Classical Mechanics
Lecture 6

Today's Concept:

Friction

Stuff you asked about:

It might be good to go into more detail about when to use static or kinetic friction for the example of the car going around the circle. It would be easy in future examples to mistakenly use kinetic friction when static friction is called for.

Maybe explain how pulleys on an angle and how forces are affected in some example question.

Focus on the visual of the x and y components for forces for inclined planes.

tension questions with things pulling on both ends are difficult for me, especially when trying to find out what the tension is or using some other net forces to find out what tension is

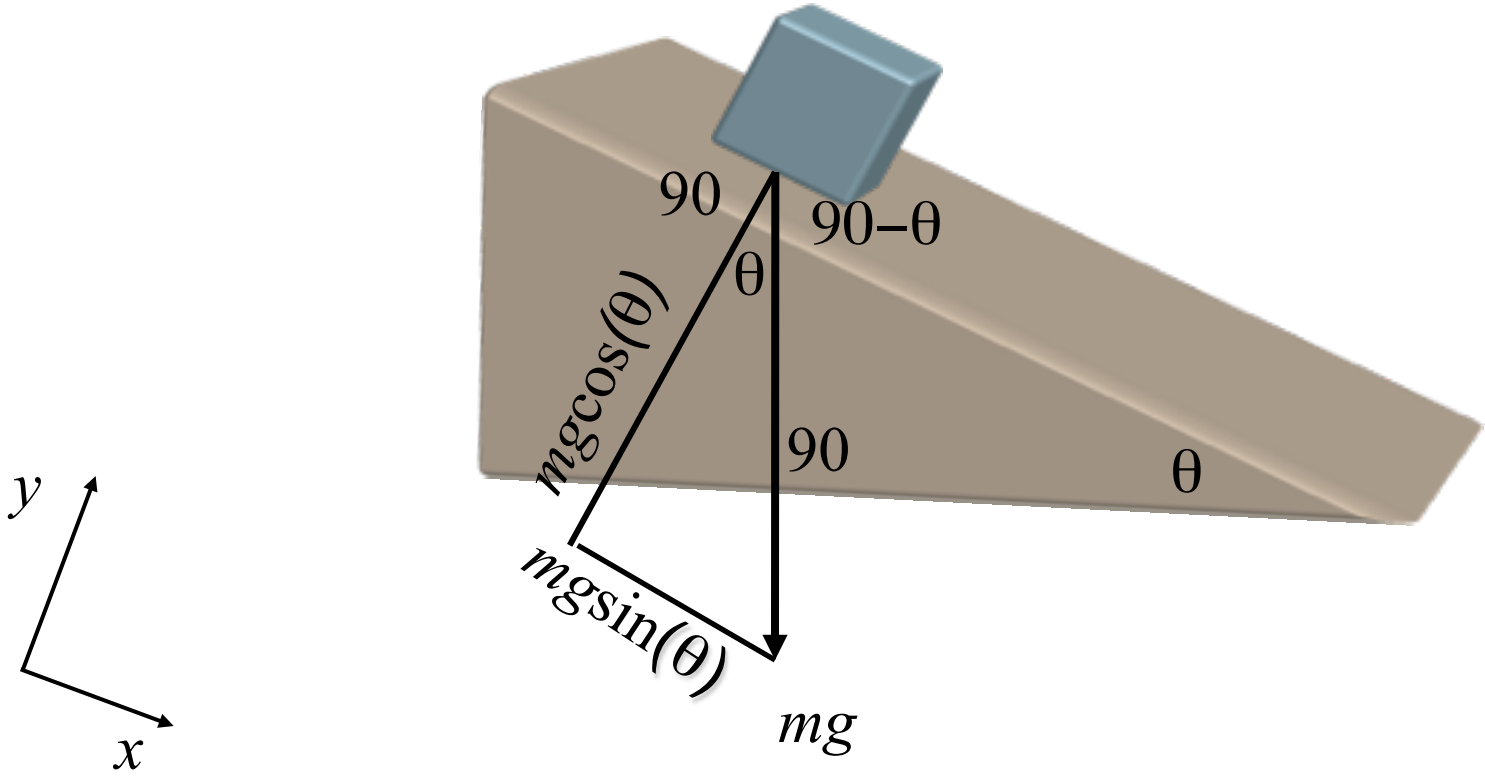
The most difficult concept was the static frictional force. I would like this discussed in lecture.

I got really confused about static frictional force. What's the difference? and why is it sometimes less then μmg.

None of them :P Yawn. No, really, this stuff should be pretty easy.

