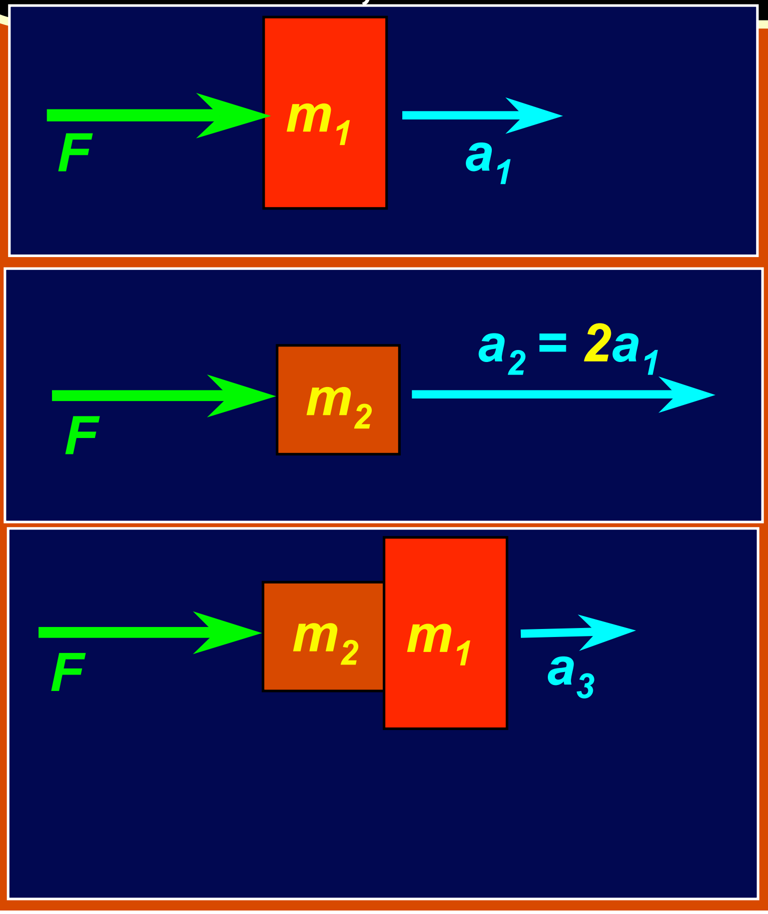
ConcepTest 4.6 Force and Two Masses

A force F acts on mass m_1 giving acceleration a_1. The same force acts on a different mass m_2 giving acceleration $a_2 = 2a_1$. If m_1 and m_2 are glued together and the same force F acts on this combination, what is the resulting acceleration?

1) 3/4 a_1
2) 3/2 a_1
3) 1/2 a_1
4) 4/3 a_1
5) 2/3 a_1



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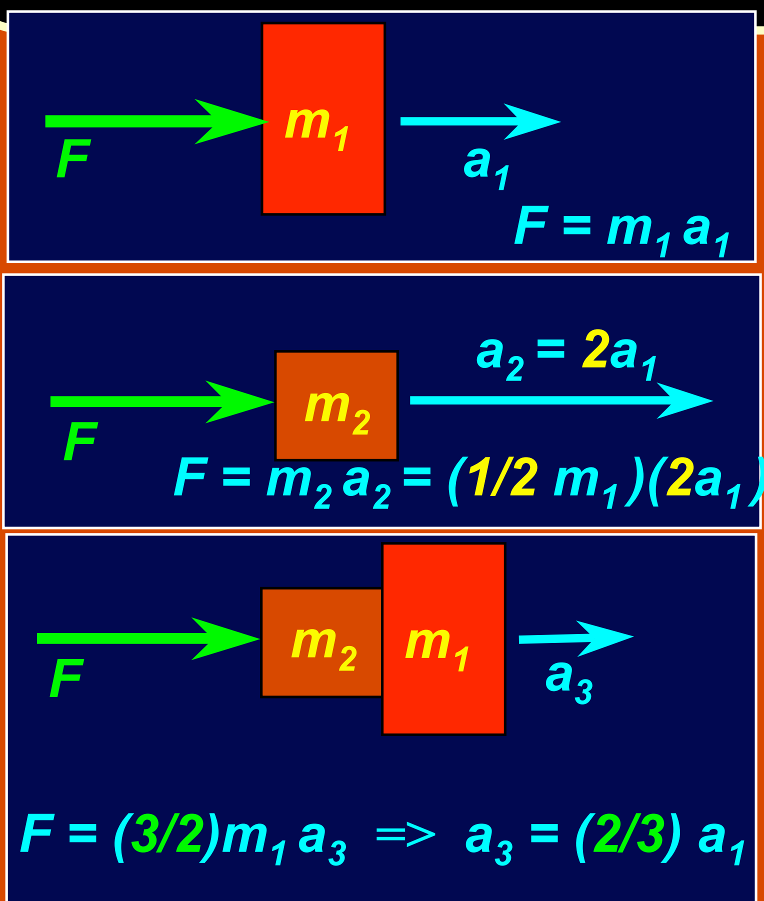

