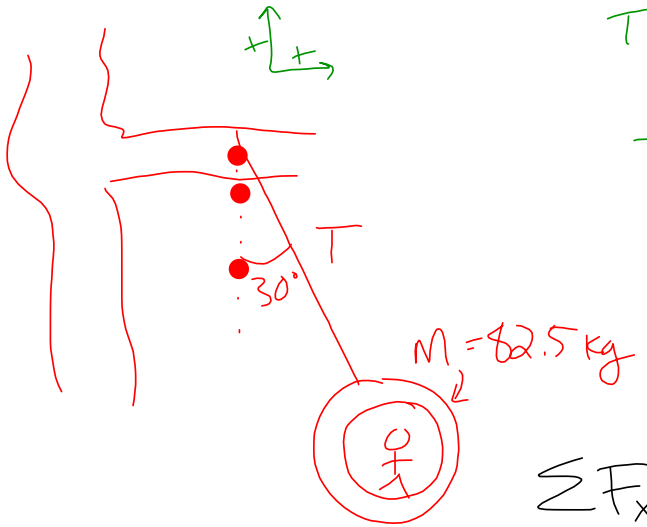
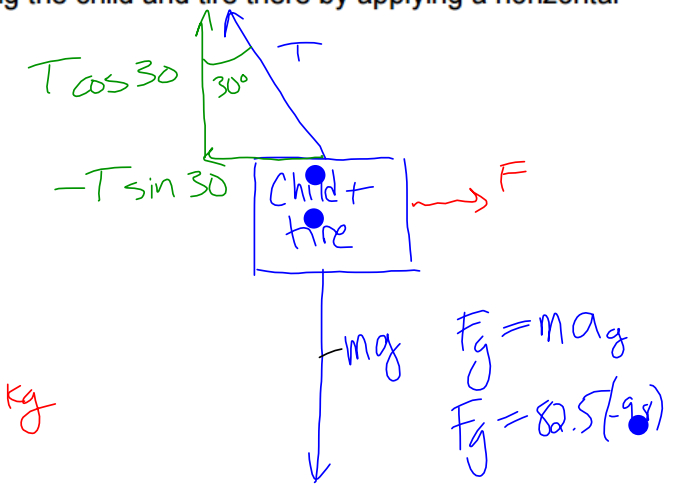
3. A child likes to hang on a tire tied to a tree branch. If the child and tire have a combined mass of 82.5 kg and are pulled back far enough to make an angle of 30.0° with the vertical, what is the tension in the rope supporting her? (Do not worry about the fact that the horizontal forces will not balance. If it makes you feel better, assume someone is holding the child and tire there by applying a horizontal force.) [934 N]





