

Unit IX: Worksheet 2

1. Kim holds a 2.0 kg air rifle loosely and fires a bullet of mass 1.0 g. The muzzle velocity of the bullet is 150 m/s. What is the recoil speed of the rifle?

$$(2.0 \text{ kg})(0) + (0.001 \text{ kg})(150) = (2.0 \text{ kg})(v) + (0.001)(150)$$

$$-2.0 \text{ kg}(v) = 0.15$$

$$v = 0.075 \text{ m/s}$$

2. If the girl in the previous question holds the rifle tightly against her body, the recoil speed is less. Explain. Calculate the new recoil speed assuming the girl has a mass of 48 kg.

more mass

$$-(50 \text{ kg})(v) = (0.001)(150)$$

$$= 0.003 \text{ m/s}$$

3. In a freight yard a train is being put together from freight cars. An empty freight car, coasting at 10 m/s, strikes a loaded car that is stationary, and the cars couple together. Each of the cars has a mass of 3000 kg when empty, and the loaded car contains 12,000 kg of canned soda (a year's supply for the Physics class). With what speed does the combination of the two cars start to move?

$$(3000 \text{ kg})(10 \text{ m/s}) + (15,000 \text{ kg})(0 \text{ m/s}) = (18,000)(x)$$

$$30,000 \text{ kg m/s} = 18,000 x$$

$$x = 1.7 \text{ m/s}$$

4. An astronaut whose mass is 80. kg carries an empty oxygen tank with a mass of 10. kg. He throws the tank away from himself with a speed of 2.0 m/s. With what velocity does he start to move off into space?

$$(80 \text{ kg} + 10 \text{ kg})(0) = (10 \text{ kg})(2.0 \text{ m/s}) + (80 \text{ kg})(x)$$

$$-20 \text{ kg m/s} = (80 \text{ kg})(x)$$

$$-0.25 \text{ m/s}$$

5. A tennis player returns a 30. m/s serve straight back at 25. m/s, after making contact with the ball for 0.50 s. If the ball has a mass of 0.20 kg, what is the force she exerted on the ball?

$$m \Delta v = F \cdot t$$

$$(-25 \text{ m/s} - 30 \text{ m/s})(0.20 \text{ kg}) = F(0.50 \text{ s})$$

$$-11 \text{ kg m/s} = F(0.5 \text{ s})$$

$$-22 \text{ N}$$

6. A 50. kg cart is moving across a frictionless floor at 2.0 m/s. A 70. kg boy, riding in the cart, jumps off so that he hits the floor with zero velocity.

a. What impulse did the boy give to the cart?

$$(50 \text{ kg} + 70 \text{ kg})(2.0 \text{ m/s})$$

$$Ft = m \Delta v$$

$$Ft = (70 \text{ kg})(0 - 2.0 \text{ m/s})$$

$$-140 \text{ N}\cdot\text{s}$$

b. What was the velocity of the cart after the boy jumped?

$$(50 + 70 \text{ kg})(2.0 \text{ m/s}) = (50 \text{ kg})(v) + 70(0)$$

$$(120 \text{ kg})(2.0 \text{ m/s}) = (50 \text{ kg})(v)$$

$$240 \text{ kg}\cdot\text{m/s} = 50 \text{ kg}(v)$$

$$4.8 \text{ m/s}$$

7. Two girls with masses of 50.0 kg and 70.0 kg are at rest on frictionless in-line skates. The larger girl pushes the smaller girl so that the latter rolls away at a speed of 10.0 m/s. What is the effect of the action on the larger girl? What is the impulse that each girl exerts on the other?

$$(50 \text{ kg})(10 \text{ m/s}) + (70 \text{ kg})(v) = 0$$

$$-7.14 \text{ m/s}$$

$$Ft = 500 \text{ kg}\cdot\text{m/s}$$

8. A 2.0 kg melon is balanced on a bald man's head. His son shoots a 50.0 g arrow at it with a speed of 30.0 m/s. The arrow passes through the melon and emerges with a speed of 18.0 m/s. Find the speed of the melon as it flies off the man's head.

