UF | UNIVERSITY of FLORIDA

Pre-Health Post-Baccalaureate Program
PHY2053 Study Guide & Practice Problems

Topics Covered:

Apparent Weight
Resistant Forces
Pulleys

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Apparent Weight

- → One's weight is their force due to gravity:

$$w = mg$$

- → The sensation of one's weight, or how heavy one feels, is actually due to the equal and opposite normal force acting on a person by the ground.
- → Apparent weight, w_{app}, depends on supporting contact forces.
- → If one is not accelerating, then:

$$w = w_{app} = F_N$$

- → If one is in free-fall or weightless (no normal force), then they do not have an apparent weight.

① An 80 kg man is on an elevator that is accelerating upward at $2\ m/s^2$.

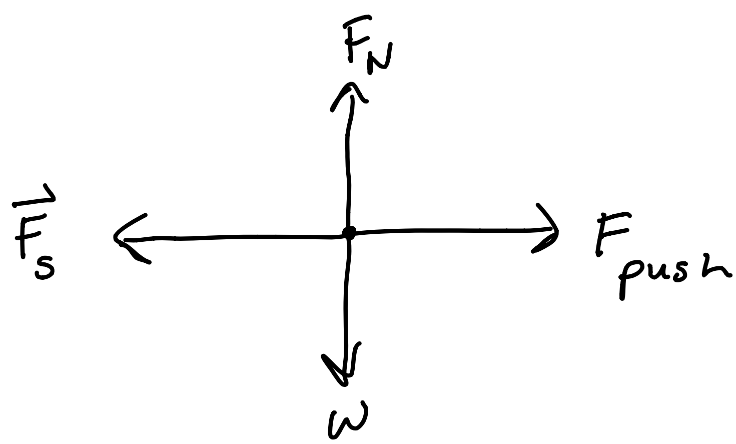
a) Draw the FBD.

b) How heavy does he feel?

Resistant Forces

- Static friction, $\vec{F}_s$
  - $\vec{F}_s$ is the force that a surface exerts on an object to resist motion
  - static means stationary
  - $\vec{F}_s$ is a response to an applied force, so the magnitude of $\vec{F}_s$ depends on the magnitude of the applied force

Ex: A person pushes a heavy refrigerator, but it does not move

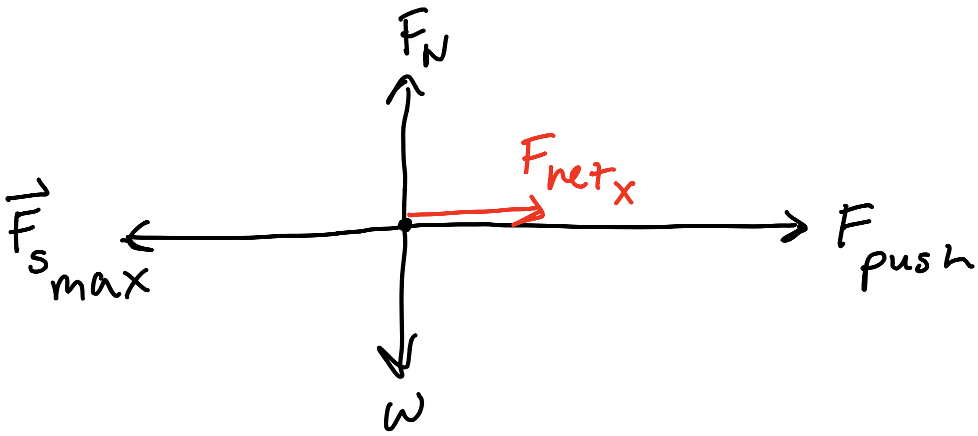


→ However, if the person keeps pushing harder and harder (that is, with a greater and greater force), then the refrigerator will begin to accelerate at some point because static friction has a maximum value:

$$\vec{F}_{s_{max}} = \mu_s F_N$$

→ μ_s is the coefficient of static friction. μ is between 0 and 1, and is fundemental to the physical relationship between the object and the surface

