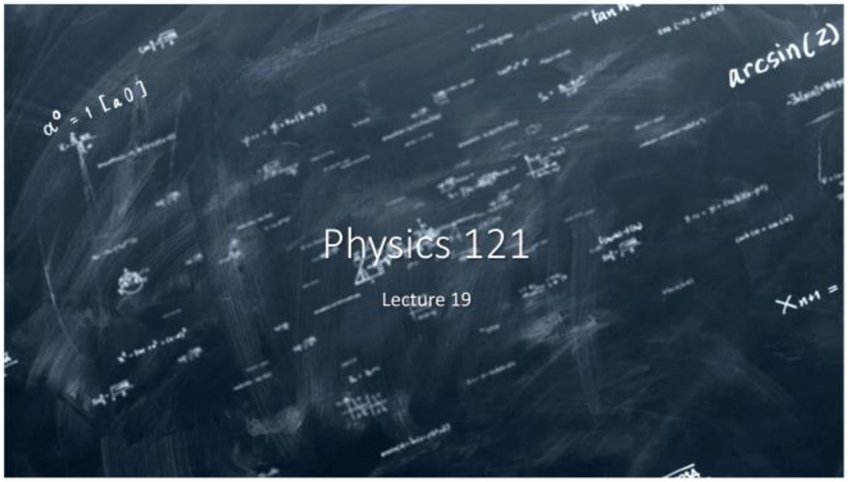
Lecture 19 - 3.16

Thursday, March 16, 2023 8:19 AM



Devotional Thought

What is the law of consecration?

It is an organized way in which individuals consecrate **their time, talents**, and **possessions** to the Church to build the Lord's kingdom and serve His children.

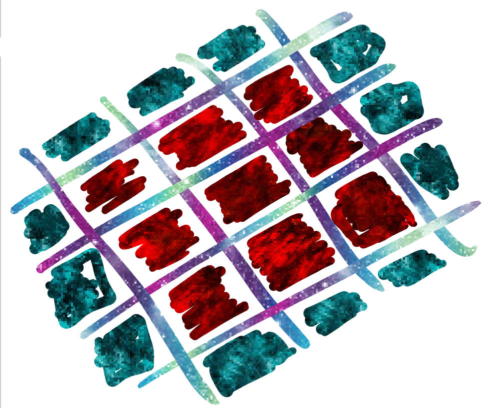
Elder Johnson

The greatest impact comes as we move forward with faith—keeping our covenants in order to receive His direction and His power, submitting to His will, and letting God prevail.

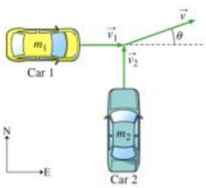
D&C 82

18 And all this for the benefit of the church of the living God, that every man may [a]improve upon his [b]talent, that every man may [c]gain other [d]talents, yea, even an hundred fold, to be cast into the Lord's [e]storehouse, to become the common [f]property of the whole church—

19 [a]Every man seeking the interest of his [b]neighbor, and doing all things with an [c]eye single to the glory of God.



Review – Lecture 18



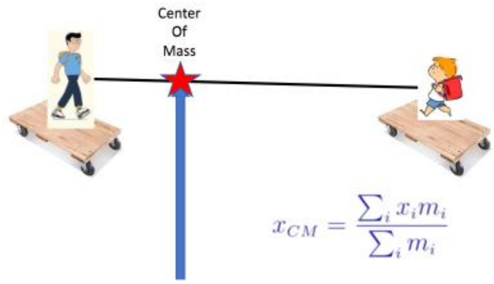
$$v_{1f} = 2v_{CM} - v_1$$

Check Vertical and Horizontal momentum seperately

Two kinds of collisions

ELASTIC
- Objects collide and bounce
- Kinetic energy is conserved
- No permanent deformation of the objects

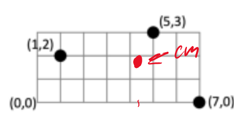
INELASTIC
- Objects collide and stick
- Kinetic energy is NOT conserved
- Objects stick because they lock together, or are permanently bent, or chemical reaction, or...



$$x_{CM} = \frac{\sum_i x_i m_i}{\sum_i m_i}$$

If we have a bunch of masses, we can define a "center of mass"

- Think about three particles, equal mass.



$$x_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} \qquad y_{CM} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

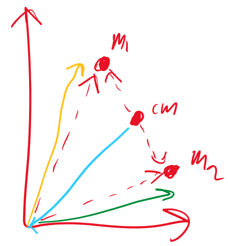
$$\frac{\cancel{m}1 + \cancel{m}5 + \cancel{m}7}{3\cancel{m}} = 4,3 \qquad \frac{\cancel{m}2 + \cancel{m}3 + \cancel{m}0}{3\cancel{m}} = 1,8$$

If the particles are moving, the center of mass can also move

If you have a bunch of point masses:

$$v_{CM} = \frac{\sum_i v_i m_i}{\sum_i m_i}$$

Q1: The total momentum in the center of mass frame is...



