Lecture 21

$$K = \frac{1}{2} m v^2$$

momentum

$$\vec{p} = m\vec{v}$$

How difficult is it to stop an object?

$$\vec{F} = \frac{d\vec{p}}{dt} = \frac{d}{dt}(m\vec{v})$$

$\int_{net} dt$ $\int dt$

$= m \frac{d\vec{v}}{dt}$

$\vec{F}_{net} = m\vec{a}$

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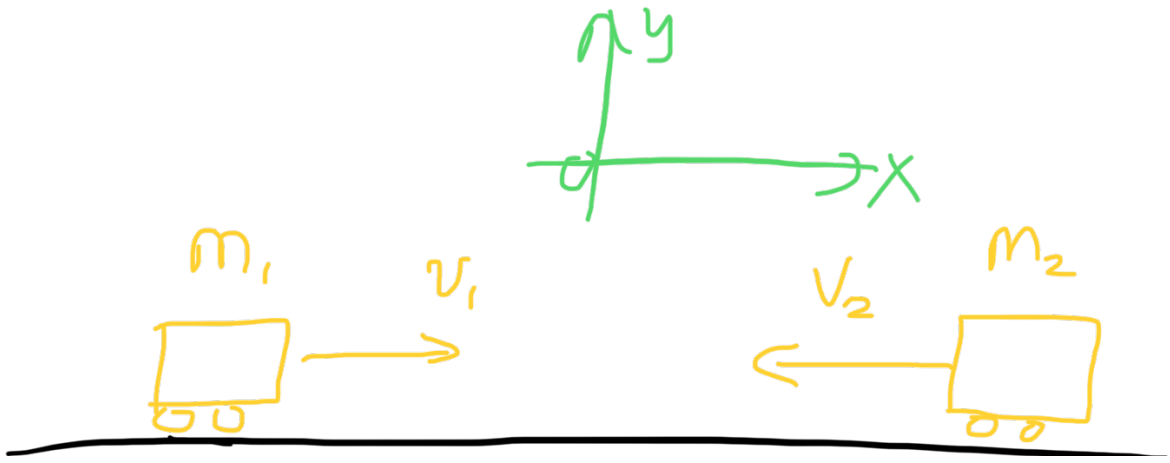
1. Systems of objects
2. What if $\vec{F}_{net} = 0$



$$\vec{P}_{system} = \vec{P}_1 + \vec{P}_2$$

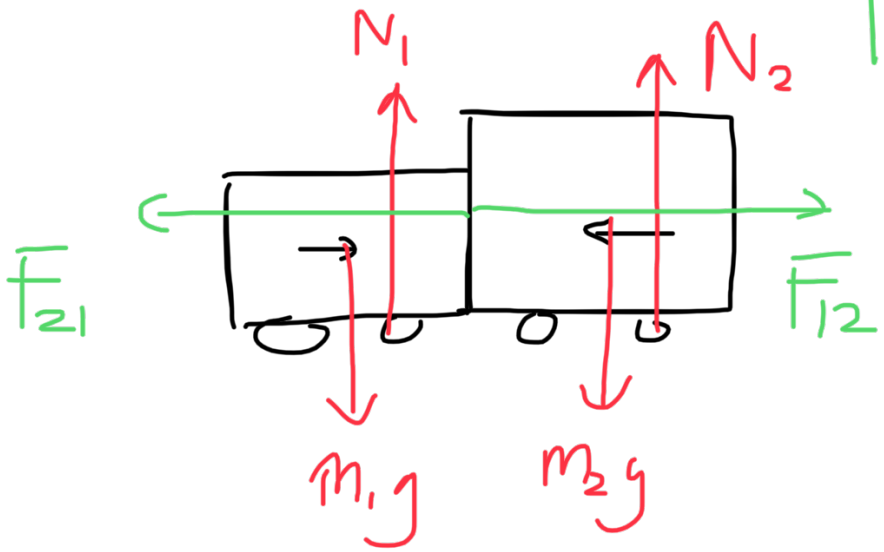
$$= m_1 v_1 + (-m_2 v_2)$$

$$= m_1 v_1 - m_2 v_2$$

Collision

$|N_1| = m_1 g$

$|N_2| = m_2 g$



$|F_{21}| = |F_{12}|$ N3L

$$\vec{F}_{net} = \cancel{\vec{N}_1 + \vec{m}_1\vec{g}} + \cancel{\vec{N}_2 + \vec{m}_2\vec{g}} + \cancel{\vec{F}_{12} + \vec{F}_{21}} = 0$$