Ex: When the force of the person's push is greater than $\mu_s F_N$, the there will be a net force on the refrigerator and it will accelerate



→ Kinetic Friction, $\vec{F}_k$

→ When the refrigerator begins to slide, the friction force acting upon it is the force of kinetic friction:

$$\vec{F}_k = \mu_k F_N$$

- → $\vec{F}_k$ always opposes the direction of the motion
- → $\mu_s > \mu_k$, which is why it is harder to get an object to start sliding than it is to keep it sliding
- → The magnitude of F_k does not depend on how fast the object is moving!

→ Rolling Friction, $\vec{F}_r$

- → Force caused by wheels/tires which opposes the motion of an object (usually a vehicle):

$$\vec{F}_r = \mu_r F_N$$

→ Friction summary:

If the object is:	use:
not moving relative to the surface	static
sliding on the surface	kinetic
rolling along the surface	rolling

→ Drag, $\vec{F}_D$

→ Drag is the force which resists the motion of an object in a fluid medium (i.e. a skydiver falling or a rocket launching)

- Unlike friction, the magnitude of drag is dependent on the object's velocity

- Equation:

$$\vec{F}_D = \frac{1}{4} \rho A v^2$$

ρ : density of air

A : cross-sectional area

v : velocity

- Terminal velocity is the point at which the magnitude of an object's drag equals its weight (net force equals zero, therefore the object stops accelerating)

