To Review

Equilibrium

The complete motion of an object can be described as the translational motion of its center of mass and the rotational motion about its center of mass. An object at rest or moving with constant velocity is in equilibrium, its motion is unchanging and its acceleration is zero.

Translational Equilibrium

The first condition for equilibrium.
The sum of the external forces is zero.

$$\sum F = 0 \qquad \boxed{\sum F_x = 0 \quad \sum F_y = 0}$$

Rotational Equilibrium

The second condition for equilibrium.
The sum of the external torques about any pivit point is zero

$$\sum \hat{\tau} = 0 \qquad \boxed{\hat{\tau}_c = \hat{\tau}_{cc}}$$

Static Equilibrium

a body is in static equilibrium if it is at rest.
In static equilibrium, the sum of the external forces is zero, and the sum of the external torques is zero.

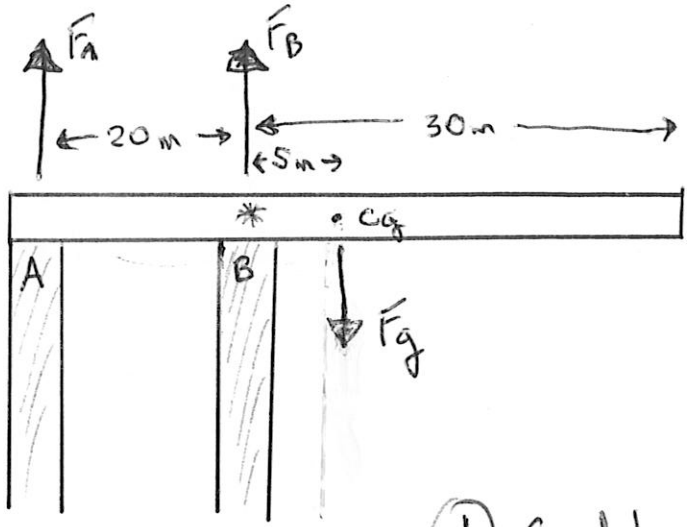
$$\sum F = 0 \qquad \sum \hat{\tau} = 0$$

I will demonstrate Static Equilibrium with the Cantilever (diving board). Usually with static equilibrium problems there are two variables to solve for. You can solve for one variable by meeting the conditions for Rotational Equilibrium ($\sum \curvearrowleft = 0$) and the other variable can be solved by meeting the conditions for Translational Equilibrium ($\sum F = 0$)

The Cantilever

Mass = 1200 kg
length = 50 m

Solve for F_A and F_B



F_A and F_B are forces acting on the beam due to the supports

(1) Conditions for Rotational Equilibrium

$$\sum \curvearrowleft = 0$$

F_A and F_g would produce a clockwise rotation around pivot point B ($\sum \curvearrowleft \neq 0$) F_B produces no torque because it runs through the pivot point. F_A must be negative in order to meet the condition for rotational equilibrium. a negative force is created by screwing down the beam to the post!

$$\curvearrowright_A = \curvearrowright_{cg}$$

$$r_A F_A \sin 90^\circ = r_{cg} F_g \sin 90^\circ \qquad (F_g = mg)$$

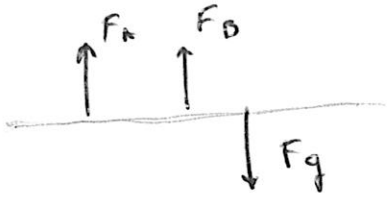
$$20(F_A) = 5(1200)(9.8)$$

$$F_A = 2940$$

$$\boxed{F_A = -3000\ N}$$

(2) To solve for F_B we must meet the other condition for static Equilibrium → that is translational equilibrium

$$\sum F = 0$$



$$F_A + F_B = F_g$$

$$F_B = F_g - F_A$$
$$= mg - (-3000)$$
$$= 1200 + 3000$$
$$= 15000$$

$$F_B = 15000\ N$$