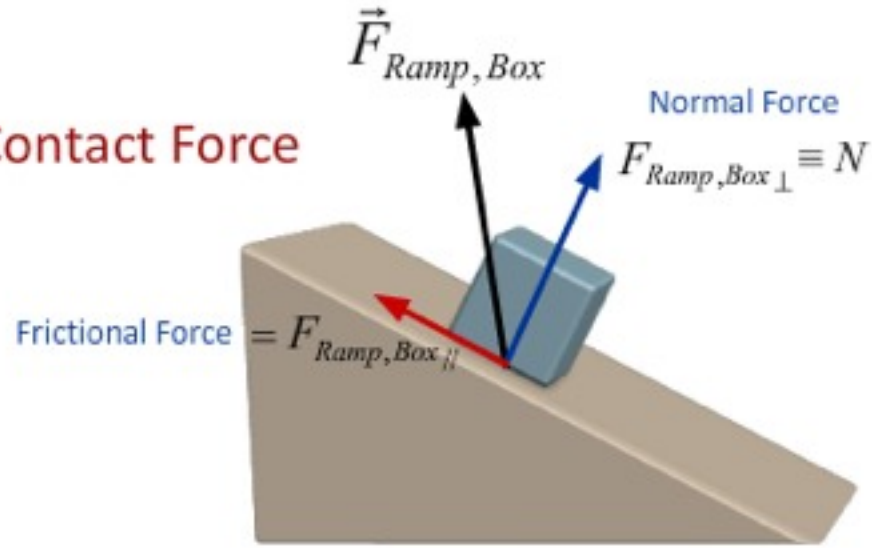
Stuff you asked about:

I know this is more of a geometrical issue, but I couldn't see how the angle used to break down the weight components of a block sitting on a ramp into its x and y components, is the same as the angle of the ramp. If you could briefly explain that in lecture it would be very nice.



Friction

Components of a Contact Force



Kinetic Friction

$$f_k = \mu_k N$$

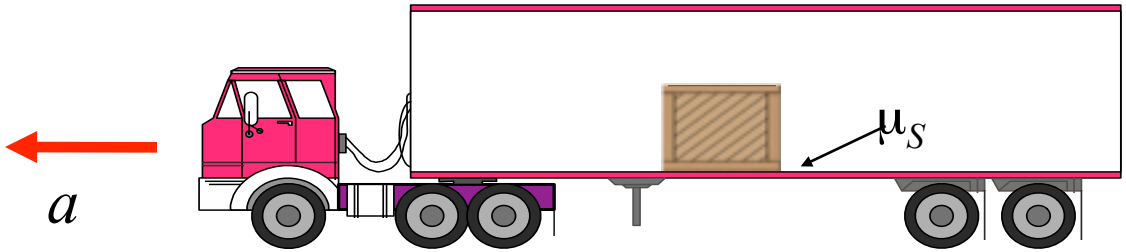
Static Friction

$$f_s \leq \mu_s N$$

Always opposes the relative motion of two surfaces

CheckPoint

A box sits on the horizontal bed of a moving truck. Static friction between the box and the truck keeps the box from sliding around as the truck drives.

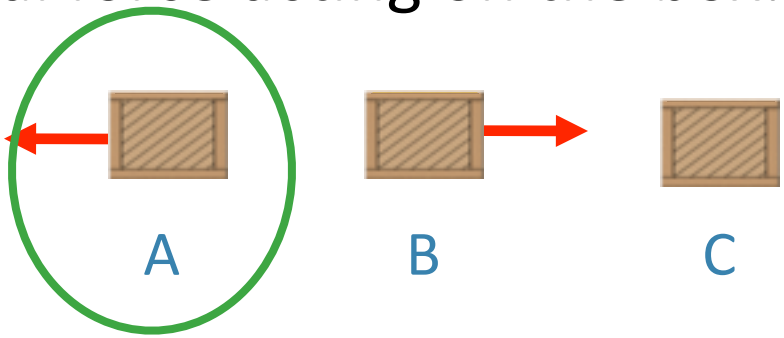


If the truck moves with constant acceleration to the left as shown, which of the following diagrams best describes the static frictional force acting on the box:

A B C

CheckPoint

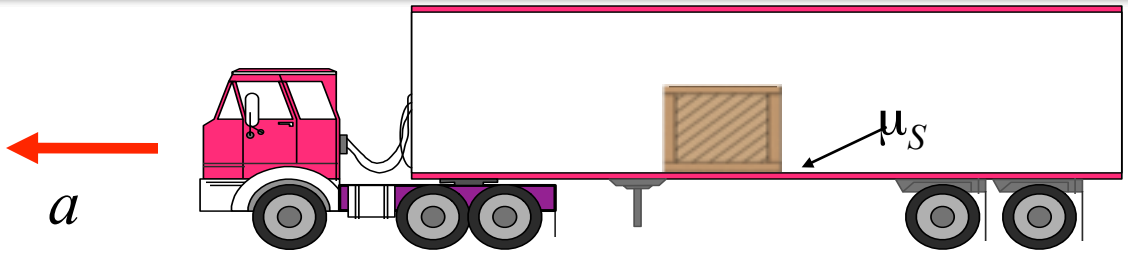
If the truck moves with constant accelerating to the left as shown, which of the following diagrams best describes the static frictional force acting on the box:



A) There must be a leftward static frictional force which imparts a leftward acceleration of the same magnitude as the truck's acceleration to the box, or the box will slide.

