"PARTICLE" WEEK

WHAT'S A FREE BODY Diagram?

3.1 EQUILIBRIUM

"EQUILIBRIUM"... Particle remains @
constant velocity \( v = \text{const} \),
i.e., if \( v = 0 \), particle remains
@ REST

NEWTON's FIRST LAW:

\[
\sum F = 0
\]

NEWTON's SECOND LAW

\[
\sum F = m\ddot{a}
\]

with \( \ddot{a} = 0 \)
no acceleration

3.2 FREE BODY Diagram

super, super, super important!

to evaluate \( \sum F = 0 \), we must know **All**

forces acting on the particle!

& "FREE BODY Diagram"... Drawing

that shows the particle with

**All forces acting on it**
- II -

4. CABLES... weightless & unstretchable
   can only support tension along their axis

5. Pulley...
   frictionless (for now)
   tension force of a cable that passes over a pulley may change in direction but not in magnitude

Example, free body diagram @ A

1. I draw outlineshape (easy!)
   isolate particle of interest

2. II show all forces (tricky! practise!)
   forces pointing away are tensile forces

3. III label each force
   \( F_{AD}, F_{AC}, F_{AB}, F_{BD}, F_{DC}, F_{BC} \)
3.3 COPLANAR FORCE SYSTEMS

EQUILIBRIUM

\[ \sum \mathbf{F} = 0 \quad \mathbf{F} = \begin{bmatrix} F_x \\ F_y \end{bmatrix} \]

\[ \sum F_x = 0 \quad \sum F_y = 0 \]

EXAMPLE 3.2

determine tension \( T_A \) & \( T_C \) in cables \( BA \) & \( BC \) necessary to support the 60kg cylinder!

\[ W = m g \]

\[ W_y = 60 \text{ kg} \cdot 9.81 \frac{\text{N}}{\text{kg}} \]

\[ W_y \approx 589 \text{ N} \]

II EQUILIBRIUM

two equations, two unknowns

\[ \sum F_x = 0 : \quad - \frac{4}{5} T_A + T_C \cos 45^\circ = 0 \]

\[ \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} = 0.707 \]

\[ \sum F_y = 0 : \quad + \frac{3}{5} T_A + T_C \sin 45^\circ - W_y = 0 \]

\[ \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} = 0.707 \]

e.g. isolate \( T_A \) in (1) and plug into (2) to calculate \( T_C \), and then, from (1), calculate \( T_A \)
\[ T_A = \frac{5}{4} \cdot \frac{1}{2} \sqrt{2} \ T_c \]  
\[ T_c \cdot \frac{1}{2} \sqrt{2} + \frac{3}{4} \cdot \frac{8}{7} \cdot \frac{1}{2} \sqrt{2} \ T_c - W_y = 0 \]  
\[ \frac{7}{8} \sqrt{2} \ T_c = +W_y \rightarrow T_c = \frac{8}{7} + \frac{1}{4} \ W_y \]

\[ T_c \approx 476 N \quad \text{box or underline solution} \]
\[ T_A = \frac{5}{4} \cdot \frac{1}{2} \sqrt{2} \cdot \frac{8}{7} + \frac{1}{4} \ W_y = \frac{50}{7} + \ W_y \]  
\[ T_A \approx 420 N \quad \text{signs are both positive, assumed directions are correct!} \]

check with (2) always try to check solution

\[ \frac{3}{5} \cdot 420 N + \frac{1}{2} \sqrt{2} \cdot 476 N - \frac{589}{N} = 0 \]

\[ \frac{252N}{334N} \quad \frac{334N}{589N} \]