PHGN100 TOC

PHGN 100 - 2024-01-10

#notes #phgn100 #physics
PHGN100 - Block One

Real Physics Time

- Kinematics, don't care why things move, but we do care about *how* things move
- Equations

$$v_x(t) = \frac{dx(t)}{dt}$$

$$a_x(t) = \frac{d_v}{y}$$

- ok gotta go write those out more
- Speed vs velocity, speed tends to be just v, velocity is $\vec{v}$ or v_x

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example prob

- Acceleration is 5.7 m/s^3 (t), If $V_o t$ if 2.93 m/s, find velocity at t_f
- Velocity at final time is velocity at initial time + integral of acceleration from initial time to final time

$$v_{ix} + \int$$

Do some integration, $\frac{1}{2}ct^2$
$v_{ix} = \frac{1}{2}c(t_f^2 - t_i^2)$
25.73 m/s? Probably?

$$v_x(t) = v_x(t_i) + \int_{t_i}^{t} a_x(t')dt'$$

So that works out to be just about the same

$= v_{ix} + \frac{1}{2}c(t^2 - t_i^2)$

PHGN 100 - 2024-01-17

#notes #phgn100 #physics
PHGN100 - Block One

- Phys tends to write vectors in terms of $\vec{V} = V_x\hat{\imath} + V_y\hat{\jmath} + V_z\hat{k}$
- If $\vec{V}$ is a vector, then V is its magnitude
  - Question to ask
    - If something is positive or negative
- Alright let's get to integrating acceleration ig
  - $$v_x(t_f) = v_x(t_i) + \int_{t_i}^{t_f} a_x(t)dt$$
    $$v_i \sin\theta = \int_{t_i}^{t_f} a_0 e^{t/t_i} dt$$
    $$v_i \sin\theta + a_o t_i e^{t/t_i}\Big|_{t_i}^{t_f}$$

  You get there using $u = \frac{t}{t_i}$

PHGN 100 - 2024-01-22

#notes #phgn100 #physics
PHGN100 - Block One

- For 2d motion, we end up having vectors for x and y, and most of the time, they don't interact
- Bigger values of v_{iy} will take longer to slow to zero with the same acceleration
- Velocity is samesies right after launch as it is right before we land
- Hit time would be $t_{hit} = \frac{2v_1 \sin\theta}{g}$
- $t_{peak} = \frac{\text{y component}}{g}$
- Horizontal velocity is just the $\cos\theta * v_i$, which we just need to integrate with respect to time
  - So overall pos is just $x_0 + \int_0^{t_{hit}} v_x(t)dt = 0 + \int_0^{t_{hit}} v_1 \cos\theta dt$
- Hey, we could use the first derivative test to find the best angle to launch at
-

Funky question

- Airplane

$$a_y(t) = [\frac{v_x(t)}{v_{ix}} - 1] \;\; a_x(t) = Bt$$

$$v_{x(t)} = v_x(0) + \int_0^t a_x(t')dt' = v_{ix} + \frac{1}{2}Bt^2$$

- Oh hey look, we have 1/2 at^2 from algebra based physics

$$v_y(t) = v_{iy} + \int_0^t (\frac{v_x(t')}{v_{ix}})$$

$$v_{iy} + \int_0^t [\frac{\frac{1}{2}Bt^2 + v_{ix}}{v_{ix}} - 1]$$

Oh hey rename 1 to $\frac{v_{ix}}{v_{ix}}$

$$v_{iy} + \int_0^t [\frac{\frac{1}{2}Bt^2}{v_{ix}}]gdt'$$

Ugly ass integral. It's ugly. It's terrible.