B) Friction always acts in the direction opposite to the applied force. Since the truck is accelerating to the left, the applied force is to the left. Therefore, friction acts towards the right.

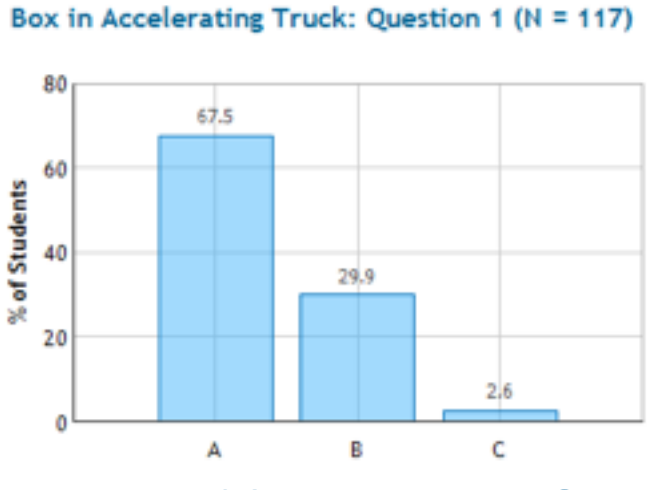
CheckPoint



If the truck moves with constant accelerating to the left as shown, which of the following diagrams best describes the static frictional force acting on the box:

A B C

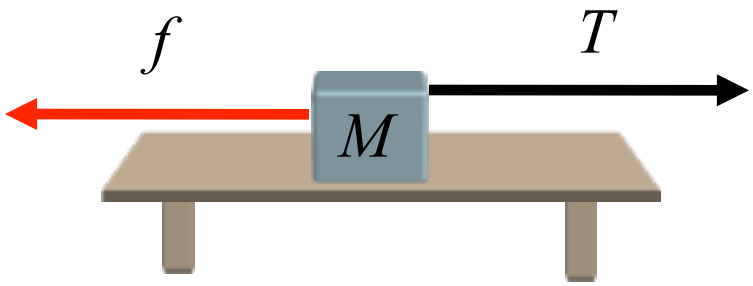
the force has to go in the same direction as the acceleration.



Clicker Question

A box of mass M sits on a horizontal table. A horizontal string having tension T applies a force on the box, but static friction between the box and the table keeps the box from moving.

What is the magnitude of the total force acting on the box?



A) Mg
B) mMg
C) T
D) 0

Since acceleration is zero.

CheckPoint

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What is the magnitude of the static frictional force acting on the box?

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B) mMg
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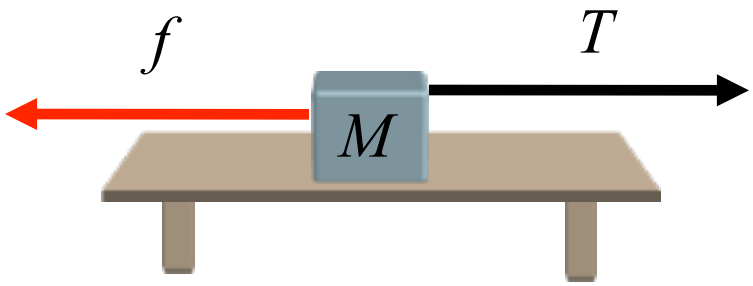
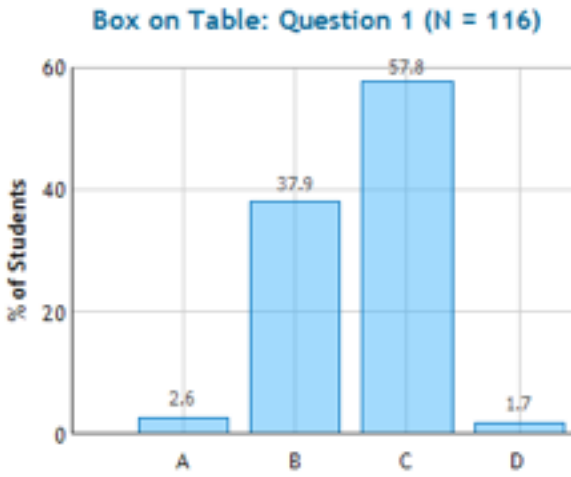
D) 0



Since the box is not moving the forces must be equal, otherwise there would be an acceleration.