$$\Sigma F_x = \emptyset$$

$$-T\sin 30 + F = \emptyset$$

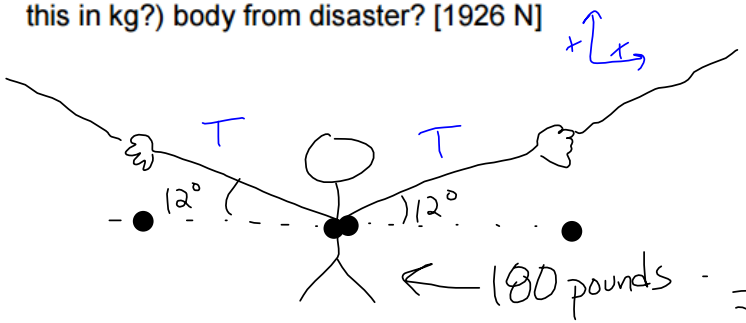
$$\Sigma F_y = \emptyset$$

$$T\cos 30 - mg = \emptyset$$

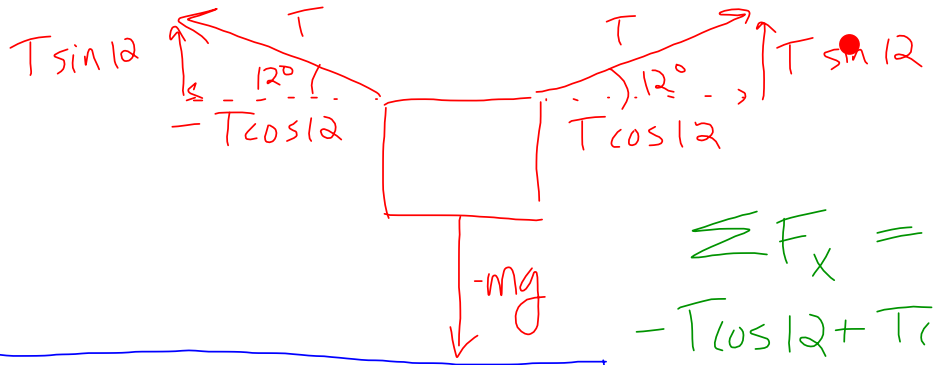
$$T = \frac{mg}{\cos 30} = \frac{(82.5)(9.8)}{\cos 30}$$

$$\boxed{T = 934\ N}$$

4. While walking a tightrope, Harry had some good luck and some bad luck. The good luck was that just as the rope broke, he grabbed the broken ends. The bad luck was that the rope only makes an angle of 12.00° with the horizontal. What force must Harry's arm supply to keep his 180.0 pound (what is this in kg?) body from disaster? [1926 N]



$180 \text{ pounds} \cdot \frac{1 \text{ kg}}{2.2 \text{ lbs}} = 81.8 \text{ kg}$



$T \sin 12 + T \sin 12 + (81.8)(-9.8)$

$\Sigma F_x = \emptyset$

$-T \cos 12 + T \cos 12 = \emptyset$

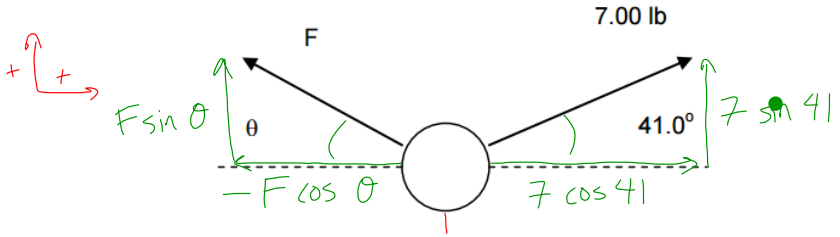
$\Sigma F_y = \emptyset$

or $T \sin 12 + T \sin 12 - mg = \emptyset$

$$T = \frac{mg}{2 \sin 12} = \frac{(81.8)(9.8)}{2 \sin 12}$$

$$T = 1928 \text{ N}$$

7. Find the indicated angle θ and the magnitude of the missing force F. The ball has a weight of 8.00 lb. [32.8°, 6.29 lb]



$\Sigma F_x = 0$

$-F\cos\theta + 7\cos 41 = 0$

$F = \dfrac{7\cos 41}{\cos\theta}$

$\Sigma F_y = 0$

$F\sin\theta + 7\sin 41 - 8 = 0$

$F = \dfrac{8 - 7\sin 41}{\sin\theta}$

$\dfrac{7\cos 41}{\cos\theta} = \dfrac{8 - 7\sin 41}{\sin\theta}$

$\dfrac{\sin\theta}{\cos\theta} = \dfrac{8 - 7\sin 41}{7\cos 41}$

$\tan\theta = \dfrac{8 - 7\sin 41}{7\cos 41}$

$\theta = \tan^{-1}\dfrac{8 - 7\sin 41}{7\cos 41}$

$\theta = 32.8°$

$F = \dfrac{8 - 7\sin 41}{\sin\theta} = \dfrac{8 - 7\sin 41}{\sin 32.8} = 6.29\text{ lb}$

Objectives:

Students will understand how pulleys function to change the direction of forces.

Students will recognize how to use statics equations to solve problems involving pulleys and forces.

