Key

# Physics 30 Worksheet # 1: *Momentum*

1. Calculate the momentum of a $1.60 \times 10^3$ kg car traveling at 20.0 m/s.

$P = mv = (1.60 \times 10^3)(20.0) = 32000 \text{ kg m/s}$

2. Calculate the momentum of a $2.50 \times 10^3$ kg truck traveling at 110 km/h.

3. How fast is a 1.50 kg ball moving if it has a momentum of 4.50 kg.m/s?

$P = mv \quad \frac{P}{m} = v = \frac{4.50}{1.50} = 3 \text{ m/s}$

4. A 75.0 g ball is rolling at a speed of 57.0 cm/s. Calculate the ball's momentum.

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5. A 5.00 kg ball accelerates at a rate of 2.00 $m/s^2$ for 1.50 seconds. Calculate the ball's momentum after the acceleration. Assuming it starts at rest

$\Delta p = F \cdot \Delta t \quad F = ma \quad \Delta p = ma \cdot \Delta t = (5.00)(2.00)(1.50)$

$\Delta p = 15 \text{ kg m/s}$

6. A 2.00 kg rock is dropped from the top of a 30.0 m high building. Calculate the ball's momentum at the time that it strikes the ground.

7. A 1.00 kg rock is thrown up into the air from ground level at a speed of 8.00 m/s. The ball travels up to a maximum height, then returns to the ground. Calculate the rock's momentum as it strikes the ground. Rock will return at same speed

$P = mv = (1.00)(-8.00) = -8.00 \text{ kg m/s}$ down

8. A 1.50 kg rock is thrown up into the air from ground level, reaches a maximum height of 7.00 m, then returns to the ground. Calculate the rock's momentum as it strikes the ground.

# Physics 30 Worksheet # 2: *Impulse*

1. A force of 20.0 N is applied to a 3.00 kg object for 4.00 seconds. Calculate the impulse experienced by the object.

$\Delta p = F \cdot \Delta t = (20.0)(4.00) = 80.0\ Ns$

2. A 1200 kg car traveling at 20.0 m/s speeds up to 30.0 m/s. What is the impulse experienced by the car?

3. A 1500 kg car accelerates from 55.0 km/h to 90.0 km/h. Calculate the impulse experienced by the car.

$55.0\ km/h = 15.3\ m/s \quad 90.0\ km/h = 25.0\ m/s$

impulse is change in momentum

$\Delta p = p_f - p_i = mv_f - mv_i = m(v_f - v_i) = (1500)(25.0 - 15.3)$

$\Delta p = 14550\ kg\,m/s$

$14550\ Ns$

4. A 1200 car accelerates from rest to 10.0 m/s in a time of 4.50 seconds. Calculate the force that the car's tires exerted on the road.

5. A 1500 kg car traveling at 80.0 km/h comes to a screeching halt in a time of 4.00 seconds. Calculate the force of friction experienced by the car.

$80.0\ km/h = 22.2\ m/s$

$\Delta p = F \cdot \Delta t$

$\Delta p = m(v_f - v_i)$

$\frac{m(v_f - v_i)}{\Delta t} = F$

$\frac{(1500)(-22.2)}{(4.00)} = -8325\ N$

6. A 1.00 kg ball traveling towards a soccer player at a velocity of 5.00 m/s rebounds off the soccer player's foot at a velocity of 8.50 m/s. If the time of contact between the ball and the player's foot was $2.00 \times 10^{-2}$ seconds, what was the force that the foot applied on the ball?

7. A 1.50 kg rock falls from the top of a 10.0 m high building and strikes the ground below. Calculate the impulse experienced by the rock during its fall.

$mgh = \frac{1}{2}mv^2 \quad v = \sqrt{2gh} = \sqrt{2(10)(10.0)} = 14.1\ m/s$

$\text{impulse} = \Delta p = m(v_f - v_i) = (1.50)(-14.1) = -21.2\ kg\cdot m/s$

$-21.2\ N\cdot s$

8. A 1.50 kg rock falls from the top of a 10.0 m high building and strikes the ground below. What is the force of the ground acting on the rock if it comes to a stop in 0.350 seconds.