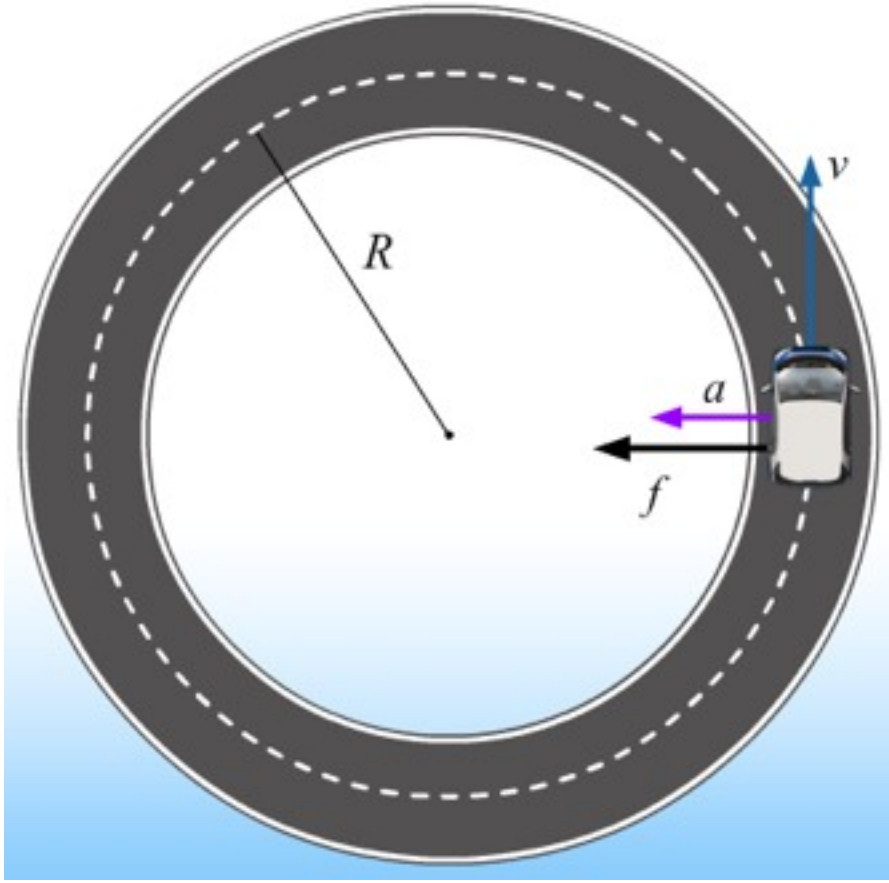
Question: How fast can the car go without skidding off the road?

