This Week

Edition 8	Edition 7
3:10	3:11
3:33	3:27
3:63	3:57
4:17	4:15
4:16	n/a

Tutorial and Test 2

Need to know all of chapter 3 and up to and including sect 4.5 (Newton's 3rd law): average velocity, average acceleration, displacement, the four equations of kinematics, relative motion, Newton's laws of motion.

WileyPLUS Assignment 1

Due Monday, October 5 at 11:00 pm

Chapters 2 & 3

The hint given for Q3.22 is for a different question from edition 7!!

WileyPLUS Assignment 2

Chapters 4, 5

Will be available Monday, October 5

Due...

Objects in Equilibrium

An object is in equilibrium when its acceleration is zero – it remains at rest, or moves with constant velocity.

This implies that the net force acting on it is zero (first law).

$$F_x^{net} = 0$$
$$F_y^{net} = 0$$

- Equilibrium is often expressed in terms of the net force on an object being zero.

- The object may be moving, but at constant velocity.

Clicker Question: Focus on Concepts, Question 20

A certain object is in equilibrium. Which one of the following statements is **not** true?

A) The object has a constant velocity.

B) The object has no acceleration.

C) The object must be at rest.

D) No net force acts on the object.

C) The object could be moving.

Clicker Question: Focus on Concepts, Question 19

Which one of the following objects is in equilibrium?

A) A taxi coming to a halt to discharge a passenger.

B) A brick falling from a bridge.

C) A space probe with its engines shut down, moving through a vast empty region of outer space.

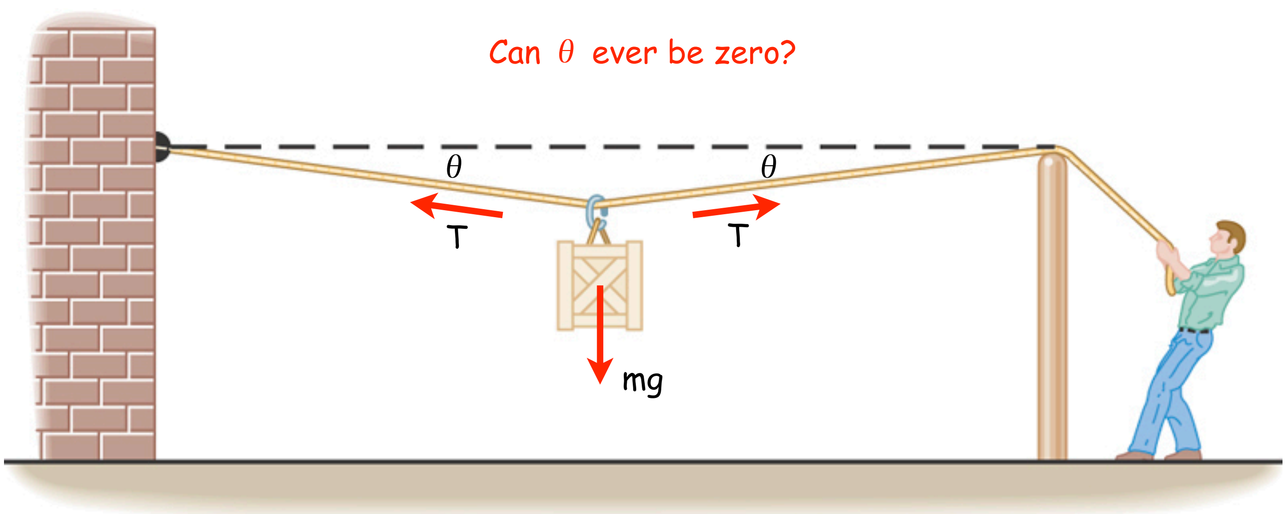
D) A race horse taking off at the beginning of a race.

E) A projectile as it passes through the topmost point of its trajectory.

