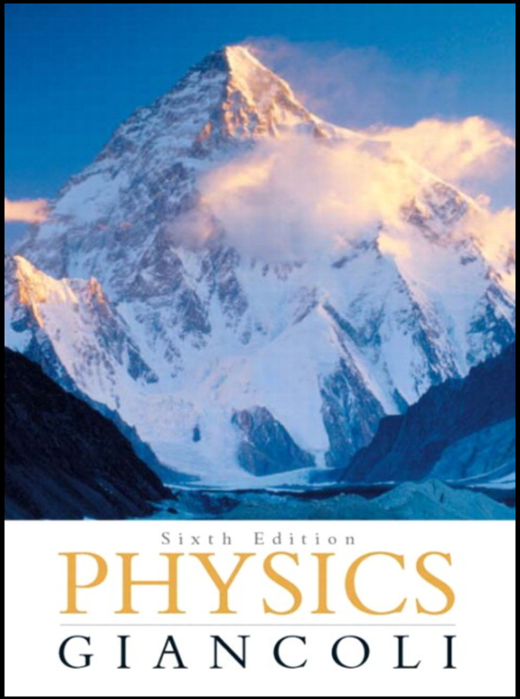

ConcepTest PowerPoints

Chapter 4

Physics: Principles with Applications, 6th edition

Giancoli

ConcepTest 4.1a Newton's First Law I

A book is lying at rest on a table. The book will remain there at rest because:

1) there is a net force but the book has too much inertia
2) there are no forces acting on it at all
3) it does move, but too slowly to be seen
4) there is no net force on the book
5) there is a net force, but the book is too heavy to move

ConcepTest 4.1a Newton's First Law I

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3) it does move, but too slowly to be seen
4) there is no net force on the book
5) there is a net force, but the book is too heavy to move

There are forces acting on the book, but the only forces acting are in the *y*-direction. Gravity acts downward, but the table exerts an upward force that is equally strong, so the two forces cancel, leaving no net force.

ConcepTest 4.1b Newton's First Law II

A hockey puck slides on ice at constant velocity. What is the *net* force acting on the puck?

1) more than its weight
2) equal to its weight
3) less than its weight but more than zero
4) depends on the speed of the puck
5) zero

ConcepTest 4.1b Newton's First Law II

A hockey puck slides on ice at **constant velocity**. What is the *net* force acting on the puck?

1) more than its weight
2) equal to its weight
3) less than its weight but more than zero
4) depends on the speed of the puck
5) zero

The puck is moving at a **constant velocity**, and therefore it is **not accelerating**. Thus, there must be **no net force** acting on the puck.

Follow-up: Are there any forces acting on the puck? What are they?

ConcepTest 4.1c Newton's First Law III

You put your book on the bus seat next to you. When the bus stops suddenly, the book slides forward off the seat. Why?

1) a net force acted on it
2) no net force acted on it
3) it remained at rest
4) it did not move, but only seemed to
5) gravity briefly stopped acting on it

ConcepTest 4.1c Newton's First Law III

You put your book on the bus seat next to you. When the bus stops suddenly, the book slides forward off the seat. Why?

1) a net force acted on it
2) no net force acted on it
3) it remained at rest
4) it did not move, but only seemed to
5) gravity briefly stopped acting on it

The book was initially moving forward (since it was on a moving bus). When the bus stopped, the book **continued moving forward**, which was its **initial state of motion**, and therefore it slid forward off the seat.

Follow-up: What is the force that usually keeps the book on the seat?

ConcepTest 4.1d Newton's First Law IV

You kick a smooth flat stone out on a frozen pond. The stone slides, slows down and eventually stops. You conclude that:

1) the force pushing the stone forward finally stopped pushing on it
2) no net force acted on the stone
3) a net force acted on it all along
4) the stone simply "ran out of steam"
5) the stone has a natural tendency to be at rest

ConcepTest 4.1d Newton's First Law IV

You kick a smooth flat stone out on a frozen pond. The stone slides, slows down and eventually stops. You conclude that:

1) the force pushing the stone forward finally stopped pushing on it
2) no net force acted on the stone
3) a net force acted on it all along
4) the stone simply "ran out of steam"
5) the stone has a natural tendency to be at rest

After the stone was kicked, no force was pushing it along! However, there must have been **some force** acting on the stone **to slow it down and stop it**. This would be friction!!

Follow-up: What would you have to do to keep the stone moving?

ConcepTest 4.2a Cart on Track I

Consider a cart on a horizontal frictionless table. Once the cart has been given a push and released, what will happen to the cart?

1) slowly come to a stop
2) continue with constant acceleration
3) continue with decreasing acceleration
4) continue with constant velocity
5) immediately come to a stop

ConcepTest 4.2a Cart on Track I

Consider a cart on a horizontal frictionless table. Once the cart has been given a push and released, what will happen to the cart?

1) slowly come to a stop
2) continue with constant acceleration
3) continue with decreasing acceleration
4) continue with constant velocity
5) immediately come to a stop

After the cart is released, there is no longer a force in the x-direction. ***This does not mean that the cart stops moving!!*** It simply means that the cart will ***continue moving with the same velocity*** it had at the moment of release. The initial push got the cart moving, but that force is not needed to *keep* the cart in motion.

ConcepTest 4.2b Cart on Track II

We just decided that the cart continues with constant velocity. What would have to be done in order to have the cart continue with constant acceleration?

1) push the cart harder before release
2) push the cart longer before release
3) push the cart continuously
4) change the mass of the cart
5) it is impossible to do that

ConcepTest 4.2b Cart on Track II

We just decided that the cart continues with constant velocity. What would have to be done in order to have the cart continue with constant acceleration?

1) push the cart harder before release
2) push the cart longer before release
3) push the cart continuously
4) change the mass of the cart
5) it is impossible to do that

In order to achieve a non-zero acceleration, it is necessary to maintain the applied force. The only way to do this would be to continue pushing the cart as it moves down the track. This will lead us to a discussion of Newton's Second Law.

ConcepTest 4.3 Truck on Frozen Lake

A very large truck sits on a frozen lake. Assume there is no friction between the tires and the ice. A fly suddenly smashes against the front window. What will happen to the truck?

1) it is too heavy, so it just sits there
2) it moves backward at const. speed
3) it accelerates backward
4) it moves forward at const. speed
5) it accelerates forward

ConcepTest 4.3 Truck on Frozen Lake

A very large truck sits on a frozen lake. Assume there is **no friction** between the tires and the ice. A fly suddenly smashes against the front window. What will happen to the truck?

1) it is too heavy, so it just sits there
2) it moves backward at const. speed
3) it accelerates backward
4) it moves forward at const. speed
5) it accelerates forward

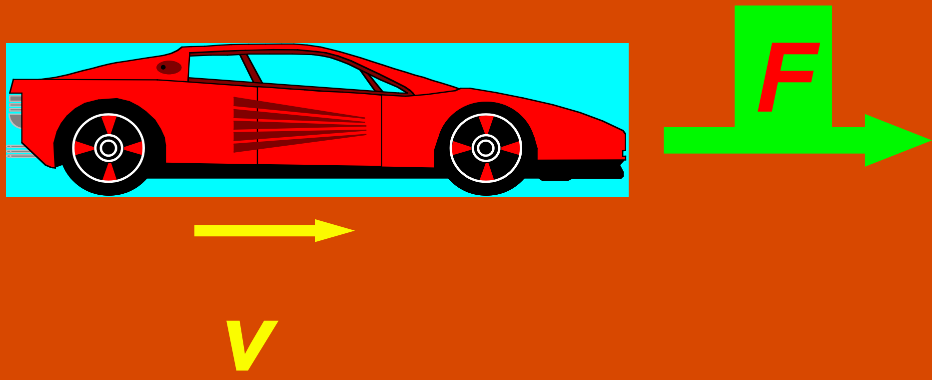
When the fly hit the truck, it exerted a force on the truck (only for a fraction of a second). So, in this time period, the truck accelerated (backwards) up to some speed. After the fly was squashed, it no longer exerted a force, and the truck simply continued moving at constant speed.