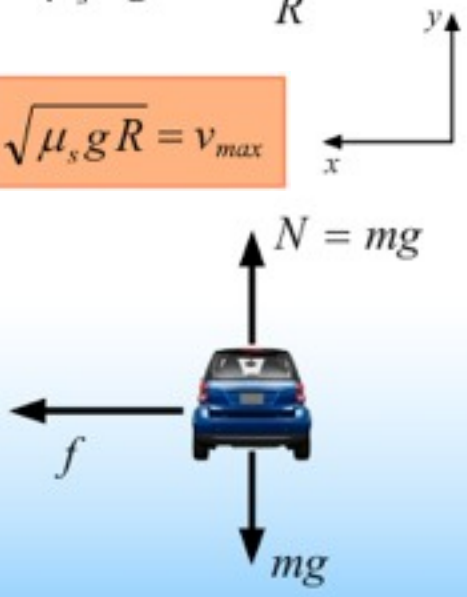
$$f = m\frac{v^2}{R}$$

$$\mu_s N = m\frac{v_{max}^2}{R}$$

$$\mu_s mg = m\frac{v_{max}^2}{R}$$

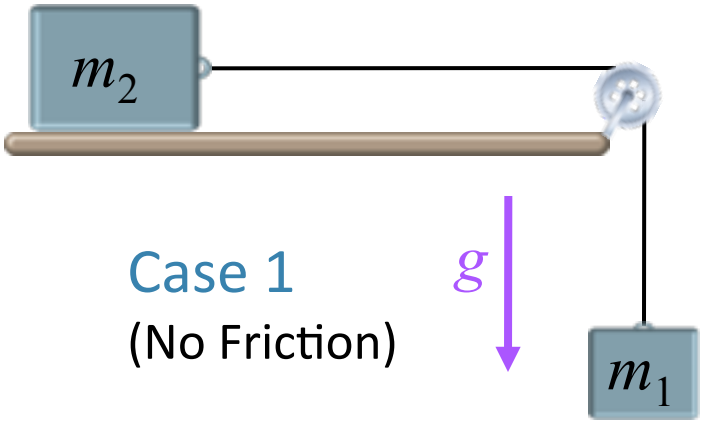
$$\sqrt{\mu_s g R} = v_{max}$$

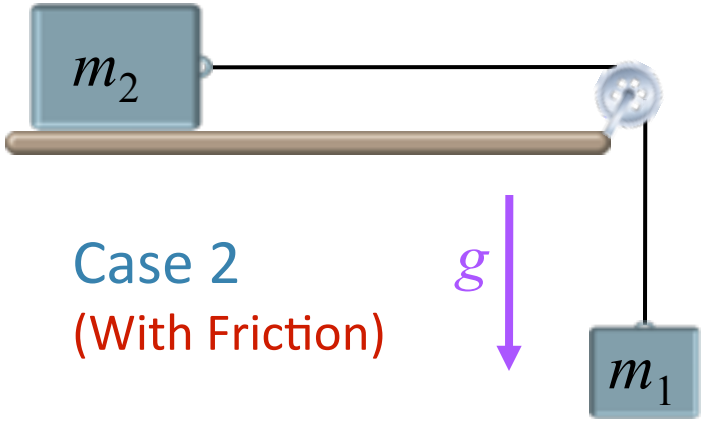




CheckPoint

A block slides on a table pulled by a string attached to a hanging weight. In Case 1 the block slides without friction and in Case 2 there is kinetic friction between the sliding block and the table.





In which case is the tension in the string biggest?

A) Case 1 B) Case 2 C) Same

~65% got this right

Clicker Question

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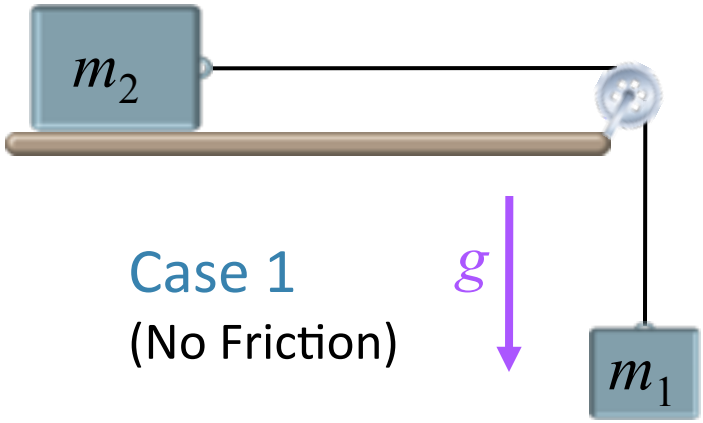
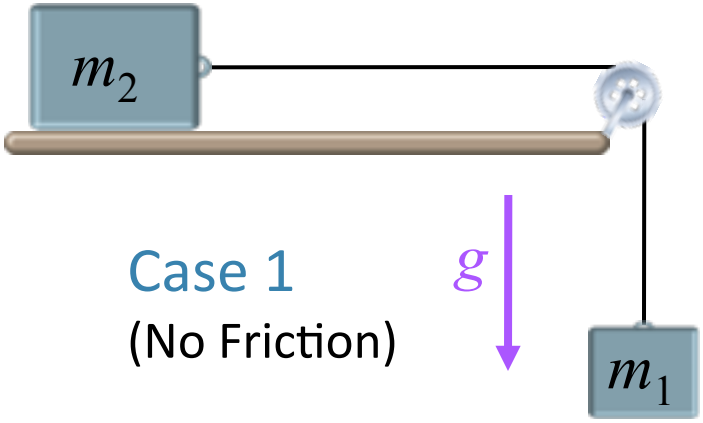
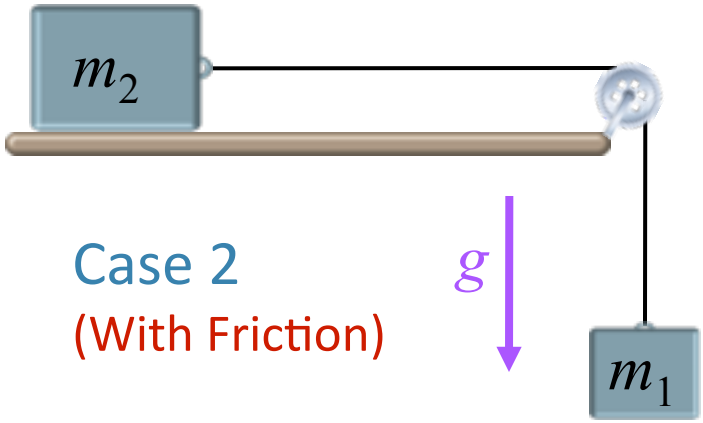


What is the tension in the string in Case 1?