Mass m_2 must be $(1/2)m_1$ because its acceleration was $2a_1$ with the same force. Adding the two masses together gives $(3/2)m_1$, leading to an acceleration of $(2/3)a_1$ for the same applied force.

ConcepTest 4.7 Climbing the Rope

When you climb up a rope, the first thing you do is pull down on the rope. How do you manage to go up the rope by doing that??

1) **this slows your initial velocity which is already upward**
2) **you don't go up, you're too heavy**
3) **you're not really pulling down – it just seems that way**
4) **the rope actually pulls you up**
5) **you are pulling the ceiling down**

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When you climb **up** a rope, the first thing you do is **pull down** on the rope. **How do you manage to go up the rope by doing that??**

1) this slows your initial velocity which is already upward
2) you don't go up, you're too heavy
3) you're not really pulling down – it just seems that way
4) the rope actually pulls you up
5) you are pulling the ceiling down

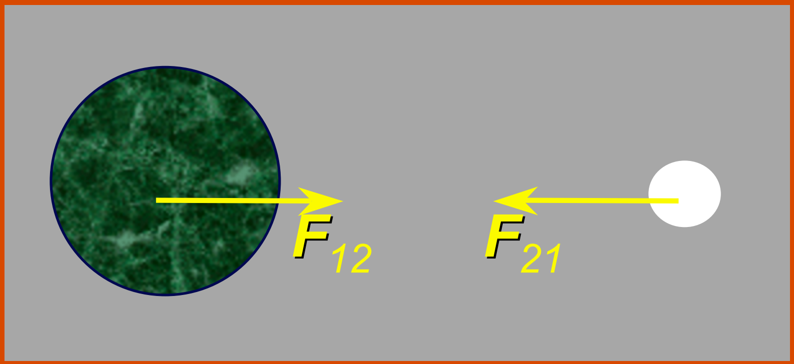
When you pull down on the rope, the rope pulls up on you!!

It is actually this upward force by the rope that makes you move up! This is the "reaction" force (by the rope on you) to the force that you exerted on the rope. And voilá, this is Newton's 3rd Law.

ConcepTest 4.8a Bowling vs. Ping-Pong I

In outer space, a bowling ball and a ping-pong ball attract each other due to gravitational forces. How do the magnitudes of these attractive forces compare?

1) **The bowling ball exerts a greater force on the ping-pong ball**
2) **The ping-pong ball exerts a greater force on the bowling ball**
3) **The forces are equal**
4) **The forces are zero because they cancel out**
5) **There are actually no forces at all**