Follow-up: What is the truck doing 5 minutes after the fly hit it?

ConcepTest 4.4a Off to the Races I

From rest, we step on the gas of our Ferrari, providing a force *F* for *4 secs*, speeding it up to a final speed *v*. If the applied force were only 1/2 *F*, how long would it have to be applied to reach the *same* final speed?

1) *16 s*
2) *8 s*
3) *4 s*
4) *2 s*
5) *1 s*



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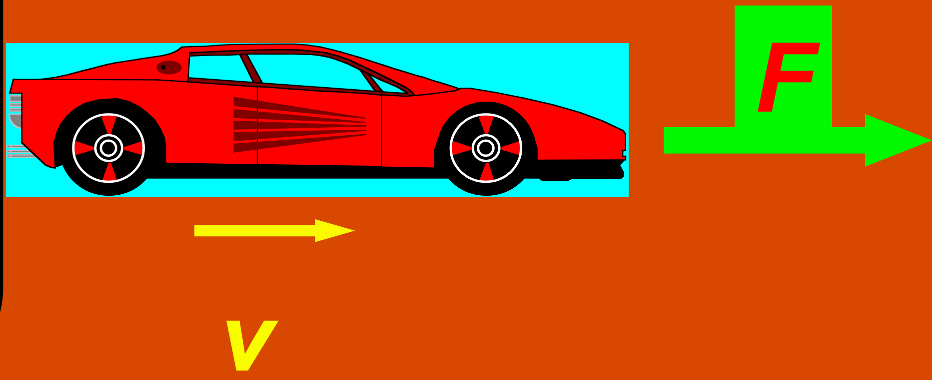
1) *16 s*
2) *8 s*
3) *4 s*
4) *2 s*
5) *1 s*

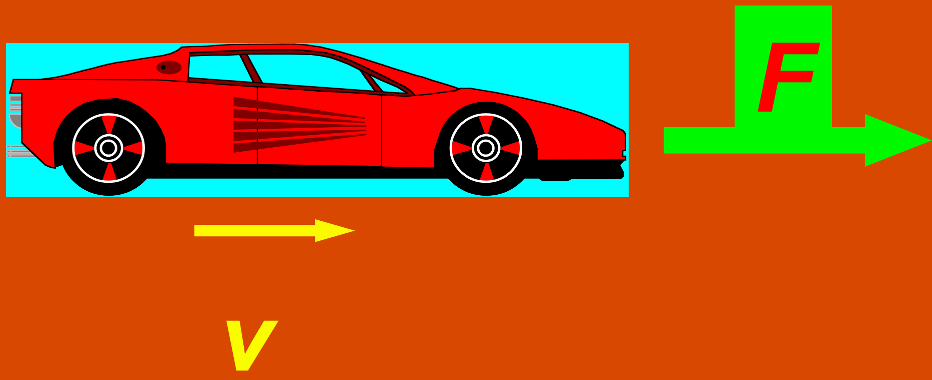
In the first case, the acceleration acts over time *T = 4 s* to give velocity *v = aT*. In the second case, the force is half, therefore the acceleration is also half, so to achieve the *same final speed*, the time must be doubled.



ConcepTest 4.4b Off to the Races II

From rest, we step on the gas of our Ferrari, providing a force *F* for *4 secs*. During this time, the car moves 50 m. If the same force would be applied for *8 secs*, how much would the car have traveled during this time?

1) *250 m*
2) *200 m*
3) *150 m*
4) *100 m*
5) *50 m*



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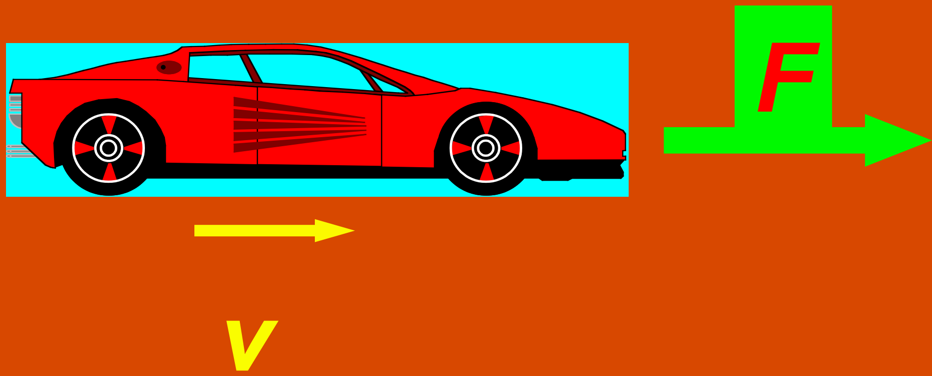
1) *250 m*
2) *200 m*
3) *150 m*
4) *100 m*
5) *50 m*

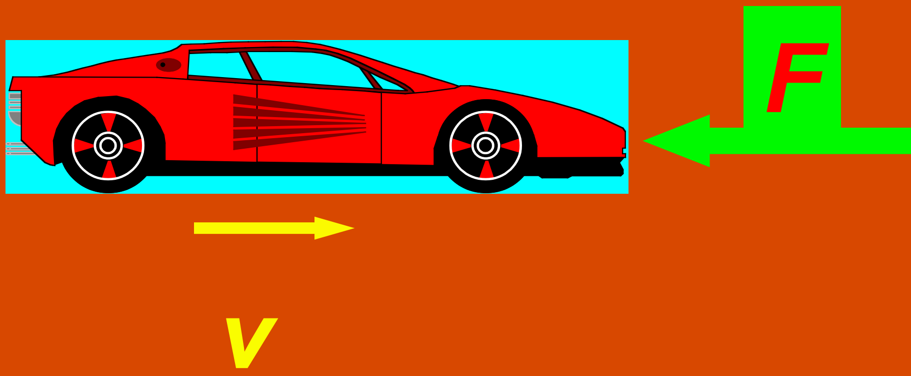
In the first case, the acceleration acts over time $T = 4$ s, to give a distance of $x = \frac{1}{2}aT^2$ (why is there no v_0T term?). In the 2nd case, the time is doubled, so the distance is quadrupled because it goes as the square of the time.



ConcepTest 4.4c Off to the Races III

We step on the brakes of our Ferrari, providing a force *F* for *4 secs*. During this time, the car moves 25 m, but does not stop. If the same force would be applied for *8 secs*, how far would the car have traveled during this time?

