

Example 2: Force/Impulse

- ❑ mass of the ball = 0.145kg.
- ❑ mass of the bat = 0.9 kg.
- ❑ velocity of swing = 30 m/sec
- ❑ contact time < 1 msec
- ❑ fastball velocity ~ 100 mph (44.4 m/s)
- ❑ calculate average force, impulse



3 factors to maximize range

$$v_{ball}^+ = (1 + \eta)v_{bat}^- + \eta(-v_{ball}^-)$$

<u>Backspin (RPM)</u>	<u>optimum angle</u>	<u>distance</u>
0	36°	355 ft
500	35°	361 ft
1000	34°	368 ft
1500	32°	375 ft
2000	31°	382 ft
2500	29°	389 ft

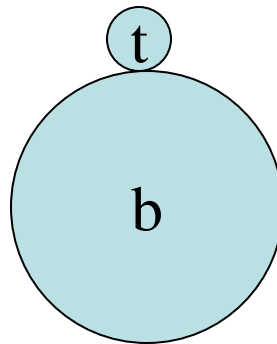
[Professor Alan Nathan, UIUC]

Example

With floor

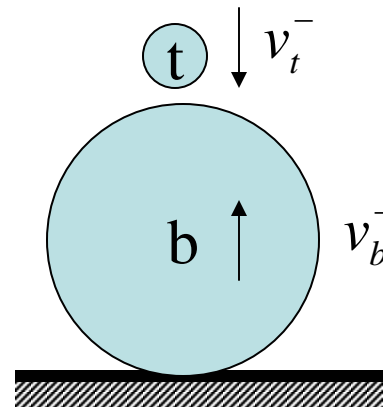
$$e_t =$$

$$e_b =$$



Between t&b

$$e_{tb} = 0.8$$

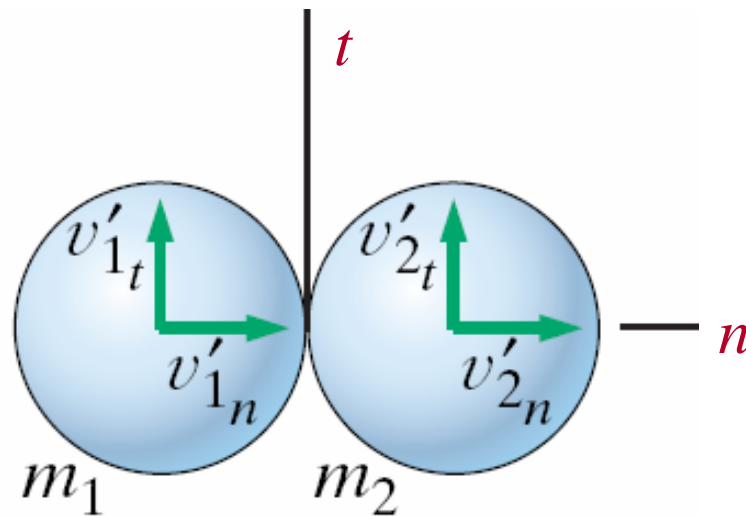
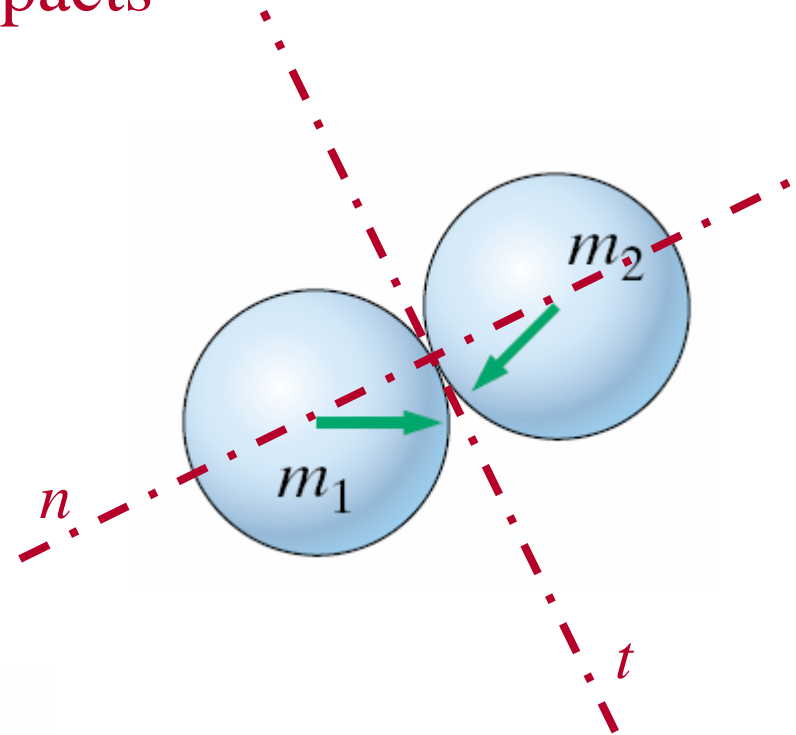
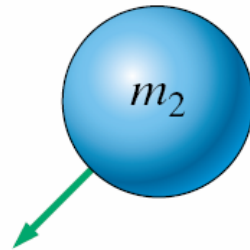
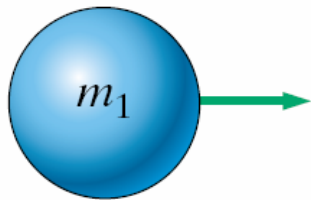


