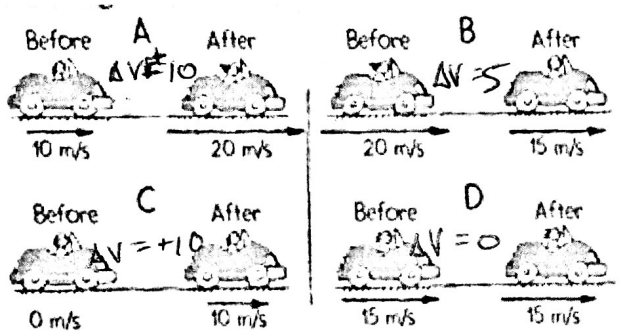
Worksheet- Momentum - Impulse & Momentum 1 Name:

17. Rank the following from greatest momentum to least momentum:



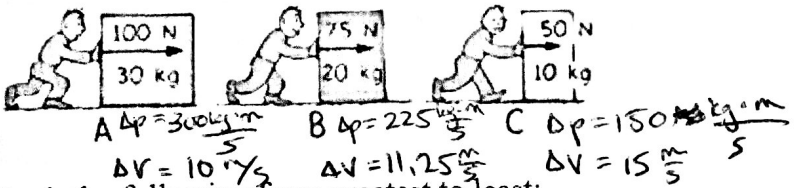
B, D, C, A

18. Rank the following from greatest change in momentum to least change in momentum:



A+C, B, D

19. Rick pushes crates starting at rest across a floor for 3 seconds with a net force as shown:



Rank the following from greatest to least:

Change in Momentum:

A, B, C

Final Speed:

C, B, A

Momentum after 3 seconds:

A, B, C

Worksheet- Momentum - Impulse & Momentum 1

Name:

1. An ostrich with a mass of 146 kg is running with a velocity of 17 m/s south. Find its momentum.

$p = mv$

$= 146\text{kg} \cdot 17\frac{\text{m}}{\text{s}} = \boxed{2482\ \frac{\text{kg}\cdot\text{m}}{\text{s}}}$

2. A 21 kg child is riding a 5.9 kg bike with a velocity of 4.5 m/s to the east.

A) What is the momentum of the child?

$p_c = (21\text{kg})(4.5\frac{\text{m}}{\text{s}}) = \boxed{94.5\ \frac{\text{kg}\cdot\text{m}}{\text{s}}}$

B) What is the momentum of the bike?

$p_b = (5.9\text{kg})(4.5\frac{\text{m}}{\text{s}}) = \boxed{26.55\ \frac{\text{kg}\cdot\text{m}}{\text{s}}}$

C) What is the total momentum of the child and bike together?

$p_T = (21 + 5.9)(4.5) = \boxed{121.05\ \frac{\text{kg}\cdot\text{m}}{\text{s}}}$

3. What velocity must a car with a mass of 1210 kg have in order to have the same momentum as a pickup truck with a mass of 2250 kg and a velocity of 25 m/s?

$p_c = p_T$

$(1210\text{kg})(v) = (2250\text{kg})(25\frac{\text{m}}{\text{s}})$

$1210\text{kg}\cdot v = 56250\ \frac{\text{kg}\cdot\text{m}}{\text{s}}$

$\boxed{v = 46.5\frac{\text{m}}{\text{s}}}$

4. A 2500 kg car traveling to the north is slowed down uniformly from an initial velocity of 20.0 m/s by a 6250 N braking force. neg.

A) What is the change in velocity of the car in the first 2.5 seconds?

$\Delta p = -6250\text{N} \cdot 2.5\text{s} = -15625\ \frac{\text{kg}\cdot\text{m}}{\text{s}} = p_f - p_i$

$p_i = 2500\text{kg} \cdot 20\frac{\text{m}}{\text{s}} = 50000\ \frac{\text{kg}\cdot\text{m}}{\text{s}}$

$-15625 = p_f - 50000$

$p_f = 34375\ \frac{\text{kg}\cdot\text{m}}{\text{s}} = m v$ (2500kg)

$\boxed{v_f = 13.75\frac{\text{m}}{\text{s}}}$

$\Delta v = 13.75 - 20 = -6.25\frac{\text{m}}{\text{s}}$

B) What is the car's velocity after 2.5 seconds?