1) *100 m*
2) *50 m < x < 100 m*
3) *50 m*
4) *25 m < x < 50 m*
5) *25 m*

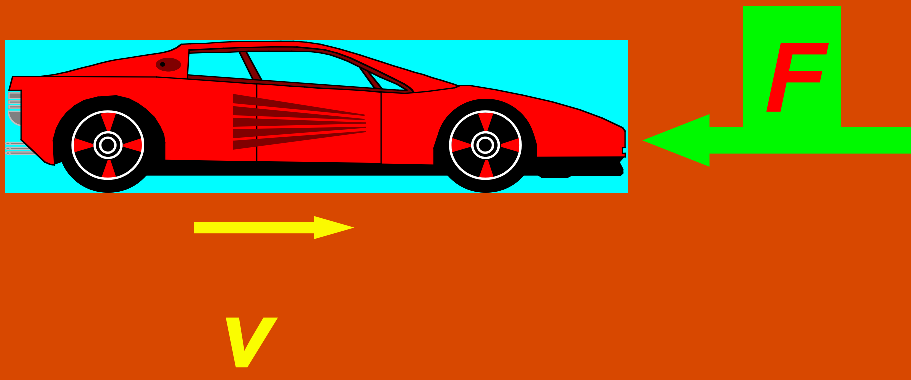


ConcepTest 4.4c Off to the Races III

We step on the brakes of our Ferrari, providing a force *F* for *4 secs*. During this time, the car moves 25 m, but does not stop. If the same force would be applied for *8 secs*, how far would the car have traveled during this time?

1) *100 m*
2) *50 m < x < 100 m*
3) *50 m*
4) *25 m < x < 50 m*
5) *25 m*

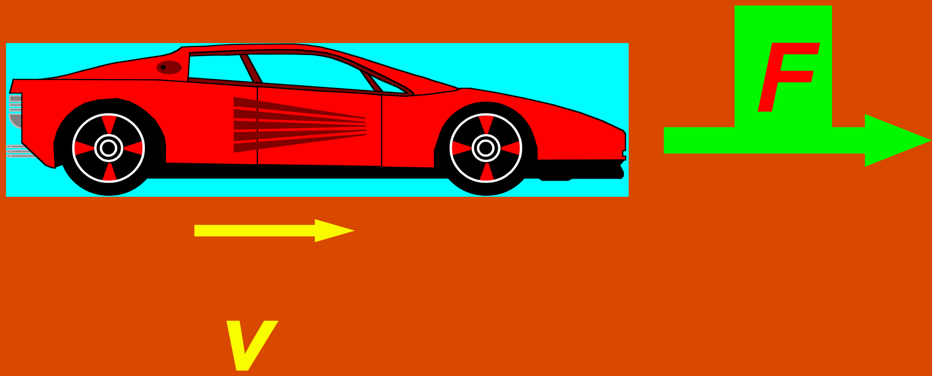
In the first 4 secs, the car has still moved 25 m. However, since the car is slowing down, in the next 4 secs, it must cover less distance. Therefore, the total distance must be more than 25 m but less than 50 m.



ConcepTest 4.4d Off to the Races IV

From rest, we step on the gas of our Ferrari, providing a force *F* for *40 m*, speeding it up to a final speed *50 km/hr*. If the same force would be applied for *80 m*, what final speed would the car reach?

1) *200 km/hr*
2) *100 km/hr*
3) *90 km/hr*
4) *70 km/hr*
5) *50 km/hr*

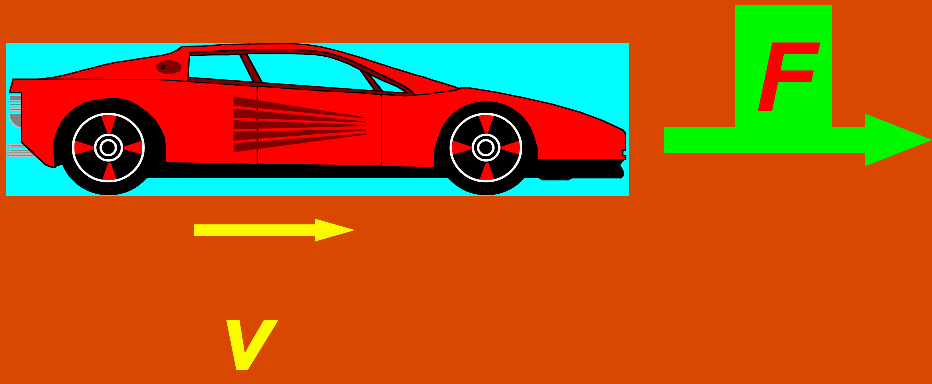


ConcepTest 4.4d Off to the Races IV

From rest, we step on the gas of our Ferrari, providing a force *F* for *40 m*, speeding it up to a final speed *50 km/hr*. If the same force would be applied for *80 m*, what final speed would the car reach?

1) *200 km/hr*
2) *100 km/hr*
3) *90 km/hr*
4) *70 km/hr*
5) *50 km/hr*

In the first case, the acceleration acts over a distance *x = 40 m*, to give a final speed of $v^2 = 2ax$ (why is there no v_0^2 term?).
In the 2nd case, the distance is **doubled**, so the speed increases by a factor of √2 .



ConcepTest 4.5 Force and Mass

A force F acts on mass M for a time interval T, giving it a final speed v. If the *same* force acts for the *same* time on a different mass $2M$, what would be the final speed of the bigger mass?

1) $4v$
2) $2v$
3) v
4) $1/2\ v$
5) $1/4\ v$

ConcepTest 4.5 Force and Mass

A force F acts on mass M for a time interval T, giving it a final speed v. If the *same* force acts for the *same* time on a different mass $2M$, what would be the final speed of the bigger mass?

1) $4v$
2) $2v$
3) v
4) $1/2\ v$
5) $1/4\ v$

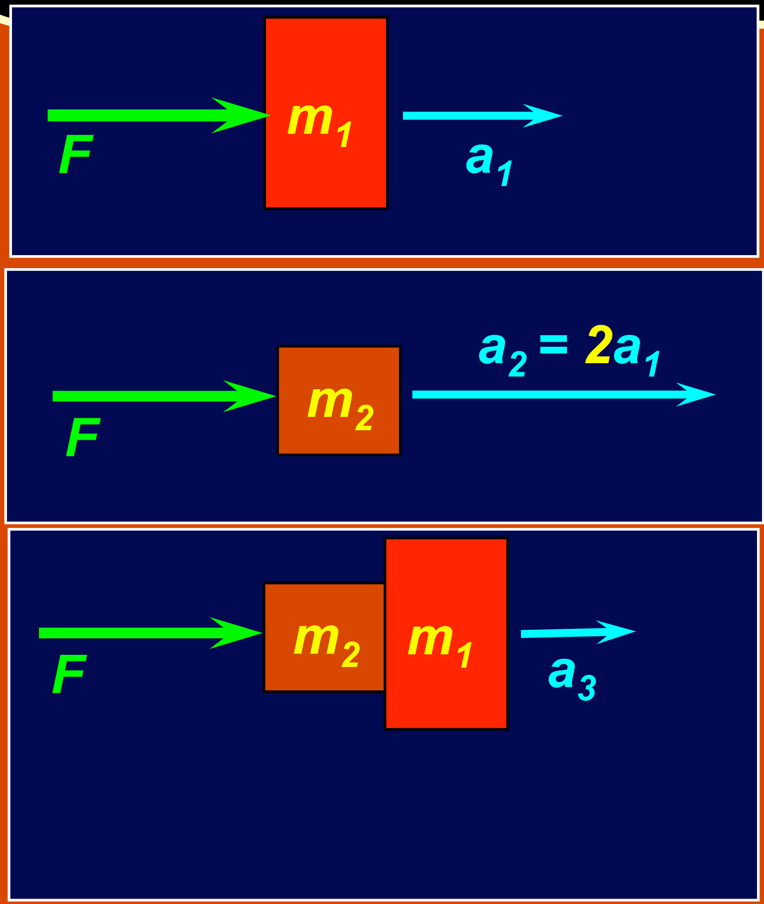
In the first case, the acceleration acts over time T to give velocity $v = aT$. In the second case, the mass is **doubled**, so the acceleration is cut in **half**, therefore, in the same time T, the **final speed will only be half** as much.