PHGN 100 - 2024-01-24

#notes #phgn100 #physics

PHGN100 - Block One

1-4 advanced kinematics

- for an object with piecewise acceleration, figure out where tf it is
- use kinematics in "chase" style problems
- average vector quantities
  - with difference, both vector and graphical
  - and integrals!
- more integral shit
- Using a definite integral to t is a wonderful way of getting an equation while still cheating the $+C$

piecewise fella

- From t_1 to t_2, $a_A(t)$, from time t_2 to t_3, $a_B(t)$

- Given some $v_x(t_1)$, how fast is it moving at t_3? $v_x(t_3) = ?$
- $v_x(t_3) = v_x(t_1) + \int_{t_1}^{t_2} a_{A,x}(t)dt + \int_{t_2}^{t_3} a_{B,x}(t')dt'$
  - So our final velocity is the initial velocity, + the final velocity of the first segment, and finally smacking the final change in velocity at the end

time for....

the chase

Given $v_{car,x}(t)$ and $v_{moto,x}(t)$, two vehicles reach the same final position at the same time
$v_{car,x}(t) \neq v_{moto,x}(t)$
How far apart were they initially

- We can just go round and round and integrate velocities to get displacement and all that fun stuff

$$x_{car}(t_{i)+} \int_{t_i}^{t_f} v_{car,x}(t)dt = x_{moto}(t_i) + \int_{t_i}^{t^f} v_{moto,x}(t)dt$$

- I love the amount of physics questions where the answer is "we don't care!"
  - Why didn't we solve for acceleration here? We don't give a fuck!
- Displacement and average velocity have the same sign, because like, how in the world would you end up along the other direction

PHGN 100 - 2024-01-29

#notes #phgn100 #physics
[PHGN100 - Block One]

honestly just lots of notation shit

- The vector $\vec{F}_{\text{ba}}$ is the force of b on a
- 2nd subscript is a the thing being acted on
- Objects do not need to be in contact

more notation

- Gravity (mostly in celestial body contexts) $\vec{F}_{G,Eb}$
- Weight on earth also just gets $\vec{W}_{Eb}$

- Weight is always directed down

- We've got springs, $\vec{F}_{sp,ab}$
- Normal force, $\vec{N}_{TB}$
- $\vec{f}_{s,TB}$ static friction
  - vs...
- $\vec{f}_{k,TB}$ kinetic friction
- and finally tension, $\vec{T}_{SB}$

things that are definitively not forces

- Velocity
- Inertia is also not a force
  - tendency to not accelerate, but not a force
- Pressure
  - that's a force per area
- Centripetal acceleration
- Torque
- Centrifugal is also not real.
  - Fakers.

newton's laws (just to have them, ig)

1. In an intertial reference frame, an object will move with a constant velocity unless acted upon by a net external force
2. The acceleration of a system is proportional to the net external force and inversely proportional to its inertial mass
   1. There's some icky math I don't really want to write
   2. $\vec{a}_b = \frac{\sum_f \vec{F}_{jb}}{m_b}$
3. If object a exerts a force on another object b, there is an equal and opposite force acting from object b on object a
   1. $\vec{F}_{ab} = -\vec{F}_{ba}$
   2. or $F_{ab} = F_{ba}$
   3. Hand on forehead, forehead on hand
4. “Screenshot 2024-01-29 at 10.40.45 AM.png” could not be found.

> he had WAY too much fun with this
>
> - we got sesame street'd
> - is 2 the same as 3? no! is normal the same as gravitational? still no
>
> 2362n

> PHGN 100 - 2024-01-31
>
> #notes #phgn100 #physics
> PHGN100 - Block One
>
> # friction
>
> - really, truly, is a sneaky son of a bitch
>   - kinetic friction really isn't that bad
>   - static friction is lazy
>   - only has whatever magnitude it needs in order to prevent motion
>   - summary of a whole lot of demonstration: pain in the ass
>
> ### clicker
>
> - push a book such that it slides to the right
>   - This means we have static friction to the left
>
> ## block
>
> - you pull on a block with a rope downward with increasing θ, what happens to the normal force?
>   - goes up
>   - oh hey, we'll need that to calculate friction
> - μ is constant in this class, in real life we... honestly don't really know. shit's weird.
> - $
> - friction opposes relative slip, so if you're sitting on a conveyor belt, static friction is probably going to drag you along
> -

PHGN 100 - 2024-02-05

#notes #phgn100 #physics
PHGN100 - Block One

- We really need to free blaster from his tension suspended hell

$$\vec{T}_1 \sin(\theta) = \vec{W}_{EB} + \vec{T}_3 \sin(\theta)$$

$$T_2 = T_1 \cos(\theta) + T_3 \cos(\theta)$$

$$\vec{T}_3 = \frac{\vec{T}_1 \sin(\theta) + \vec{W}_{EB}}{\sin(\theta)}$$

$$\vec{T}_2 = \vec{T}_1 \cos(\theta) + \left(\frac{\vec{T}_1 \sin(\theta) + \vec{W}_{EB}}{\sin(\theta)}\right) * \cos(\theta)$$

