Unit 1

*note

to find values in 2D, split into vector components - this will involve trig! (usually)

Kinematics eqs

position: $X_f = X_i + V_o t + \frac{1}{2} a t^2$ $(\Delta x = V_o t + \frac{1}{2} a t^2)$

Velocity: $V_f = V_o + at$ (no Δx) interchangable w/ y

Other formulas

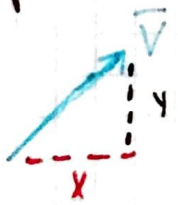
When time doesn't matter → $V_f^2 = V_i^2 + 2a\Delta x$ (no t)

When acceleration doesn't matter → $\Delta x = \frac{1}{2}(V_i + V_f)t$ (no a)

Can be used in questions asking?

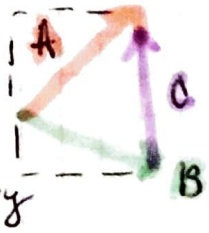
- Projectile motion in 1 & 2 dimensions (x & y)
- how far something moves / accelerates (constant & not constant) & calculating speed
- how much time it takes for something to move

HWs to review (and quizzes) - H1, H2, Q1, Practice Q 1

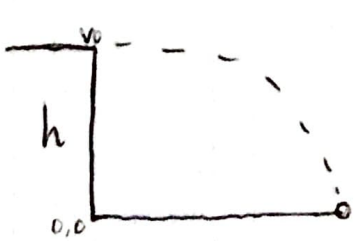
* 

if $A + B = C$

then $A_x + B_x = C_x$ & $A_y + B_y = C_y$



Remember to change coordinate systems w/ angles below/above the horizontal if it makes life easier!!! ☺



also write questions (if helpful) to find what you need

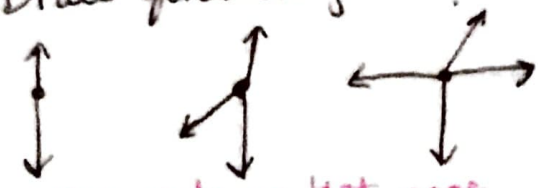
"What is ___ when ___ is ___?"

V_f	h	0
$X(t)$	$Y(t)$	0

make a drawing!!

Unit 2

Draw force diagrams!



See note on last page about vectors & CPs

- Newton's 2nd → $\vec{F} = ma$
  - Can break into components
    $\vec{F}_x$ & $\vec{F}_y$
  - Can include: Tension, Friction, Traction
  - Will include: F_N (normal force) & gravity (usually)

Can be used in questions asking?

- Calculating Static or Kinetic Friction → $\mu \cdot F_N = F_{Fric}$ (↑ in opposite direction of motion)
- things sliding on surfaces in 1 or 2 D
- Vehicles "pulling" forward in 1 or 2D
- finding acceleration to insert into a kinematics eq.
- finding tension in ropes / pulley stetem

HW & Quizzes to Review: HW 3-5, Practice Q 2 # 2, 3, 6, 7
HW 3 Q 3 is a good one!

* Space & circles ↑ ≈

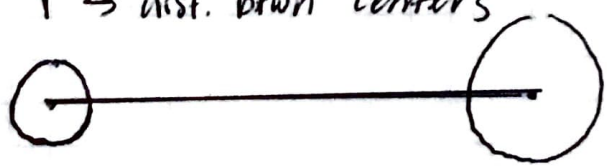
quick subsection!

$$\vec{F}_g = \frac{G M_1 M_2}{r^2}$$

$G_{Earth} = 6.67 \cdot 10^{-11} \frac{N \cdot m^2}{kg^2}$

where F_g: - diminishes over dist
- larger for more massive objects

r → dist. btwn centers



HW 5 is best for Review, Practice Quiz # 4

Unit 2 Cont

Circles & Space

$\theta = \omega t$ ← full rotation ↓ useful for sub. ↑

$\omega \rightarrow$ angular velocity $\quad \omega = \frac{\text{angle}}{\text{time}}; \frac{2\pi \text{rad}}{t}; \frac{V}{r}$

$a_c \rightarrow$ Centripetal acceleration $\quad a_c = \omega^2 r; \frac{v^2}{r}$

! always goes towards the center

↳ This is derived from $S = \theta r$ & $V = \omega r$

↳ dist. traveled = angle rotated · radius

$r \rightarrow$ radius, meters

Can be used in questions asking?

