TOPICS

- KINEMATICS
  LINEAR & ANGULAR
- DYNAMICS
  NEWTON'S LAWS
  • CONSTANT FORCES
  • $F = F(v)$, DRAG
- CONSERVATION LAWS

KINEMATICS

CONSTANT ACCELERATION: a_0 & α_0 (NOT APPLIED TO $a_{cp} = $ CONST.)

KNOW HOW TO DERIVE

$a_0 = \frac{dv}{dt}$ $\qquad$ $\alpha_0 = \frac{d\omega}{dt}$ $\qquad$ INTEGRATION

$v = v_0 + a_0 t$ $\qquad$ $\omega = \omega_0 + \alpha_0 t$ $\qquad$ INTEGRATION

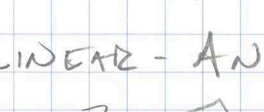
$x = x_0 + v_0 t + \frac{1}{2} a_0 t^2$ $\qquad$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha_0 t^2$

$v^2 = v_0^2 + 2a_0(x - x_0)$ $\qquad$ $\omega^2 = \omega_0^2 + 2\alpha_0(\theta - \theta_0)$ $\qquad$ NO t

SELECT THE EQUATION THAT AVOIDS MULTIPLE STEPS
eg. CALCULATING t TO SUBSTITUTE INTO ANOTHER EQUATION. INSTEAD, USE THE "NO t" EQUATION.

FOR MULTIPLE OBJECTS DETERMINE WHAT QUANTITY OBJECTS SHARE
eg THEY GO THE SAME DISTANCE $\Rightarrow x_{ONE} = x_{OTHER}$
THEY TRAVEL FOR THE SAME TIME $\Rightarrow t_{ONE} = t_{OTHER}$

LINEAR - ANGULAR CONVERSION



$$s = R\theta \qquad s = \text{ARC LENGTH}$$

$$\Rightarrow v = R\omega, \quad a_{TAN} = R\alpha, \quad a_{cp} = \frac{v^2}{R}$$

PROJECTILES
TIME LINKS x & y
- KEEP IN SYMBOLS UNTIL FINAL STEP

DYNAMICS

NEWTON'S LAWS OF DYNAMICS

I. STUFF COASTS

ZERO EXCEPT IN ROCKETS

II. $\sum \vec{F}_{EXT} = \frac{d\vec{p}}{dt} = \vec{v}\cancel{\frac{dm}{dt}} + m\frac{d\vec{v}}{dt} = mv\frac{dv}{dt}$; $\sum \vec{\tau}_{*} = \frac{d\vec{L}}{dt} = I\alpha$

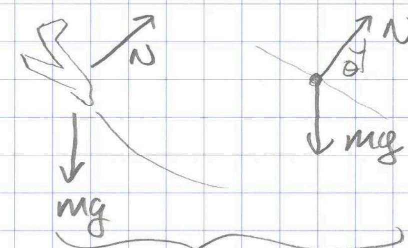
III. STUFF PUSHES BACK

APPLICATIONS OF N.S.L.

- SKETCH SITUATION
- MAKE A SEPARATE FBD (WITH FORCES, ANGLES, COORDINATES)
- WRITE OUT

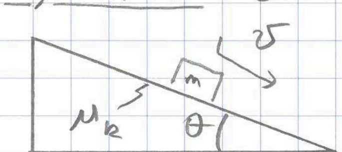
$$\underbrace{\sum F}_{\text{FORCES}} = \underbrace{ma}_{\text{ACCELERATION}}$$

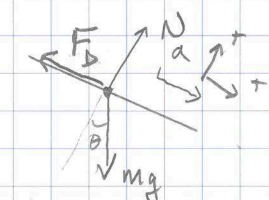
IN EACH COORDINATE DIRECTION



DO BOTH!

EXAMPLE: BLOCK SLIDING WITH DRAG





WORK VERTICALLY (DON'T STRING OUT IN A ROW)

$\sum F_{\perp} = m\cancel{a_{\perp}}$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$

$\sum F_{\parallel} = ma_{\parallel}$ ← DON'T SKIP THIS!

$mg\sin\theta - F_D = m\frac{dv}{dt}$ OR $mv\frac{dv}{dx}$

$\cancel{m}g\sin\theta - \cancel{m}kv = \cancel{m}\frac{dv}{dt}$

$\Rightarrow \int_0^t dt = \int_{v_0}^{v} \frac{dv}{g\sin\theta - kv}$

DRAG

- OPPOSES VELOCITY
  (USE FBD TO BE CERTAIN OF SIGN)
- USE FORM OF NSL THAT'S MOST CONVENIENT

$$\sum F = m\frac{dv}{dt} = mv\frac{dv}{dx}$$

- USE LIMITS IN INTEGRATION!
  → 0 TO t, x_0 TO x, v_0 TO v

CONSERVATION LAWS

LINEAR MOMENTUM $\frac{d\vec{p}}{dt} = 0$

$\Sigma F = \frac{d\vec{p}}{dt} = 0 \Rightarrow$ NO EXTERNAL FORCES ACT

$\vec{p}_i = \vec{p}_f \Rightarrow$ TRUE IN EACH COORDINATE DIRECTION

ANGULAR MOMENTUM $\frac{d\vec{L}}{dt} = 0$

$$\left.\begin{aligned} \vec{\tau} &= \vec{r} \times \vec{F} = r_\perp F = r F_\perp = I\alpha \\ \vec{L} &= \vec{r} \times \vec{p} = rmv \sin\theta = I\omega \end{aligned}\right\} \text{KNOW THESE}$$

$\Sigma \vec{\tau} = \frac{d\vec{L}}{dt} = 0 \Rightarrow$ NO EXTERNAL TORQUES ACT

ENERGY

WORK $W_{ab} = \int_a^b \vec{F} \cdot d\vec{r}$, $W =$ (FORCE)(DISTANCE PARALLEL) KINETIC ENERGY $T = \frac{1}{2}mv^2$

WORK-ENERGY THEOREM I

$$W_{TOTAL} = \Delta T = T_f - T_i = \frac{1}{2}m_f v_f^2 - \frac{1}{2}m_i v_i^2$$

POTENTIAL ENERGY

$$\Delta U = -W_{CONSERVATIVE} = -\int_a^b \vec{F} \cdot d\vec{r} = U_b - U_a$$

WORK-ENERGY THEOREM II

$$W_{TOTAL} = W_{NC} + W_{CONS} = \Delta T$$

$$W_{NC} - \Delta U = \Delta T$$

$$W_{NC} = \Delta T + \Delta U = \Delta(T+U)$$

$$W_{NC} = \Delta E_{MECHANICAL}$$

STABILITY

EQUILIBRIUM POINT HAS $\left.\frac{dU(x)}{dx}\right|_{x=x_0} = 0$

STABILITY:
$\frac{d^2U}{dx^2} > 0$ STABLE
$\quad '' \quad = 0$ NEUTRALLY STABLE
$\quad '' \quad < 0$ UNSTABLE