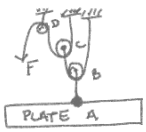
Statics
Frames and Machines
Example 1

Determine the Force, F, needed to hold plate A in equilibrium for the following pulley system:

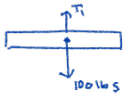


WEIGHT OF PLATE A = 100 lbs

- ALWAYS START WITH DRAWING A FREE BODY DIAGRAM
- FOR FRAMES AND SIMPLE MACHINES, BREAK DOWN THE SYSTEM INTO INDIVIDUAL COMPONENTS
- FOR THIS EXAMPLE WE NEED TO FBD THE PLATE AND EACH PULLEY
- YOU CAN START ON THE RIGHT AND MOVE LEFT, OR START AT THE LEFT AND MOVE RIGHT. BOTH METHODS WILL GIVE YOU THE SAME FINAL ANSWER.
- EVERYONE HAS THEIR OWN PREFERENCE, BUT I THINK IT'S EASIER TO START WITH THE ELEMENT THAT HAS A KNOWN VALUE (THE PLATE), HOWEVER, I WILL DEMONSTRATE BOTH WAYS SO YOU CAN SEE AND CHOOSE FOR YOURSELF

METHOD #1: RIGHT TO LEFT

STEP #1: FBD THE PLATE



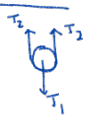
STEP #2: SOLVE FOR UNKNOWNS USING EQUATIONS OF EQUILIBRIUM

$+\uparrow \Sigma F_y = 0$

$-100\text{lbs} + T_1 = 0 \quad \therefore T_1 = 100\text{lbs}\uparrow$

STEP #3: REPEAT STEPS #1 & #2 FOR EACH PULLEY

PULLEY B

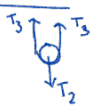


$+\uparrow \Sigma F_y = 0$

$-T_1 + T_2 + T_2 = 0$

$-100\text{lbs} + 2T_2 = 0 \quad \therefore T_2 = \frac{100\text{lbs}}{2} = 50\text{lbs}\uparrow$

PULLEY C



$+\uparrow \Sigma F_y = 0$

$-T_2 + T_3 + T_3 = 0$

$-50\text{lbs} + 2T_3 = 0 \quad \therefore T_3 = \frac{50\text{lbs}}{2} = 25\text{lbs}\uparrow$

PULLEY D

$F = T_3$

$\therefore F = 25\text{lbs}$

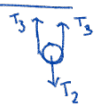
$F = 25\text{lbs}$

METHOD #2: LEFT TO RIGHT

PULLEY D

$F = T_3$

PULLEY C



$+\uparrow \Sigma F_y = 0$

$-T_2 + T_3 + T_3 = 0$

$-T_2 + F + F = 0$

$2F - T_2 = 0$

$\therefore T_2 = 2F$

PULLEY B

$+\uparrow \Sigma F_y = 0$

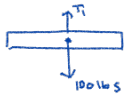
$-T_1 + T_2 + T_2 = 0$

$-T_1 + 2F + 2F = 0$

$-T_1 + 4F = 0$

$\therefore T_1 = 4F$

PLATE A



$+\uparrow \Sigma F_y = 0$

$-100\text{lbs} + T_1 = 0$

$-100\text{lbs} + 4F = 0$

$\therefore F = \frac{100\text{lbs}}{4} = 25\text{ lbs}$

$F = 25\text{lbs}$