A) $T = 0$ B) $T = mg$ C) T is between 0 and mg



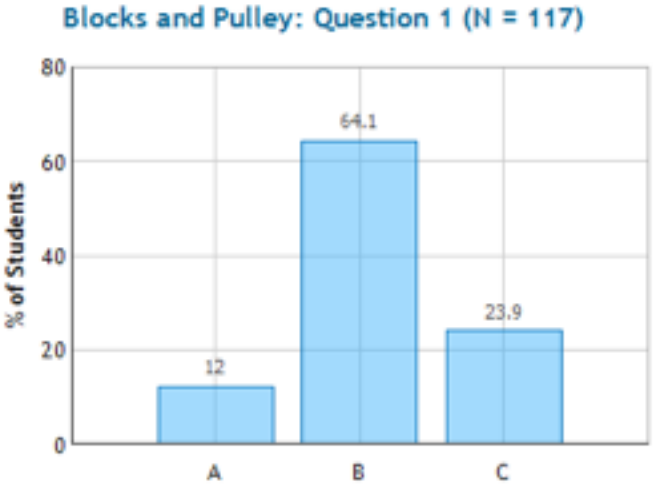


In which case is the tension in the string biggest?

A) Case 1 B) Case 2 C) Same

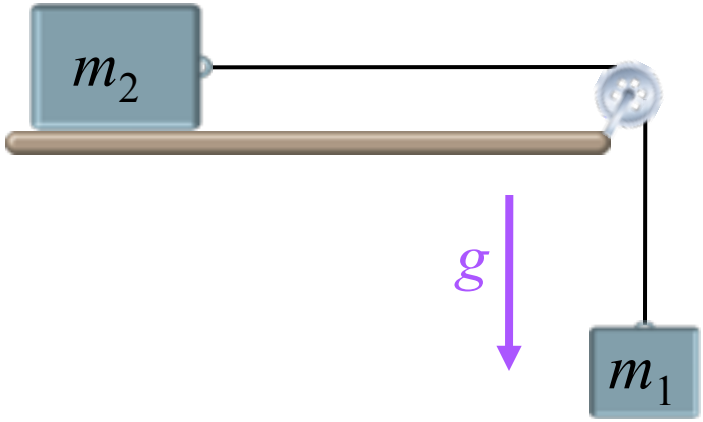
B) M1 will not be accelerating as fast in case two than in case one because there is the extra force of friction acting against mass 1. Since the acceleration is smaller in case two, there has to be more of a force acting against gravity, the only other possible force is Tension.

C) The tension on the string is m1*g regardless of what is happening on top of the table; the force is equal.



Lets work it out

A block (m_2) slides on a table pulled by a string attached to a mass (m_1) hanging over the side. The coefficient of kinetic friction between the sliding block and the table is μ_k. What is the tension in the string?



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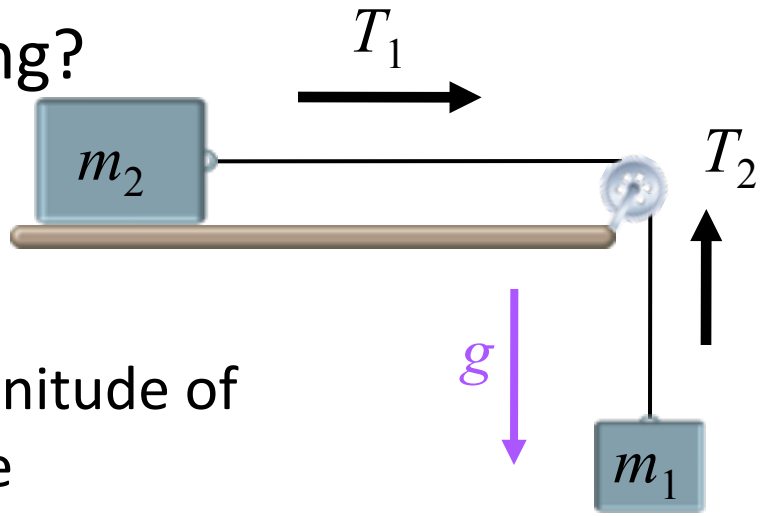

What is the relationship between the magnitude of the tension of the string at block 2 and the magnitude of the tension in the string at block 1?