Follow-up: What would you have to do to get $2M$ to reach speed v?

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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3) $1/2\ a_1$
4) $4/3\ a_1$
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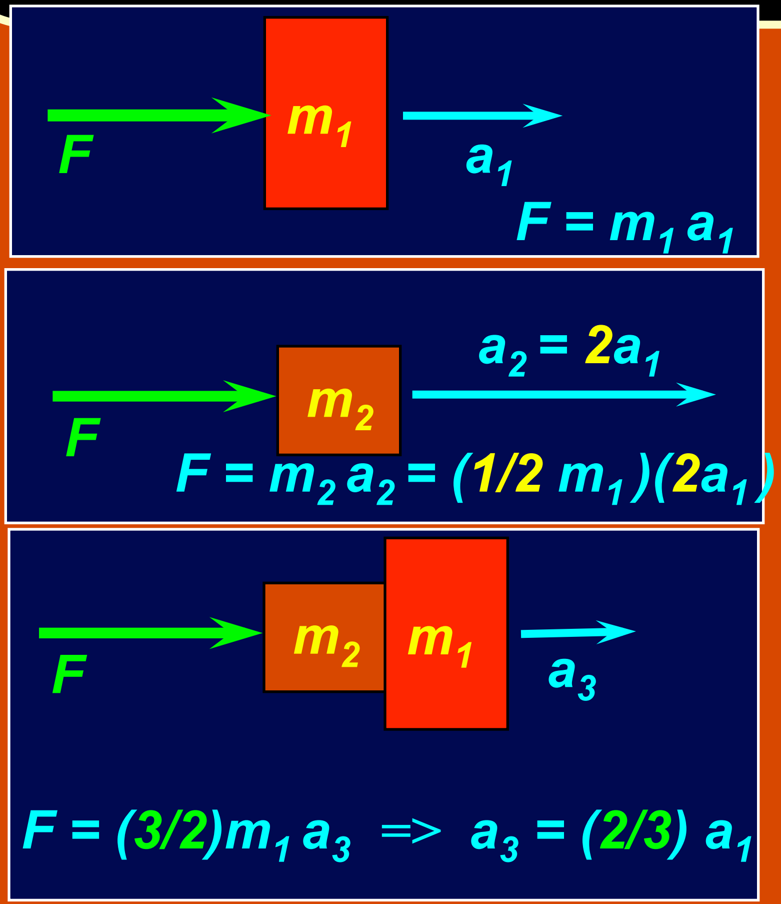
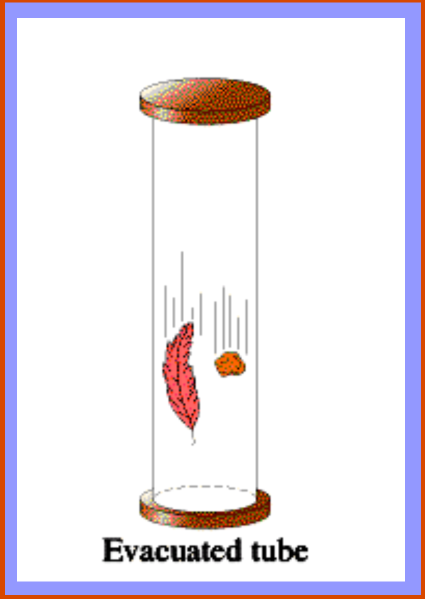


Mass m_2 must be $(1/2)m_1$ because its acceleration was $2a_1$ with the same force. Adding the two masses together gives $(3/2)m_1$, leading to an acceleration of $(2/3)a_1$ for the **same applied force**.

ConcepTest 4.7a Gravity and Weight I

What can you say about the force of gravity F_g acting on a stone and a feather?

1) F_g is greater on the feather
2) F_g is greater on the stone
3) F_g is zero on both due to vacuum
4) F_g is equal on both always
5) F_g is zero on both always



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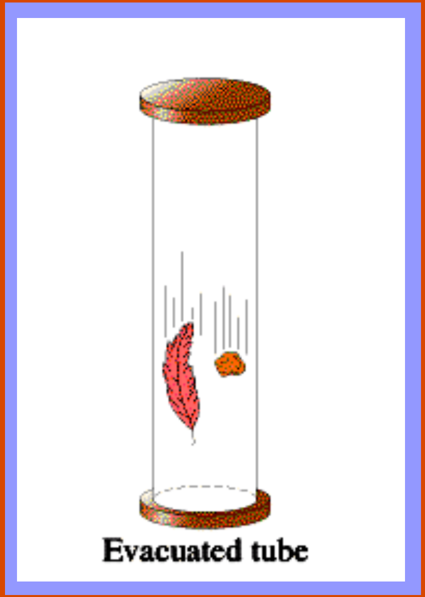
4) F_g is equal on both always
5) F_g is zero on both always

The force of gravity (weight) depends on the mass of the object!! The stone has more mass, therefore more weight.



ConcepTest 4.7b Gravity and Weight II

What can you say about the acceleration of gravity acting on the stone and the feather?

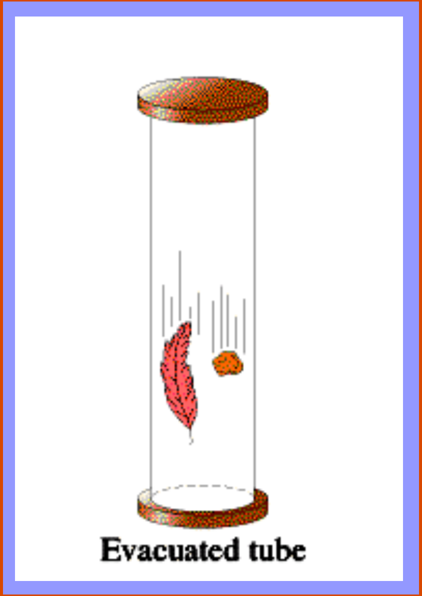
1) it is greater on the feather
2) it is greater on the stone
3) it is zero on both due to vacuum
4) it is equal on both always
5) it is zero on both always

ConcepTest 4.7b Gravity and Weight II

What can you say about the acceleration of gravity acting on the stone and the feather?

1) it is greater on the feather
2) it is greater on the stone
3) it is zero on both due to vacuum
4) it is equal on both always
5) it is zero on both always

The acceleration is given by ***F/m*** so here the mass divides out. Since we know that the force of gravity (weight) is ***mg***, then we end up with acceleration ***g*** for both objects.



Follow-up: Which one hits the bottom first?

ConcepTest 4.8 On the Moon

An astronaut on Earth kicks a bowling ball and hurts his foot. A year later, the same astronaut kicks a bowling ball on the Moon with the same force. His foot hurts...

1) more
2) less
3) the same

ConcepTest 4.8 On the Moon

An astronaut on Earth kicks a bowling ball and hurts his foot. A year later, the same astronaut kicks a bowling ball on the Moon with the same force. His foot hurts...

