Dynamics
Applying Laws of Motion
More Types of Forces

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De Anza College

Jan 28, 2020

Last time

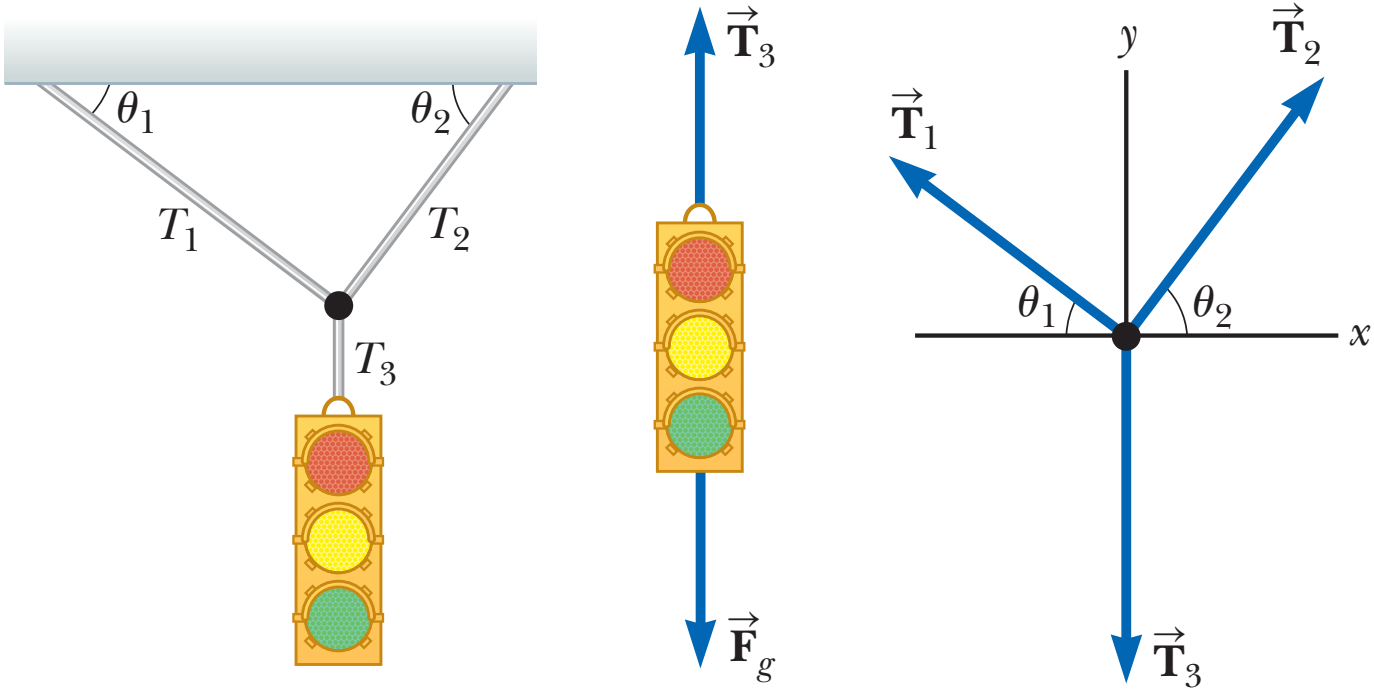
- fields
- gravity
- tension
- equilibrium

Overview

- static equilibrium example
- normal force

Statics with Tensions

Example: A traffic light weighing 200 N is suspended by two light cables, as shown in the diagram, so that $\theta_1 = 30°$ and $\theta_2 = 45°$.



Find the tensions T_1 and T_2.

From last time:

$$T_3 = F_g = 200N \qquad (1)$$

Statics with Tensions

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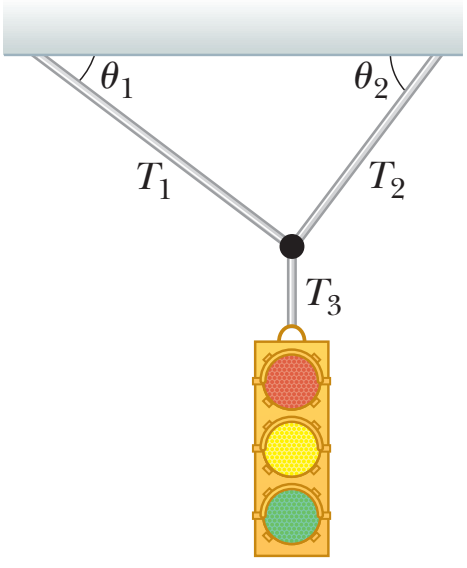