Statics with Pulleys

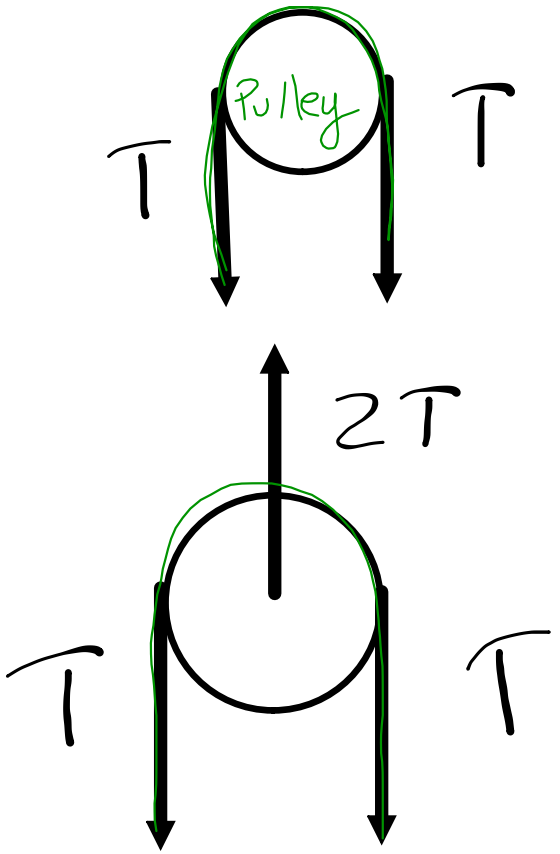
Assumption:

- Pulleys are massless and frictionless

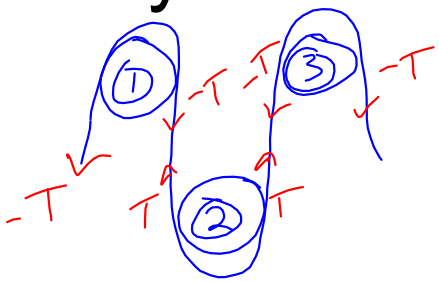
Two things to know:

- The tension in a string or rope is ALWAYS the same and acts as a pulling force in both directions (this means that the tension along one side of a pulley is always the same as the tension along the other side)

- The rules of statics apply (this means that the total of the upwards forces will always equal the total of the downwards forces on any pulley)



Number the pulleys ...



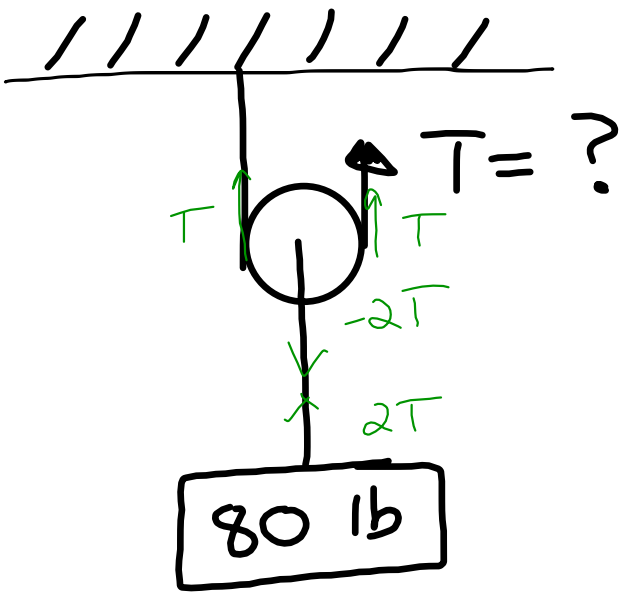
Follow the signs ...