C) The space probe, zero net force acting on it

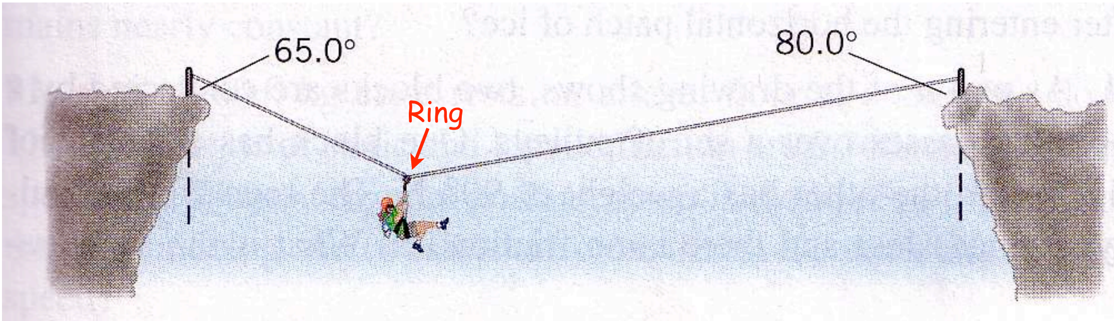
Can the person who is pulling the rope ever make the rope perfectly horizontal?

Can θ ever be zero?



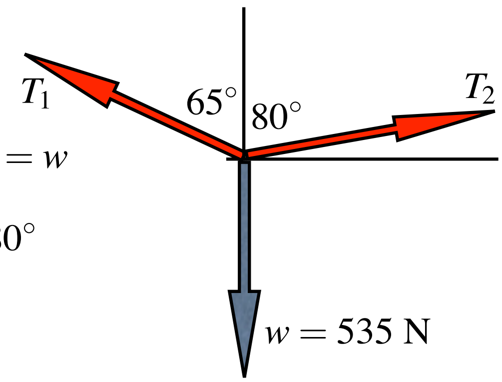
To support the weight:

$$mg = 2T \sin\theta$$



4.62/102: The mountaineer weighs 535 N. What are the tensions in the two sections of the cable?

Forces on the ring:



Vertically: $T_1 \cos 65^\circ + T_2 \cos 80^\circ = w$

Horizontally: $T_1 \sin 65^\circ = T_2 \sin 80^\circ$

Eliminate T_1, solve for T_2

$$\boxed{\begin{array}{ll} \text{Vertically: } T_1 \cos 65^\circ + T_2 \cos 80^\circ = w & (1) \\ \text{Horizontally: } T_1 \sin 65^\circ = T_2 \sin 80^\circ & (2) \end{array}}$$

$$\text{So, } T_1 = T_2 \frac{\sin 80^\circ}{\sin 65^\circ} = 1.0866 \times T_2 \qquad (2)$$

Substitute into (1):

$$T_2 \times 1.0866 \cos 65^\circ + T_2 \cos 80^\circ = w = 535 \text{ N}$$

$$\underline{T_2 = 535/(1.0866 \cos 65^\circ + \cos 80^\circ) = 535/0.63287 = 845N}$$

and $\underline{T_1 = 1.0866 \times T_2 = 918 \text{ N}}$

Clicker Question: Focus on Concepts, Question 18

A heavy block is suspended from a ceiling using pulleys in three different ways, as shown in the drawings. Rank the tension in the rope that passes over the pulleys in ascending order (smallest first).

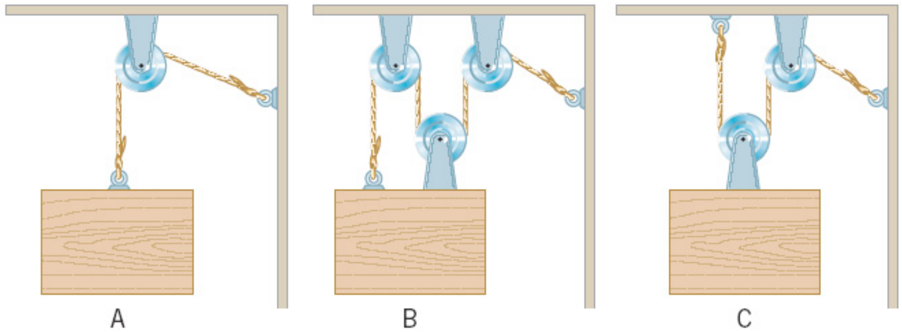
A) C, B, A

B) C, A, B

C) A, B, C

D) B, A, C

E) B, C, A



E) From largest to smallest number of sections of rope supporting the block

Clicker Question: Focus on Concepts, Question 23

Two identical boxes are being pulled across a horizontal floor at a constant velocity by a horizontal pulling force of 176 N that is applied to one of the boxes, as the drawing shows. There is kinetic friction between each box and the floor. Find the tension in the rope between the boxes.