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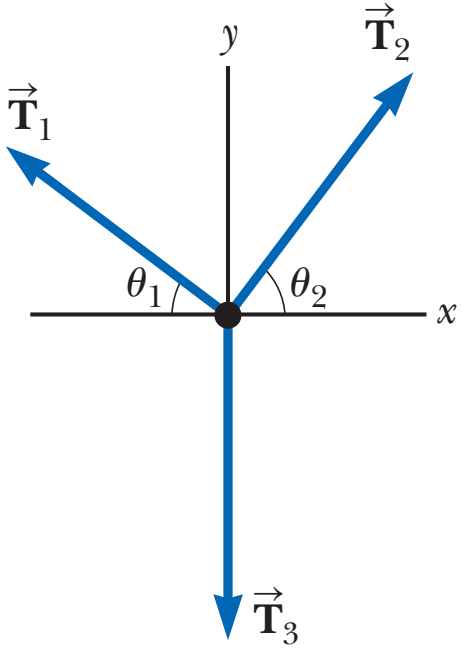

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junction, x-direction:

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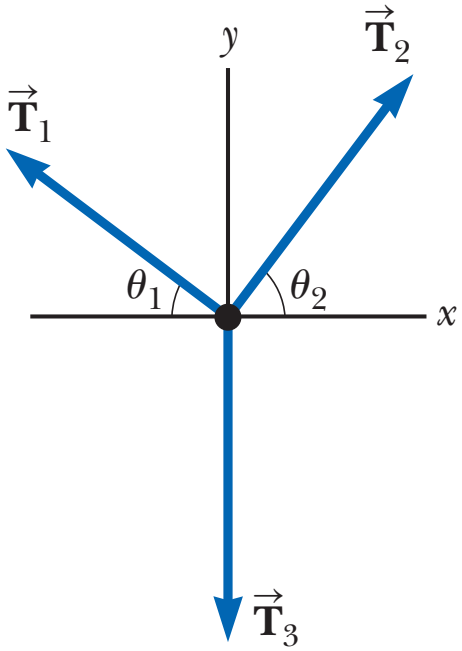

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junction, y-direction:

$$\begin{aligned} F_{\text{net},y} &= \cancel{m}^{0}\cancel{a_y}^{0} \\ T_1 \sin\theta_1 + T_2 \sin\theta_2 - T_3 &= 0 \\ T_1 \sin\theta_1 + T_2 \sin\theta_2 &= T_3 \qquad (3) \end{aligned}$$

Statics with Tensions

$$T_1 \cos\theta_1 = T_2 \cos\theta_2 \tag{2}$$

And using eq (1), equation (3) becomes:

$$T_1 \sin\theta_1 + T_2 \sin\theta_2 = F_g \tag{4}$$

We have two independent equations, and just the two unknowns T_1 and T_2. ($\theta_1 = 30^\circ$ and $\theta_2 = 45^\circ$.) Solve as you like!

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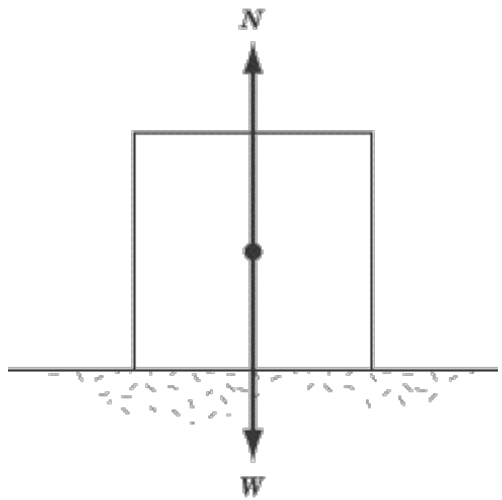
Answer:

$$T_1 = 146 \text{ N}, T_2 = 179 \text{ N}$$

Some types of forces

The Normal Force

The normal force supports and object sitting on a surface. It acts in a direction **perpendicular to the surface**.