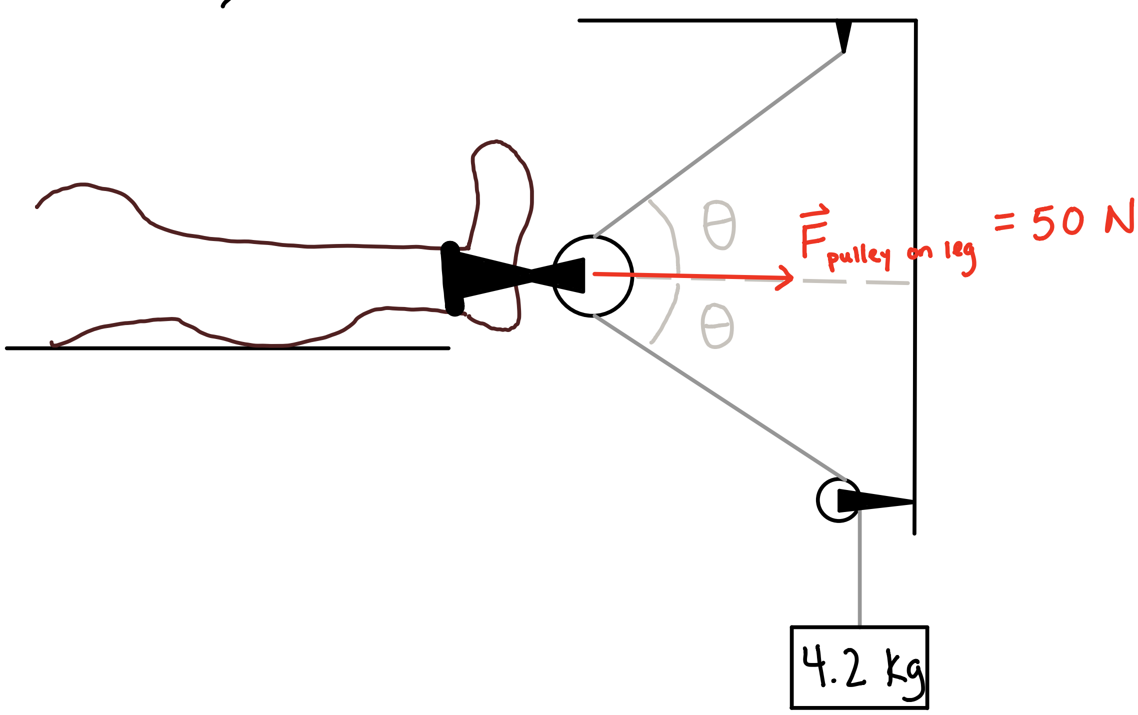
Ropes, Pulleys, and Tension

- → Rope and pulley assumed to be massless
- → No friction assumed between the pulley and its axel
- → If a force acts on one end of the rope, the tension in the whole rope equals the magnitude of the acting force
- → If two objects are connected by a rope, the tension is the same at both ends
- → Like other forces, split tension up into x and y components before dealing with it

② After a leg fracture, Stanley's leg is stabilized by a pulley system (Shown below). The rig is designed such that Stanley's leg is attached directly to the center pulley, which uses the ropes' tension to pull the leg straight out with a force of 50 N. At the bottom of the pulley system hangs a 4.2 kg mass.

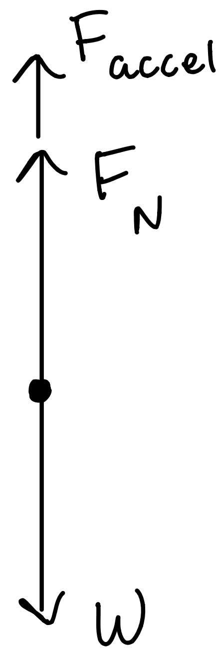
a) Draw the FBD

b) Find θ



Solutions

① a) FBD



b) $W_{app} = F_N + F_{accel}$

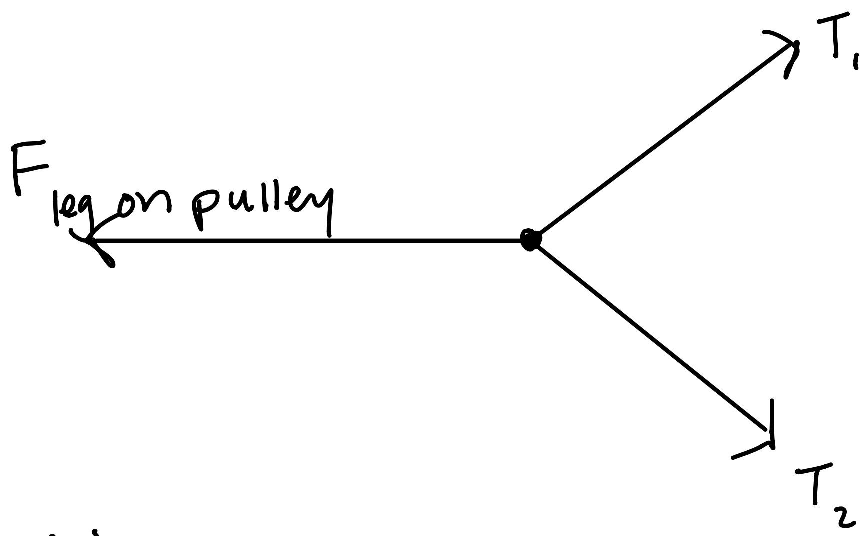
$W_{app} = mg + ma$

$W_{app} = m(g + a)$

$W_{app} = 80(9.8 + 2)$

$W_{app} = 944 \text{ N}$

② a) FBD



b) $T = mg$

$T = (4.2)(9.8) = 41.2\ N$

$F_{net_x} = T_{1_x} + T_{2_x} - F_{l/p} = 0$

$2T_x - F_{l/p} = 0$

$2T\cos\theta - F_{l/p} = 0$

$$\cos\theta = \frac{F_{elp}}{2T}$$

$$\theta = \cos^{-1}\left(\frac{F_{elp}}{2T}\right)$$

$$\theta = \cos^{-1}\left(\frac{50}{82.4}\right)$$

$$\theta = 52.6^\circ$$