Physics A - PHY 2048C

Mass & Weight, Normal Force, and Friction

09/25/2019

My Office Hours:
Thursday 2:00 - 3:00 PM

212 Keen Building

Warm-up Questions

1. Did you read Chapters 6.1 - 6.6?
2. In your own words: What is *mass* and *weight*?
3. A ball tossed straight up has $v = 0$ m/s at its highest point. Is it in equilibrium? Explain.
4. An astronaut takes his bathroom scale to the moon and then stands on it. Is the reading of the scale his weight?

Outline

1 Normal Forces

2 Transmitting Forces
Statics

Normal Force

A normal force acts perpendicularly to the plane of contact.

Normal forces are common in nature and occur whenever the surfaces of two objects come in contact.

Normal Force: Example

A normal force acts perpendicularly to the plane of contact.

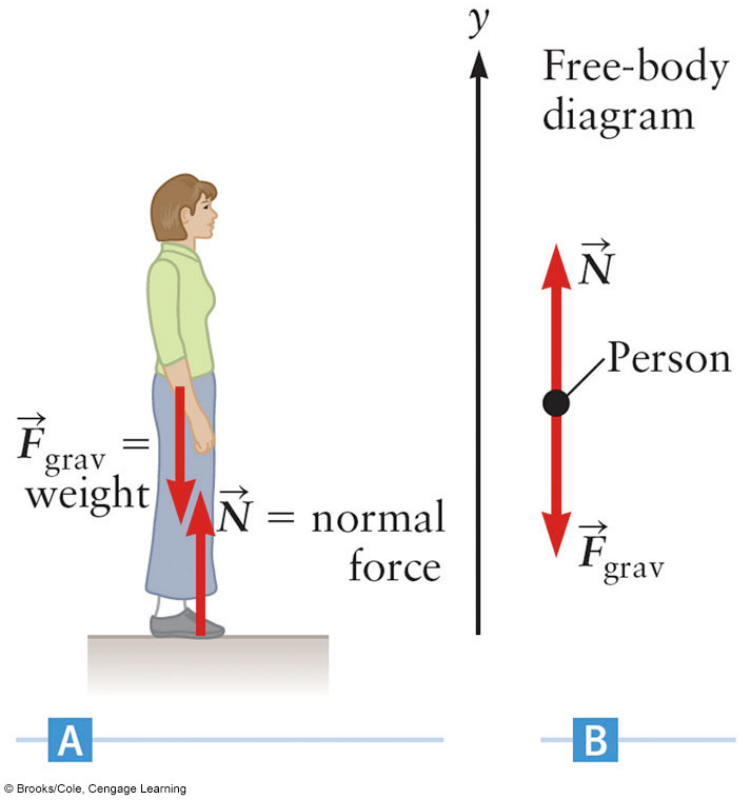
Normal forces are common in nature and occur whenever the surfaces of two objects come in contact.

The person is at rest: $a = 0$

$$\Sigma F = -mg + N = ma = 0$$

$$N = mg$$

In this case, the normal force is equal in magnitude to the weight and opposite in direction to the person's weight.



Normal Force: Example

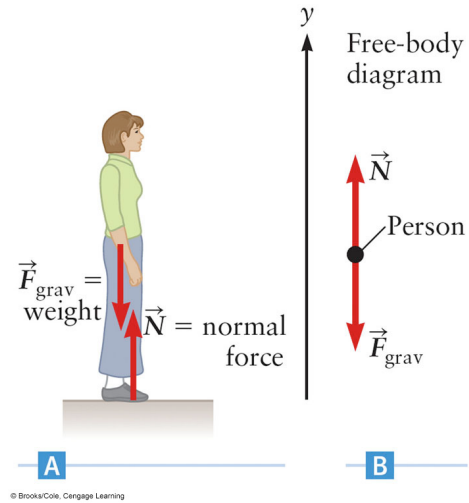
A normal force acts perpendicularly to the plane of contact.

Normal forces are common in nature and occur whenever the surfaces of two objects come in contact.