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standard x-y, blaster is hanging on a rope in a train, yadayayadayada

- Weight has to be constant as you increase θ, yadyada
-

PHGN 100 - 2024-02-15

#notes #phgn100 #physics
PHGN100 - Block Two

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

- this is future alec looking back, wow I did not write a lot

PHGN 100 - 2024-02-21

#notes #phgn100 #physics
PHGN100 - Block Two

- Fun fact, you can approximate just about any function with a polynomial series
  - We'll get to that in calc 2.... later
  - This also means that we can approximate just about any *force* with a polynomial series

- $f = \frac{1}{T}, \omega = 2\pi f$
- $f = \frac{1}{2\pi}\sqrt{\frac{k_1+k_2}{m_b}}$

PHGN 100 - 2024-02-26

#notes #phgn100 #physics
PHGN100 - Block Two

- Dot product is a projection of how much of 1 vector is parallel to the other
- Cross product is perpendicularish
- $\hat{i}\hat{j}k\hat{i}\hat{j}k$
- Dot is $V_1 V_2 \cos(\theta)$, cross is $|\vec{V}_1 \times \vec{V}_2| \sin(\theta)$
-

PHGN 100 - 2024-02-28

#notes #phgn100 #physics

PHGN100 - Block Two

torque time

as a wise man once said, you torque me right round baby right round like a fulcrum baby right round right round

The larger the moment of inertia, the harder it is to get rotation

All translational motion has a rotational analog

Translational	Rotational
External Forces act on the system	External forces create torque
$\vec{F}_{ab}$	$\vec{\tau}_a b$
Mass, m_b	Moment of intertia, I_b
Acceleration, $\vec{a}_b$	Angular acceleration, $\vec{\alpha}_b$
Sum of the forces	Sum of the torques
External forces shown on FBD	Extended free body diagram (can no longer reduce objects to dots)

The physics department lost their sledgehammer

$\vec{\tau}_{F_{ab}} = \vec{r} \times \vec{F}_{ab}$
Also could be defined as $\tau = rF_{ab\perp}$
which is $\tau = \sin(\theta) rF_{ab}$

PHGN 100 - 2024-03-04

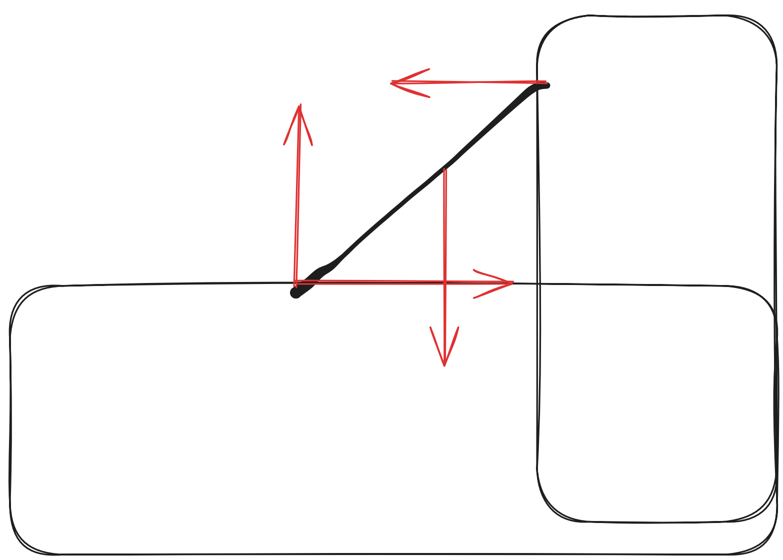
#notes #phgn100 #physics

PHGN100 - Block Two

first clicker

- started with a rotating wheel, the tension in the direction of the rotation was larger (exploding head)

clicker two



- Reasoning behind picking the bottom left of the pickaxe is because any torque acting on the axis itself is going to be 0
- you could set the axis at where the two normal forces intersect but that's *cringe*

$$f_s \times DE = W_{EP}$$

alright, least # of equations possible, answer he gave was one, it's arguably two because you do need to get weight from the mass

rotational statics

- block hang from cable on strut pin yadayada

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  Sure, let's sall that counterclockwise is positive

