# lecture #4 Equilibrium, FBDs

Jan/16/2013

*Intro to FBDs = Free Body Diagrams
*Solving particles at equilibrium

if particle remains at rest

has a constant velocity if was in motion

- Must satisfy Newton's 1st law of motion to maintain equilibrium

$$\Sigma F = 0$$

→ sufficient condition for equilibrium

- Newton's 2nd law of motion

if $\Sigma F = ma = 0$

⇒ particle in equilibrium because $a = 0$ & $\Sigma F = 0$ ⟨ particle at constant velocity OR rest

- equilibrium equation ⇒ used to solve problems dealing with equilibrium of a particle involving no more than 3 unknowns.

FBD (Free Body Diagram)

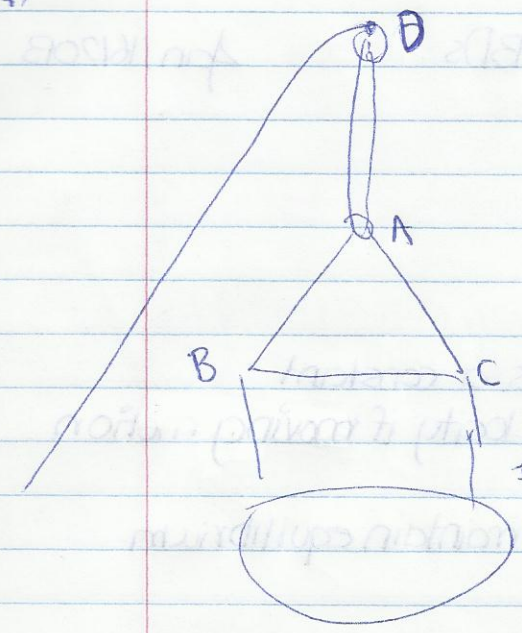
- used to show the relative magnitude & direction of all forces acting upon an object.
- knowns & unknowns, all forces must be accounted to apply the equation of equilibrium

Procedure for drawing a FBD

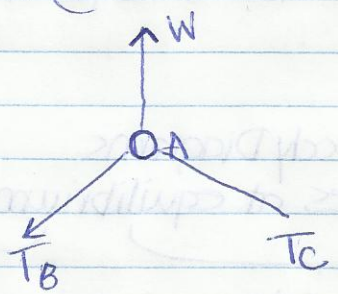
① take particle from surrounding

② sketch outline shape with all forces of particle

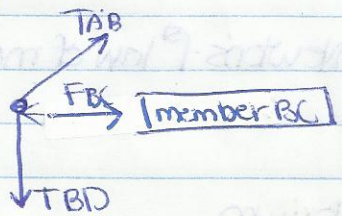
③ label All forces with both their magnitude & direction



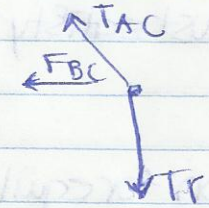

FBD @A



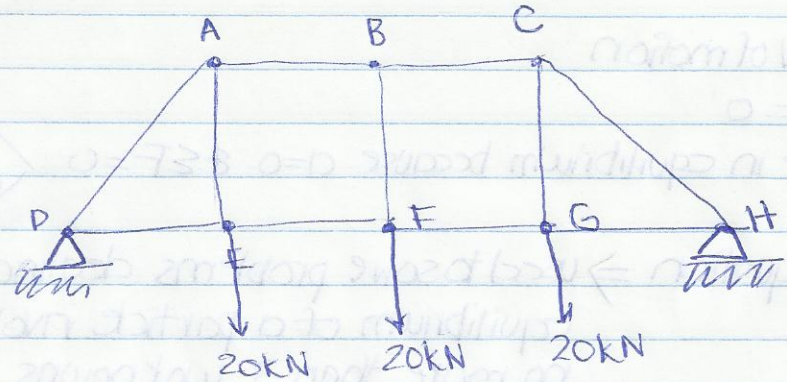

FBD @B



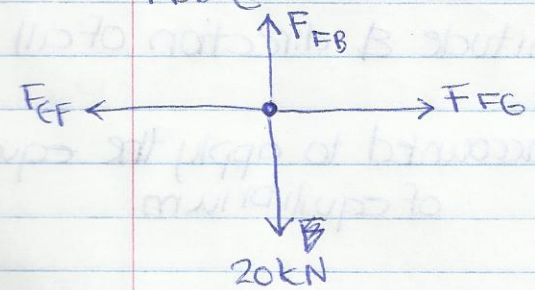

FBD@ C




Example




FBD @F




$\Sigma F_x = 0$

$\Sigma F_y = 0$

$F_{BF} = 20kN$

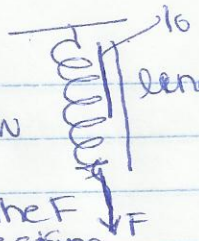
FBD FG


FBD@G

FBDs

2 Typs

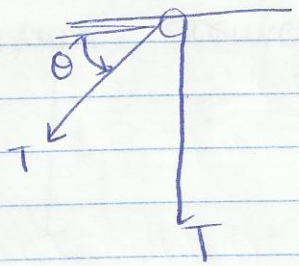
Springs
- Hooke's law
- $F = ks$



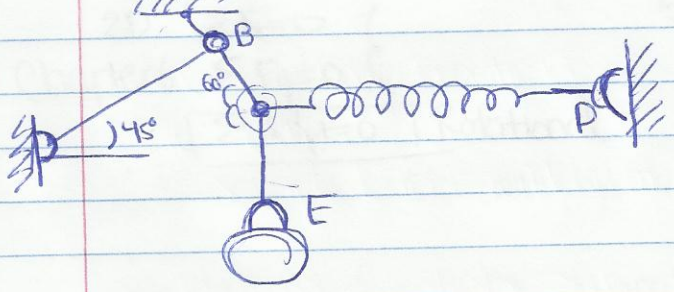

when $s$ is positive the F must pull on the string
when $s$ is negative ⇒ push

$k$ = spring stiffness
$s$ = deformed (compressed or elongated) distance
$s = l - l_0$

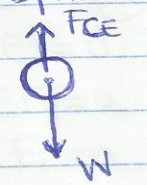
Cables
- always in tension
- negligible weight
- do not stretch
- Frictionless pulley



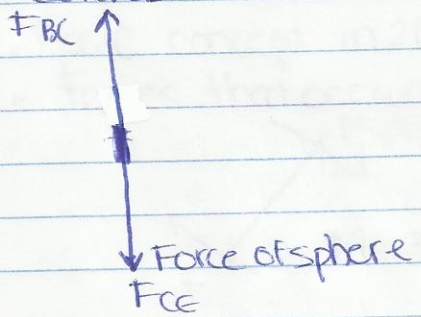

Example




FBD of sphere




Cord CE




FBD @ C