The person is at rest: $a = 0$

$$\Sigma F = -mg + N = ma = 0$$

$$N = mg$$

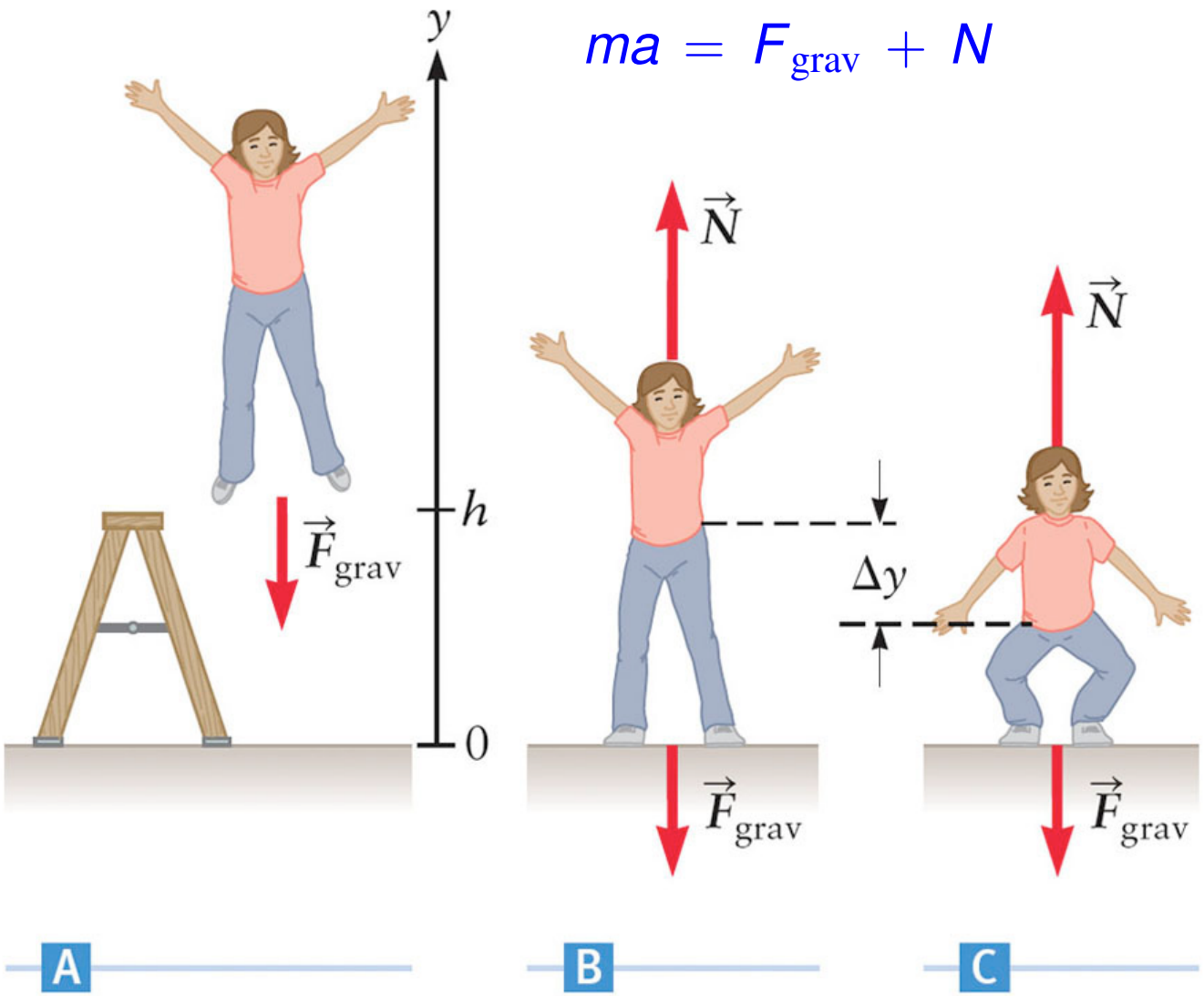


Free Body Diagram

- A free body diagram should be used for analysis using Newton's Second Law.
- It is a simplified diagram showing all the forces acting on each object involved in the problem.