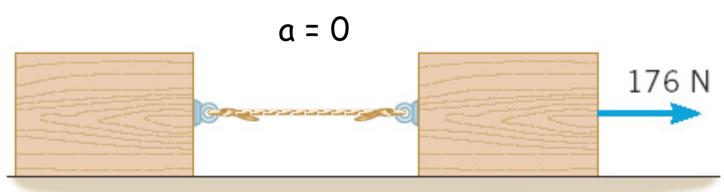
A) 176 N

B) 88.0 N

C) 132 N

D) 44.0 N

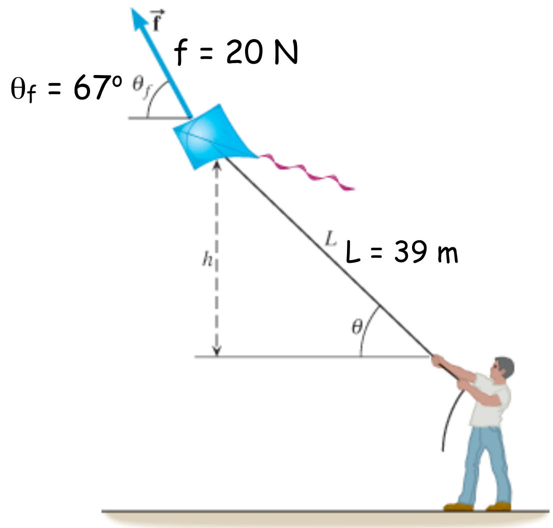
E) There is not enough information to calculate the tension.



B) A 176 N force pulls two identical boxes
So a force of 88 N must pull one box

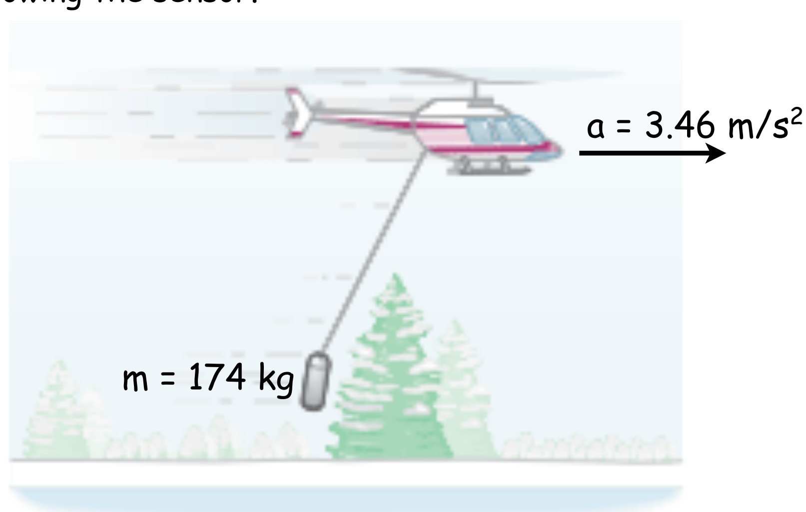
Chapter 4, Problem 68

A kite is hovering over the ground at the end of a straight 39-m line. The tension in the line has a magnitude of 14 N. Wind blowing on the kite exerts a force of 20 N, directed 67° above the horizontal. Note that the line attached to the kite is not oriented at an angle of 67° above the horizontal. Find the height of the kite, relative to the person holding the line.