1) more
2) less
3) the same

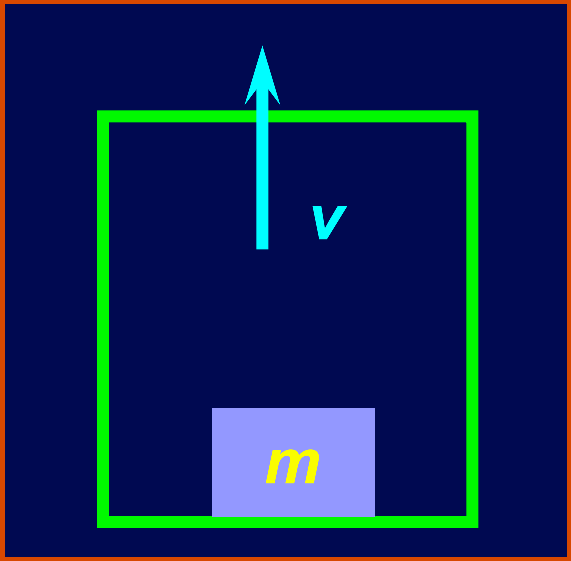
The ***masses*** of both the bowling ball and the astronaut remain the same, so his foot feels the same resistance and hurts the ***same*** as before.

Follow-up: What is different about the bowling ball on the Moon?

ConcepTest 4.9a Going Up I

A block of mass *m* rests on the floor of an elevator that is moving upward at constant speed. What is the relationship between the force due to gravity and the normal force on the block?

1) $N > mg$
2) $N = mg$
3) $N < mg$ (but not zero)
4) $N = 0$
5) depends on the size of the elevator



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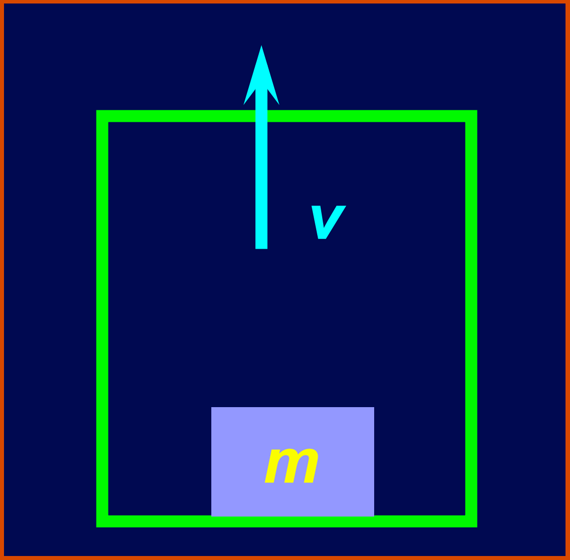
A block of mass *m* rests on the floor of an elevator that is **moving upward at constant speed**. What is the relationship between the force due to gravity and the normal force on the block?

1) $N > mg$
2) $N = mg$
3) $N < mg$ (but not zero)
4) $N = 0$
5) depends on the size of the elevator

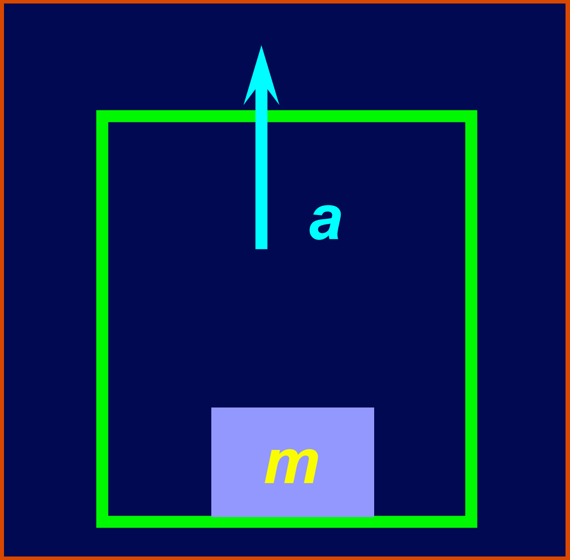
The block is moving at constant speed, so it must have **no net force** on it. The forces on it are *N* (up) and *mg* (down), so $N = mg$, just like the block at rest on a table.



ConcepTest 4.9b Going Up II

A block of mass *m* rests on the floor of an elevator that is accelerating upward. What is the relationship between the force due to gravity and the normal force on the block?

1) $N > mg$
2) $N = mg$
3) $N < mg$ *(but not zero)*
4) $N = 0$
5) depends on the size of the elevator



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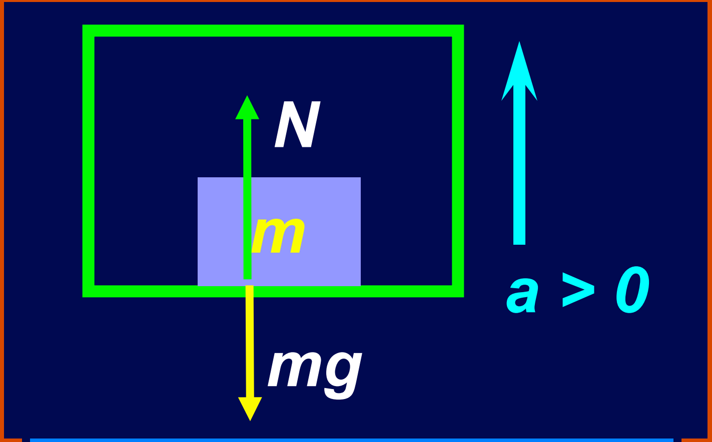
1) $N > mg$
2) $N = mg$
3) $N < mg$ (but not zero)
4) $N = 0$
5) depends on the size of the elevator

The block is accelerating upward, so it *must* have a net upward force. The forces on it are N (up) and mg (down), so N must be <u>greater</u> than mg in order to give the net upward force!



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

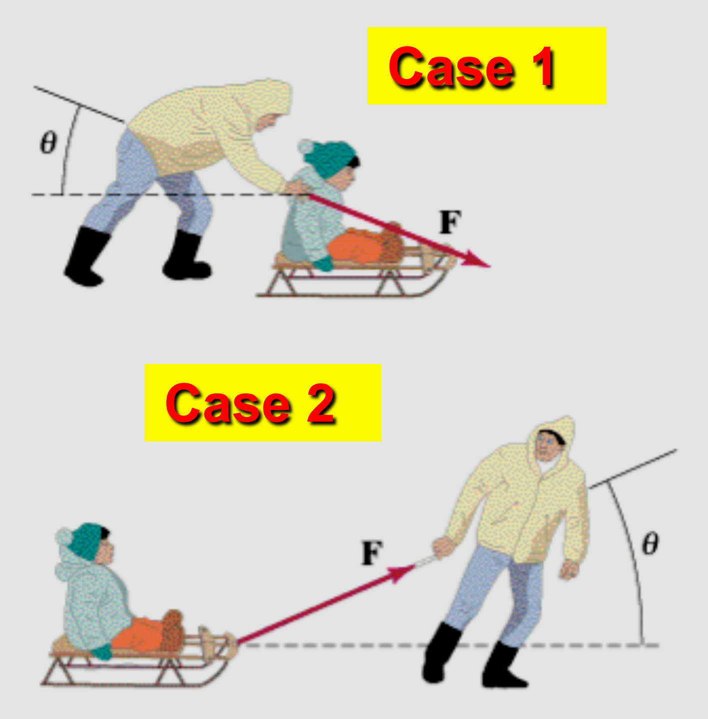
$\therefore \quad N > mg$

Follow-up: What is the normal force if the elevator is in free fall downward?