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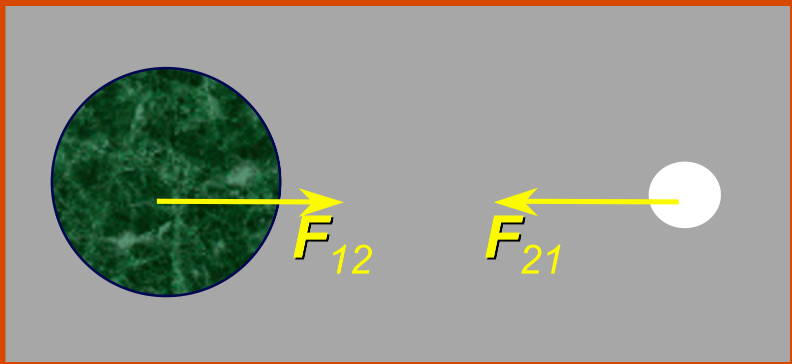
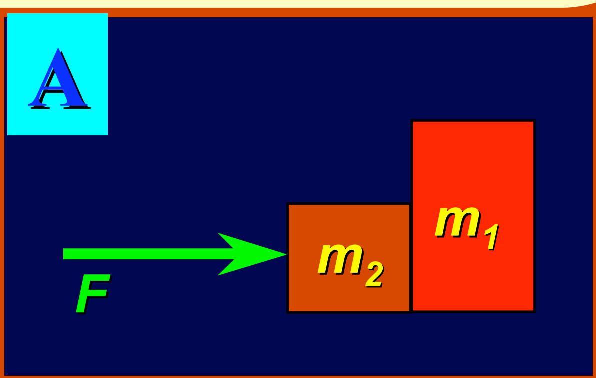
The **forces** are equal and opposite by Newton's 3rd Law!

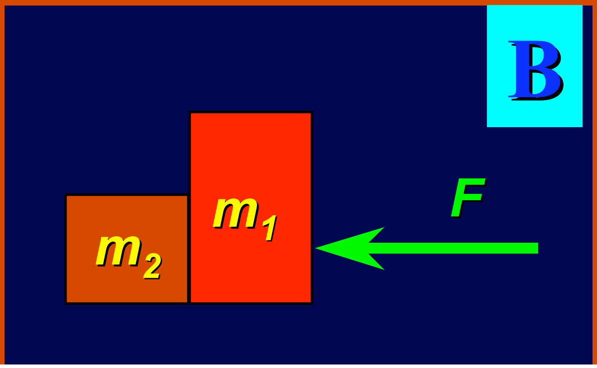


ConcepTest 4.10a Contact Force I

If you push with force F on either the heavy box (m_1) or the light box (m_2), in which of the two cases below is the contact force between the two boxes larger?

1) case A
2) case B
3) same in both cases





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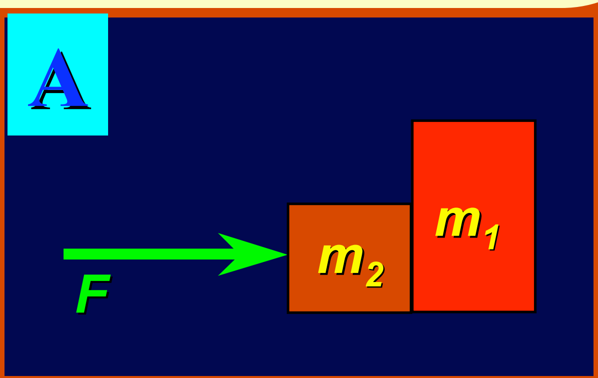
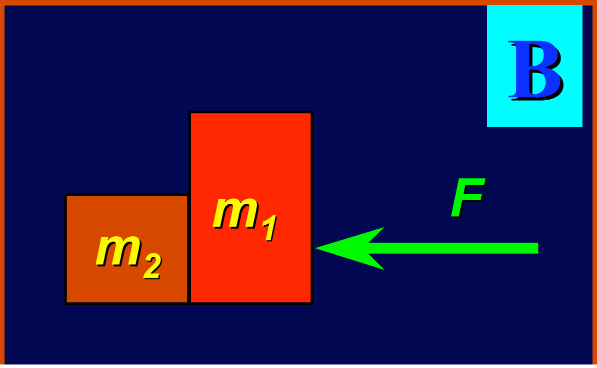
If you push with force F on either the heavy box (m_1) or the light box (m_2), in which of the two cases below is the contact force between the two boxes larger?

