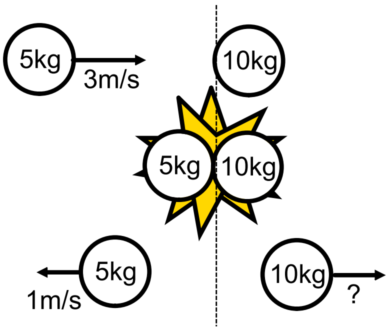
L07 - Collision in 2-Dimensions

Warm-Up: Collisions in 1-Dimension - Pt 1

Example #1a: Moving object of mass 5kg hits stationary object of mass 10kg.



Initial Momentum of System = Final Momentum of System

$m_a v_a + m_b v_b = m_a v_a + m_b v_b$

(5kg)(+3m/s) + (10kg)(0m/s) = (5kg)(-1m/s) + (10kg)(v_b)

+15 kg*m/s + 0 kg*m/s = -5 kg*m/s + (10)(v_b)

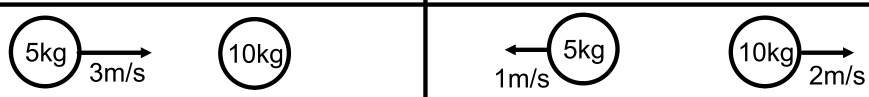
15 = -5 + 10v_b

20 = 10v_b

+2 m/s [R] = v_b

Example #1b: Is this collision elastic?

Initial Kinetic Energy			**Final Kinetic Energy**		



Initial			Final		
$1/2mv^2$	+	$1/2mv^2$	$1/2mv^2$		$1/2mv^2$
$1/2(5kg)(3m/s)^2$	+	$1/2(10kg)(0m/s)^2$	$1/2(5kg)(1m/s)^2$	+	$1/2(10kg)(2m/s)^2$
22.5J	+	0J	2.5J	+	20J

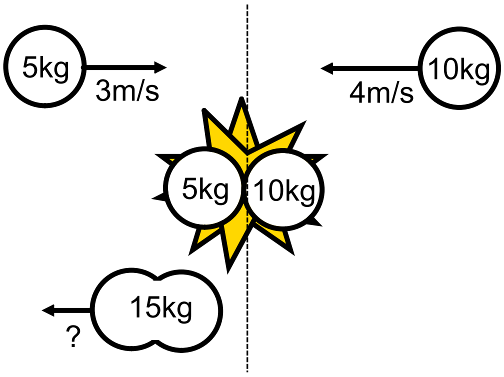
22.5J = 22.5J

Elastic Collision

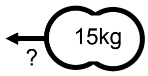
.

Warm-Up: Collisions in 1-Dimension - Pt 2

Example #2: Two objects moving towards each other hit and stick.



Initial Momentum of System = Final Momentum of System



$m_a v_a + m_b v_b = m_a v_a + m_b v_b$

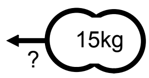
$(5kg)(+3m/s) + (10kg)(-4m/s) = (m_a + m_b)(v_f)$

$+15\ kg{*}m/s + -40\ kg{*}m/s = (15kg)v_f$

$-25 = 15v_b$

$-1.\overline{6}\ m/s\ [R] = v_b$

Example #2b: Is this collision elastic?

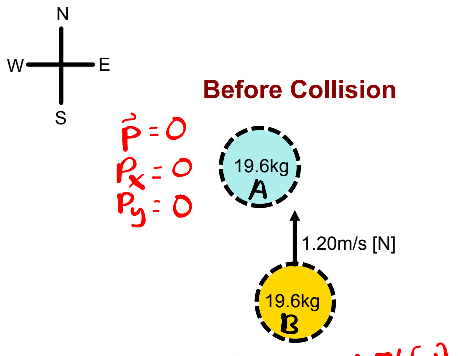
Initial Kinetic Energy	Final Kinetic Energy
	
$1/2mv^2 + 1/2mv^2$	$1/2mv^2$
$1/2(5kg)(3m/s)^2 + 1/2\ (10kg)(4m/s)^2$	$1/2(15kg)(1.\overline{6}m/s)^2$
$22.5J + 80J$	$20.8\overline{3}\ J$

$102.5J > 20.8\overline{3}\ J + E_{Th}$

Inelastic Collision

Collisions in 2-Dimensions

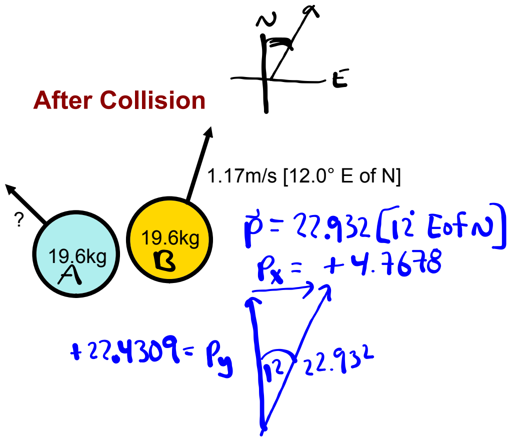
Q1: A 19.6-kg curling stone (A) moving at 1.20 m/s [N] strikes another identical stationary stone (B) off centre, and moves off with a velocity of 1.17 m/s [12.0° E of N]. What will be the velocity of stone B after the collision? Ignore frictional and rotational effects.



