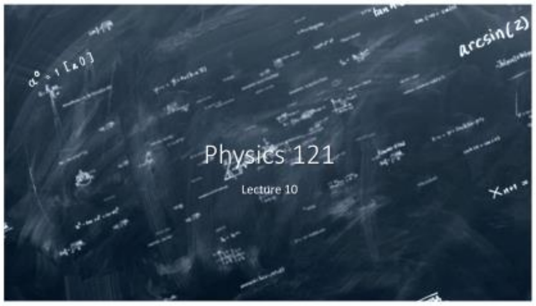
Lecture 10 - 2.9

Thursday, February 9, 2023 9:27 AM



Devotional Thought

A Master Class in Leadership: One Day with the Savior

In the end, leadership is about serving, teaching, encouraging and truly caring for individuals with kindness.

Blessed is the leader who does not seek the high position but is drafted into service because of his ability and willingness to lead.

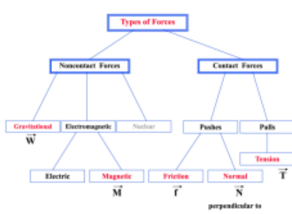
MARK A. BRAGG

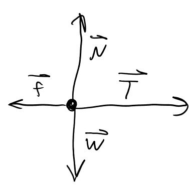
Review

Newton's first
A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless acted on by a net external force.

Newton's second
The acceleration of a system is directly proportional to and in the same direction as the net external force acting on the system and is inversely proportional to its mass.

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





$$\sum \vec{F} = \vec{F}_{net} = ma$$

$$-f + T = m \cdot a_x$$

$$-W + N = ma_y$$

Some Geometry Review

If C + D = 90 degrees:

C = F

A = D

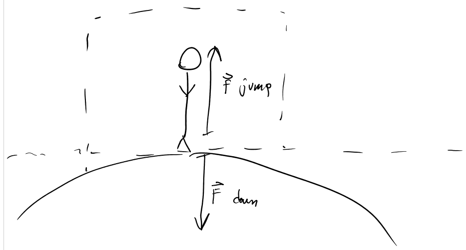
E = B

if you rotate the triangles to have the same orientation, they are the same triangle, of different scale

Discussion - Jumping

Let's suppose you are standing on the ground and you want to jump into the air. From a physics perspective, how is this even possible? What forces are acting on you?

Exert a force down on the ground, and the ground will exert an opposite but equal force back on you.



Weight and Mass $1\,\text{N} = 1\,\text{kg} \cdot \text{m/s}^2$

Weight is a synonym for Gravitational Force = mass * g

Which statement is True?

A) A dumbbell has the same mass on earth and moon
B) A dumbbell has the same weight on earth and moon
C) Developing physicists should avoid dumbbells at all costs

Weight is a force

$F = ma$

mass stays constant, but gravity changes, so the weight changes

NEWTON'S THIRD LAW OF MOTION

Discussion for next FHE:

If change is caused by a force and every force has an opposing counterpart...

...why is it save to go and try to change people's hearts?

Newton's 3rd law $\vec{F}_{1,2} = -\vec{F}_{2,1}$

- When two objects interact, each exerts a force on the other. Those forces are equal in strength and opposite in direction.
  - You walk by pushing back on the earth and the earth pushes forward on you
  - "Third Law Pairs"
  - Third-law pair forces act on DIFFERENT OBJECTS!

iClicker: the 3rd-law pair?

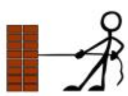
A book lies at rest on the table. What is the "third law pair" to the WEIGHT of the book?

A. The table pushing up on the book
B. The gravitational pull of the book on the earth
C. The book pushing down on the table
D. The normal force
E. More than one of the above

$$\vec{F}_{\text{gravity}} = \frac{Gm_1m_2}{r^2}$$

Pulling: Talk to your neighbor for a minute

A person pulls on a rope attached to a wall. He pulls with a force of 100 N. What is the tension in the rope? Why doesn't he fall over?



Pulling: iClicker

A person pulls on one end of a rope attached He pulls with a force of 100 N. His buddy is pulling on the other end of the rope with a force of 100 N. What is the tension in the rope?