C) How far does the car move during this 2.5 seconds?

tricky!

$v_f = v_i + at$

$13.75 = 20 + a(2.5)$

$a = -2.5\frac{\text{m}}{\text{s}^2}$

$d = v_i t + \frac{1}{2}at^2$

$= (20)(2.5) + \frac{1}{2}(-2.5)(2.5)^2$

$\boxed{d = 42.19\text{m}}$

D) How long does it take the car to come to a complete stop?

$p_f = 0\ \frac{\text{kg}\cdot\text{m}}{\text{s}}$ $\Delta p = p_f - p_i = -50000\ \frac{\text{kg}\cdot\text{m}}{\text{s}} = F \cdot t$

$-50000\ \frac{\text{kg}\cdot\text{m}}{\text{s}} = -6250\text{N} \cdot t$

$\boxed{t = 8\text{s}}$

5. If a boxer is able to make the impact time five times longer by "rolling" with the punch, by how much will the f of impact be reduced?

$\frac{F}{5}$

Worksheet- Momentum - Impulse & Momentum 1 Name:

6. When a dish falls, will the impulse be less if it lands on a carpet or if it lands on a hard floor? Explain.

Δp is the same, so I is the same

In which case is there a larger time of impact? Explain.

t is longer for carpet, in contact longer

In which case is there a larger force? Explain.

F is larger for floor, b/c t is smaller

In which case is there a larger change in momentum? Explain.

Same for both

7. Suppose the time of impact on an object is doubled and the force is unchanged.

A) What happens to the impulse? (Be more specific than increases or decreases.)

increases by x 2 (F · 2t)

B) What happens to the change in momentum? (Be specific.)

increases by x2 (F · 2t)

8. Write the exaggerated Impulse Equation (Ft = mΔv) for the following situations:

A) driving into a haystack vs. hitting a brick wall

F↓, t↑ F↑, t↓

B) a superball that bounces vs. a wad of clay that splats on a floor

Δv↑, Δv↓

9. A 0.5 kg **ball** at rest is set into motion with a force lasting for 0.01 sec, creating a speed 10 m/s.
A 0.5 kg **box** at rest is set into motion with a force lasting for 0.01 sec, creating a speed 5 m/s.

A) Which has a larger change in momentum? (ball) or box or neither

B) Which has a larger impulse? (ball) or box or neither

C) Which has a larger time of impact? ball or box or (neither)

D) Which has a larger force of impact? (ball) or box or neither

10. A 1500 kg **car** traveling at 20 m/s collides with a pole and comes to rest in 0.5 seconds.
A 1500 kg **boat** traveling at 20 m/s collides with the sandy shore and comes to rest in 1.0 sec.

A) Which has a larger change in momentum? car or boat or (neither)

B) Which has a larger impulse? car or boat or (neither)

C) Which has a larger time of impact? car or (boat) or neither

D) Which has a larger force of impact? (car) or boat or neither

Worksheet- Momentum - Impulse & Momentum 1 Name:

no stick

1. A 16 kg canoe moving to the right at 12 m/s makes an elastic head on collision with a 4 kg raft moving to the left 6 m/s. After the collision, the raft moves to the right at 22.7 m/s. Find the velocity of the canoe after the collision.

$P_{ic} = (16kg)(12\frac{m}{s}) = 192\frac{kg\cdot m}{s}$ $\quad \Sigma P_i = \Sigma P_f$ $\quad P_{fc} = (4kg)(22.7\frac{m}{s}) = 90.8\frac{kg\cdot m}{s}$

$P_{ir} = (4kg)(-6\frac{m}{s}) = -24\frac{kg\cdot m}{s}$ $\quad 192\frac{kg\cdot m}{s} + -24\frac{kg\cdot m}{s} = 90.89\frac{kg\cdot m}{s} + P_{fc}$

$P_{fc} = 77.11 = (16kg)v$ $\quad v = 4.82\frac{m}{s}$

2. A 4 kg bowling ball sliding to the right at 8 m/s has an elastic head on collision with another 4 kg bowling ball initially at rest. The first ball stops after the collision. Find the velocity of the second ball after the collision.