$\vec{V}_{1cm} = -\vec{V}_{cm} + \vec{V}_1$

$\vec{V}_{2cm} = -\vec{V}_{cm} + \vec{V}_2$

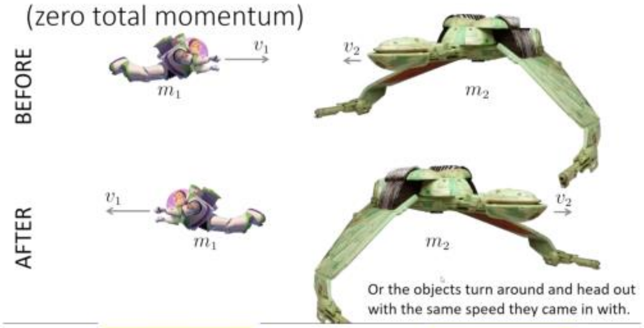
$P_{cm} = V_{1cm} \cdot m_1 + V_{2cm} \cdot m_2$

$\Rightarrow V_1 m_1 - V_{cm} m_1 + V_2 m_2 - V_{cm} m_2$

$= \cancel{V_1 m_1 + V_2 m_2} - \cancel{(m_1+m_2)} \cdot (\cancel{V_1 m_1 + V_2 m_2}) / \cancel{(m_1 + m_2)} = 0$

Total Momentum in CM reference is always 0

Collisions in the center of mass reference frame (zero total momentum)



Or the objects turn around and head out with the same speed they came in with.

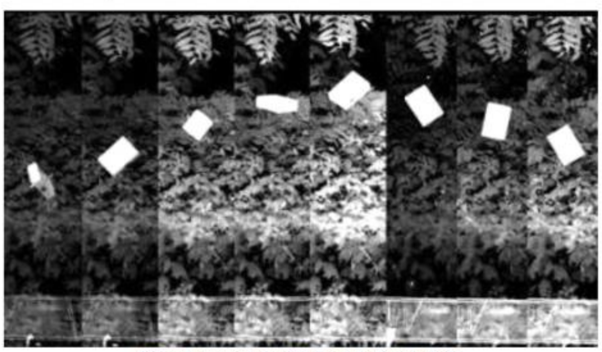
$v_{1f} = 2v_{CM} - v_1$ $\qquad$ $v_{2f} = 2v_{CM} - v_2$

What do you think?

A) Lower
B) Same height
C) Higher

https://www.youtube.com/watch?v=vWVZ6APXM4w

The unexpected solution.



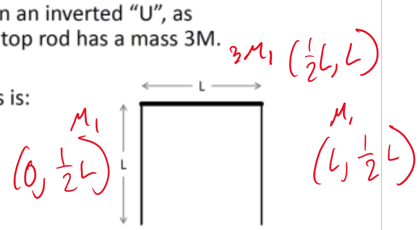
https://www.youtube.com/watch?v=BLYoyLcdGPc

Three rods

Three thin rods each of length L are arranged in an inverted “U”, as shown. The two side rods have a mass M. The top rod has a mass 3M. Where is the center of mass of the system?

The “horizontal” location of the center of mass is:

A. The middle of the top rod
B. Closer to the left rod
C. Closer to the right rod
D. Closer to the top rod



$$X_{CM} = \frac{\sum m_i \cdot x_i}{\sum m_i} = \frac{\cancel{M}\cdot 0 + 3\cancel{M}\cdot\frac{1}{2}L + \cancel{M}L}{1+3+1\ \cancel{M}} = \frac{(3\cdot\frac{1}{2}+1)L}{5}$$

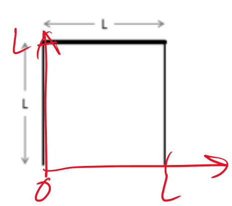
$$= \frac{(\frac{3}{2}+1)L}{5} = \frac{\frac{5L}{2}}{5} = \frac{2.5L}{5}$$

Three rods

Three thin rods each of length L are arranged in an inverted “U”, as shown. The two side rods have a mass M. The top rod has a mass 3M. Where is the center of mass of the system?

The “vertical” location of the center of mass is:

A. -L/5 $\quad 4/5\ L$
B. -L/4
C. -L/3
D. -L/2



$$= \frac{\frac{1}{2}L\cdot\cancel{M} + L\cdot 3\cancel{M} + \frac{1}{2}L\cdot\cancel{M}}{5\cancel{M}}$$

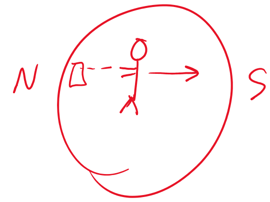
$$= \frac{\frac{1}{2}L + 3L + \frac{1}{2}L}{5}$$

$$= \boxed{\frac{4}{5}L}$$

Remember your kinematic equations?

A 73.9 kg man stands in the middle of a frozen pond of radius 5.41 m. He is unable to get to the other side because of lack of friction between his shoes and the ice. To overcome this difficulty, he throws his 1.29-kg physics textbook horizontally towards the north shore, at a speed of 5.12 m/s.

How long does it take him to reach the south shore?



$$0 = m_B \cdot v_B + m_S v_S$$

$$V_S = \frac{m_B v_B}{m_S} = \frac{1.29\,\cancel{kg}}{73.9\,\cancel{kg}} \cdot 5.12\,m/s = 0.09\ m/s$$

$$v = \frac{d}{t} \rightarrow t = \frac{r}{v_S} = \frac{5.41\,m}{0.09} \cdot s = \boxed{60\,s}$$

Momentum and kinetic energy

A pitcher claims he can throw a 0.145-kg baseball with as much momentum as a 3.39 g bullet moving with a speed of 1500 m/s.(a)

Which has greater kinetic energy, the ball or the bullet?

A) The Ball.
B) The Bullet.
C) They are the same, obviously.
D) Impossible to tell.

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

$$K_{bullet} = \frac{1}{2} \cdot 0.0039 \cdot (1500)^2$$

$$K_{ball} = \frac{1}{2} \cdot 0.145 \cdot (35)^2$$

$$P = m \cdot v$$

$$P_{bullet} = 0.0039 \cdot 1500$$

$$P_{baseball} = 0.145 \cdot v_B$$

$$v_B = \frac{5.085}{0.145} \approx 35\ m/s$$

Exit Poll

- Please provide a letter grade for todays lecture:

A. A
B. B
C. C
D. D
E. Fail