$$\vec{F}^{(1)}_{net} \neq 0$$

$$\vec{F}^{(2)}_{net} \neq 0$$

$$\vec{F}^{(sys)}_{net} = \frac{d\vec{p}_{sys}}{dt} = 0$$

momentum of system does not change!

Conservation of Momentum

→ – Cars, trains, atoms, stars, planets, black holes, ...

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after collision

$$\vec{P}_{sys} = -m_1 V_3 + m_2 V_4$$

$$\vec{P}_i = \vec{P}_f \quad (\text{CoM})$$

$$m_1 v_1 - m_2 v_2 = -m_1 v_3 + m_2 v_4$$

Energy

Is energy conserved?

YES!

Is kinetic energy conserved?

Maybe

If kin. energy is

Conserved →

ELASTIC

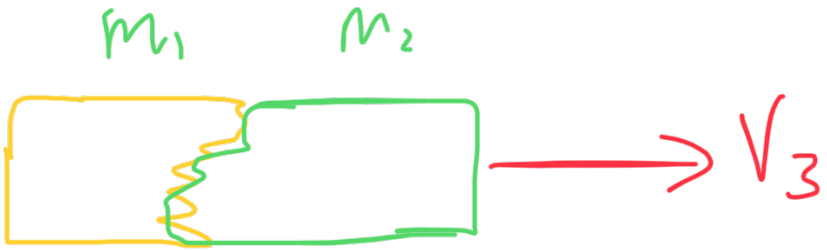
objects in initial state and final state are identical

$$K^{(i)}_{sys} = K^{(f)}_{sys}$$

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_3^2 + \frac{1}{2} m_2 v_4^2$$

(2)

Objects stick together



totally inelastic collision

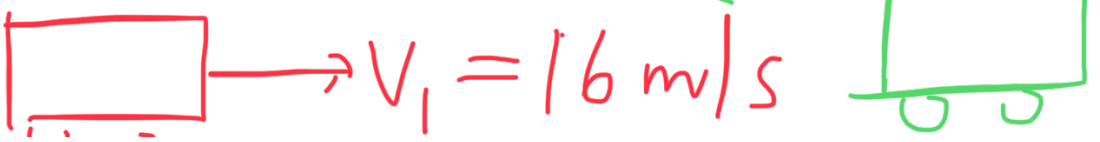
$$\vec{P}^{(+)}_{sys} = (m_1 + m_2) V_3$$

$$\vec{P}_i = \vec{P}_f$$

$$m_1 V_1 - m_2 V_2 = (m_1 + m_2) V_3$$

$m_2 = 2000\ kg$

$m_1 = 1000\ kg$



$V_2 = 24 m/s$

$\vec{P}_i = m_1 V_1 - m_2 V_2$

$= (1000)(16)$

$- (2000)(24)$

$= 16000 - 48000$

$\vec{P}_i = -32,000 \; kgm/s$

$= \vec{P}_f$

$= (m_1 + m_2) V_3$

$= (3000) V_3$

$V_3 = -\frac{32000}{}$

$$v_3 = \frac{}{3000}$$

$$V_2 = -10.7 \text{ m/s}$$

$$K_i^{sys} = \frac{1}{2} m_1 V_1^2 + \frac{1}{2} m_2 V_2^2$$

$$= \frac{1}{2}(1000)(16)^2 + \frac{1}{2}(2000)(24$$

$$= 704,000 \text{ J}$$

$$K_f^{sys} = \frac{1}{2}(m_1 + m_2) V_3^2 = 17200$$

$$= \frac{1}{2}(3000)(-10.7)^2$$