$P_{i1} = (4kg)(8m/s) = 32\frac{kg\cdot m}{s}$ $\quad P_{f2} = 0$ $\quad \Sigma P_i = \Sigma P_f$ $\quad P_{f2} = 32\frac{kg\cdot m}{s} = m\cdot v$

$P_{i2} = 0\frac{kg\cdot m}{s}$ $\quad 32\frac{kg\cdot m}{s} + 0 = P_{f2} + 0$ $\quad 32\frac{kg\cdot m}{s} = (4kg)(v)$

$v = 8\frac{m}{s}$

3. A 1500 kg car traveling at 15 m/s to the south collides with a 4500 kg truck that is initially at rest at a stoplight. The car and truck stick together. What is the final velocity of the two entangled vehicles?

$P_{iL} = 1500kg\cdot 15m/s = 22500\frac{kg\cdot m}{s}$ $\quad \Sigma P_i = \Sigma P_f$ $\quad m_2 = (4500+1500) = 6000$

$P_{it} = 0\frac{kg\cdot m}{s}$ $\quad 22500 + 0 = P_f$ $\quad 22500 = 6000\cdot v$

$P_f = 22500 = m\cdot v$ $\quad v = 3.75\frac{m}{s}$

4. A grocery shopper tosses a 9 kg bag of rice into a stationary 18 kg grocery cart. The bag hits the cart with a horizontal speed of 5.5 m/s toward the front of the cart. What is the final speed of the cart and bag?

$P_i = (9kg)(5.5\frac{m}{s}) = 49.5\frac{kg\cdot m}{s}$ $\quad 49.5 = 27v$

$P_f = P_i$ $\quad P_f = 49.5\frac{kg\cdot m}{s} = (9+18)v$ $\quad v = 1.83\frac{m}{s}$

5. A 1.5×10^4 kg railroad car moving at 7 m/s to the north collides with and sticks to another railroad car of the same mass that is moving in the same direction at 1.5 m/s. What is the velocity of the joined cars after the collision?

$P_i = (1.5\times10^4 kg)(7\frac{m}{s}) + (1.5\times10^4 kg)(1.5\frac{m}{s}) = 127{,}500\frac{kg\cdot m}{s}$

$P_f = 127{,}500\frac{kg\cdot m}{s} = (1.5\times10^4 + 1.5\times10^4)v$ $\quad v = 4.25\frac{m}{s}$

6. A dry cleaner throws a 22 kg bag of laundry onto a stationary 9 kg cart. The cart and laundry bag begin moving at 3 m/s to the right. Find the velocity of the laundry bag before the collision.

$P_i = P_f$ $\quad P_i = 0\frac{kg\cdot m}{s} + (22kg)(v)$ $\quad v = 4.23\frac{m}{s}$

$P_f = (9+22)(3\frac{m}{s}) = 93\frac{kg\cdot m}{s}$ $\quad 93\frac{kg\cdot m}{s} = 22kg\cdot v$

7. A 47.4 kg student runs down the sidewalk and jumps with a horizontal speed of 4.0 m/s onto a stationary skateboard. The student and skateboard move down the sidewalk with a speed of 3.95 m/s. What is the mass of the skateboard? $P_i = (47.4kg)(4\frac{m}{s}) + 0 = 189.6\frac{kg\cdot m}{s}$ $\quad 48 = 47.4 + m_{SB}$

$P_f = P_i$; $\quad P_f = 189.6\frac{kg\cdot m}{s} = (47.4kg + m_{SB})(3.95\frac{m}{s})$ $\quad m_{SB} = 0.6kg$

8. Suppose carts on air track have the same mass. They move toward each other at the same speed and stick together when they collide (called a perfectly inelastic collision.) Describe the motion after the collision.

no motion -

momentums cancel out

Worksheet- Momentum - Impulse & Momentum 1 Name:

9. Suppose one glider is at rest and is loaded so that it has three times the mass of the moving glider. Again, the gliders stick together when they collide (called a perfectly inelastic collision.) Describe the motion after the collisi

$p_i = mv_i + 0 = mv_i$ $mv_i = 4m v_f$ They will be moving

$p_f = p_i$; $p_f = mv_i = 4m \cdot v_f$ $v_f = \frac{v_i}{4}$ at one fourth the original speed.

