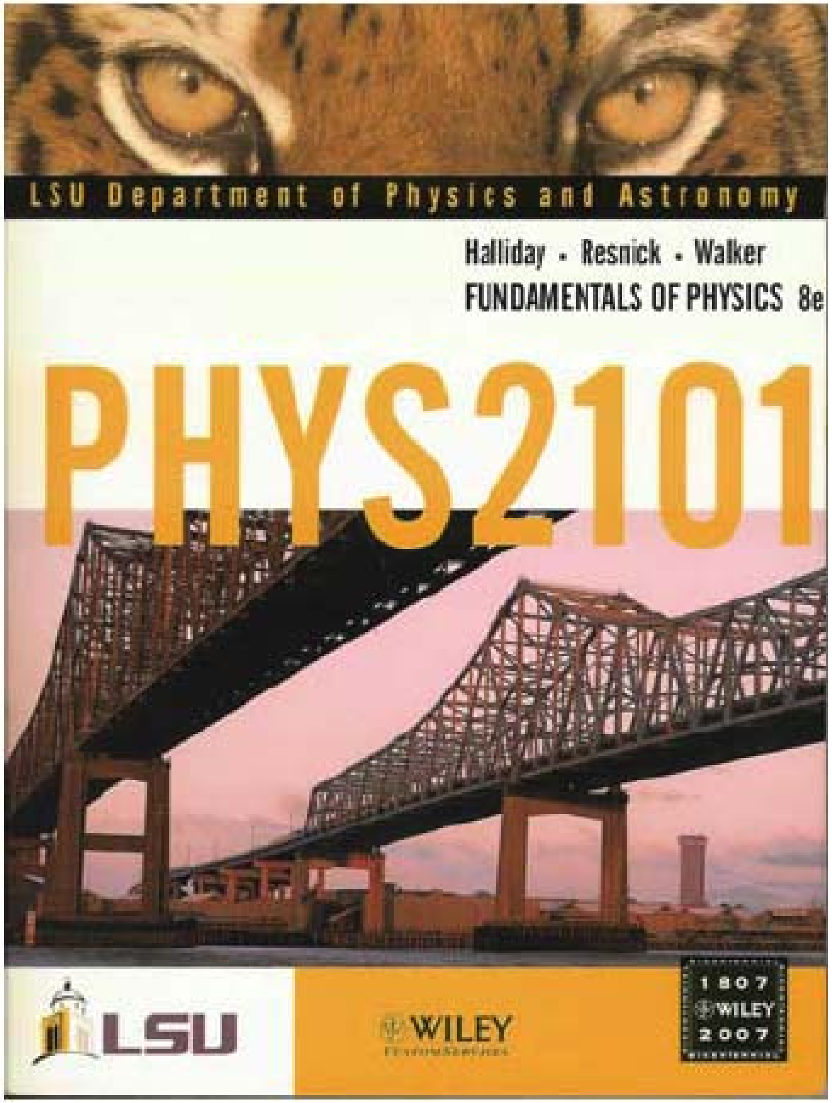


Physics 2101
Section 3
Feb. 26th : Ch. 9

Announcements:

- Quiz #3 today
- HW due
- Study session Monday evening at 6:00PM at Nicholson 130

Test#2 (Ch. 7-9) will be at 6 PM, March 3 (6) Lockett)

Class Website:
http://www.phys.lsu.edu/classes/spring2010/phys2101-3/
Or go directly to my website

Linear Momentum

Total Linear Momentum of N particles:

$$\vec{P}_{tot} = \vec{p}_1 + \vec{p}_2 + \vec{p}_3 + \ldots + \vec{p}_N = M\vec{v}_{com}$$

total mass M

velocity of COM

$$\frac{d\vec{P}_{tot}}{dt} = M\frac{d\vec{v}_{com}}{dt} = M\vec{a}_{com} = \vec{F}_{net,ext}$$