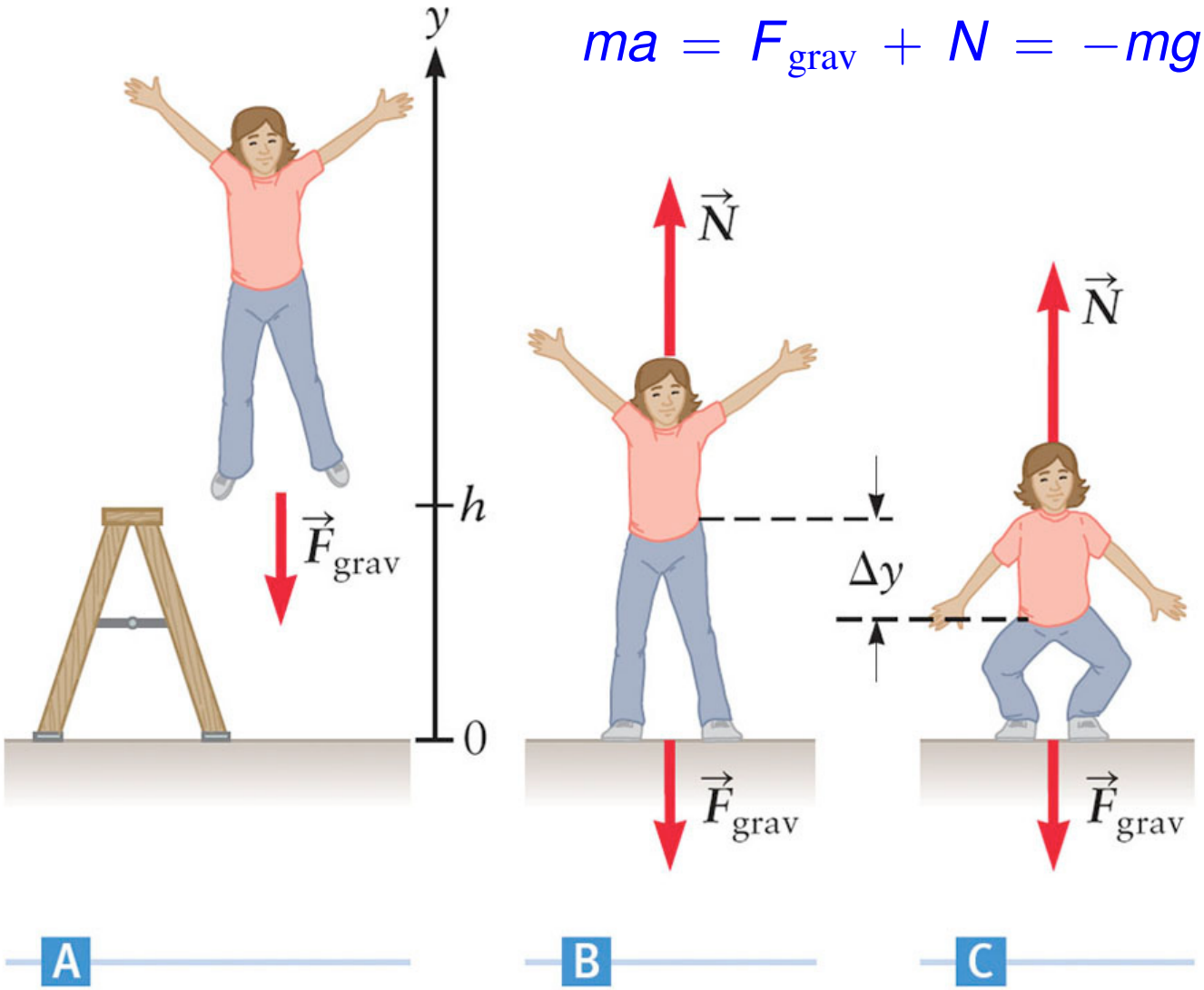
Normal Force: Example

$$ma = F_{\text{grav}} + N$$



Normal Force: Example

$$ma = F_{\text{grav}} + N = -mg + N$$



Mass and Weight

The mass and the weight of an object are closely related, but they are not the same:

- Mass is an intrinsic property of the object.
- Weight depends on the location of the object.

More about mass:

1. The force of gravity depends on the mass of the object. This is called *gravitational mass.*
2. The mass of an object also determines how the object will move in response to forces. This is called *inertial mass.*

The connection between gravitation and Newton's laws of motion indicates that the inertial mass is precisely equal to the gravitational mass.