10. In terms of momentum conservation, why does a gun "kick" when fired?

The initial momentum is zero (gun + bullet @ rest) so the final momentum must also sum to zero. If the bullet has forward momentum, the gun must have backwards momentum.

11. Imagine that you are hovering next to the space shuttle in an earth-orbit and your buddy of equal mass who is moving at 4 km/h with respect to the ship bumps into you. If he holds onto you, how fast do you both move with respect to the ship? $p_i = m \cdot 4\frac{km}{hr}$ $p_f = 2m \cdot v_f$ $p_i = p_f$

$m \cdot 4\frac{km}{hr} = 2m \cdot v_f$ $\boxed{v_f = 2\frac{km}{hr}}$

12. Comic strip hero Superman meets an asteroid in outer space and hurls it at 100 m/s. The asteroid is 1000 time more massive than Superman is. In the comic strip, Superman is seen at rest after the throw. Taking physics into account, what would be his recoil speed? (Assume that before the throw, Superman and the asteroid are both at rest.) $p_i = 0$ $p_f = (1000m)(100\frac{m}{s}) + mv_{sm}$ $p_f = p_i$

$0 = 1000m(100) + mv_{sm}$

$-100000m = v_{sm} \cdot m$ $\boxed{v_{sm} = -100000}$

13. A 4000 kg truck traveling at 10 m/s collides with a 1000 kg car that is at rest. Answer the following questions concerning the collision. (Circle all that apply. Consider only the magnitude of the values, ignore the fact that son are negative numbers.)

equal + opposite

A) Which experiences a larger force? truck or car or (neither)

B) Which experiences a larger impulse? truck or car or (neither)

C) Which experiences a larger change in momentum? truck or car or (neither)

D) Which experiences a larger change in velocity? (truck) or (car) or neither

14. A 1000 kg car increases speed from 5 m/s to 10 m/s over the course of one second. Separately, a 3000 kg truck increases speed from 5 m/s to 10 m/s over the course of one second

A) Which experiences a larger force? car or (truck) or neither

B) Which experiences a larger impulse? car or (truck) or neither

C) Which experiences a larger change in momentum? car or (truck) or neither

D) Which experiences a larger change in velocity? car or truck or (neither)

Worksheet- Momentum - Impulse & Momentum 1 Name:

BEFORE COLLISION / EXPLOSION: **AFTER** COLLISION / EXPLOSION:

1. Two pool balls have identical mass and collide elastically.

v = 3 m/s v = 0 v = 0 v = $3\frac{m}{s}$

$P_i = (m)(3\frac{m}{s}) + 0$

$P_i = 3m = P_f$

$P_f = 3m = 0 + mv$

$3m = mv$

$v = 3$

2. A coasting car collides with another identical car that is parked. Assume the car's bumpers lock together during the collision.

v = 20 m/s v = 0 m/s v = $10\frac{m}{s}$ v = $10\frac{m}{s}$

$P_i = (20\frac{m}{s})(m) + 0$

$P_i = 20m = P_f$

$P_f = 20m = (2m)(v)$

$20 = 2v$

$v = 10\frac{m}{s}$

3. A Segway (100 kg) collides elastically with a golf cart (500 kg).

v = 4 m/s v = -4 m/s v = $-11\frac{m}{s}$ v = -1 m/s

$P_i = (4m/s)(100kg) + (500kg)(-4\frac{m}{s})$

$= -1600\frac{kg \cdot m}{s} = P_f$

$P_f = -1600kg \cdot \frac{m}{s} = (500kg)(-1\frac{m}{s}) + (100kg)$

$-1600kg \cdot \frac{m}{s} = -500\frac{kg \cdot m}{s} + 100v$

$-1100 = 100 \cdot v$

$v = -11\frac{m}{s}$

What is the change in momentum for the Segway?