$$(0.05)(30 \text{ m/s}) + 0 = (0.05 \text{ kg})(18.0 \text{ m/s}) + (2.0 \text{ kg})(v)$$

$$1.5 = 0.9 + (2.0)(v)$$

$$0.6 = 2.0 v$$

$$(0.3 \text{ m/s})$$

9. Mighty Miguel has a mass of 100. kg and is running towards the end zone at 9.0 m/s. Joey Gonzales (mass of 75.0 kg), runs at 12.0 m/s towards Miguel. They collide at the 2-yard line. Does Miguel score? Explain.

$$(100 \text{ kg})(9.0 \text{ m/s}) + (75)(-12) = (175)(v)$$

$$0 \text{ m/s}$$

Unit IX: Worksheet 3

1. A ball of mass 3.0 kg, moving at 2 m/s eastward, strikes head-on a ball of mass 1.0 kg that is moving at 2 m/s westward. The balls stick together after the impact. What are the magnitude and direction of the velocity of the combined mass after the collision?

$$(3.0 \text{ kg})(2 \text{ m/s}) + (1.0)(-2.0 \text{ m/s}) = (4.0)(v)$$

$$4.0 = 4.0v$$

$$v = 1.0 \text{ m/s east}$$

2. One way of measuring the muzzle velocity of a bullet is to fire it horizontally into a massive block of wood placed on a cart. Assuming no friction, we then measure the velocity with which the wood containing the bullet and cart begin to move. In one experiment the bullet had a mass of 50. g and the wood and its cart had a mass of 10. kg. After the shot, the cart, wood, and bullet moved at a constant speed, traveling 0.80 m in 0.40 s. From this data determine the original speed of the bullet.

$$(0.05 \text{ kg} + 10.0 \text{ kg})(0.80 \text{ m} / 0.40 \text{ s}) = 0 + (0.05)v$$

$$20.05 = 0.05v$$

$$v = 401 \text{ m/s}$$

3. A raft of mass 180 kg carries two swimmers of mass 50. kg and 80. kg. The raft is initially floating at rest. The two swimmers simultaneously dive off opposite ends of the raft, each with a horizontal velocity of 3 m/s. With what velocity and in what direction does the raft start to move?

$$(180 + 50 + 80)(0) = (50 \text{ kg})(3 \text{ m/s}) + (80 \text{ kg})(-3 \text{ m/s}) + 180v$$

$$150 = 240 + 180v = 0$$

$$180v = -90 \quad v = -0.5 \text{ m/s}$$

4. Discuss the following in terms of impulse and momentum:
- Why are padded dashboards safer in automobiles?
 - Why are nylon ropes, which stretch considerably under stress, favored by mountain climbers?
 - Why is it preferred that railroad cars be loosely coupled with slack between cars?

a) More stopping time means less force needed to stop

b) same as a

c) same as a & b

5. If you throw a ball horizontally while standing on roller skates, you roll backwards. Will you roll backwards if you go through the motions of throwing the ball, but hold on to it instead? Explain your reasoning.

No, you are not exerting a force on anything
so nothing is exerting a force on you.

(air, maybe you might move a very small amount)

6. Why is it difficult for a fire-fighter to hold a hose that ejects large amounts of high-speed water?

The water is pushing back on the hose.

fire fighter with a lot of force so ~~fire fighter~~

has

7. If a Mack truck and a Geo traveling at equal speeds have a head-on collision, which vehicle will experience the greatest force of impact? - same

Which will experience the greatest change in momentum? same

Which will experience the greatest acceleration? smaller

8. A billiard ball will stop short when it collides head-on with another ball which is at rest. The ball cannot stop short, however, if the collision is not exactly head-on but is at an angle. Explain why this is so in terms of momentum.

Some of the force (momentum) are acting
in a different direction