Conservation of Linear Momentum

If External force is zero (isolated, closed system)…

$$0 = \vec{F}_{net,ext} = \frac{d\vec{P}}{dt}$$

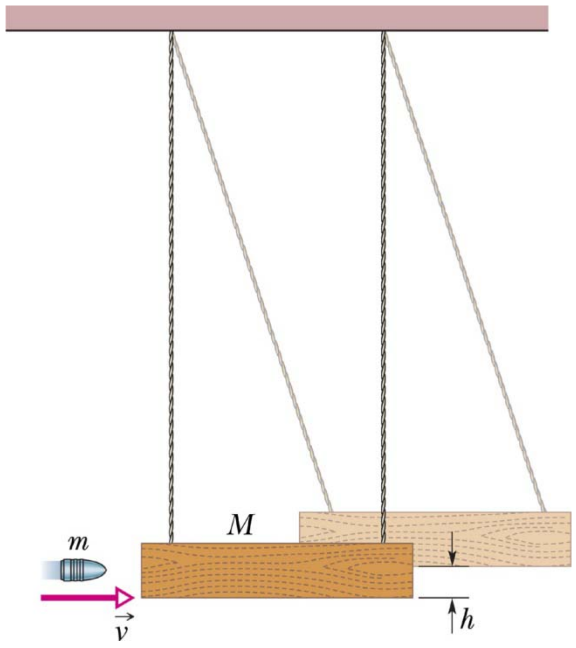
$$\vec{P} = const$$

$$\Delta\vec{P} = 0$$

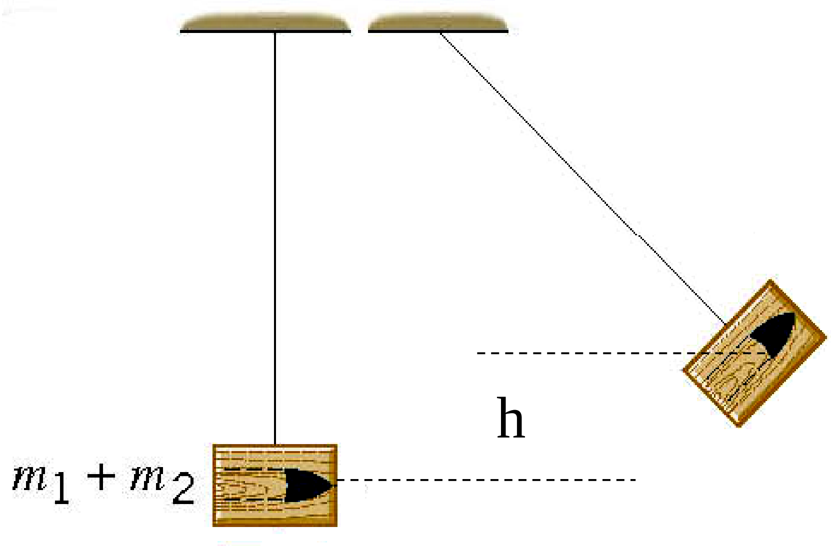
Elastic & Inelastic Collision/Scattering

$$\sum K = \text{ contant } \quad \text{(Elastic)}$$

Sample problem 9: A bullet of mass m and initial velocity v_0 collides with and sticks onto a large wooden block of mass M. Find the velocity of M+m immediately after the collision. How high does the combined block + bullet go before coming to rest temporarily.



Collisions – ballistic pendulum



A bullet with with an initial velocity of 896 m/s and a mass of 0.01 kg strikes a 2.5 kg block hung from the ceiling. How high do the block/bullet combination go ?

1) Only momentum conservation during collision
2) Conservation of Energy as it swings up under conservative force

Momentum conservation:

$$P_o = m_1 v_{o1} = P_f = (0.01kg)(896 \, m/s) = 8.96 \, kg \cdot m/s$$

$$P_f = (m_1 + m_2) v_f = 8.96 \, kg \cdot m/s$$

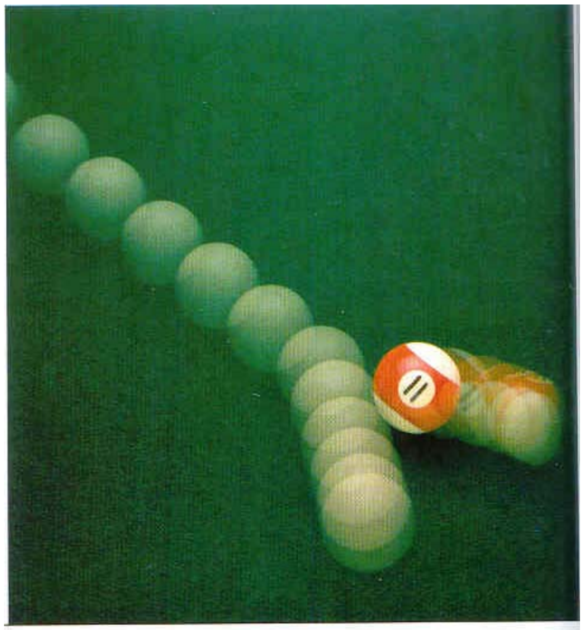
$$v_f = \frac{8.96 \, kg \cdot m/s}{2.51 kg} = 3.57 \, m/s$$