1) case A
2) case B
3) same in both cases

The acceleration of both masses together is the same in either case. But the contact force is the ***only*** force that accelerates m_1 in case A (or m_2 in case B). Since m_1 is the larger mass, it requires the larger contact force to achieve the same acceleration.





Follow-up: What is the accel. of each mass?

ConcepTest 5.3b Tension II

Two tug-of-war opponents each pull with a force of ***100 N*** on opposite ends of a rope. What is the tension in the rope?

1) ***0 N***
2) ***50 N***
3) ***100 N***
4) ***150 N***
5) ***200 N***

ConcepTest 5.3b Tension II

Two tug-of-war opponents each pull with a force of *100 N* on opposite ends of a rope. What is the tension in the rope?

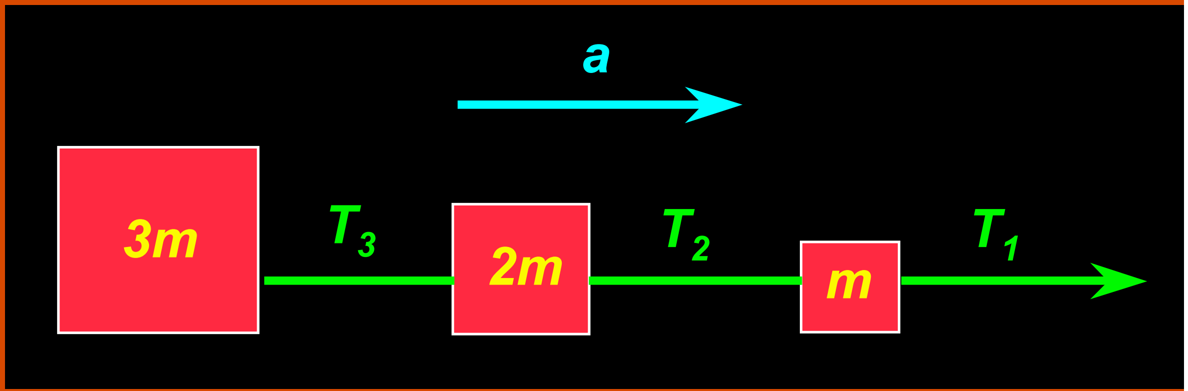
1) *0 N*
2) *50 N*
3) *100 N*
4) *150 N*
5) *200 N*

This is literally the identical situation to the previous question. The tension is not 200 N !! Whether the other end of the rope is pulled by a person, or pulled by a tree, the tension in the rope is still 100 N !!

ConcepTest 5.4 Three Blocks

Three blocks of mass *3m*, *2m*, and *m* are connected by strings and pulled with constant acceleration *a*. What is the relationship between the tension in each of the strings?

1) $T_1 > T_2 > T_3$
2) $T_1 < T_2 < T_3$
3) $T_1 = T_2 = T_3$
4) *all tensions are zero*
5) *tensions are random*



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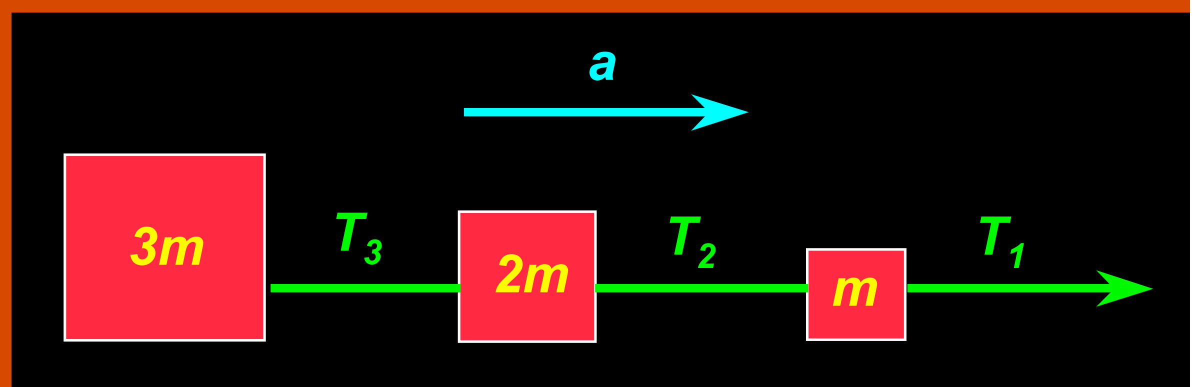
T_1 pulls the whole set of blocks along, so it must be the largest. T_2 pulls the last two masses, but T_3 only pulls the last mass.