A) $T_1 > T_2$ B) $T_1 = T_2$ C) $T_1 < T_2$

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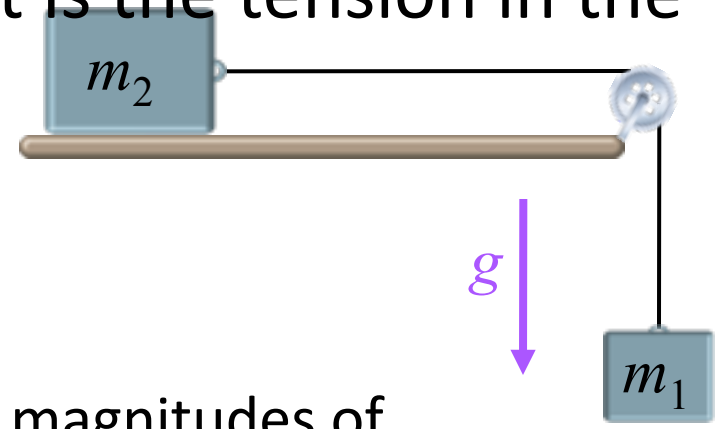
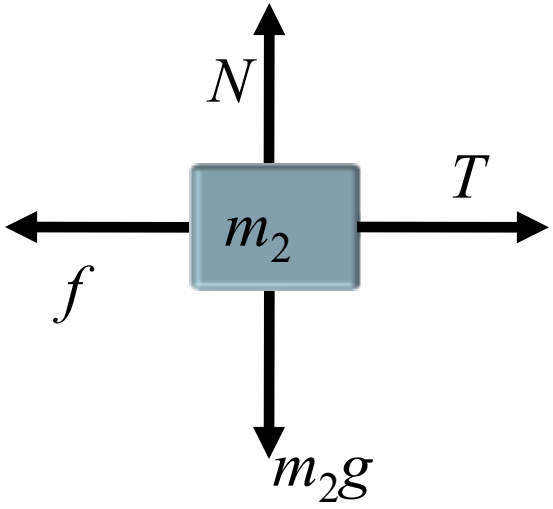
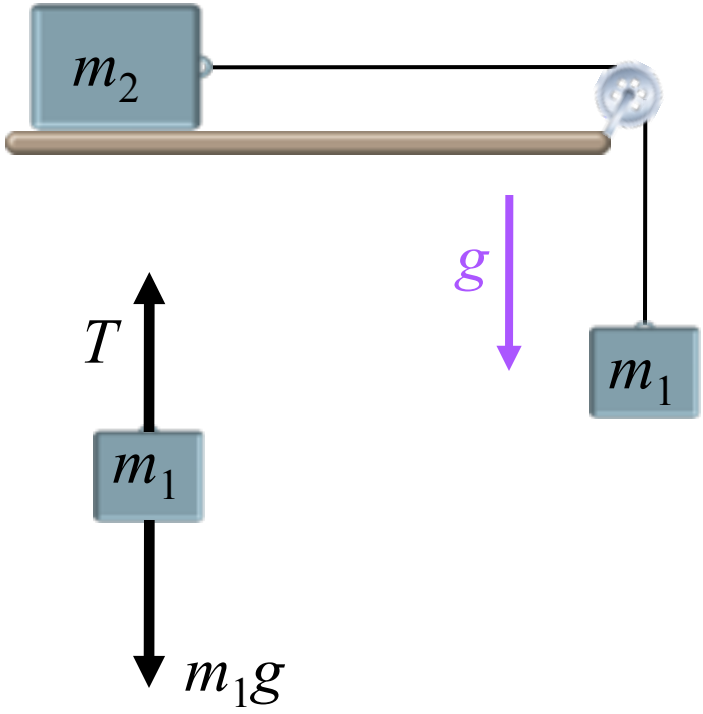


What is the relationship between the magnitudes of the acceleration of the two blocks?

