Final Exam: May 13th, Wednesday

Time : 8:30-11 am (arrive by 8:15 am)

Room: Cullimore Lecture Hall 3.

Lecture schedule

May 1st, Fri. : Sect. 006 & 008

May 4th, Mon., 4 - 5:30 @483 Tiernan: Extra Office hour

May 5th, Tue., following Fri. schedule: Sect. 006 & 008
→ Last lecture (Review Session)

No class on May 6th, Wed.

"Impulse" and "Momentum"

Last class …

Collision in 2D

Today…

Example : Ballistic Pendulum

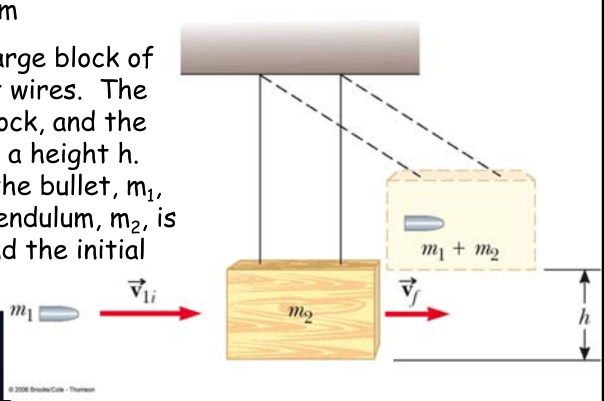
Center of mass

Motion of system of particles
(Motion of center of mass)

More example on collision & momentum

Example : Ballistic Pendulum

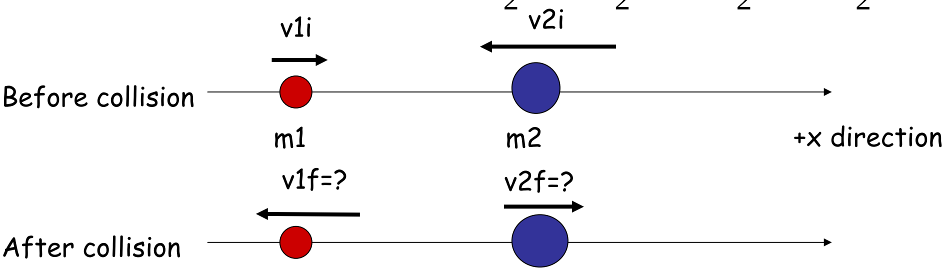
The bullet is fired into a large block of wood suspended from light wires. The bullet is stopped by the block, and the entire system swings up to a height h. Assume that the mass of the bullet, m_1, is 5.0 g, the mass of the pendulum, m_2, is 1.0 kg, and h is 5.0 cm. Find the initial speed of the bullet, v_{1i} .



Elastic Collisions in One Dimension

Both total momentum & **total kinetic energy** are conserved.

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



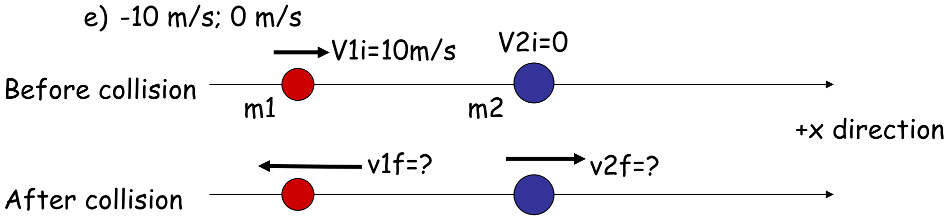
$$v_{1,f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1,i} + \frac{2m_2}{m_1 + m_2} v_{2,i} \quad \text{and} \quad v_{2,f} = \frac{2m_1}{m_1 + m_2} v_{1,i} + \frac{m_2 - m_1}{m_1 + m_2} v_{2,i}$$

(see text for proof)

iClicker Quiz

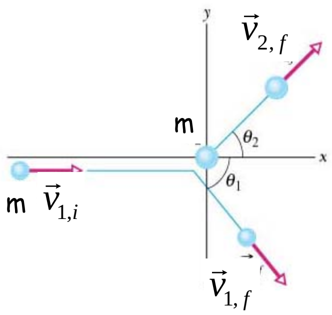
In 1D elastic collision, if m1=m2, vi1=+10 m/s, v2i=0, then, after collision v1f= ______ and v2f= ______.