- Force of objects moving in a circle (req: force diagram)
- Space Questions ∴ objects orbiting → assume circular (HW 5 #4)
  (even if its an ellipses)
  - force of objects affected by gravity and apparent weight (HW 5 #3)
    ↳ F_n exerted on object by surface below it
- Finding Velocity or Centripi. acceleration (or Static friction) or Tension...
- Find in terms of variables (Hw 5 #7) anything really

STEPS to keep in mind ☺

1. Draw cartoons & force diagrams
   - better understanding of how systems move
   - Separate diagram for each interesting object
   - Label all forces
2. Translate FD's into Newton's 2nd law
   - Change Coordinate System if needed (helps to align with $\vec{a}$)
   - ~~Solve~~ write out rather X & Y components separately
   - leave things in algebraic variables to make things easy
3. Construct System of Eq. – Solve for what you know

   Then find what you need ☺

   (This is where formulas & relations come into play)

Unit 3 & 4

- Walter's notes on his website is pretty comprehensive
  So i'll only have what I think is important to note + resources

Momentum → $P = mv$ (vector)

involves 3rd law:

if A pushes on B,
B pushes back on A

Conservation of momentum (can't be created or destroyed)

$$\underbrace{m_a v_a + m_b v_b}_{\text{initial}} = \underbrace{m_a v_a + m_b v_b}_{\text{final}}$$

$F_{A \to B} = -F_{B \to A}$ (useful for substitution!)

Δ Momentum → impulse delivered; $P_i - P_f = \vec{F}$ (when constant)

* angular Momentum → Similar concept, but Circular
  ang. velocity = rotational mass / ang. momentum

↳ $L = I\omega$ (I: inertia, ω: a. velocity)

$$\underbrace{L_a + L_B}_{\text{initial}} = \underbrace{L_A + L_B}_{\text{final}}$$

Inertia can be... MR^2 → general

$\frac{1}{2}MR^2$ → circle, cylinder

MR^2 → ring

$\frac{2}{5}MR^2$ → sphere

! what we use most

* Can also be a combo

B: $L_p = 0$, $L_\omega = CW$

A: $L_p = ?$, $L_\omega = CCW$

Note: Think of before and after scenarios

is something sticking after collision? ($V_f(m_1 + m_2)$) or not?

Can be used in questions asking?

- Momentum in 1 & 2D (vectors are vital!) (Hw 6 #1, 3 Hw 7 #1)
- angular Momentum: finding ang. velocity (Hw 7 #3) or momentum
- Momentum in Combination w/ kinematics (Hw 7 #2)

- Resources: Hw 6 & 7, Practice Quiz 3 # 2, 3, 6

READ ME → * Hw 7 #4 is good review for linear + angular momentum combinations!!!

Unit 4 Con't

Work-energy Theorem

use when there are/is
- clear initial & final states
- no need for time
- easy calculation of Σ Work

1D: $\frac{1}{2}mv_i^2 + \sum \text{Work} = \frac{1}{2}mv_f^2$
- $\frac{1}{2}mv_i^2$: Kinetic Energy (scalar)
- $\sum$ Work: ↳ sum of all work done

2D: $\frac{1}{2}mv_i^2 + \sum \text{Work} = \frac{1}{2}mv_f^2$
↳ uses dot product

Note:
- if $\vec{F}$ in direction of motion, $F\Delta x$ is + & speeds up
- if $\vec{F}$ is in opposite direction, vice versa.

Work (in 1D): $\sum \vec{F} \cdot \Delta x$
↳ size of force; ↳ distance

Work (in 2D): $\sum \vec{F}_{\parallel}(\Delta s)$ OR $\sum \vec{F}(\Delta s_{\parallel})$ ← easy!
- Component of force || to displacement
- Component of displacement || to Force

* must ALWAYS follow (be parallel) to motion

What can do Work? - Gravity, friction, tension, elasticity
Some of these can also be labeled as POTENTIAL ENERGY

Ex: PE gravity → $\frac{1}{2}mv_i^2 + (mg)h = \text{Final}$
↳ change in height

Friction, however... is nonconservative as PE forces do not depend on the path

Whereas friction DOES depend.