$P_f = (100)(-11)$ $-1100 - 400 =$

$P_i = (100)(4)$ $\Delta P = -1500\frac{kg \cdot m}{s}$

What is the change in momentum for the golf cart?

$\Delta P = 1500\frac{kg \cdot m}{s}$

Name _____ Date _____ Period _____

Worksheet: Conservation of Momentum

CHAPTER 8: Momentum

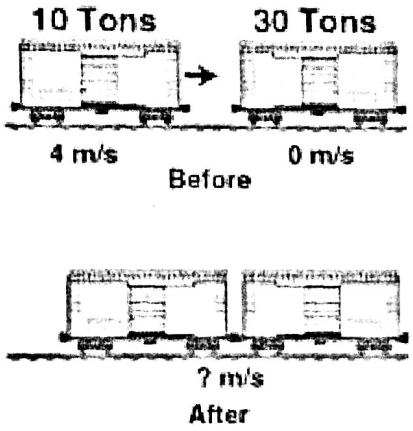
Directions: Answer the following questions concerning the conservation of momentum using the equations below. Show all of you work to receive credit.

$$p = mv \qquad Ft = \Delta(mv) \qquad impulse = F\Delta t$$

$$p_{before} = p_{after} \qquad \textbf{net momentum}_{\textbf{before}} = \textbf{net momentum}_{\textbf{after}}$$

$$(m_1v_1 + m_2v_2)_{before} = (m_1v_1 + m_2v_2)_{after}$$

1. When these two freight cars of different mass collide and couple, what will be their resultant velocity?



$p_i = (10\text{ tons})(4\frac{m}{s}) + 0 = 40 = p_f$

$p_f = (10 + 30\text{ tons})(v) = 40\text{ tons}\cdot\frac{m}{s}$

$40\text{ tons}\cdot v = 40\text{ tons}\cdot\frac{m}{s}$

$\boxed{v = 1\frac{m}{s}}$

2. A 2 kg blob of putty moving at 4 m/s slams into a 6 kg blob of putty at rest. What is the speed of the two stuck-together blobs immediately after colliding?

$p_i = (2\text{kg})(4\frac{m}{s}) + 0 = 8\frac{kg\cdot m}{s} = p_f$

$p_f = 8\frac{kg\cdot m}{s} = (2+6)v$

$8\frac{kg\cdot m}{s} = 8\cdot v$

$\boxed{v = 1\frac{m}{s}}$

3. A football player runs at 8 m/s and plows into a 80 kg referee standing on the field causing the referee to fly forward at 5.0 m/s. If this were a perfectly elastic collision, what would the mass of football player be?

$v_r = 0$

$p_i = m\cdot 8\frac{m}{s} = 8m = p_f$

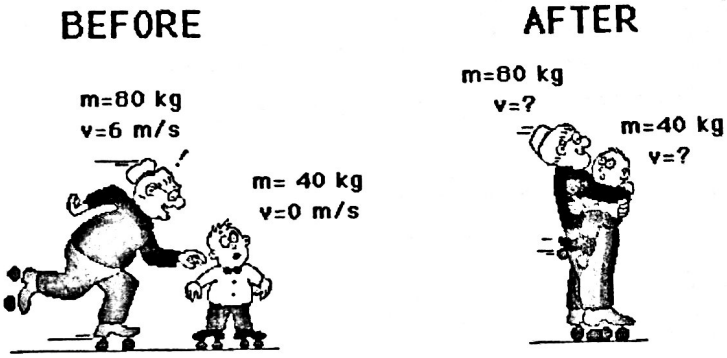
$p_f = 8m = (80\text{ kg})(5\frac{m}{s}) + 0$

$8m = 80\text{ kg}\cdot 5\frac{m}{s}$

$8m = 400$

$\boxed{m = 50\text{ kg}}$

4. Assuming that this is a perfect inelastic collision, calculate the velocity after the collision in the example below.



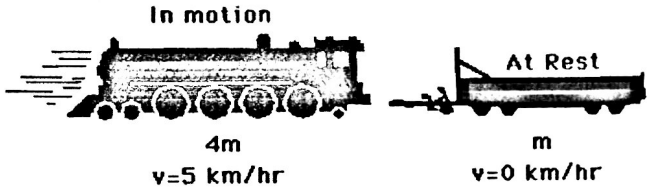
$P_i = (80\text{ kg})(6\frac{m}{s}) + 0 = 480\frac{kg\cdot m}{s} = P_f$

$P_f = 480\frac{kg\cdot m}{s} = (80+40)v$

$480 = 120v$

$v = 4\text{ m/s}$

5. A large locomotive with a mass 4 times that of the smaller motionless railroad car collides and couples together. What is their combined speed after the collision?

