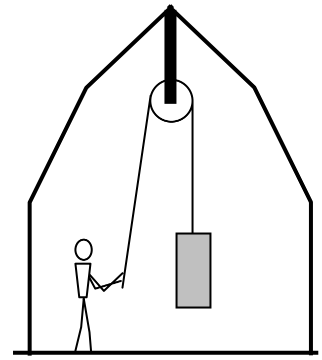
Pulleys and Lifting

$W_{man} = 200\text{lb}$
$W_{load} = 500\text{lb}$
$F_{max} = 150\text{lb}$ (strength of the man)

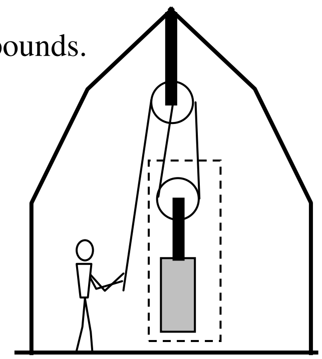


One Pulley System: If static, then…

$T = 500$ lb $F_{roof} = 1000$ lb $N = -300$ lb

Problems and Comments:

1. To just hold the load in place, he must exert 500 pounds on the rope.
2. The rope itself has to be strong enough to hold 500 pounds.
3. The connection between the pulley and the roof must hold 1000 pounds.
4. He needs toe clips to obtain the necessary *negative* normal force.

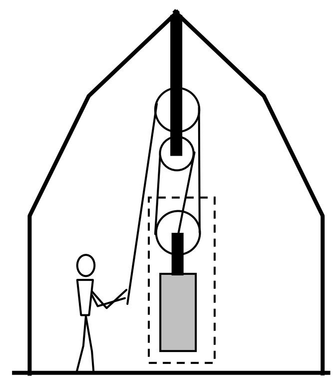


Two Pulley System:

$T = 250$ lb $F_{roof} = 750$ lb $N = -50$ lb

Problems:

1. The man still isn't strong enough ($T > F_{max}$).
2. He still needs toe clips.



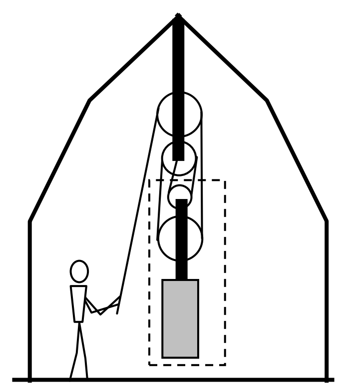
Three Pulley System:

$T = 167$ lb $F_{roof} = 667$ lb $N = +33$ lb

Problems:

1. The man still isn't strong enough ($T > F_{max}$).

→ At least this man is not pulled off of his feet.
Instead, he just can't hold onto the rope.



Four Pulley System:

$T = 125$ lb $F_{roof} = 625$ lb $N = +75$ lb

This solves all of our problems! That is:

1. $T < F_{max}$
2. $N > 0$

Trend: If we use *n* pulleys, then:

$T = W_{load}/n$ → more pulleys = easier lift, and less strain on the rope! (however, speed is reduced by the same proportion…)

$F_{roof} = (n + 1)T = W_{load}\,(n + 1)/n$ → using more pulleys decreases the strain on the roof

$N = W_{man} - T = W_{man} - W_{load}/n$ → using more pulleys increases his contact with the ground