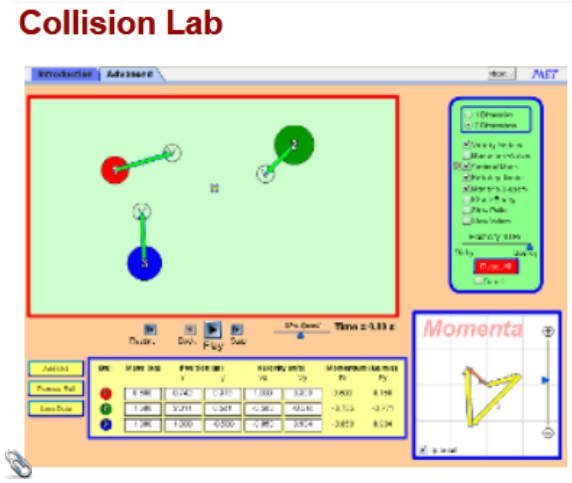
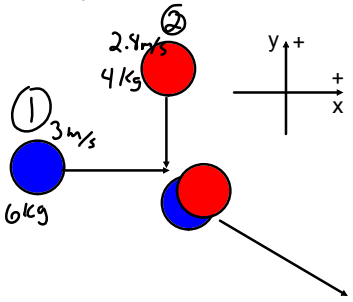
Two Dimensional (2D) Collisions

In order to solve two dimensional collision problems, write a conservation of momentum equation for the horizontal components of the momenta and a conservation of momentum equation for the vertical components of the momenta.



Reading Review: MHR pages 503 - 505.

A 4.0 kg object is travelling south at a speed of 2.8 m/s when it collides with a 6.0 kg object travelling east at a velocity of 3.0 m/s. If these objects stick together upon collision, at what velocity do the combined masses move? 2.1 m/s [E 32° S]



$v_{01x} = 3$ m/s
$v_{01y} = 0$ m/s
$v_{f1x} = ?$ $v_{f1y} = ?$
$v_{02x} = 0$ m/s
$v_{02y} = -2.8$ m/s
$v_{f2y} = ?$ $v_{f2x} = ?$

x-dir

$$m_1 v_{01x} + m_2 v_{02x} = m_1 v_{fx} + m_2 v_{f2x}$$

$$(6)(3) + (4)(0) = 6v_{f1x} + 4v_{f2x}$$

$v_{f1x} = v_{f2x} \rightarrow v_{fx}$

$$18 = 6v_{fx} + 4v_{fx}$$

$$18 = 10v_{fx}$$

$$1.8 \text{ m/s} = v_{fx}$$

y-dir

$v_{fy} = v_{f2y}$ v_{fy}

$$m_1 v_{01y} + m_2 v_{02y} = m_1 v_{f1y} + m_2 v_{f2y}$$

$$(6)(0) + 4(-2.8) = 6v_{f1y} + 4v_{f2y}$$

$$-11.2 = 6v_{fy} + 4v_{fy}$$

$$-11.2 = 10v_{fy}$$

$$-1.12 \text{ m/s} = v_{fy}$$

$$v_f = \sqrt{v_{fx}^2 + v_{fy}^2} \qquad \theta = \tan^{-1}\left|\frac{v_{fy}}{v_{fx}}\right|$$

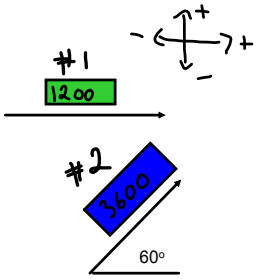
$$v_f = \sqrt{(1.8)^2 + (-1.12)^2}$$

$$v_f = 2.12 \text{ m/s} \qquad \theta = \tan^{-1}\frac{1.12}{1.8}$$

$$\theta = 32^\circ$$

$v_f = 2.12$ m/s 32° down from x-axis

Example: A 1200 kg car is moving east at 30.0 m/s and collides with a 3600 kg car moving at 20.0 m/s in a direction E 60.0° N. The vehicles interlock and move off together. Find their common velocity. (19.8 m/s, 41° up from x-axis)



Before

$v_{01x} = 30 m/s$

$v_{01y} = 0 m/s$

$v_{02x} = 20\cos 60 = 10 m/s$

$v_{02y} = 20\sin 60 = 17.3 m/s$

After

$v_{f1x} = ?$ $v_{f1y} = ?$

$v_{f2x} = ?$ $v_{f2y} = ?$

Question is asking for $v_f = ?$

$v_{f1x} = v_{f2x}$ } stuck together
$v_{f1y} = v_{f2y}$

x-dir

$$m_1 v_{01x} + m_2 v_{02x} = m_1 v_{f1x} + m_2 v_{f2x}$$

$$(1200)(30) + (3600)(10) = 1200 v_{fx} + 3600 v_{fx}$$

$$36000 + 36000 = 4800 v_{fx}$$

$$72000 = 4800 v_{fx}$$

$$15 m/s = v_{fx}$$

y-dir

$$m_1 v_{01y} + m_2 v_{02y} = m_1 v_{f1y} + m_2 v_{f2y}$$

$$0 + (3600)(17.3) = (1200) v_{fy} + 3600 v_{fy}$$

$$62280 = 4800 v_{fy}$$

$$13 m/s = v_{fy}$$

$$v_f = \sqrt{v_{fx}^2 + v_{fy}^2} \qquad \theta = \tan^{-1}\left|\frac{v_{fy}}{v_{fx}}\right|$$

$$v_f = \sqrt{(15)^2 + (13)^2}$$

$$\theta = \tan^{-1}\frac{13}{15} = 41^\circ$$

$$v_f = 19.8 m/s$$

$v_f = 19.8 m/s$ 41° up from x-axis

Attachments

collision-lab_en.jar