Outline

1 Normal Forces

2 Transmitting Forces
Statics

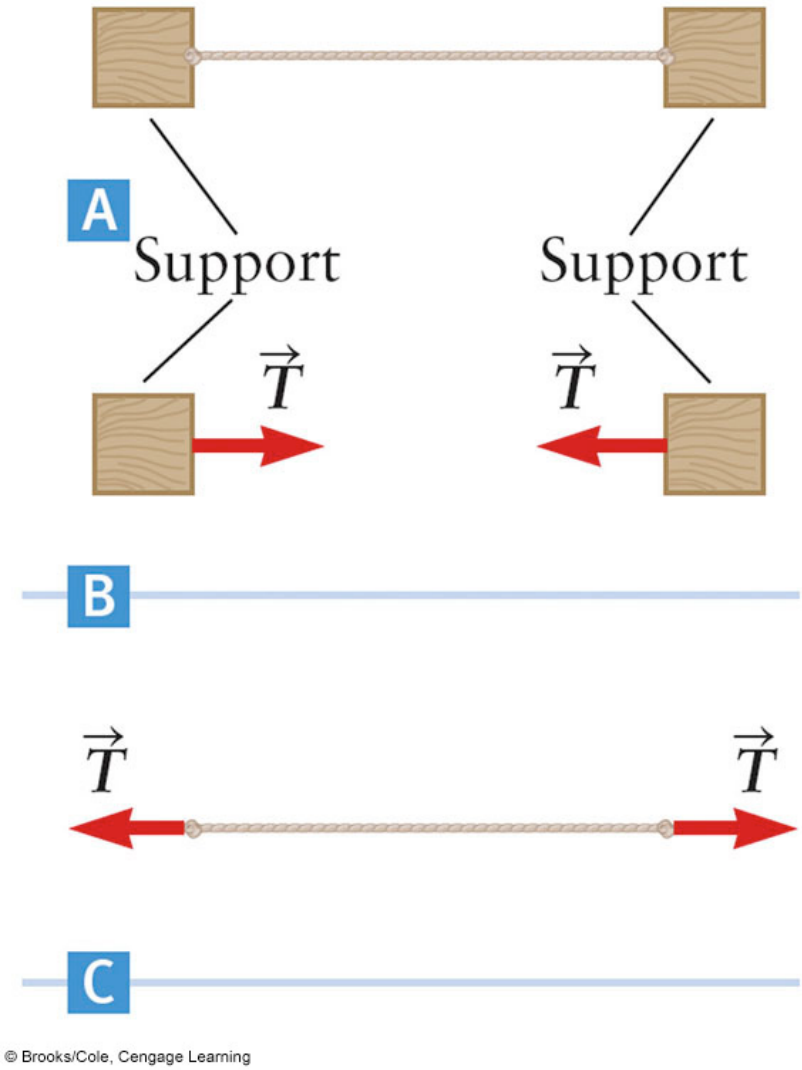
Tension

Strings exert forces on objects they are connected to:

- Cables and ropes act the same way.

The strings exert forces due to their *tension:*

- The ends of the string both exert a force of magnitude T on the supports where they are connected.
- T is the tension in the string.



Example: Elevator Cable

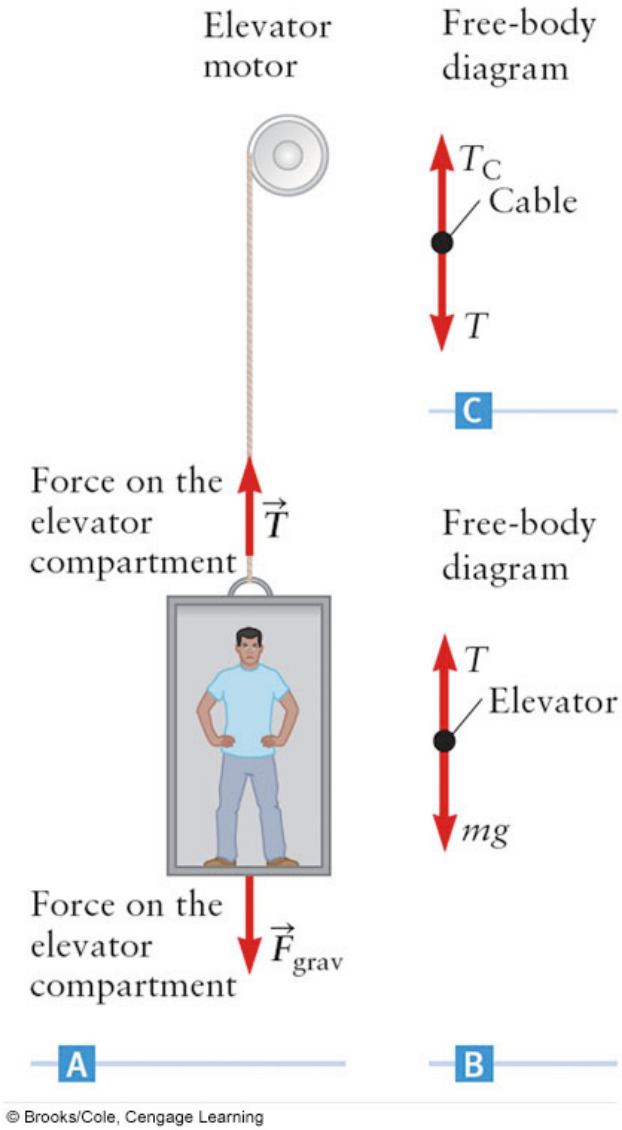
Two forces are acting on the compartment:

1. Gravity acting downward
2. Tension T in cable acting upward

Assume acceleration upward:

- Newton's Second Law

$$T - mg = ma$$



Example: Elevator Cable

Two forces are acting on the compartment:

1. Gravity acting downward
2. Tension T in cable acting upward

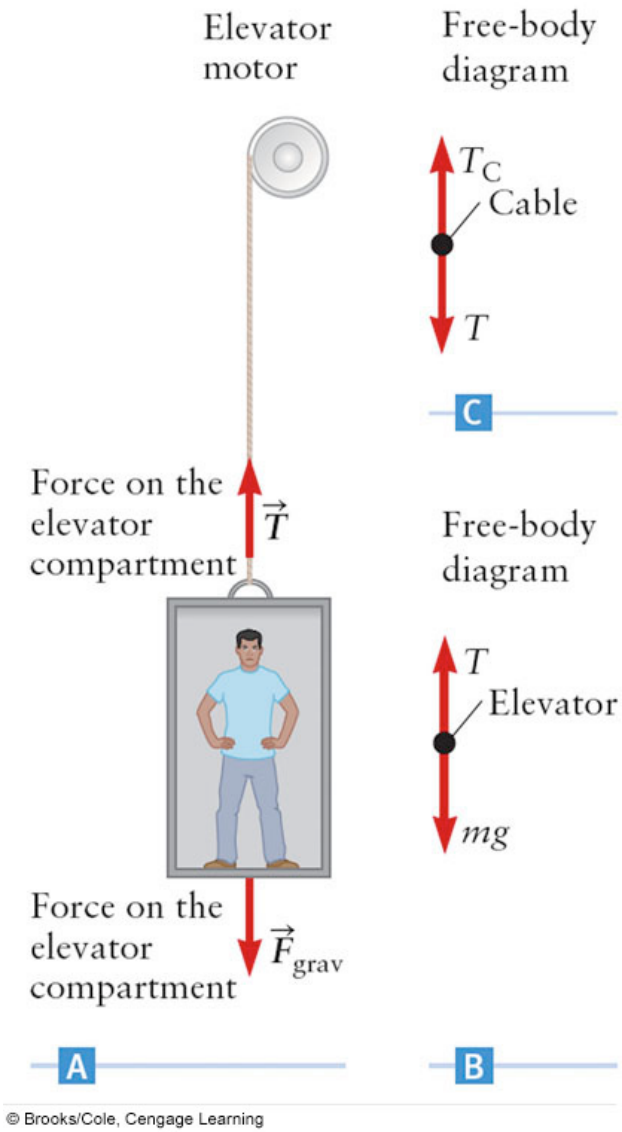
Assume acceleration upward:

- Newton's Second Law

$$T = mg + ma$$

- For a massless cable:

  Tension is the same for all points along the cable.



Statics and Equilibrium

Statics is an area of mechanics dealing with problems in which both the velocity and acceleration are zero:

- The object is said to be in *translational equilibrium* or simply in *equilibrium.*
- Since the acceleration is zero, the net force is zero

$$F = F_1 + F_2 + ... = 0.$$

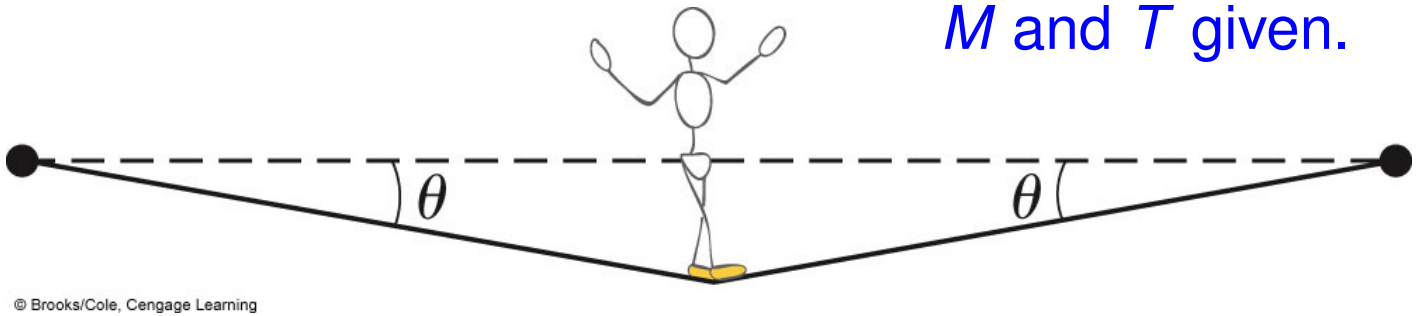
Example: Balancing Act

Statics is an area of mechanics dealing with problems in which both the velocity and acceleration are zero:

- The object is said to be in *translational equilibrium* or simply in *equilibrium.*
- Since the acceleration is zero, the net force is zero

$$F = F_1 + F_2 + \ldots = 0.$$

along x $T_{\text{left}} \cos\theta = T_{\text{right}} \cos\theta$ ➜ $T_{\text{left}} = T_{\text{right}}$



M and T given.

Example: Balancing Act

Statics is an area of mechanics dealing with problems in which both the velocity and acceleration are zero:

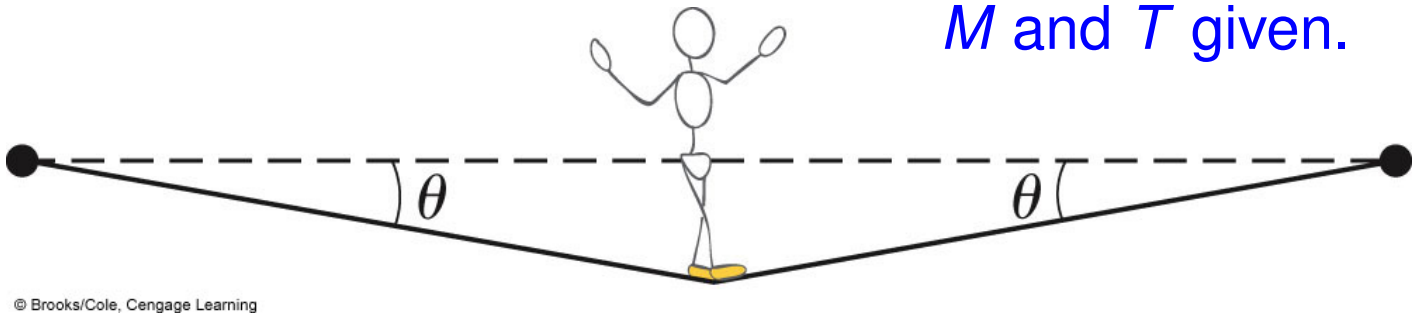
- The object is said to be in *translational equilibrium* or simply in *equilibrium.*
- Since the acceleration is zero, the net force is zero

$$F = F_1 + F_2 + \ldots = 0.$$

along x $T_{\text{left}} \cos\theta = T_{\text{right}} \cos\theta \rightarrow T_{\text{left}} = T_{\text{right}}$

along y $T_{\text{left}} \sin\theta + T_{\text{right}} \sin\theta = M_{\text{person}}\, g$

M and T given.



Example: Balancing Act

Statics is an area of mechanics dealing with problems in which both the velocity and acceleration are zero:

- The object is said to be in *translational equilibrium* or simply in *equilibrium.*
- Since the acceleration is zero, the net force is zero

$$F = F_1 + F_2 + \ldots = 0.$$

along x $T_{\text{left}} \cos\theta = T_{\text{right}} \cos\theta$ ➜ $T_{\text{left}} = T_{\text{right}}$

along y $T_{\text{left}} \sin\theta + T_{\text{right}} \sin\theta = M_{\text{person}}\, g$

➜ $\sin\theta = M_{\text{person}}\, g\,/\,(2 \cdot T)$

M and T given.