

Momentum – Unit 4, Ch. 10

$$p = mv$$

$$p_{\text{before}} = p_{\text{after}} \quad \text{net momentum before} = \text{net momentum after}$$

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

PART A – MOMENTUM

1.

A steel ball whose mass is 2.0 kg is rolling at a rate of 2.8 m/s. What is its momentum?

FORMULA	GIVEN	WORK
$p = m \cdot v$	$m = 2.0\text{kg}$ $v = 2.8\text{m/s}$	$p = 2.0\text{kg} \cdot 2.8\text{m/s}$
ANSWER: 5.6 kg * m/s		

2.

A marble is rolling at a velocity of 1.5 m/s with a momentum of 0.10 kg·m/s. What is its mass?

FORMULA	GIVEN	WORK
$m = \frac{p}{v}$	$p = 0.10\text{kg} \cdot \text{m/s}$ $v = 1.5\text{m/s}$	$m = \frac{0.10\text{kg} \cdot \text{m/s}}{1.5\text{m/s}}$
ANSWER: $m = 0.0\bar{6}\text{kg}$ 60grams		

PART B – CONSERVATION OF MOMENTUM

3.

Suppose you are playing ice hockey in the middle of a totally frictionless frozen pond. How can you move yourself to the edge of the pond? Remember that without friction, you won't be able to push against the ice. Explain what you would do and why it would work.

You can throw your hockey stick, ice skate, or helmet and your body will move in the opposite direction due to the Conservation of momentum.

4.

A 4.5-kg ham is thrown into a stationary 15-kg shopping cart. At what speed will the cart travel if the ham had an initial speed of 2.2 m/s? (**HINT** What is the new mass?)

BEFORE MOMENTUM OF HAM ALONE		
FORMULA	GIVEN	WORK
$p = m \cdot v$	m=4.5kg v=2.2 m/s	$p = 4.5kg \cdot 2.2m / s$ $p = 9.9kg \cdot m / s$
AFTER SPEED OF HAM AND CART		
FORMULA	GIVEN	WORK
$v = \frac{p}{m}$	p=9.9 kg * m/s m=19.5 kg	$v = \frac{9.9kg \cdot m / s}{19.5kg}$
ANSWER: v= 0.51 m/s		

5.

A 6-kg bowling ball rolling at 5 m/s strikes a stationary 4-kg bowling ball. If Ball #1 is moving forward at 2 m/s after the collision, what is the speed and direction of Ball #2?

BEFORE	AFTER
$p_{\text{Ball 1}}: 6\text{kg} * 5\text{m/s} = 30 \text{ kg*m/s}$ $p_{\text{Ball 2}}: 4\text{kg} * 0\text{m/s} = 0\text{kg*m/s}$ $p_{\text{Total}} = p_{\text{Ball 1}} + p_{\text{Ball 2}}$ $p_{\text{Total}} = 30\text{kg*m/s} + 0\text{kg*m/s} = 30\text{kg*m/s}$ $p_{\text{Total}} = 30\text{kg*m/s}$	$p_{\text{Ball 1}}: 6\text{kg} * 2\text{m/s} = 12 \text{ kg*m/s}$ We know that the total p before has to equal the total p after. From the before calculations we know the total p is 30kg*m/s. We also know that Ball 1 has a 'p' of 12kg*m/s after. Therefore, $p_{\text{Total}} \text{ MINUS } p_{\text{Ball 1}} \text{ EQUALS } p_{\text{Ball 2}}$ $30\text{kg*m/s} - 12\text{kg*m/s} = 18\text{kg*m/s}$ We still need to find the speed of ball #2. We know now that $p=m*v$ so, $p_{\text{Ball 2}}: 4\text{kg} * \text{velocity}_{\text{after}} = 18\text{kg*m/s}$ Solve for velocity by dividing both sides by 4kg and we get...
ANSWER: 4.5 m/s	

6.

Make two event chains showing what happens when a rolling ball (Ball 1) hits a resting ball (Ball 2). Use the phrases: *gains momentum, hits Ball 2, is hit by Ball 1, loses momentum, rests, rolls, slows down, starts rolling.*