ConcepTest 4.10 Normal Force

Below you see two cases: a physics student pulling or pushing a sled with a force *F* which is applied at an angle θ. In which case is the normal force greater?

1) case 1
2) case 2
3) it's the same for both
4) depends on the magnitude of the force *F*
5) depends on the ice surface



ConcepTest 4.10 Normal Force

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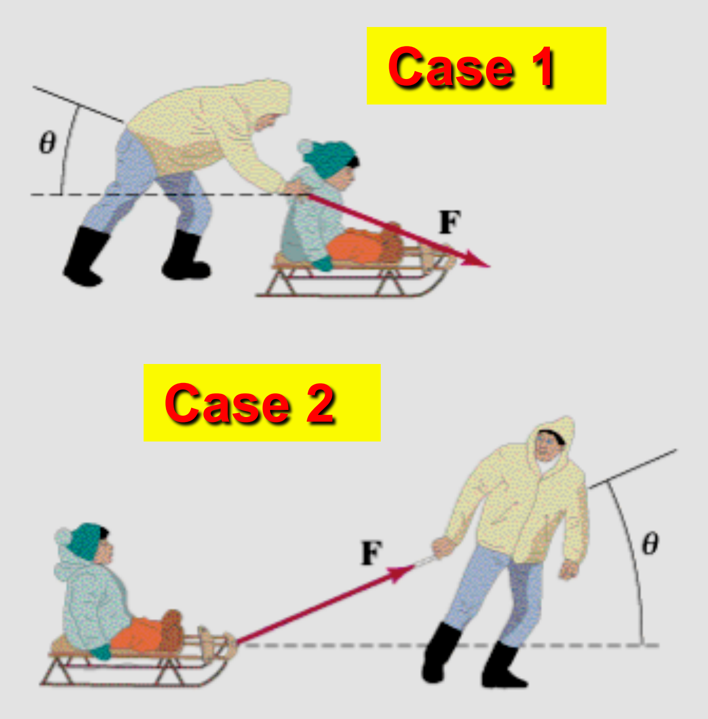
1) case 1
2) case 2
3) it's the same for both
4) depends on the magnitude of the force *F*
5) depends on the ice surface

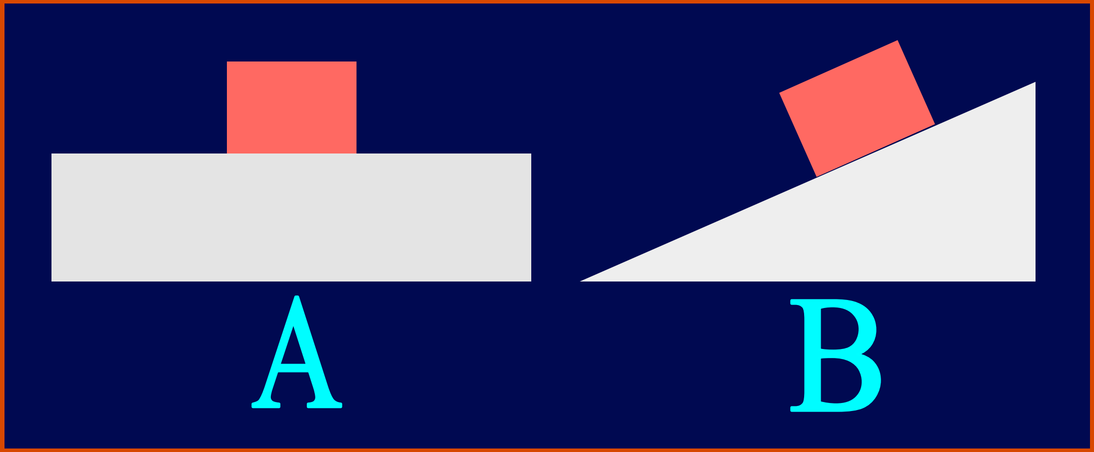
In Case 1, the force *F* is pushing down (in addition to *mg*), so the normal force needs to be larger. In Case 2, the force *F* is pulling up, against gravity, so the normal force is lessened.



ConcepTest 4.11 On an Incline

Consider two identical blocks, one resting on a flat surface, and the other resting on an incline. For which case is the normal force greater?

1) case A
2) case B
3) both the same ($N = mg$)
4) both the same ($0 < N < mg$)
5) both the same (N = 0)



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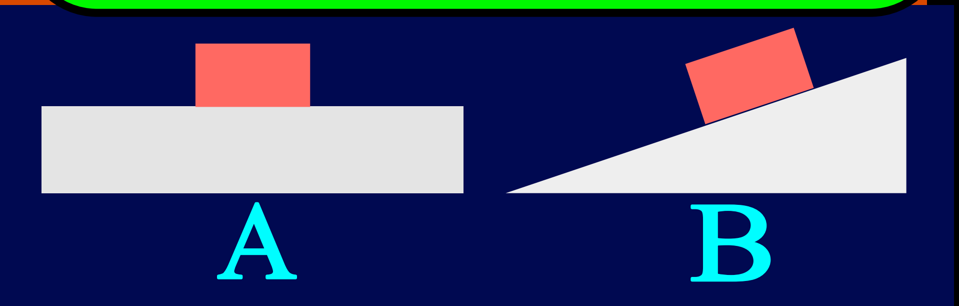
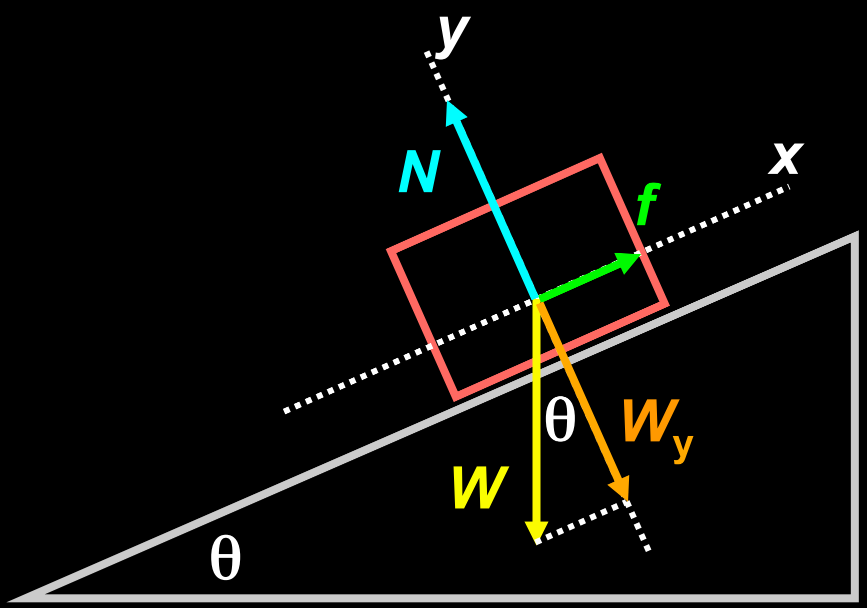
1) case A
2) case B
3) both the same ($N = mg$)
4) both the same ($0 < N < mg$)
5) both the same ($N = 0$)

In Case A, we know that $N = W$. In Case B, due to the angle of the incline, $N < W$. In fact, we can see that $N = W\cos(\theta)$.





ConcepTest 4.12 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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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 4.13a 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?