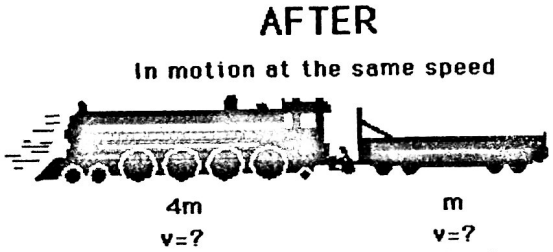


$P_i = (4m)(5\frac{km}{hr}) = 20m = P_f$

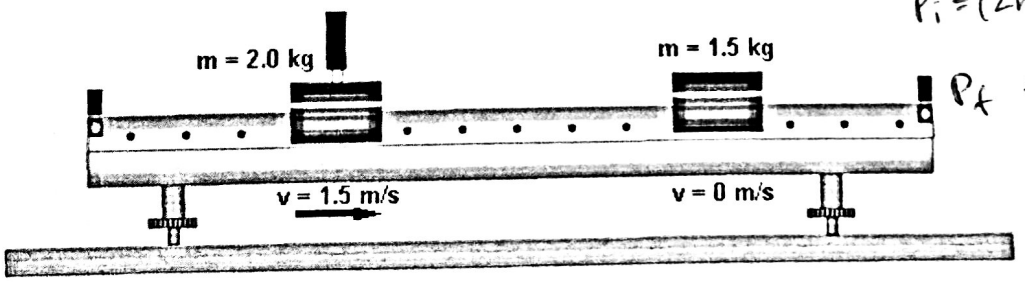
$P_f = 20m = 5m \cdot v$

$20 = 5v$

$v = 4\frac{km}{hr}$



6. A 2.0 kg mass is moving on a frictionless airtrack. It collides into a motionless 1.5 kg mass. What is the the combined speed of the two masses if they stick together on impact?



$P_i = (2kg)(1.5\frac{m}{s}) = 3\frac{kg\cdot m}{s} = P_f$

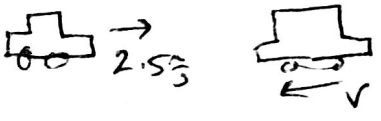
$P_f = 3\frac{kg\cdot m}{s} = (2+1.5)v$

$3\frac{kg\cdot m}{s} = 3.5v$

$v = 0.86\frac{m}{s}$

7. A 1000 kg car is rolling down the street at 2.5 m/s. How fast would a 2500 kg car have to collide into it in order to bring it to rest (0 m/s)?

$P_f = 0$



$P_f = P_i = 0$

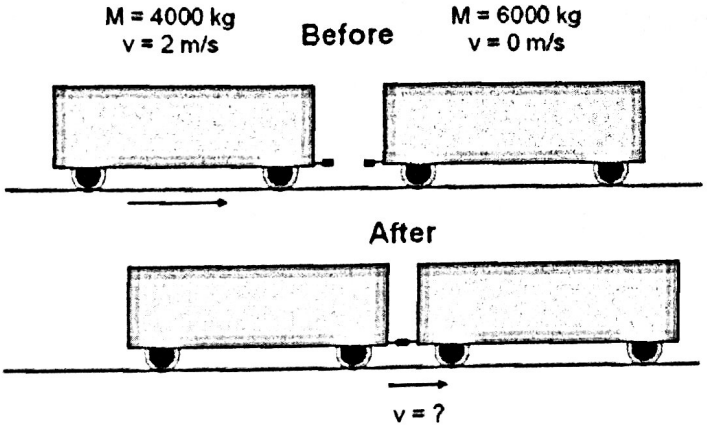
$P_i = (1000kg)(2.5\frac{m}{s}) + (2500kg)(v) = 0$

$2500\frac{kg\cdot m}{s} + 2500v = 0$

$-2500v = 2500\frac{kg\cdot m}{s}$

$v = -1\frac{m}{s}$

8. A railroad car slams into another railroad car and couples together. What is the combined speed of the railroad cars after the collision?