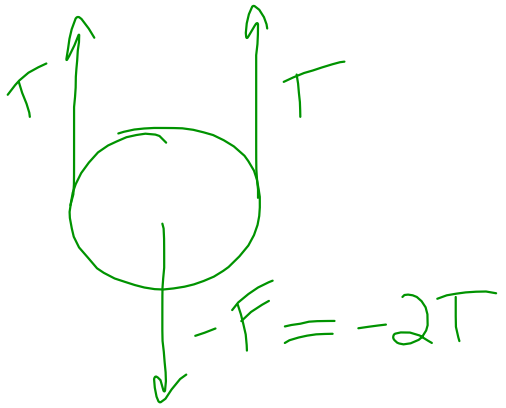
All upward forces will be ⊕

All downward forces will be ⊖

Every time a rope or pulley reverses the direction of a force: REVERSE THE SIGN (Multiply by −1)

Example 1

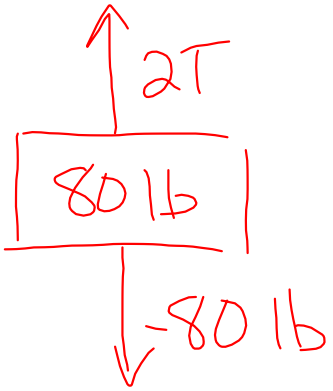




$$\Sigma F_y = 0$$

$$T + T + -F = 0$$

$$F = 2T$$

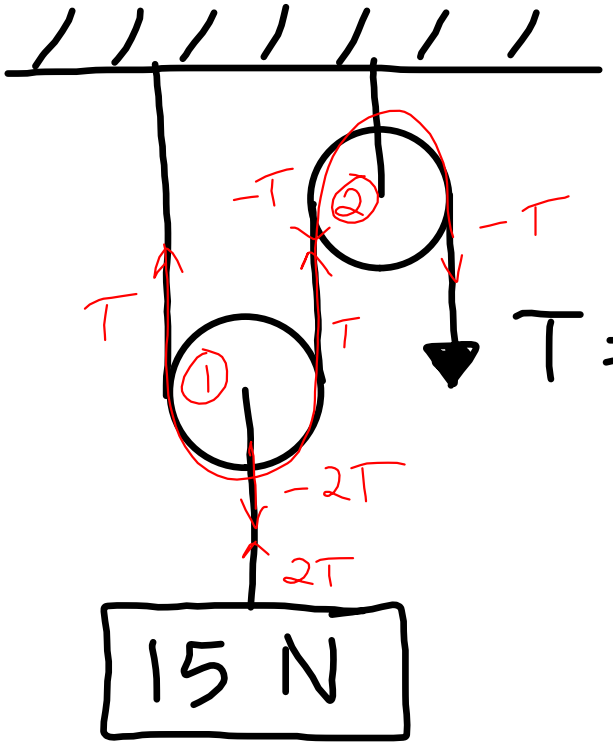


$$\Sigma F_y = 0$$

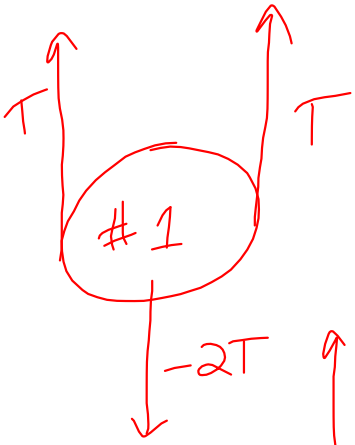
$$2T - 80 = 0$$

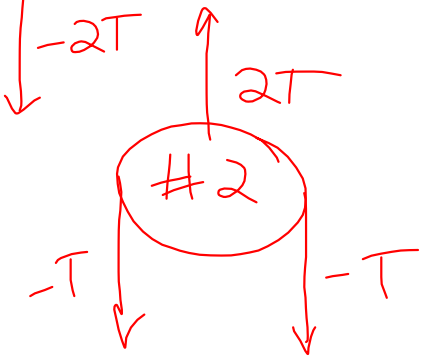
$$\boxed{T = 40\ lb}$$

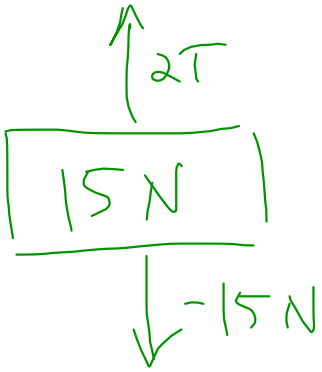
EXAMPLE 2



T = ?