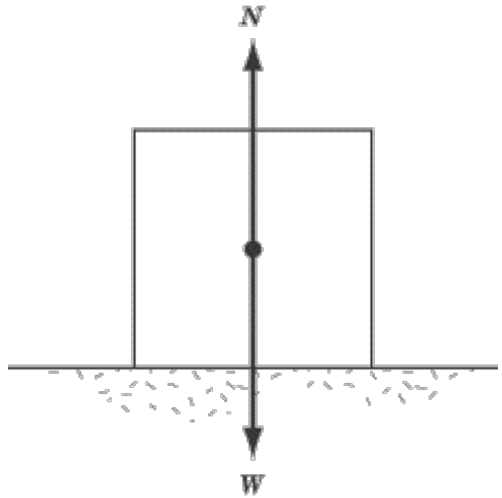


The magnitude of the normal force can be measured using a scale.

[1] Figure from www.sparknotes.com

Some types of forces

The Normal Force



For an object of weight $\vec{\mathbf{W}}$ sitting on a level surface (that is not accelerating), the *normal force*, $\vec{\mathbf{N}}$ is

$$\vec{\mathbf{N}} = -\vec{\mathbf{W}}$$

Be careful! There are many cases in which the above equation is not true!

[1] Figure from www.sparknotes.com

The Normal Force

The normal force supports an object that sits on a surface, but its magnitude is different in different circumstances.

In general, one needs to work out what it will be in each problem.

Some cases where the normal force is different than the weight of an object are:

- the object is in an accelerating elevator.
- the object sits on an incline.
- there are other forces with vertical components (besides gravity). **See suitcase example!**

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The amount of friction depends on properties of the object and the surface. More about this to follow!

Tension and Normal Force: #60, pg 144

60. W A woman at an airport is towing her 20.0-kg suitcase at constant speed by pulling on a strap at an angle θ above the horizontal (Fig. P5.60). She pulls on the strap with a 35.0-N force, and the friction force on the suitcase is 20.0 N. (a) Draw a free-body diagram of the suitcase. (b) What angle does the strap make with the horizontal? (c) What is the magnitude of the normal force that the ground exerts on the suitcase?

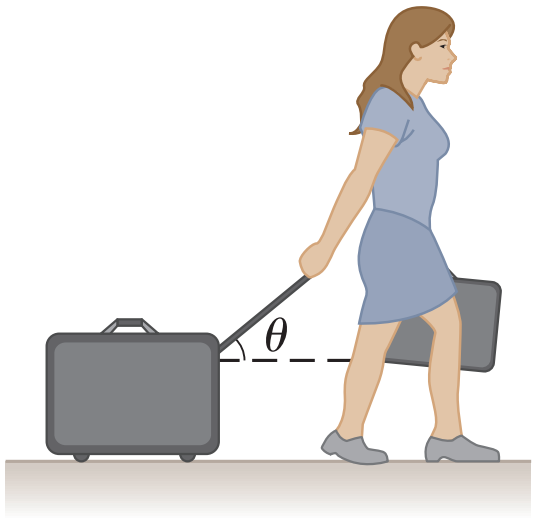

Figure P5.60

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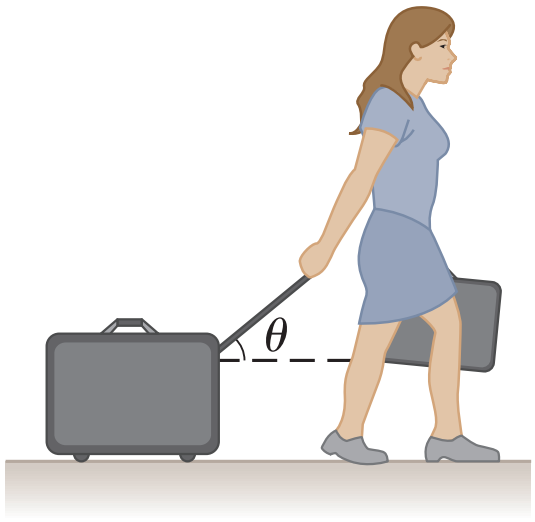

Figure P5.60

Answers:

b) $\theta = 55.2°$

c) $n = 167$ N

Summary

- equilibrium and tension example
- the normal force

Quiz this Friday.

(Uncollected) Homework

Serway & Jewett,

- Ch 5, Prob: 21 (set yesterday)
- Ch 5, onward from page 136. Probs: 39 CQ 13; Probs: 28, 39, 43, 47, 95 (can wait)