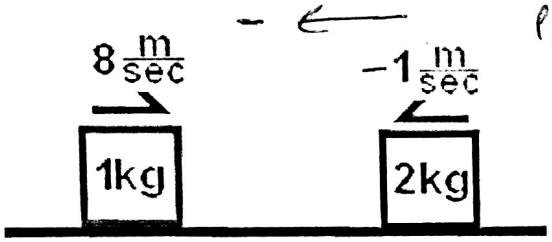


$p_i = (4000)(2\frac{m}{s}) = 8000\ \frac{kg \cdot m}{s} = p_f$

$= 8000\ \frac{kg \cdot m}{s} = (10{,}000\ kg)(v)$

$v = 0.8\ \frac{m}{s}$

9. Two blocks moving in opposite directions collide and stick together after the collision. What is their combined speed after the collision?



$p_i = (8\frac{m}{s})(1kg) + (-1\frac{m}{s})(2kg)$

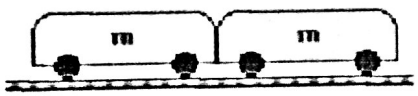
$= 8 + -2 = 6\ \frac{kg \cdot m}{s} = p_f$

$p_f = 6\ \frac{kg \cdot m}{s} = (1+2)v$

$6\ \frac{kg \cdot m}{s} = 3v$

$v = 2\ \frac{m}{s}$

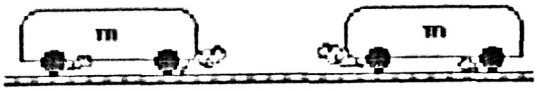
10. An explosion causes the cars to move apart from each other. According to the diagram below, what is the speed of each of the cars as they move away from each other?



Before explosion

$p_i = 0 = p_f$

p total = 0



After explosion

p to the left = 20 p to the right = 20

$p_f = -20 + 20$

p total = 0

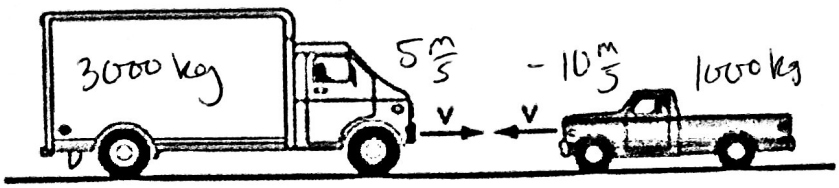
$20 = mv$

$v_1 = \frac{20}{m}\ \frac{m}{s}$

$-20 = mv$

$v_2 = \frac{-20}{m}$

11. A 3000-kg truck moving rightward with a speed of 5 km/hr collides head-on with a 1000-kg car moving leftward with a speed of 10 km/hr. The two vehicles *stick together* and move with the same velocity after the collision. Determine the post-collision speed of the car and truck.



$p_i = (3000kg)(5\frac{m}{s}) + (1000kg)(-10\frac{m}{s})$

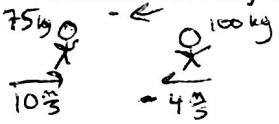
$= 15000 + -10000$

$p_i = 5000 = p_f$

$p_f = 5000\ \frac{kg \cdot m}{s} = (4000\ kg)(v)$

$v = 1.25\ \frac{m}{s}$

12. During a goal-line stand, a 75-kg fullback moving eastward with a speed of 10 m/s collides head-on with a 100-kg lineman moving westward with a speed of 4 m/s. The two players collide and *stick together*, moving at the same velocity after the collision. Determine the the post-collision velocity of the two players.