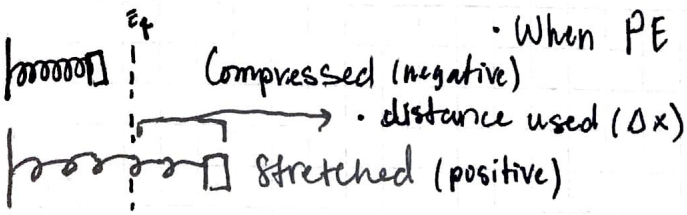
$\Delta H = \frac{V_f^2 - V_i^2}{2g}$

Created by Coach AJ (from when I took this)

SPRINGS → $F_{elastic} = k(\Delta x)$

↑ Spring Constant, $\frac{N}{m}$

Equilibrium when $\vec{F} = 0$



- When PE ⇒ $F_{elas} = \frac{1}{2}k(\Delta x)^2$

Unit 5

last section :)
gonna be real short
(famous last words)

POWER

is measured in Watts ($\frac{1 \text{ Joule}}{\text{sec}}$)

$P = \vec{F} \cdot \vec{V}$ → derived from Work-Energy

- P: rate of work done w/ watts
- $\vec{F}$: force of power
- $\vec{V}$: rate of distance

ROTATIONAL KE

$\vec{V} = \omega r$ so $KE = \frac{1}{2} m v^2$

$KE = \frac{1}{2} m r^2 \omega^2 \rightarrow \frac{1}{2} \lambda m r^2 \omega^2$

I

→ we recognize this?

$\lambda =$ (slow → fast)
- 1 → ring
- 1/2 → cylinder
- 2/3 → hollow ball
- 2/5 → solid ball

$\omega^2 = \frac{V_f^2}{r^2}$ where $V_f = \omega r$

↳ radius being rolled on

is the rolling constant aka "no slip"

A diagram I use for studying

translation + rotation = rolling

Ex: $\underbrace{mgh}_{PE_i} = \underbrace{\frac{1}{2} m v_f^2}_{E_{Trans}} + \underbrace{\frac{1}{2}\left(\frac{1}{2} m r^2\right) \omega_f^2}_{E_{rolling}}$

To find V_f → $\sqrt{\frac{gh(2)}{1+\lambda}}$ which = 1/2 in ex.

Sound

$v = \lambda f$

- v: speed of sound
- λ: wavelength
- f: frequency

Fund: $\lambda = 2L$ $\quad f = \frac{V}{2L}$

for each harmonic $\lambda = \frac{2L}{X}$ $\quad f = \frac{V}{2L} \cdot X$

Base Quantities, Units & more!

Base Quantities	Unit	Sym
length	Meters (m), feet (ft)	L
mass	grams (g), pounds (lb)	m
time	Seconds (s)	t

Quantities

↑ your best friends for life ↑ :)

Force	Newtons ($kg\frac{m}{s^2}$), $lb = \frac{slug\ ft}{s^2}$	F, Weight
Velocity	m/s , ft/s	V
~~Energy Joule~~	$kg\frac{m^2}{s^2}$, N·m, W·s	~~Joule Energy~~, J
Power	$kg\frac{m^2}{s^3}$, J/s, $N\cdot\frac{m}{s}$	Watts, W
Acceleration	m/s^2	a
Frequency	Hz, 1 cycle/sec	

Remember Some Constants/values given can be unitless!

me & my homies HATE english units :/ SI is superior

VECTOR vs SCALAR

has magnitude + direction

- displacement
- Velocity (except in energy problems)
- force
- notated w/ arrow ex: $\vec{V}$

specified with units, sometimes solved algebraically

- given base quantities (see above)
- no notation

K	H	D	W	D	C	M
3	2	1	Base	-1	-2	-3
Kilo	Hecto	Deka		deci	centi	milli

use your conversions ~!

Other things to know + more

- Quadratic eq → useful in Kinematics (unit 1)

$0 = ax^2 + bx + c \rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

if $\sqrt{\ }$ is negative / becomes imaginary

there is no real answer

- $F_{Friction}$ → Nonconservative force (see Work & Energy - Unit 4)

$\leq \mu_s F_N$ Sticking

$= \mu_k F_N$ Sliding

- Is momentum conserved in a portal? Is energy?

(be prepared to answer questions like this)

Ex: a) Always b) Sometimes c) Never

Explain your reasoning

- Check out Walter's notes on Work, Energy & Momentum on the announcements tab (they may be more helpful !!)
- Have past Hw pdfs and reference sheets out in one place & organized for the exam. (its better than chegg)
- Try your best to not freak out (note to self)

Lastly, take a deep breath. We made it to the end. You got this !!! Good luck w/ finals week!

Stay Hydrated PHY 211!

- @ Amazing Max. jpeg on discord + Twitch

Class of 2024