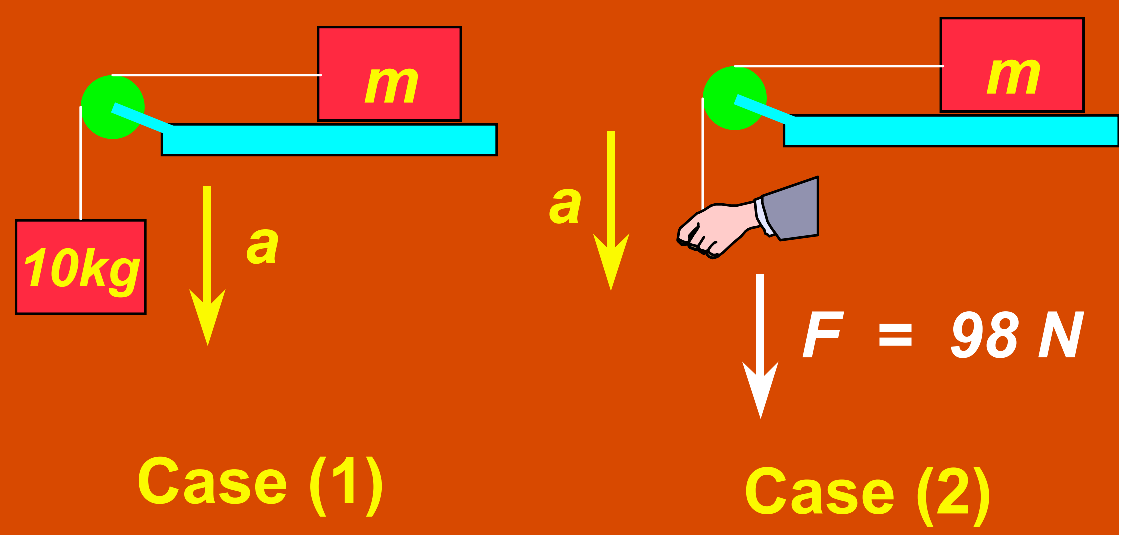


Follow-up: What is T_1 in terms of *m* and *a*?

ConcepTest 5.5 Over the Edge

In which case does block *m* experience a larger acceleration? In (1) there is a *10 kg* mass hanging from a rope and falling. In (2) a hand is providing a constant downward force of *98 N*. Assume massless ropes.

1) *case 1*
2) *acceleration is zero*
3) *both cases are the same*
4) *depends on value of m*
5) *case 2*