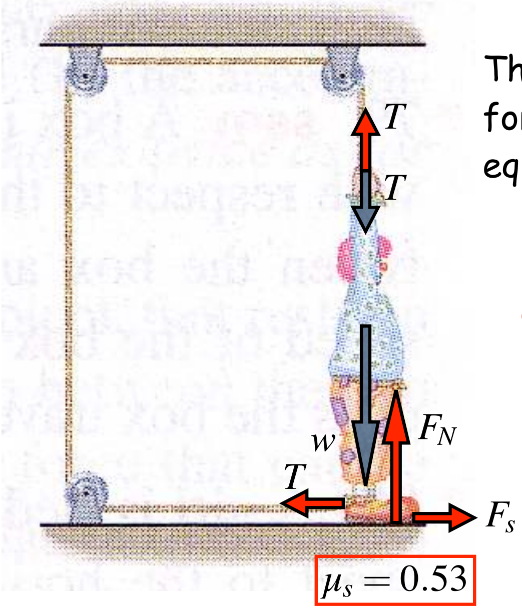


Chapter 4, Problem 74

A helicopter flies over the arctic ice pack at a constant altitude, towing an airborne 174-kg laser sensor which measures the thickness of the ice. The helicopter and the sensor move only in the horizontal direction and have a horizontal acceleration of magnitude 3.46 m/s^2. Ignoring air resistance, find the tension in the cable towing the sensor.

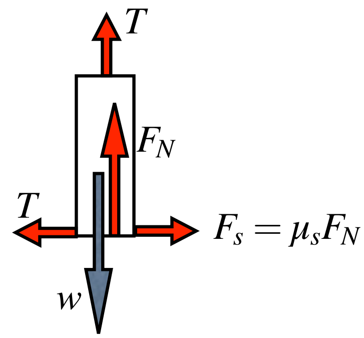


4.60/54: A circus clown weighs 890 N. He pulls vertically on the rope that passes over three pulleys and is tied to his feet. What is the minimum pulling force needed to yank his feet out from beneath himself?



The clown pulls down on rope with force T. The rope pulls back with equal force.

Forces acting **on the clown**:



If T > F_s, his feet will slip

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That is:

maximum value

$T > F_s = \mu_s F_N \rightarrow$ set $T = \mu_s F_N$

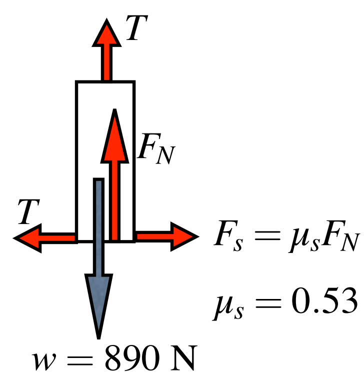
$\boxed{\text{What is } F_N\text{?}}$

Forces in the vertical direction:

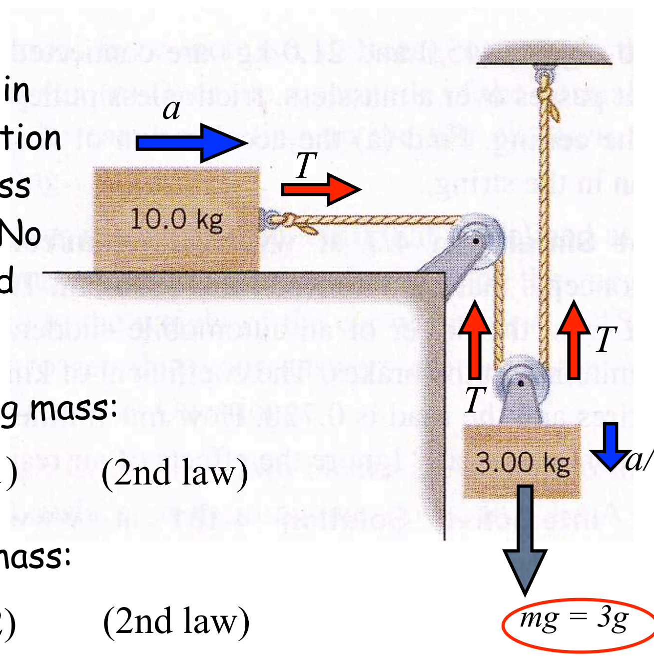
$T + F_N = w = 890\text{ N}$ or $\mu_s F_N + F_N = 890\text{ N}$

So, $F_N = (890\text{ N})/(1 + 0.53) = 582\text{ N}$

Substitute $\underline{T = \mu_s F_N = 0.53 \times 582 = 308\text{ N}}$



4.91/83: Find the tension in the rope and the acceleration of the 10 kg mass (massless rope, frictionless pulley). No friction between block and table.