Newton's Amplifier

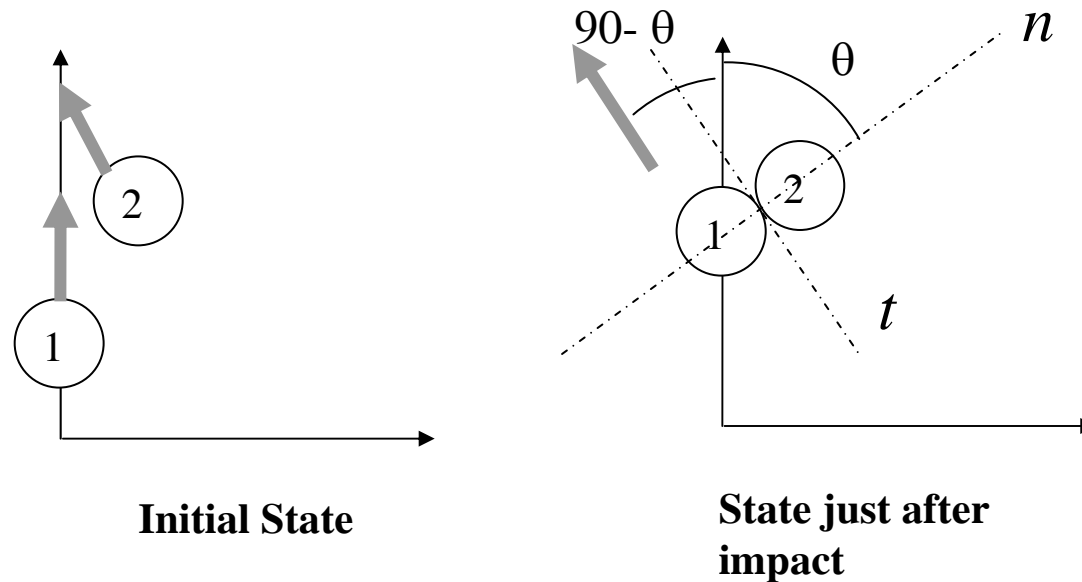


Oblique impacts

Relative velocity vector is *not* along the contact normal



Impact in two dimensions

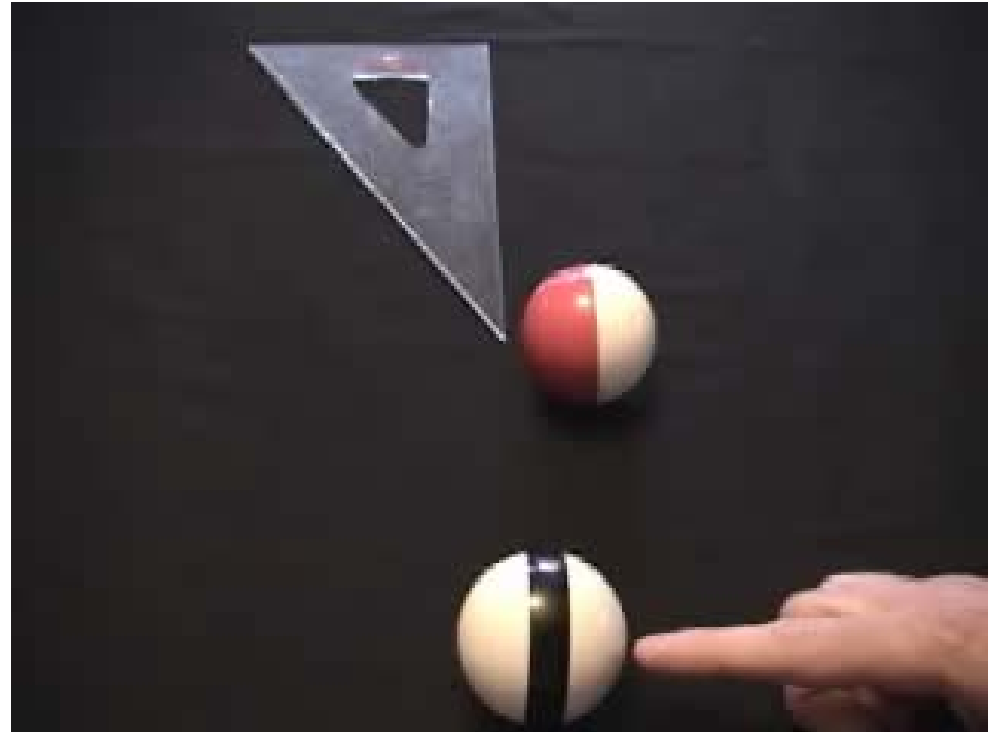


- Given initial state, find final state ($\mathbf{v}_1, \mathbf{v}_2$)
 - Total linear momentum is conserved - 2 equations
 - **If linear impulse acts only in the normal direction**, linear momentum in the tangential direction is conserved – 1 equation
 - Need an impact model to provide the 4th equation

90 degree rule in pool/billiards

Oblique Impact

- ❑ Masses are equal
- ❑ Elastic collision
- ❑ Effects of spin/rolling are negligible



Principles of Conservation of Momentum

□ Conservation of Linear Momentum

$$LI_{1-2} = \int_{t_1}^{t_2} m \mathbf{a} dt = \mathbf{L}_2 - \mathbf{L}_1$$

$$\text{If } LI = 0, \\ \mathbf{L}_2 = \mathbf{L}_1$$

□ Conservation of Angular Momentum

$$AI_{O_{1-2}} = \int_{t_1}^{t_2} \mathbf{M}_O dt = \mathbf{H}_O(t_2) - \mathbf{H}_O(t_1)$$

$$\text{If } AI_O = 0, \\ \mathbf{H}_{O2} = \mathbf{H}_{O1}$$