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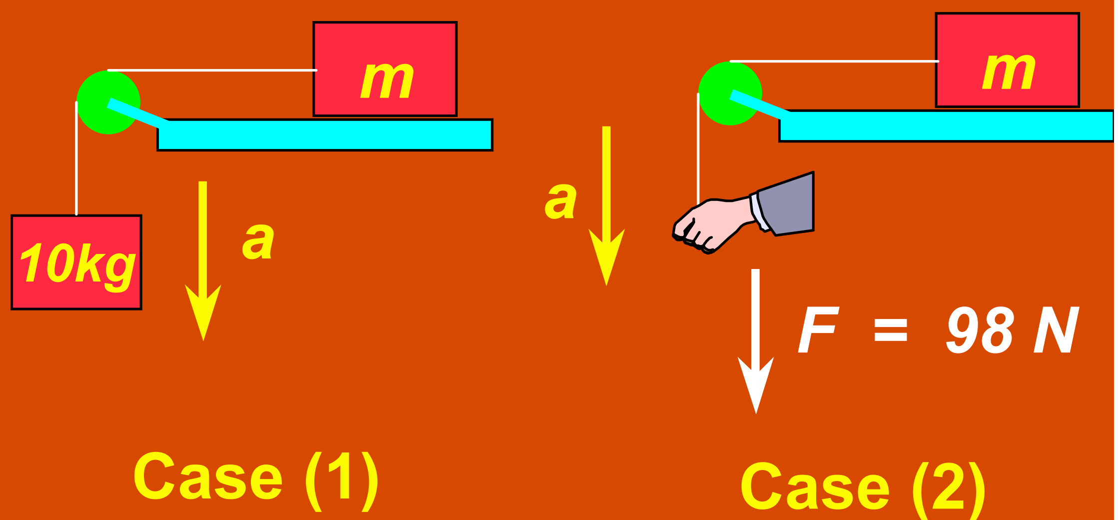
1) *case 1*
2) *acceleration is zero*
3) *both cases are the same*
4) *depends on value of m*
5) *case 2*

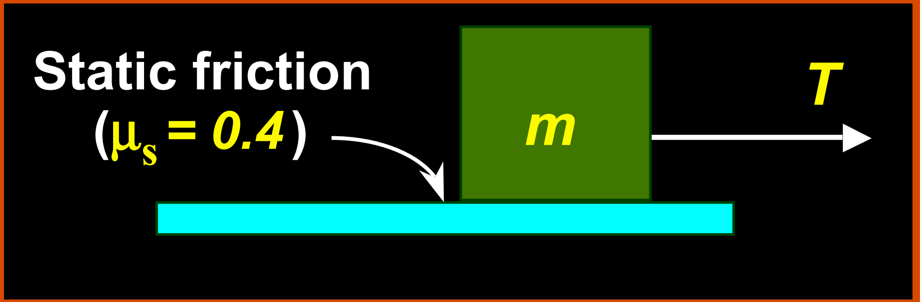
In (2) the tension is *98 N* due to the hand. In (1) the tension is less than *98 N* because the block is accelerating down. Only if the block were at rest would the tension be equal to *98 N*.



ConcepTest 5.12 Will it Budge?

A box of weight 100 N is at rest on a floor where m_s = *0.5*. A rope is attached to the box and pulled horizontally with tension *T = 30 N*. Which way does the box move?

1) **moves to the left**
2) **moves to the right**
3) **moves up**
4) **moves down**
5) **the box does not move**

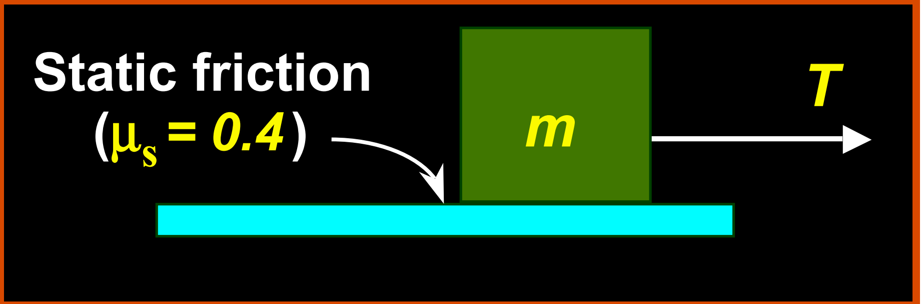


ConcepTest 5.12 Will it Budge?

A box of **weight 100 N** is at rest on a floor where $\mu_s = 0.4$. A rope is attached to the box and pulled horizontally with tension $T = 30$ N. Which way does the box move?

1) moves to the left
2) moves to the right
3) moves up
4) moves down
5) the box does not move

The static friction force has a **maximum** of $\mu_s N = 40$ N. The tension in the rope is only 30 N. So the pulling force is not big enough to overcome friction.