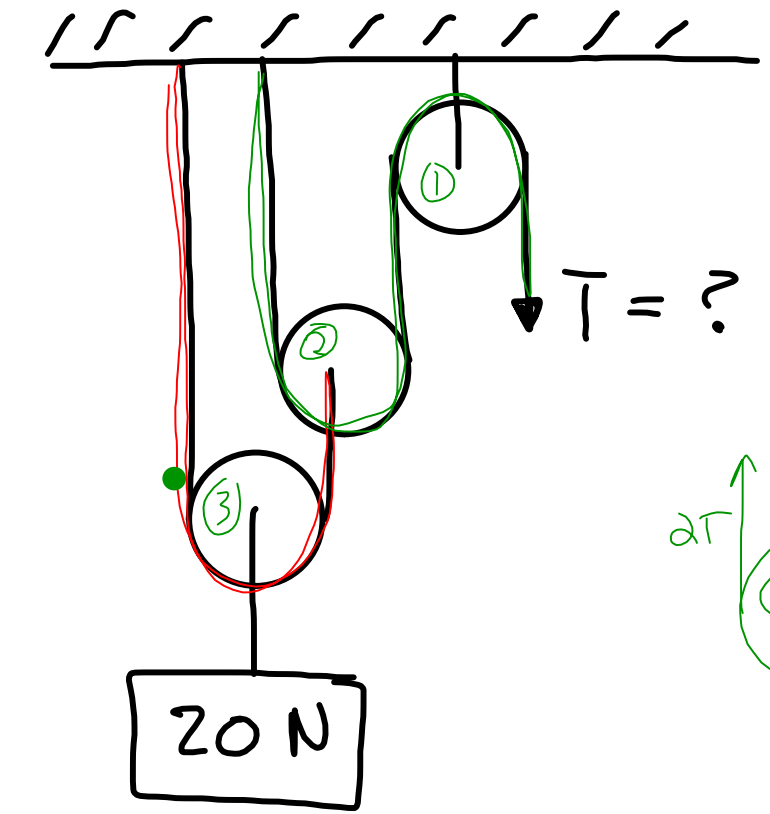


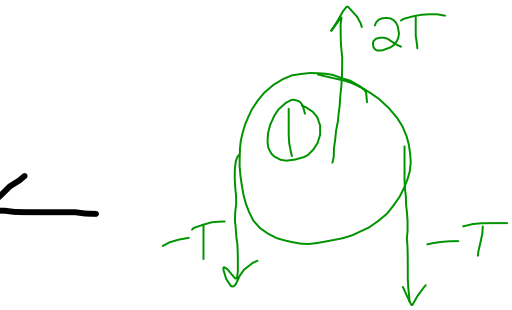
$\Sigma F_y = 0$

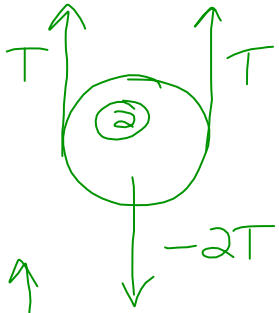
$2T - 15 = 0$

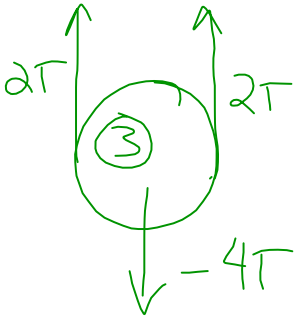
$T = 7.5\ N$

