TORQUE & STATIC EQUILIBRIUM

● Remember: If the _____ on an object is ____, then _____, which we call _____.

- However, sometimes this is not sufficient for equilibrium. For example:

- So there are actually TWO conditions that are necessary for an object to have "_____" equilibrium:

(1) First Condition → _____ → _____ → _____ Equilibrium

(2) Second Condition → _____ → _____ → _____ Equilibrium

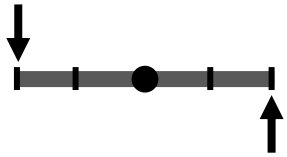
BOTH → _____ Equilibrium

- "Static" refers to the fact that _____ and _____.

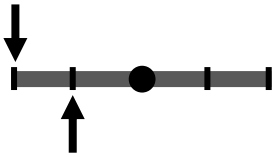
- This is sometimes called Equilibrium of Rigid Bodies because we'll deal with Rigid Bodies only, no Point Masses.

EXAMPLE: In all of the following, a light bar is free to rotate about a perpendicular axis through its center. The bar is not attached, so it is also free to move horizontally / vertically. All forces have the same magnitude (double arrows are a single force with double the magnitude). Ignore gravity. For each: Is the object in linear equilibrium? Is it in rotational equilibrium?

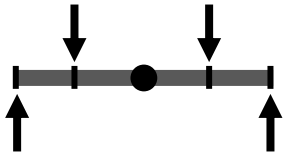
[Linear EQ | Rotational]



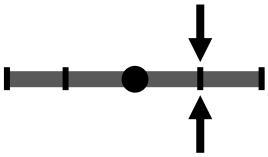
[Linear EQ | Rotational]



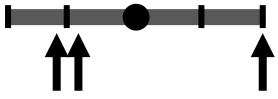
[Linear EQ | Rotational]



[Linear EQ | Rotational]



[Linear EQ | Rotational]



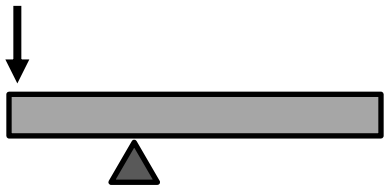
[Linear EQ | Rotational]

EXAMPLE: BALANCING A BAR WITH A FORCE

EXAMPLE**:** The bar below is 4 m long and has mass 10 kg. Its mass is distributed uniformly, therefore its center of mass is located in the middle of the bar. The bar is free to rotate about a fulcrum positioned 1 m away from its left end. You want to push straight down on the left edge of the bar, to try to balance it**.**

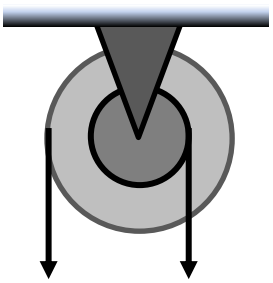
(a) What magnitude of force should you apply on the bar**?**

(b) How much force does the fulcrum apply on the bar**?**



PRACTICE: BALANCING A COMPOSITE DISC

PRACTICE**:** A composite disc is made out of two concentric cylinders, as shown. The inner cylinder has radius 30 cm. The outer cylinder has radius 50 cm. If you pull on a light rope attached to the edge of the outer cylinder (shown left) with 100 N, how hard must you pull on a light rope attached to the edge of the inner cylinder (shown right) so the disc does not spin**?**



EXAMPLE: PIN HOLDING A HORIZONTAL BAR

EXAMPLE: A 20-kg, 3 m-long bar is held horizontally against a wall by a pin (shown as red). Calculate the torque the pin must provide in order to hold the bar horizontally. You may assume the bar has uniform mass distribution.