STATIC / COMPLETE EQUILIBRIUM IN 2D

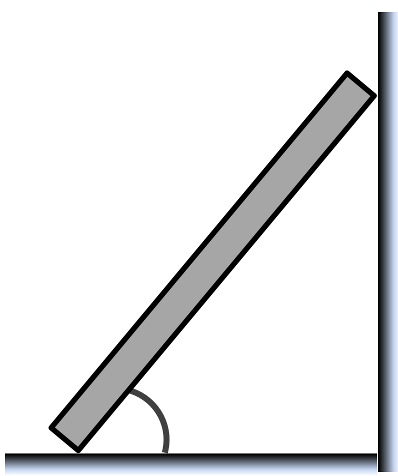
● So far we've solved Equilibrium problems that were essentially 1 dimensional: all forces acted in the same axis (X or Y).

- More advanced problems have forces in 2 axes, and some will need to be ______________________________.

- Remember however that Torques are ____________, so we will never need to ____________________ them.

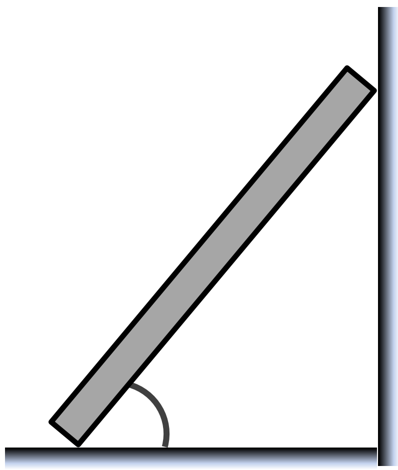
EXAMPLE: A ladder of mass 10 kg (uniformly distributed) and length 4 m rests against a vertical wall while making an angle of 53º with the horizontal, as shown. Calculate the magnitude of the:

(a) Normal force at the bottom of the ladder;
(b) Normal force at the top of the ladder;
(c) Frictional force at the bottom of the ladder;
(d) Minimum coefficient of static friction needed;
(e) Total contact force at the bottom of the ladder.



PRACTICE: PERSON ON A LADDER

PRACTICE**:** A ladder of mass 20 kg (uniformly distributed) and length 6 m rests against a vertical wall while making an angle of **Θ** = 60° with the horizontal, as shown. A 50 kg girl climbs 2 m up the ladder. Calculate the magnitude of the total contact force at the bottom of the ladder **(**Remember**:** You will need first calculate the magnitude of $\mathbf{N_{,BOT}}$ and $\mathbf{f_{,S}}$**).**



EXAMPLE: MINIMUM ANGLE AND FRICTION ON LADDER

EXAMPLE**:** A ladder of mass M (uniformly distributed) and length L rests against a vertical wall while making an angle with the horizontal, as shown. Derive an expression for the**:**

- **(a)** Minimum coefficient of static friction necessary for the ladder to stay balanced at an angle of **Θ;**
- **(b)** Minimum angle at which the ladder can stay balanced, for a coefficient of static friction of **$\mu_{,S}$.**
- **(c)** Minimum angle at which the ladder can stay balanced, for any coefficient of friction, if there any no masses on it**.**