We have a weight force that acts on the block
Weight force on the strut
Tension from the rope, which is that we're solving for
There's some shenanigans going on at the pin as well

- hey, set your axis of rotation where you get to invalidate something you don't want to think about (read: the pin, in this case)

$$\sum \vec{\tau} = \tau_{T_{GS}} - \tau_{W_{ES}} - \tau_{WEb}$$

$$\sum \vec{\tau} = dT_{GS}\sin(\theta) - \frac{L}{2}m_s g\sin(\Theta) - Lm_b g\sin(\Theta) = 0$$

$$dT_{GS}\sin(\theta) = \frac{L}{2}m_s g\sin(\phi) + Lm_b g\sin(\phi)$$

- Quick bit o mathematical shenanigans
- $$T_{gs} = \frac{Lg\sin\phi(\frac{1}{2}m_s + m_b)}{d\sin\theta}$$
- there is, in fact, still bullshit going on at the pin
- you can solve for it by breaking the force into horizontal and vertical components and just doing sum of the forces is 0, but you can't put further names on them than the x and y components, because there's some shenanigans afoot

PHGN 100 - 2024-03-06

#notes #phgn100 #physics

rolling

(of perfectly rigid bodies on perfectly rigid surfaces without slipping)

so generally, when a wheel moves..

- the whole thing generally translates in a direction, at the velocity of the center of mass
    - (the entire wheel moves at this velocity)
- If it rolls to get there, there's also a torque and some rotating shenanigans going on
  - magnitude is the same, direction is perpendicularish
  to get the rolling whatever, you add translational and rotational
- which makes the top 2x the translational velocity
- the bottom 0
- and the sides at weird directions
- when we've got rolling without slipping, we have static friction
  - which means the value isn't just $\mu * N$, it's going to be some N2L based shenanigans
  Quick equations

$$x_{cm} = R\theta_{cm}$$

$$v_{cm} = R\omega_{cm}$$

$$a_{cm} = R\alpha_{cm}$$

  cm is about the center of mass

For some rolling object, with

$$I_{\text{round object}} = cMR^2$$

Determining which rolling object is going to win, let's use our newton's second lawys

$$\sum_j \vec{F}_{jb} = m_b \vec{a}_{b,cm}$$

$$x = m_b g \sin(\theta) - f_{s,pb} = m_b a_{b,cm}$$

and that's our translational sum, now for our rotational sum

$$\sum_j \vec{\tau}_{F_{jb}} = I_b \vec{a}_b$$

$$AOR : f_{s,pb} R = I_{cm} \alpha_{b,cm}$$

Hey, we got three equations, three unknowns, we nee- **Third Equation**

$$a_{b,cm} = R\alpha_{b,cm}$$

That's the no slip condition

Combine them, and you get...

$$f_{s,pb} = \frac{I_{cm} a_{b,cm}}{R^2}$$

You can plug that into the other end, and you geeeet

$$m_b g \sin\theta - \frac{I_{cm} a_{b,cm}}{R^2} = m_b a_{b,cm}$$

You can solve for a with a smidget of algebra bullshit

$$a_{b,cm} = \frac{m_b g \sin\theta}{m_b + (I_{cm}/R^2)}$$

You can plug moment of inertia in, and you get

$$a_{b,cm} = \frac{g \sin\theta}{1 + c}$$

Note: wheel bullshit will just follow sum of the forces

PHGN 100 - 2024-03-11

#notes #phgn100 #physics

work and kinetic energy shenanigans

- Work is a scalar
- We generally use joules for energy and work done
  - You don't have to push the whole object, we want the displacement of where the force is being applied
- Obligatory note about einstein being a pain in the neck and mass being energy yadayada
- We've got conservative and non-conservative forces
  - Conservative forces are....
    - independent of the path
    - Depend only on the endpoints
    - On a closed path, the work of a conservative force is equal to 0
    - Gravity and Ideal Springs
- $$gmh = mv^2$$
  $$\sqrt{gh} = v$$