Before collision:

$\vec{p} = 0$, $p_x = 0$, $p_y = 0$ (stone A)

$\vec{p} = 23.52\ kg\,m/s\ [N]$, $p_x = 0$, $p_y = +23.52$ (stone B)



After collision (stone B):

$\vec{p} = 22.932\ [12^\circ\ E\ of\ N]$

$p_x = +4.7678$

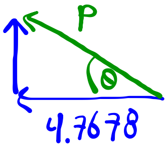
$+22.4309 = p_y$

x-comp

$$p_i = p_f$$
$$p_{iA} + p_{iB} = p_{fA} + p_{fB}$$
$$0 + 0 = p_{fA} + 4.7678$$
$$p_{fA} = -4.7678\ kg\,m/s$$

y-comp

$$p_i = p_f$$
$$p_{iA} + p_{iB} = p_{fA} + p_{fB}$$
$$0 + 23.52 = p_{fA} + 22.4309$$
$$p_{fA} = +1.08911922\ kg\,m/s$$

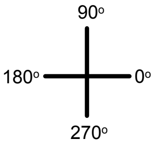


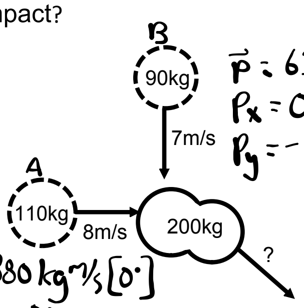
$\vec{p} = 4.8906\ kg\,m/s\ [12.87^\circ\ N\ of\ W]$

$$\vec{p} = m\vec{v}$$
$$\vec{v} = \frac{\vec{p}}{m} = \frac{4.8906\ kg\,m/s\ [12.87^\circ\ N\ of\ W]}{19.6}$$
$$\vec{v} = 0.2495\ m/s\ [12.87^\circ\ N\ of\ W]$$

Collisions in 2-Dimensions

Q2: A 90-kg quarterback moving at 7.0 m/s [270°] is tackled by a 110-kg linebacker running at 8.0 m/s [0°]. What will be the velocity of the centre of mass of the combination of the two players immediately after impact?





$\vec{p} = 630\ kg\,m/s\ [270°]$
$p_x = 0$
$p_y = -630$

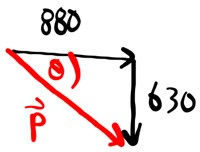
$\vec{p} = 880\ kg\,m/s\ [0°]$
$p_x = +880$
$p_y = 0$

x-comp

$p_i = p_f$
$p_{iA} + p_{iB} = p_f$
$880 + 0 = p_f$
$p_f = +880\ kg\,m/s$

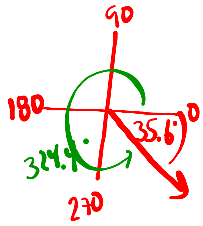
y-comp

$p_i = p_f$
$p_{iA} + p_{iB} = p_f$
$0 + (-630) = p_f$
$p_f = -630\ kg\,m/s$



$\theta = 35.6°$

$\vec{p} = 1082.266\ kg\,m/s\ [324.4°]$

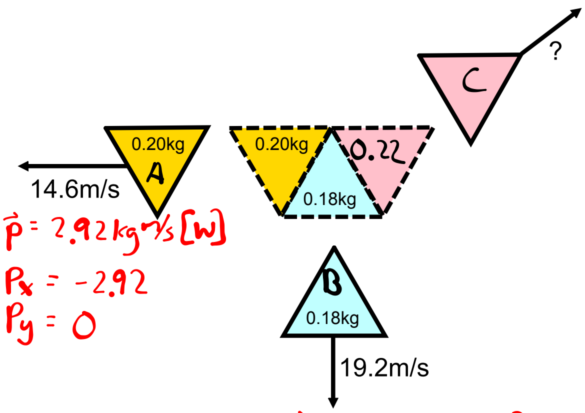


$\vec{p} = m\vec{v}$
$\vec{v} = \frac{\vec{p}}{m} = 5.41\ m/s\ [324.4°]$

.

Collisions in 2-Dimensions

Q3: A 0.60-kg fireworks bundle is at rest just before it explodes into three fragments. A 0.20-kg fragment (A) flies at 14.6 m/s [W], and a 0.18-kg fragment (B) moves at 19.2 m/s [S]. What is the velocity of the third fragment (C) just after the explosion?



$\vec{p} = 2.92\ kg\,m/s\ [W]$

$p_x = -2.92$

$p_y = 0$

$\vec{p} = 3.456\ kg\,m/s\ [S]$

$p_x = 0$

$p_y = -3.456$

x-comp

$p_i = p_f$

$p_{i_{sys}} = p_{f_A} + p_{f_B} + p_{f_C}$

$0 = -2.92 + 0 + p_{f_C}$

$p_{f_C} = +2.92\ kg\,m/s$

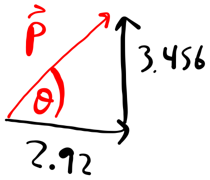
y-comp

$p_i = p_f$

$p_{i_{sys}} = p_{f_A} + p_{f_B} + p_{f_C}$

$0 = 0 + (-3.456) + p_{f_C}$

$p_{f_C} = +3.456$



$\vec{p} = 4.5244\ kg\,m/s\ [49.8^\circ\ N\ of\ E]$

$\vec{v} = 20.6\ m/s\ [49.8^\circ\ N\ of\ E]$

.