$p_i = (75\,kg)(10\,\frac{m}{s}) + (100\,kg)(-4\,\frac{m}{s})$

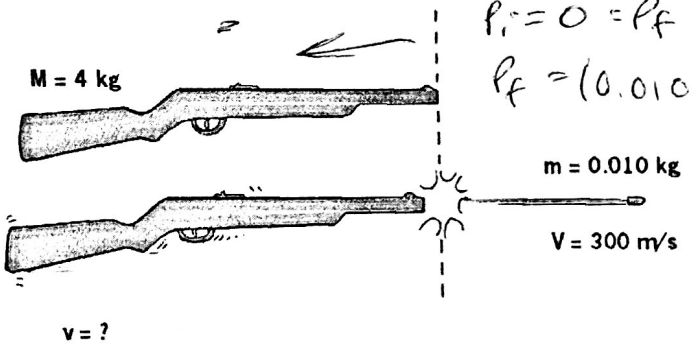
$= 750\,\frac{kg\cdot m}{s} + -400\,\frac{kg\cdot m}{s}$

$p_i = 350\,\frac{kg\cdot m}{s} = p_f$

$p_f = 350\,\frac{kg\cdot m}{s} = (75+100)\,v$

$\boxed{v = 2\,\frac{m}{s}}$

13. Calculate the velocity of the rifles recoil after firing.



$p_i = 0 = p_f$

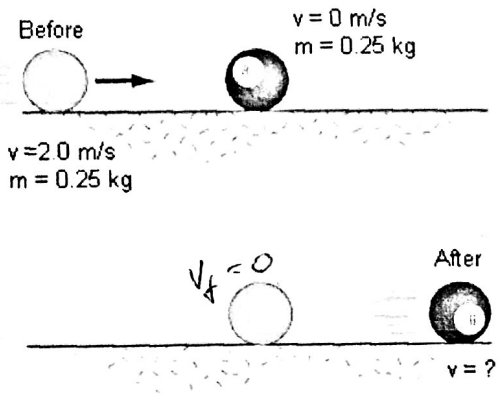
$p_f = (0.010\,kg)(300\,\frac{m}{s}) + (4\,kg)(v)$

$3\,kg\cdot\frac{m}{s} + 4v = 0$

$4v = -3\,kg\cdot\frac{m}{s}$

$\boxed{v = 0.75\,\frac{m}{s}}$

14. What is the velocity of the "8" ball after the elastic collision below?

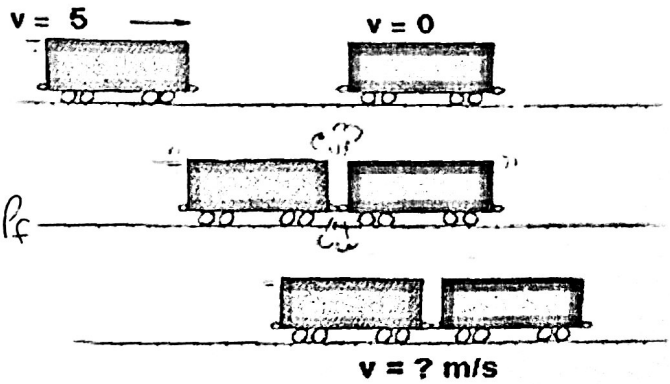


$p_i = (0.25\,kg)(2\,\frac{m}{s}) + 0 = 0.5\,\frac{kg\cdot m}{s} = p_f$

$p_f = 0.5\,\frac{kg\cdot m}{s} = (0.25\,kg)\cdot v$

$\boxed{v_f = 2\,\frac{m}{s}}$

15. A 6000 kg railroad car moving at 5 m/s collides into a stationary car with a mass of 4000 kg. If they couple together after the collision, what will be their combined velocity immediately after impact?



$p_i = (6000\,kg)(5\,\frac{m}{s}) + 0 = 30{,}000\,\frac{kg\cdot m}{s} = p_f$

$p_f = 30{,}000\,\frac{kg\cdot m}{s} = (6000\,kg + 4000\,kg)\cdot v$

$30{,}000\,\frac{kg\cdot m}{s} = 10000\,kg\cdot v$

$\boxed{v = 3\,\frac{m}{s}}$