Energy conservation:

$$KE_o = PE_f = \tfrac{1}{2}(m_1 + m_2) v_f^2 = (m_1 + m_2) gh$$

$$h = \frac{\tfrac{1}{2} v_f^2}{g} = 0.650m$$

Collisions in 2D



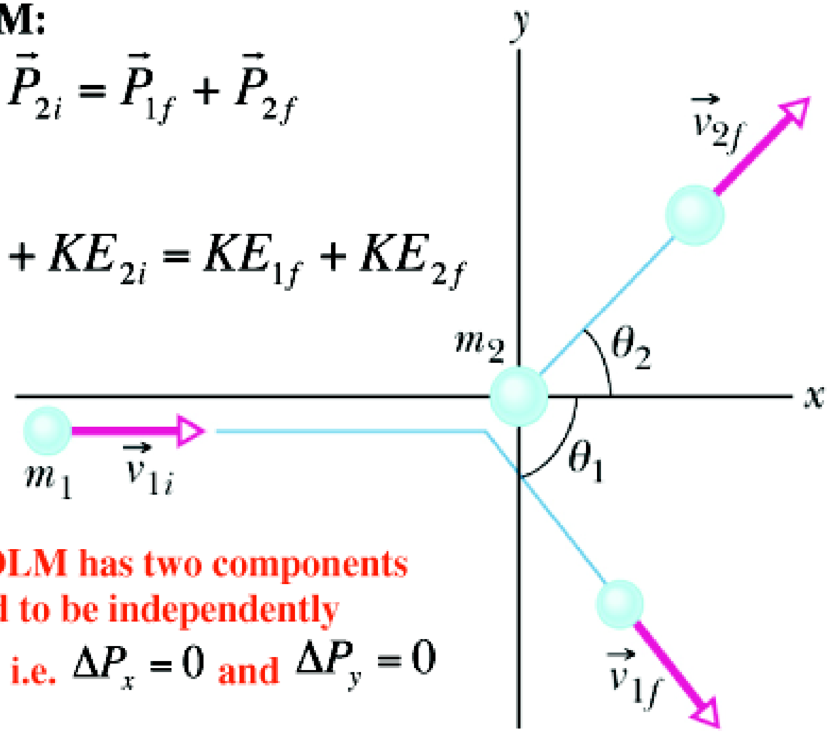
NOW ONTO HARDER THINGS:
2-D Elastic

Still COLM:

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

& COKE:

$$KE_{1i} + KE_{2i} = KE_{1f} + KE_{2f}$$



NOTE: COLM has two components that need to be independently satisfied, i.e. $\Delta P_x = 0$ and $\Delta P_y = 0$

Example: ${}_{1i} = 0$ $\quad v_{2i} = 0$

COLM- $\hat{x}$: $m_1 v_{1i} = m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2$

COLM- $\hat{y}$: $0 = -m_1 v_{1f} \sin\theta_1 + m_2 v_{2f} \sin\theta_2$

and

COKE: $\frac{1}{2} m_1 v_{1i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$

8 variables and 3 Equations

2 mass & 4 velocity & 2 angle

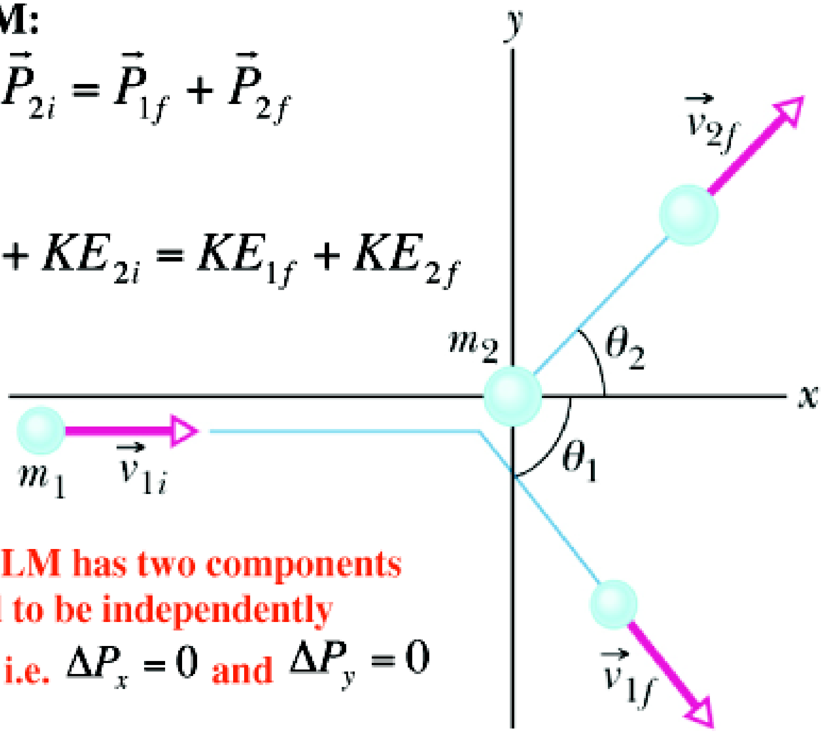
NOW ONTO HARDER THINGS:
2-D Elastic

Still COLM:

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

& COKE:

$$KE_{1i} + KE_{2i} = KE_{1f} + KE_{2f}$$



NOTE: COLM has two components that need to be independently satisfied, i.e. $\Delta P_x = 0$ and $\Delta P_y = 0$

Example

$\vec{v}_{1i} = v_{1i}\hat{x}$; $\vec{v}_{2i} = 0$ & ELASTIC

We do know θ_1

COLM in x-direction

$$m_1 v_{1i} = m_1 v_{1f} \cos\theta_1 + m_2 v_{2f} \cos\theta_2$$

COLM in y-direction

$$0 = -m_1 v_{1f} \sin\theta_1 + m_2 v_{2f} \sin\theta_2$$

Kinetic energy conservation (ELASTIC)

$$\frac{1}{2} m_1 v_{1i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

BE careful !!!

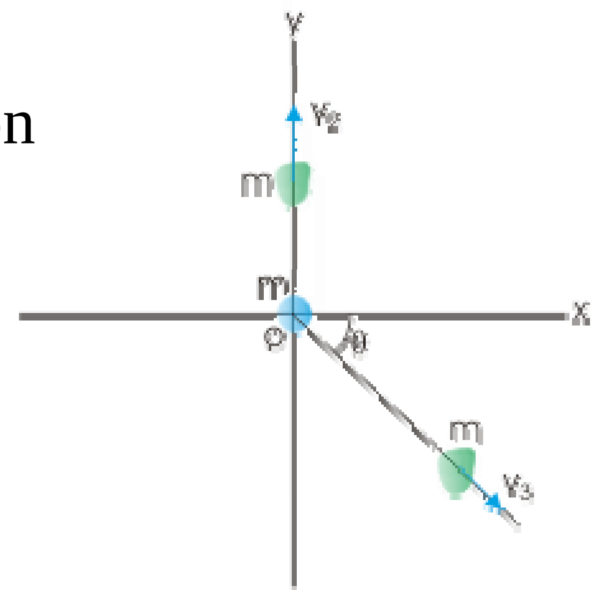
3 equations for there unknown quantities: v_{1f}, v_{2f} and θ_2

Example: Supplementary HW 4

A ball of mass "m", which is moving with a speed "v_1" in x-direction, strikes another ball of mass "2m", placed at the origin of horizontal planar coordinate system. The lighter ball comes to rest after the collision, whereas the heavier ball breaks in two equal parts. One part moves along y-axis with a speed "v_2". Find the direction of the motion of other part.

What do we know:

$v_{1i},\ v_{1f} = 0,$ More than two bodies after collision



Total momentum conserves

$\sum \vec{P}_i$: x-component: mv_1

y-component: zero

BEFORE

$\sum \vec{P}_f$: x-component: $mv_3 \cos\theta$

y-component: $mv_2 - mv_3 \sin\theta$

AFTER

Conservation:

$$mv_1 = mv_3 \cos\theta$$

$$0 = mv_2 - mv_3 \sin\theta$$

$$\tan\theta = \frac{v_2}{v_1}$$

Is it an elastic collision?

Formula sheet for the quiz #3

Law of conservation of linear momentum:

$$\vec{P}_i = \vec{P}_i \quad (\text{if } \sum \vec{\mathrm{F}}_{\text{ext}} = 0)$$

$$m_{1i}\vec{v}_{1i} + m_{2i}\vec{v}_{2i} = m_{1f}\vec{v}_{1f} + m_{2f}\vec{v}_{2f}$$

Free-fall motion:

$$v_f^2 = v_i^2 + 2\mathrm{a}(\mathrm{y}\text{-}\mathrm{y}_0) \;\; (\mathrm{a} = -g)$$

Kinetic energy: $K = \dfrac{1}{2}mv^2$

Gravitational potential energy: $\mathrm{U} = mgh$

Relationaship between work done by external force and total mechanical energy

$$W = \Delta E_{mec} = \Delta K + \Delta U$$