a) 5 m/s; 5 m/s
b) -5 m/s; 5 m/s
c) 0 m/s; 10 m/s
d) 0 m/s; -10 m/s
e) -10 m/s; 0 m/s



$$v_{1,f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1,i} + \frac{2m_2}{m_1 + m_2} v_{2,i} \quad \text{and} \quad v_{2,f} = \frac{2m_1}{m_1 + m_2} v_{1,i} + \frac{m_2 - m_1}{m_1 + m_2} v_{2,i}$$

Example 1: 90 degree deflection rule in a game of pool

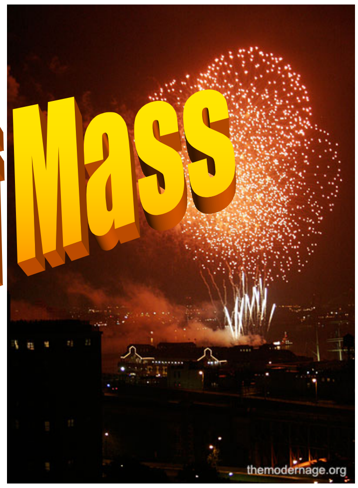


Assume that the collision is elastic, and the two balls have the same mass.

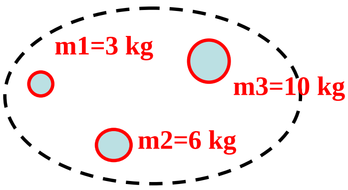
Show that the angle between the outgoing balls is 90 degree.

(No forward, back or side spin is in effect.)

How could we analyze the motion of extended objects, or system of particles?



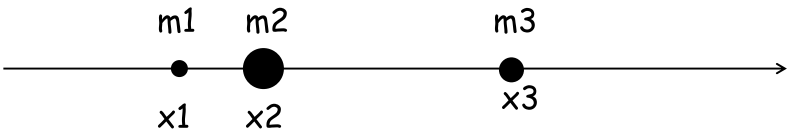
Concept of Center of Mass



For a system of particles or an extended object,

"Center of mass" is an "average" position for mass distribution.

Definition of center of mass (com) in 1D



In 1D,

$$x_{com} = \frac{m_1 x_1 + m_2 x_2 + \ldots}{m_1 + m_2 + \ldots} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

, where x_i is position of mass m_i

Definition of center of mass (com) in 2D, 3D

$$x_{com} = \frac{m_1 x_1 + m_2 x_2 + \ldots}{m_1 + m_2 + \ldots} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

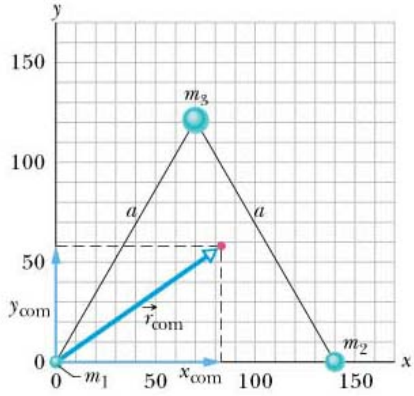
$$y_{com} = \frac{m_1 y_1 + m_2 y_2 + \ldots}{m_1 + m_2 + \ldots} = \frac{\sum_i m_i y_i}{\sum_i m_i}$$

$$z_{com} = \frac{m_1 z_1 + m_2 z_2 + \ldots}{m_1 + m_2 + \ldots} = \frac{\sum_i m_i z_i}{\sum_i m_i}$$

, where (x_i, y_i, z_i) is the position of m_i

Example 3

Three particles of masses $m1$ = 1.1 kg, $m2$ = 2.5 kg, and $m3$ = 3.4 kg are located as shown in the figure: m1 is at (0,0), m2 is at (140 m,0), and m3 is at (70 m, 120 m). Find the coordinate of the center of mass.



iClicker Quiz

A two-section piece, represented by the gray area on the figure, is cut from a metal plate of uniform thickness. The point that corresponds to the center of mass of this piece is closest to

(a) 1
(b) 2
(c) 3
(d) 4
(e) 5