

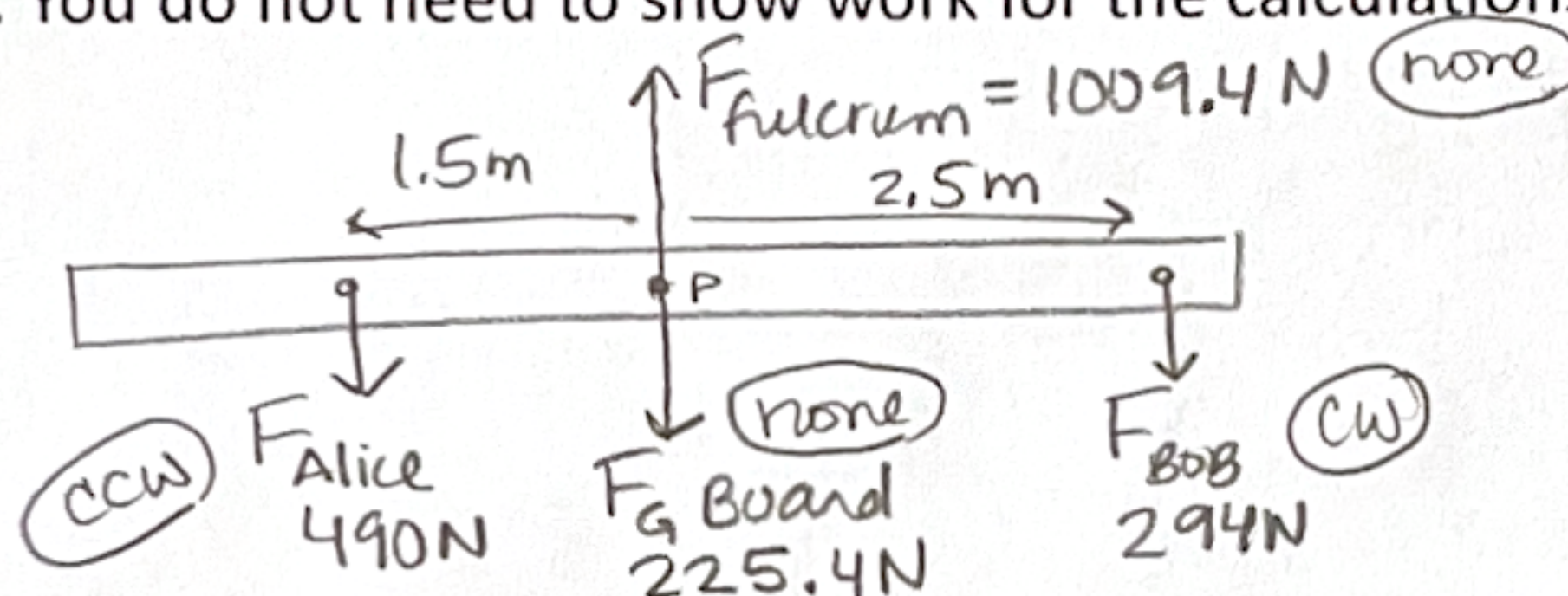
Turning Ability of a Force – Part 1

This exercise only involves the analysis of forces that are perpendicular to the distance of the force from the pivot point. Later we will learn to work with forces in any direction.

The situation: A 23 kg uniform board that is 6-meters long is supported by a fulcrum at its center. Alice (50 kg) sits on the left side a distance of 1.5 m from the left end of the board, and Bob (30 kg) sits on the right side, a distance of 5.5 m from the left end of the board. The board is balanced.

a) Draw a picture showing the board, pivot, and both children. Label all given information on the picture.

b) Draw a free-body diagram of the board. Calculate the magnitude of each force and write the values on the diagram. You do not need to show work for the calculations.