Example 3







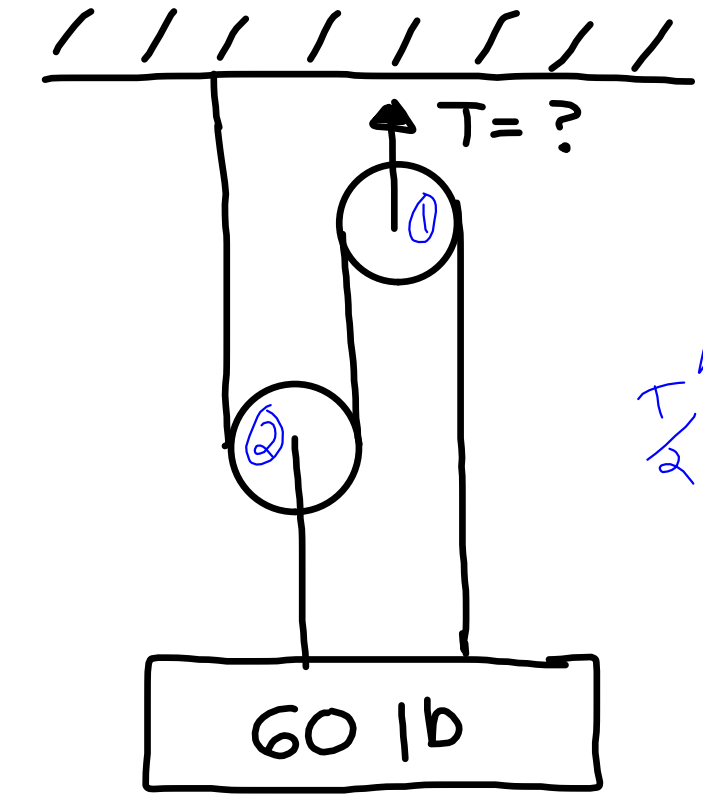


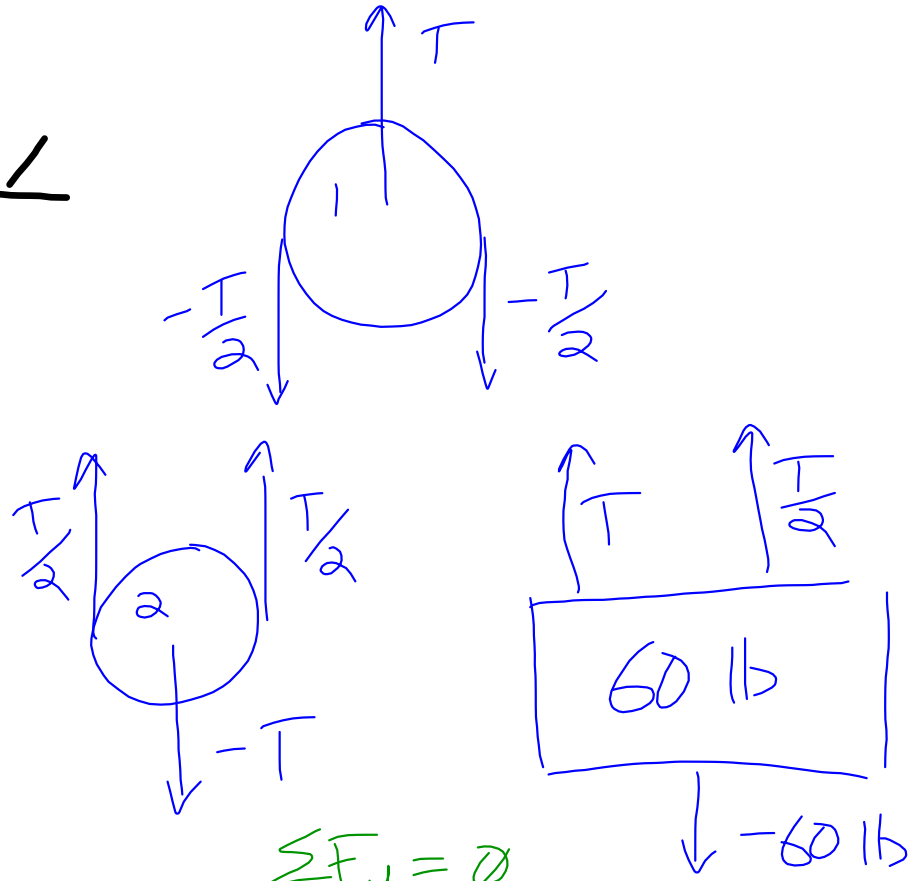
$\Sigma F_y = 0$

$4T - 20N = 0$

$T = 5N$

EXAMPLE 4



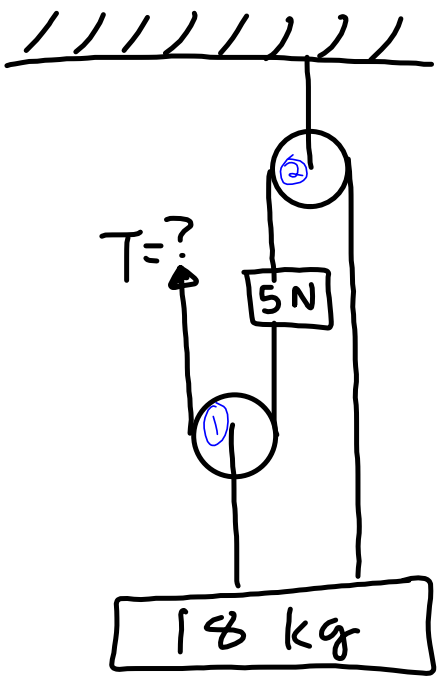