Block go slippy slidey, it was on a closed path and the work was nonzero, so the force must not be conservative.

$$\sin = \frac{\Delta h}{hyp}$$

$$\sin\theta * d = \Delta h$$

Aaand we want energy, so it's

$$gm\sin\theta * d$$

maybe.

$$W_{\vec{F}} = \int_{s_i}^{s_f} \vec{F}_{ab} \cdot d\vec{s}$$

$$\vec{W}_{Eb} = m_b g(\sin\theta)\hat{\imath} - m_b g(\cos\theta)\hat{\jmath}$$

$$\hat{\jmath}$$

doesn't really exist, since we don't float off ther amp

aaaaand that works back out to

$$m_b g\sin\theta * d$$

$$\sqrt{2g\sin\theta * d}$$

should be the velocity

PHGN 100 - 2024-03-25

#notes #phgn100 #physics

- Rotational kinetic energy just uses moment of inertia, and you use rotational speed (ω)

$$W_{F_{YC}} = \int_{\theta_i}^{\theta^f} = \tau_{F_{YC}} d\theta$$

That torque is in fact just the radius times the force, since nothing else actually does anything

quick summary of heat energy

- this shit's fucked, we ain't got no idea

- you can only really tell when you set your system to aggressively make friction an internal force, and then just kinda think about it, and yeah, you'll share 10J

PHGN 100 - 2024-03-27

#notes #phgn100 #physics

- today we're getting into potential energy
  - I definitely have *not* been using that for the last several weeks by instinct
- Change in potential energy is defined as

$$\Delta U_{\vec{F}_{int}} = -\int_{\vec{s}_i}^{\vec{s}_f} \vec{F}_{int} \cdot d\vec{s}$$

- the minus sign is hanging out from just balancing the equation - pops in from moving to the other side
- this darn thing is going to keep popping up
  - in physics, it's just a really fancy way of saying is that energy is neither created nor destroyed
  - in chemistry, it pops up in chemistry as the first law of thermodynamics
    - looks a little different, may have gotten a tad tipsy, but they've got the idea
- If the force is not conservative, that means no potential energy
-

PHGN 100 - 2024-04-03

#notes #phgn100 #physics

- Long, long chat about the center of mass not changing between ie two interacting planets

we've got three kinds of collisions!

- perfectly elastic collision
  - kinetic energy remains constant before and after the collision
- perfectly inelastic collision
  - They smack together and move off happily ever after
- inelastic
  - they crunch, munch a bit, and then KE is not the same

- If time or external forces are particularly small, you can say momentum is constant

$$5\sin(\theta) = 3, \theta = 36.67^\circ$$

$$v_{sf,x} - v_{1f,x} = v_{1i,x} - v_{2i,x}$$

PHGN 100 - 2024-04-08

#notes #phgn100 #physics

- We use $\vec{L}$ for angular momentum
  - You just use the moment of inertia times angular velocity $I_{object}\vec{\omega}_{object}$

$$\frac{L^2}{2I} = \frac{1}{2}I\omega^2$$

- Angular momentum is super similar to rotational, with one big difference - if the time

PHGN 100 - 2024-04-24

#notes #phgn100 #physics

Advanced gravitation (yippee)

$$\vec{F}_{21} = -G\frac{m_2 m_1}{r_{21}^2}\hat{r}_{21}$$

Alternatively, if you're too lazy to get a unit vector

$$\vec{F}_{21} = -G\frac{m_2 m_1}{r_{21}^3}\vec{r}_{21}$$

Little g, though

$$\vec{g}(\vec{r}_1) = -\sum_{k=2}^{N} G\frac{m_k}{{r_{k1}}^2}$$

alright alright, wtf is going on with gravity?

- what the hell is mass?
  - Is it the relationship between force and acceleration (ie $F = ma$)?
  - The property that determines the gravitational force?
- Is it a force, an acceleration, some wibbly wobbly timey-wimey stuff?

> - Why does gravity only pull?
> - Why is it such a lil baby force?
> - Basic idea of a gravitational field: gravity influences the entire universe (just.... very very small, past most points)