A. 100 N, same as before
B. 0 N, because the forces cancel
C. 200 N, because now there is another force on the rope

Experiment: Pulling on string with force meter

https://www.youtube.com/watch?v=jO6B0yx3FHE https://www.youtube.com/watch?v=DWVrt49N5g8&t=4m45s

iClicker: Anita's hammer velocity

Based on the youtube video, Anita's hammer had a horizontal velocity of v_x = 80 meters / 4 seconds = 20 m/s. Let's calculate the rest of the information.

What was v_y?

A. About 10 m/s
B. About 15 m/s
C. About 20 m/s
D. About 25 m/s

$$y(t) = y_0 + v_y t - \frac{1}{2} g t^2$$

$y(4) = 0$

$y(0) = 0$

$$y(4) = 0 = 0 + v_y t - \frac{1}{2} g t^2$$

$$= v_y t = \frac{1}{2} g t^2$$

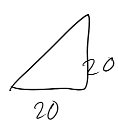
$$v_y = \frac{1}{2} g t = \frac{1}{2} 10 \cdot 4 = 20 \text{ m/s}$$

iClicker: Anita's hammer velocity

Based on the youtube video, Anita's hammer had a horizontal velocity of v_x = 80 meters / 4 seconds = 20 m/s. Let's calculate the rest of the information.

What was theta?

A. 45 degrees
B. 50 degrees
C. 55 degrees
D. 40 degrees



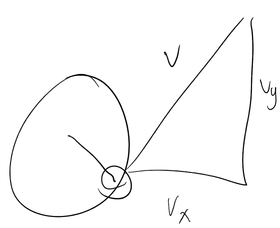
$$\tan^{-1}\left(\frac{20}{20}\right) = 45^\circ$$

iClicker: Anita's hammer velocity

Based on the youtube video, Anita's hammer had a horizontal velocity of v_x = 80 meters / 4 seconds = 20 m/s. Let's calculate the rest of the information.

What was the tangential velocity just before Anita let go?

A. 20 m/s
B. 25 m/s
C. 30 m/s
D. 35 m/s



$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{20^2 + 20^2}$$

$$\boxed{\approx 30}$$

iClicker: Anita and Newton's 3rd law

Athletes throw a metal ball (16lb/7.26kg for men, **4kg/8.8lb** for women) that is attached to a grip by a steel wire no longer than 1.22m while remaining inside a seven-foot (2.135m) diameter circle.

How much force did Anita exert on the hammer?

A. About 150 pounds
B. About 200 pounds
C. About 250 pounds
D. About 300 pounds
E. About 350 pounds

$$a_c = \frac{v^2}{r} =$$

$$F = m a_c = \frac{v^2}{r} \cdot m =$$

$$\frac{30^2}{1.22} \cdot 4 = 3000\,N$$

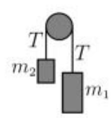
or 681 lbs

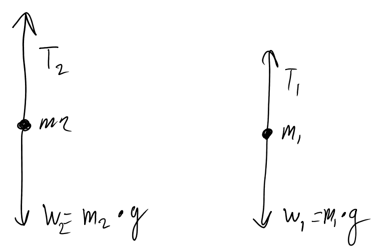
Those darn pulley problems

Two masses hanging over a pulley

Let's think about two masses hanging over a massless pulley on a frictionless, massless string. What is the acceleration of mass m_1?

Pull out a piece of paper and write a solution strategy





$m = m_1 - m_2$

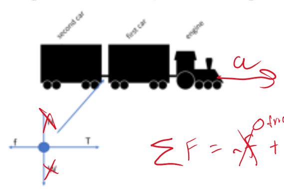
W

$$W_3 = (m_1 - m_2) \cdot g = (m_1 + m_2) \cdot a$$

$$a = \frac{m_1 - m_2}{(m_1 + m_2) \cdot g}$$

Chucka-chucka-choot-shoot problems

If such a train moves to the right with a certain acceleration, what is the Force acting between the cars?



$$\sum F = \cancel{f} + T = m \cdot a$$

0 friction

$$T = m \cdot a$$

given mass of 2nd car and acceleration of system, we can calculate T

Exit Poll

- Please provide a letter grade for todays lecture:

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