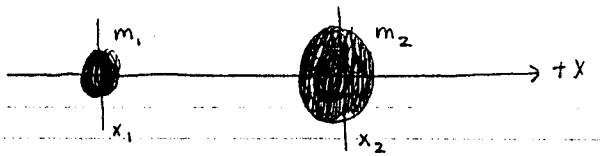
HOW TO WORK COLLISION PROBLEMS

If given information about objects after the collision, then simply use

Total Initial $\vec{P}$ = Total Final $\vec{P}$

If not given information, then

1) Draw picture in laboratory frame
2) Subtract cm motion; v_{cm}
3) Perform the head-on collision in cm
4) Add cm motion back in
5) Read off quantities of interest.



Center $\bar{x} = \frac{x_1 + x_2}{2}$

Center of Mass Position $M_{TOT}\, x_{cm} = m_1 x_1 + m_2 x_2$

" " " Velocity $M_{TOT}\, v_{cm} = m_1 v_1 + m_2 v_2 = P_{TOT}$

" " " Acceleration $M_{TOT}\, a_{cm} = m_1 a_1 + m_2 a_2 = F_{on1} + F_{on2} = F_{ext}$

Facts About Collisions

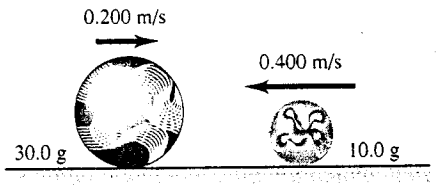
1) Center of Mass motion persists when there are no external Forces

2) In a totally INELASTIC collision, relative motion ceases.

3) In a totally ELASTIC collision, momenta reverse in the center-of-mo reference frame.

Elastic Collisions

8–22 A 10.0-g marble travels to the left with a velocity of magnitude 0.400 m/s on a smooth, level surface and makes a head-on collision with a larger 30.0-g marble moving to the right with a velocity of magnitude 0.200 m/s (Fig. 8–33). If the collision is perfectly elastic, find the velocity of each marble (magnitude and direction) after the collision. (Since the collision is head-on, all the motion is along a line.)



Consider the collisions of 3kg block @ 5 m/s with 2kg block at rest.

TOTALLY INELASTIC

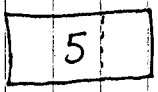
$M_{TOT} v_{cm} = m_1 v_1 + m_2 v_2$

$5 v_{cm} = 3 \cdot 5 + 2 \cdot 0$

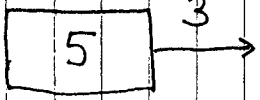
$v_{cm} = 3$

SUBTRACT V_{cm}

DO COLLISION



ADD V_{cm}



TOTALLY ELASTIC

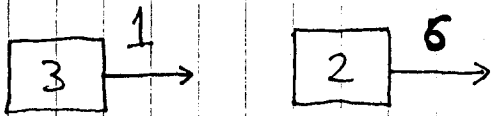
$M_{TOT} v_{cm} = m_1 v_1 + m_2 v_2$

$v_{cm} = 3$

SUBTRACT V_{cm}

DO COLLISION

ADD V_{cm}



INELASTIC COLLISION

$m_{Tot} v_{cm} = m_1 v_1 + m_2 v_2$

$40\, v_{cm} = 30(20) + 10(-40)$

$v_{cm} = 5$

SUB v_{cm}

DO COLLISION

ADD v_{cm}

Must use consistent set of units, use gm and cm/s

Cons Mom

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

$30(20) + 10(-40) = 30 v_{1f} + 10 v_{2f}$

$20 = 3 v_{1f} + v_{2f}$

Cons Energy

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

$\frac{1}{2} 30 (20)^2 + \frac{1}{2} 10 (40)^2 = \frac{1}{2} 30 v_{1f}^2 + \frac{1}{2} 10 v_{2f}^2$

$2800 = 3 v_{1f}^2 + v_{2f}^2$

Solve

$v_{2f} = 20 - v_{1f}$

$2800 = 3 v_{1f}^2 + (20 - v_{1f})^2$

$0 = v_{1f}^2 - 10 v_{1f} - 200$

$v_{1f} = \frac{10 \pm \sqrt{100 + 4(1)200}}{2}$

$= 20, -10$ cm/s

Two solutions

If $v_{1f} = 20 \rightarrow v_{2f} = -40$ cm/s

If $v_{1f} = -10$ cm/s $\rightarrow v_{2f} = 50$ cm/s

The first solution is just the before collision case — a trivial soln.

YOUNG 8.22