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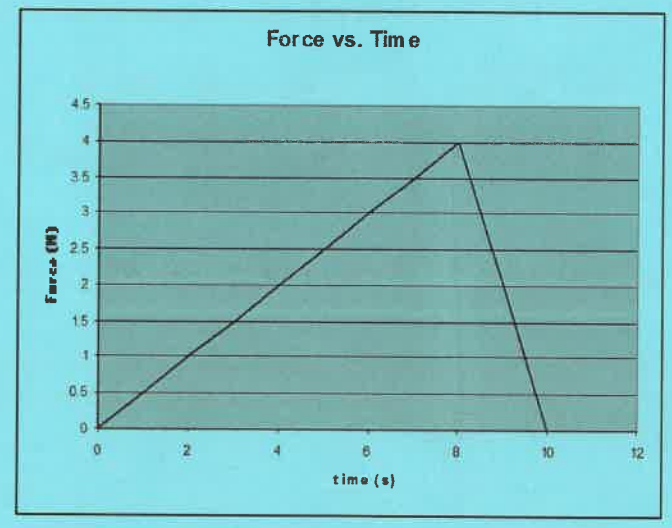
9. Calculate the impulse experienced by the 4.00 kg object represented in the graph below. Calculate the object's change in velocity.




$\Delta p = F \cdot \Delta t = \text{Area under curve} = \frac{1}{2}bh = \frac{1}{2}(10)(4)$

$\Delta p = 20\ N\cdot s$

$\Delta p = m(v_f - v_i) \qquad \frac{\Delta p}{m} = \Delta v = \frac{20}{4.00} = 5.0\ m/s$

# Physics 30 Worksheet # 3: *Conservation of Momentum (1)*

1. A 2.50 kg ball moving at 7.50 m/s is caught by a 70.0 kg man while the man is standing on ice. How fast will the man / ball combination be moving after the ball is caught by the man? ← means $V_B' = V_m'$

$P_i = P_f \qquad m_B V_B + m_m V_m = m_B V_B' + m_m V_m'$

$(2.50)(7.50) + 0 = (2.50) V_B' + (70.0) V_m'$

$\frac{(2.50)(7.50)}{(72.5)} = V_{Bm}' = .26\ m/s$

2. A 1200 kg car traveling North at 20.0 m/s collides with a 1400 kg car traveling South at 22.0 m/s. The two cars collide and entangle. What is the resulting velocity of the wreckage?

3. A 5.00 kg ball hits a 75.0 kg man standing at rest on ice. The man catches the ball. How fast does the ball need to be moving in order to send the man off at a speed of 3.00 m/s? $V_B' = V_m'$

$m_B V_B + m_m V_m = m_B V_B' + m_m V_m'$

$(5.00)(V_B) + 0 = (5.00 + 75.0)(3.00)$

$V_B = 48\ m/s$

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4. A $1.50 \times 10^3$ kg car traveling at 100 km/h South collides with a $1.20 \times 10^3$ kg car traveling North at 100 km/h. The heavier car continues to move South after the collision, but slows to 25.0 km/h. How fast is the lighter car moving after the collision?

5. A 92.0 kg football player running at 6.50 m/s North collides with an 85.0 kg football player running at 6.00 m/s South. The 92.0 kg football player continues moving at a velocity of 2.00 m/s after the collision. What is the velocity of the 85.0 kg football player after the collision?

$P_i = P_f \qquad m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$$\frac{m_1v_1 + m_2v_2 - m_1v_1'}{m_2} = v_2'$$

$$\frac{(92.0)(6.50) + (85.0)(-6.00) - (92.0)(2.00)}{(85.0)} = -1.13 \text{ m/s}$$

or 1.13 m/s South

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6. A 75.0 kg man is standing at rest on ice while holding a 4.00 kg ball. If the man throws the ball at a velocity of 3.50 m/s forward, what will his resulting velocity be?

7. A person holding a 15.0 kg gun containing one 50.0 g bullet is riding on a train that is traveling at 75.0 km/h East. If the man fires the gun and the bullet moves with a velocity of 350 m/s East (relative to the train), what is the velocity of the gun relative to the ground?

50.0 g = .050 kg  75.0 km/h = 20.8 m/s

$P_i = P_f$  $v_2'$ relative ground = 350 + 20.8 = 370.8 m/s

so all v are relative to ground.

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

$$\frac{m_1v_1 + m_2v_2 - m_2v_2'}{m_1} = v_1'$$

$$\frac{(15.0)(20.8) + (.050)(20.8) - (.050)(370.8)}{(15.0)} = v_1'$$

$v_1' = 19.6$ m/s East