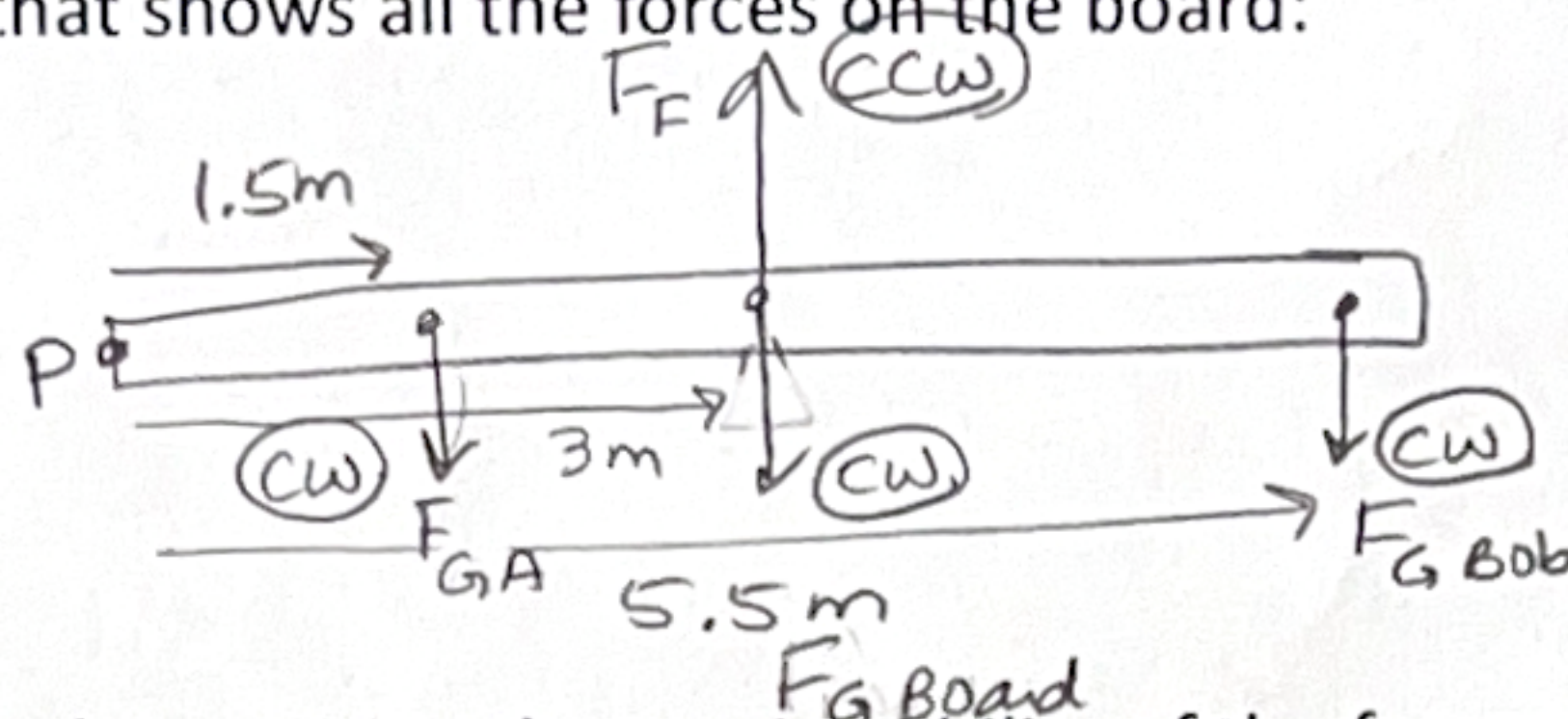
c) If the pivot point for determining the turning ability of the forces is chosen to be **at the fulcrum**, label each force on the FBD with the direction of its turning ability as *none*, *CW*, or *CCW*.

d) Using the fulcrum as the pivot point for determining the turning ability of the forces, complete this table:

List of forces:	x-component of the force (N)	y-component of the force (N)	Distance of the force from the pivot point (m)	Turning ability of the force relative to the pivot point (Nm)	Direction of the turning ability (CW or CCW)
Force of Alice on the board	0	-490	1.5	735	CCW
Force of Bob on the board	0	-294	2.5	735	CW
Force of earth on the board	0	-225.4	0	0	none
Force of fulcrum on the board	0	+1009.4	0	0	none

- Does the sum of all the clockwise turning abilities equal the sum of all the counterclockwise turning abilities? *yes! 735 Nm CCW = 735 Nm CW*

d) Draw another FBD that shows all the forces on the board:



e) If the pivot point for determining the turning ability of the forces is now chosen to be **at the left end of the board**, label each force on the FBD with the direction of its turning ability as *none*, *CW*, or *CCW*.

f) Using the left end of the board as the pivot point for determining the turning ability of the forces, complete this table:

List of forces:	x-components of the force (N)	y-component of the force (N)	Distance of the force from the pivot point (m)	Turning ability of the force relative to the pivot point (Nm)	Direction of the turning ability (CW or CCW)
Force of Alice on the board		-490	1.5 m	735	CW
Force of Bob on the board		-294.1	5.5	1617	CW
Force of earth on the board		-225.4	3.0	676.2	CW
Force of fulcrum on the board		+1009.4	3.0	3028.2	CCW

= 3028.2

- Does the sum of all the clockwise turning abilities equal the sum of all the counterclockwise turning abilities?

yes!

$$735 + 1617 + 676.2 = 3028.2 \text{ Nm}$$

$$3028.2 \text{ Nm CW} = 3028.2 \text{ Nm CCW}$$