Name_____

Date _____ Pd____

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?

Since both have no intial velocity:

$$-(m_{1f}\, v_{1f}) = m_{2f}v_{f2}$$

$$-(0.001\text{kg} * 150\text{m/s}) = (2.0\text{kg})v_{2f}$$

$$(0.150 \text{ kg m/s})/2\text{kg} = v_{2f} = -0.075 \text{ m/s}$$

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.

Since both have no intial velocity:

$$-(m_{1f}\, v_{1f}) = m_{2f}v_{f2}$$

$$-(0.001\text{kg} * 150\text{m/s}) = (50.0\text{kg})v_{2f}$$

$$(0.150 \text{ kg m/s})/50.0\text{kg} = v_{2f} = -0.003 \text{ m/s}$$

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?

$$m_1v_1 + m_2v_2 = (m_{1f} + m_{2f})v_f$$

$$3000\text{kg}(10.0\text{m/s}) + (15000\text{kg})(0.0\text{m/s}) = (18000\text{kg})(v_f)$$

$$(30000 \text{ kg m/s})/18000 \text{ kg} = v_f = 1.67\text{m/s}$$

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?

Since both have no intial velocity:

$$-(m_{1f}\, v_{1f}) = m_{2f}v_{f2}$$

$$-(10.0\text{kg} * -2.0\text{m/s}) = (80.0\text{kg})v_{2f}$$

$$(20 \text{ kg m/s})/80\text{kg} = v_{2f} = 0.25 \text{ m/s}$$

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?

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

$$F = (0.20\text{kg}*55\text{m/s})/0.50\text{s} = 22\text{N}$$

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?

$(m_1 + m_2)v = m_{1f} v_{1f} + m_{2f}v_{f2}$
$(50kg + 70kg)(2m/s) = (70kg*0m/s) + 50kg* v_{f2}$
$(240 kg m/s)/50kg = v_{f2}$
$4.8 m/s = v_{f2}$

So the cart has an impulse equal to momentum change given by:

$m\Delta v = 50kg(4.8m/s-2.0m/s) = 140 kg m/s$

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

see above

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?

Since both have no intial velocity:
$-(m_{1f} v_{1f}) = m_{2f}v_{f2}$
$-(50.0kg * -10.0m/s) = (70.0kg)v_{2f}$
$(500 kg m/s)/70kg = v_{2f} = 7.14m/s$

$F\Delta t$ = impulse = momentum = $m\Delta v$

(50.0kg * -10.0m/s) = -500 kg m/s
(70.0kg * 7.14m/s) = -500 kg m/s

According to Newton's 3rd Law the forces exerted on the each girl by the other must be equal and opposite so therefore so must the impulse.

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.

$$m_1v_1 + m_2v_2 = m_{1f} v_{1f} + m_{2f}v_{f2}$$
$$(2.0kg)(0.0 m/s) + (0.050kg)(30.0m/s) = (2.0kg)(v_{1f}) + (0.050kg)(18.0m/s)$$
$$(0.050kg)(30.0m/s-18.0m/s) = (2.0kg)(v_{1f})$$
$$+0.3 m/s = v_{1f}$$

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.

$m_1v_1 + m_2v_2 = (m_{1f} + m_{2f})v_f$
$100kg(9.0m/s) + (75.0kg)(-12.0m/s) = (175kg)(v_f)$
$(900 kg m/s + -900kg m/s)/175 kg = v_f$

$0.00 m/s = v_f$, probably would not gain the needed 2 yards.