A) $a_1 = a_2$ B) $a_1 < a_2$ C) $a_1 > a_2$

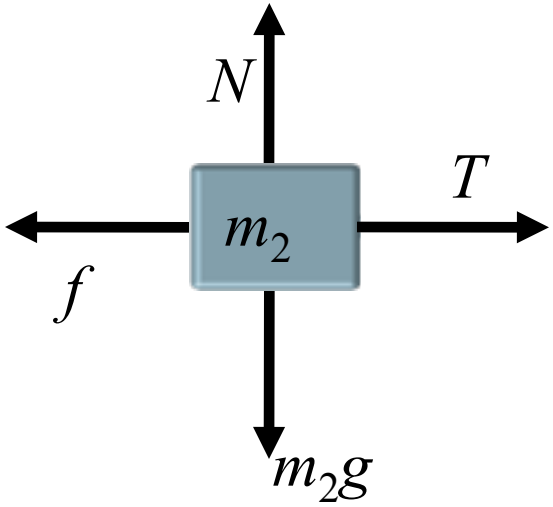
1) FBD

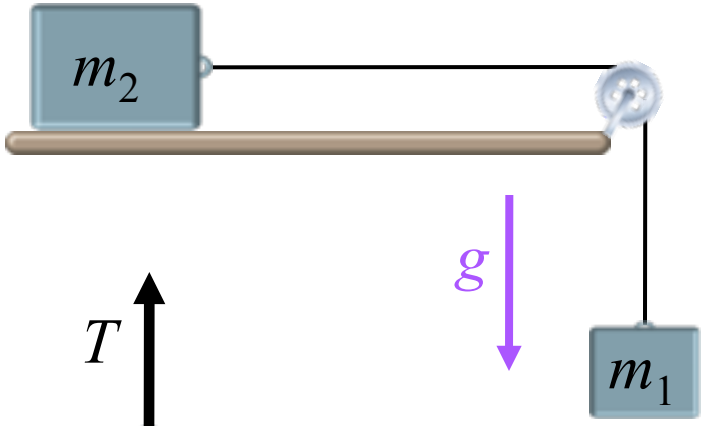


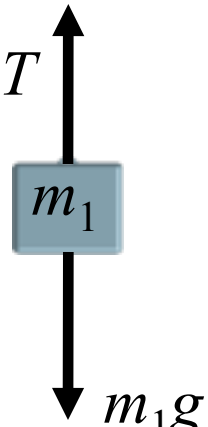


1) FBD

2) $\Sigma F = ma$







$$N = m_2 g$$

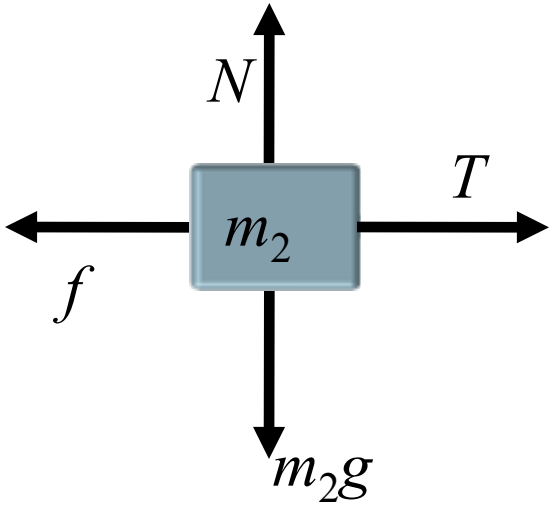
$$T - \mu m_2 g = m_2 a \qquad m_1 g - T = m_1 a$$

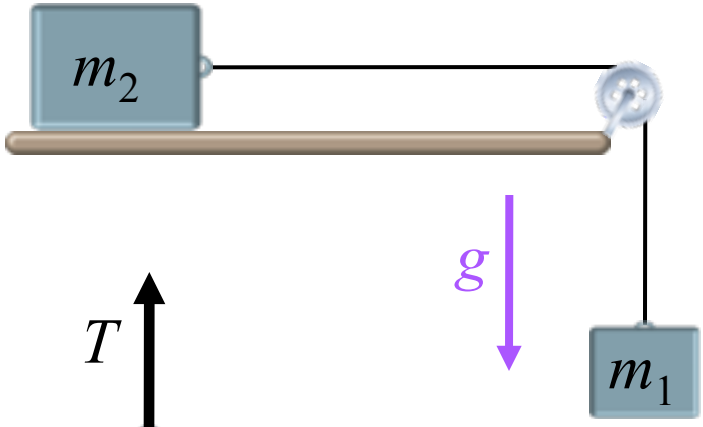
add

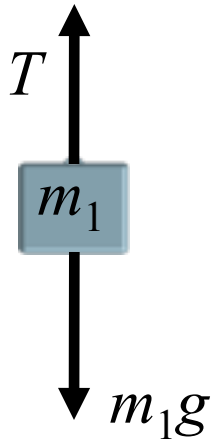
$$m_1 g - \mu m_2 g = m_1 a + m_2 a$$

$$a = \frac{m_1 g - \mu m_2 g}{m_1 + m_2}$$

1) FBD
2) $\Sigma F = ma$







$$m_1 g - T = m_1 a$$

$$a = \frac{m_1 g - \mu m_2 g}{m_1 + m_2}$$

$$T = m_1 g - m_1 a$$

T is smaller when a is bigger