Force to the right on 10 kg mass:

$$T = ma = 10a \qquad (1) \qquad \text{(2nd law)}$$

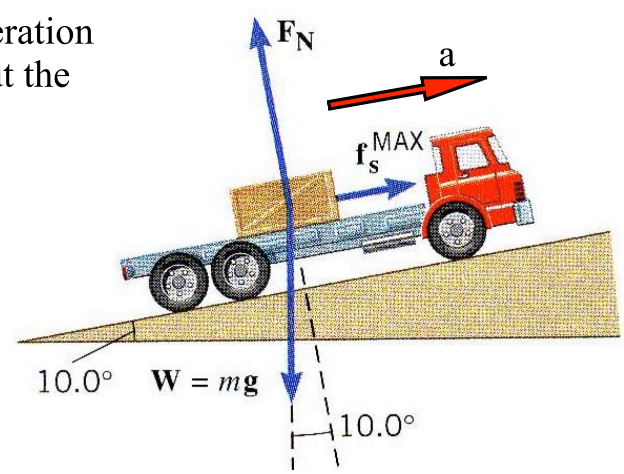
Downward force on 3 kg mass:

$$3g - 2T = 3(a/2) \qquad (2) \qquad \text{(2nd law)}$$

So, from (1) and (2): $2T = \boxed{20a = 3g - 3a/2}$

Therefore, $a = 1.37\ \text{m/s}^2$ and $T = 10a = 13.7\ \text{N}$

Find the maximum acceleration the truck can have without the crate sliding off the back.



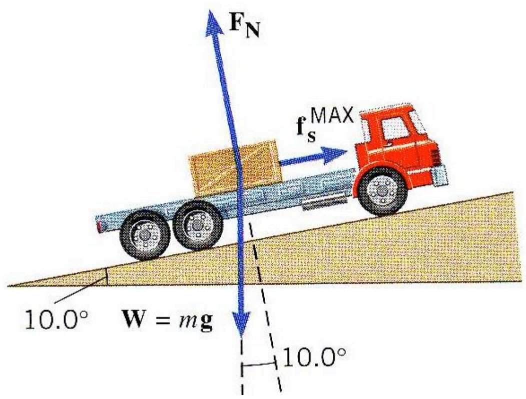
$$\mu_s = 0.35$$

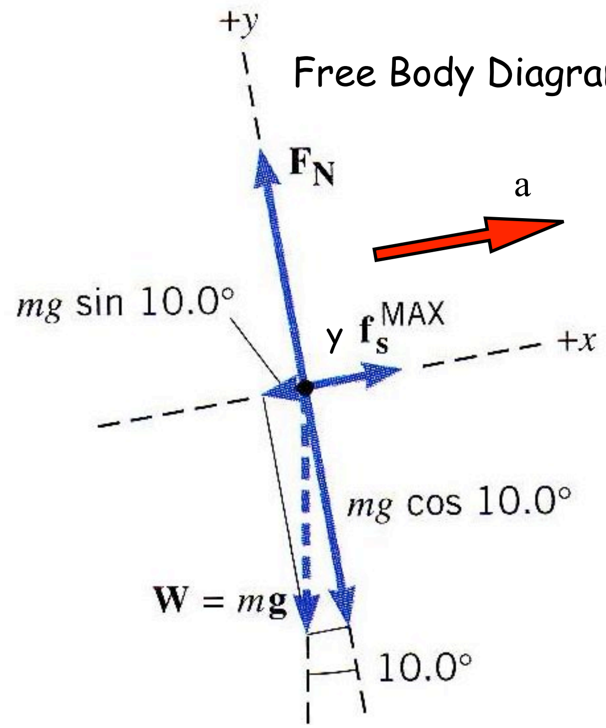
$$F_s^{max} = \mu_s F_N$$

What is F_N?

The truck and the crate are accelerated at a rate a up the slope, at 10° to the horizontal.

Rotate the axes so x is up the slope, y perpendicular to the road.





Forces acting on the crate

All of the physics so far –

- Force, mass and Newton's three laws of motion
- Newton's law of gravity
- Normal, friction and tension forces.
- Apparent weight, free fall
- Equilibrium

The rest is –

- useful equations – the four famous equations
- how to apply all of the above