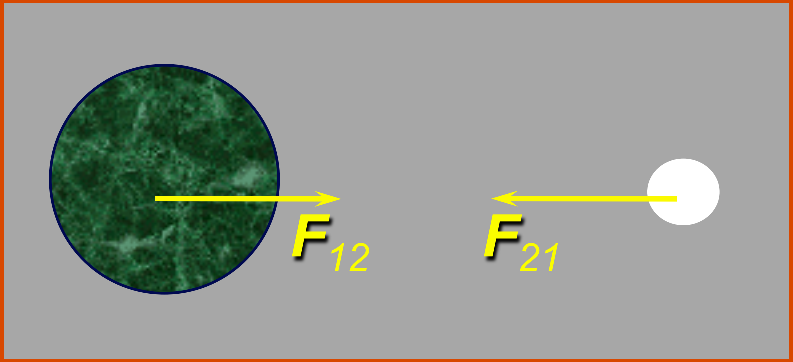
1) the bowling ball exerts a greater force on the ping-pong ball

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



ConcepTest 4.13a 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?

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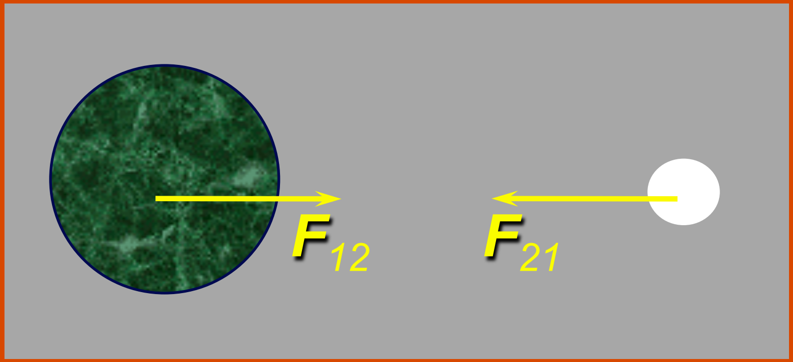
2) the ping-pong ball exerts a greater force on the bowling ball
3) the forces are equal
4) the forces are zero because they cancel out
5) there are actually no forces at all

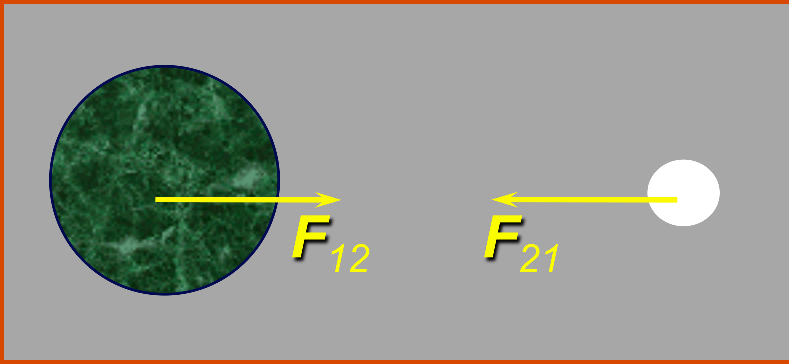
The **forces** are equal and opposite by Newton's 3rd Law!



ConcepTest 4.13b Bowling vs. Ping-Pong II

In outer space, gravitational forces exerted by a bowling ball and a ping-pong ball on each other are equal and opposite. How do their accelerations compare?

1) they do not accelerate because they are weightless
2) accels. are equal, but not opposite
3) accelerations are opposite, but bigger for the bowling ball
4) accelerations are opposite, but bigger for the ping-pong ball
5) accels. are equal and opposite



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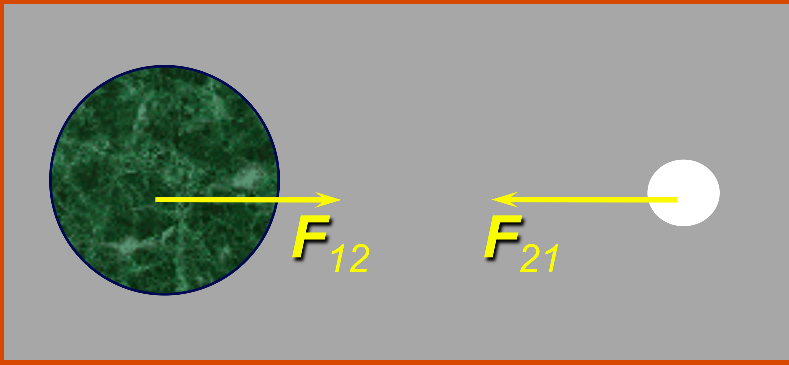
2) accels. are equal, but not opposite
3) accelerations are opposite, but bigger for the bowling ball
4) accelerations are opposite, but bigger for the ping-pong ball
5) accels. are equal and opposite

The forces are equal and opposite -- this is Newton's 3rd Law!! But the acceleration is *F/m* and so the smaller mass has the bigger acceleration.



Follow-up: Where will the balls meet if they are released from this position?

ConcepTest 4.14a Collision Course I

A small car collides with a large truck. Which experiences the greater impact force?

1) the car
2) the truck
3) both the same
4) it depends on the velocity of each
5) it depends on the mass of each

ConcepTest 4.14a Collision Course I

A small car collides with a large truck. Which experiences the greater impact force?

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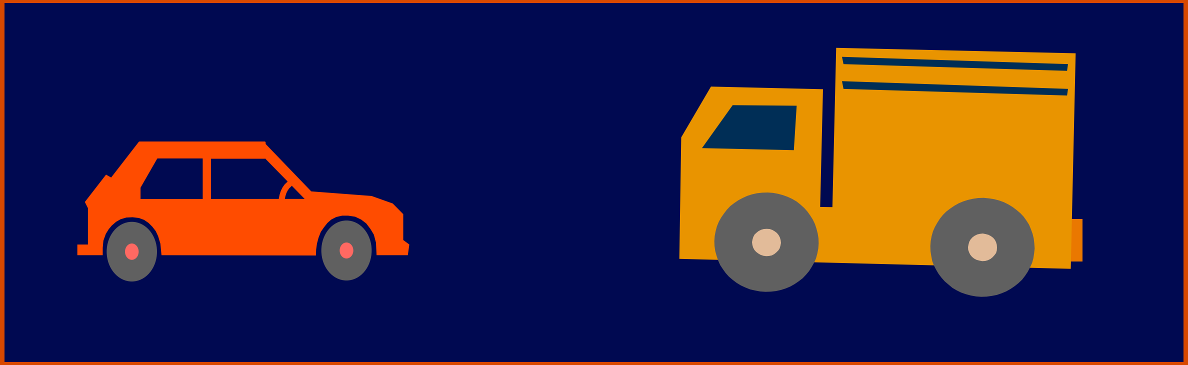


According to Newton's 3rd Law, both vehicles experience the same magnitude of force.

ConcepTest 4.14b Collision Course II

In the collision between the car and the truck, which has the greater acceleration?