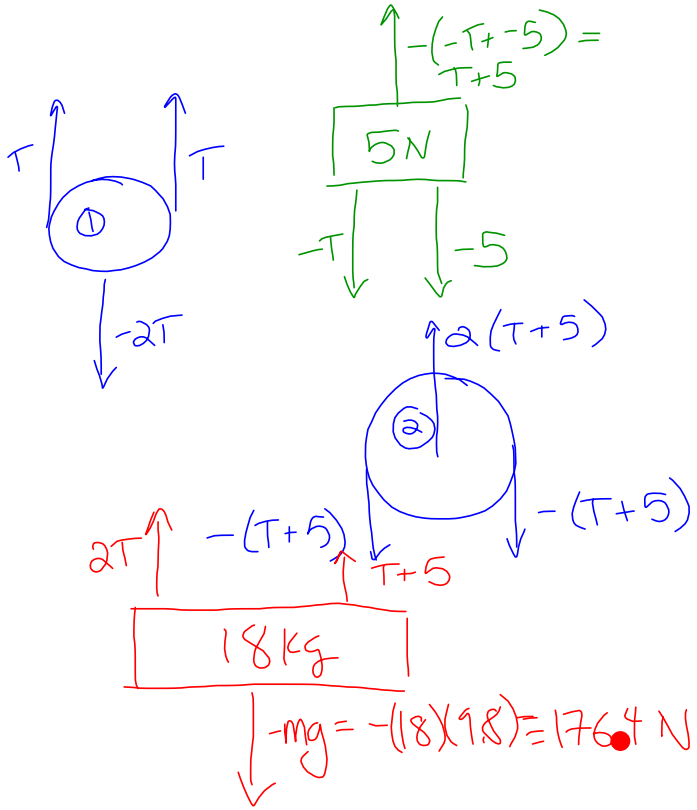
$$\Sigma F_y = 0$$

$$T + \frac{T}{2} - 60 = 0$$

$$\boxed{T = 40 \text{ lb}}$$

EXAMPLE 5





$$\Sigma F_y = 0$$

$$2T + (T + 5) - 176.4N = 0$$

$$3T = 171.4N$$

$$\boxed{T = 57.13\ N}$$