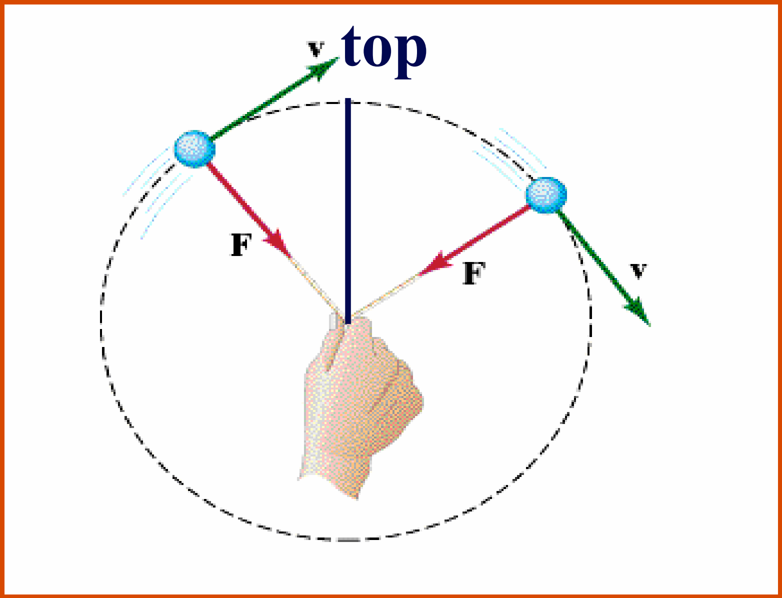


Follow-up: What happens if the tension is *35 N*? What about *45 N*?

ConcepTest 5.19c Going in Circles III

You swing a ball at the end of string in a vertical circle. Since the ball is in circular motion there has to be a ***centripetal force.*** At the top of the ball's path, what is F_c equal to?

1) $F_c = T - mg$
2) $F_c = T + N - mg$
3) $F_c = T + mg$
4) $F_c = T$
5) $F_c = mg$



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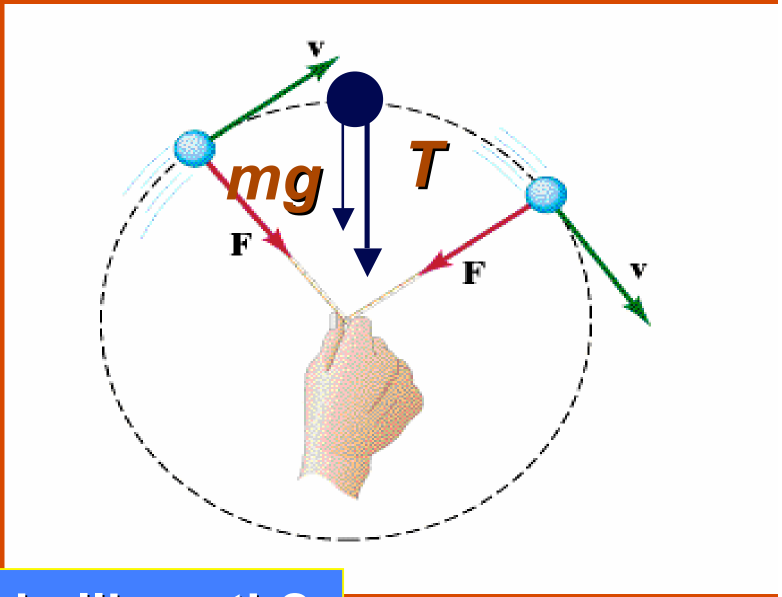
2) $F_c = T + N - mg$
3) $F_c = T + mg$
4) $F_c = T$
5) $F_c = mg$

F_c points toward the center of the circle, *i.e.* downward in this case. The weight vector points down and the tension (exerted by the string) also points down. The magnitude of the net force, therefore, is: $F_c = T + mg$



Follow-up: What is F_c at the bottom of the ball's path?