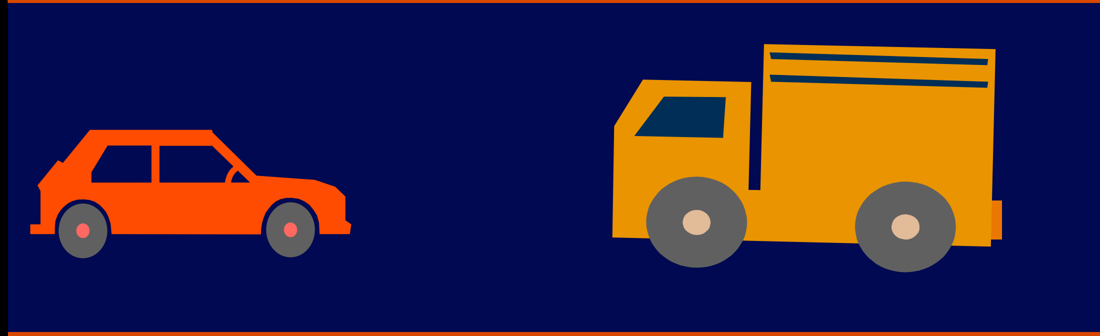
1) the car
2) the truck
3) both the same
4) it depends on the velocity of each
5) it depends on the mass of each

ConcepTest 4.14b Collision Course II

In the collision between the car and the truck, which has the greater acceleration?

1) the car
2) the truck
3) both the same
4) it depends on the velocity of each
5) it depends on the mass of each

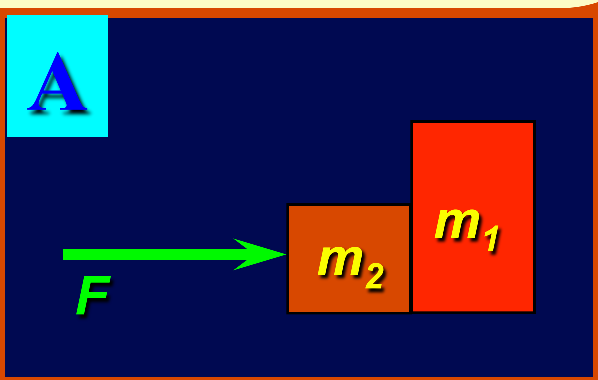
We have seen that both vehicles experience the same magnitude of force. But the acceleration is given by *F/m* so the **car** has the **larger acceleration**, since it has the **smaller mass**.

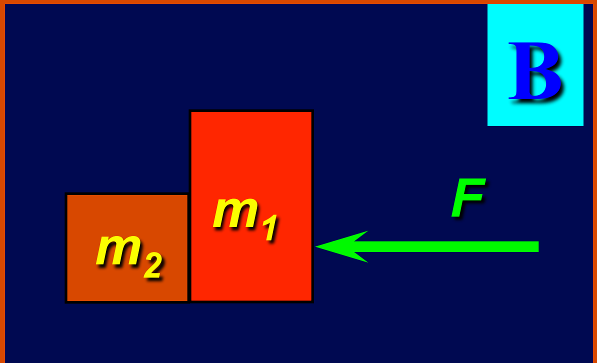


ConcepTest 4.15a Contact Force I

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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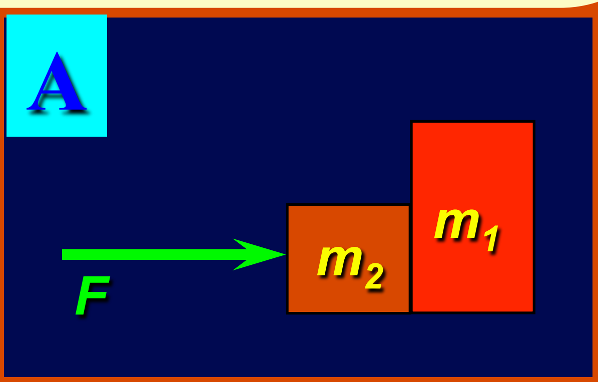
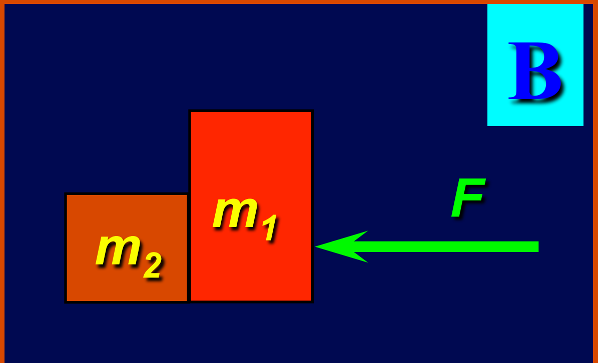




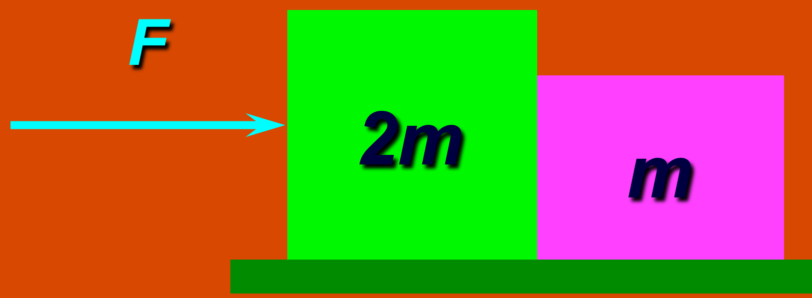
The acceleration of both masses together is the same in either case. But the contact force is the *only* force that accelerates m_1 in case A (or m_2 in case B). Since **m_1 is the larger mass**, it requires the **larger contact force** to achieve the same acceleration.

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

ConcepTest 4.15b Contact Force II

Two blocks of masses *2m* and *m* are in contact on a horizontal frictionless surface. If a force *F* is applied to mass *2m*, what is the force on mass *m* ?

1) 2 *F*
2) *F*
3) 1/2 *F*
4) 1/3 *F*
5) 1/4 *F*



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1) 2 *F*
2) *F*
3) 1/2 *F*
4) 1/3 *F*
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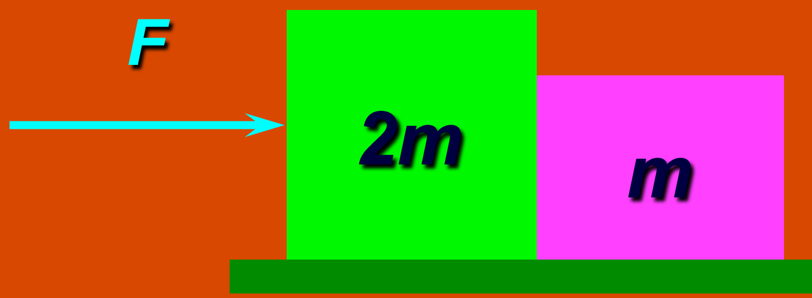
The force *F* leads to a specific acceleration of the entire system. In order for **mass *m* to accelerate at the same rate, the force on it must be smaller!** How small?? Let's see...



Follow-up: What is the acceleration of each mass?

ConcepTest 4.16a Tension I

You tie a rope to a tree and you pull on the rope with a force of *100 N*. What is the tension in the rope?

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

ConcepTest 4.16a Tension I

You tie a rope to a tree and you pull on the rope with a force of *100 N*. What is the tension in the rope?

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

The tension in the rope is the force that the rope "feels" across any section of it (or that you would feel if you replaced a piece of the rope). Since you are pulling with a force of *100 N*, that is the tension in the rope.

ConcepTest 4.16b 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 4.16b 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 4.16c Tension III

You and a friend can each pull with a force of 20 N. If you want to rip a rope in half, what is the best way?

1) you and your friend each pull on opposite ends of the rope
2) tie the rope to a tree, and you both pull from the same end
3) it doesn't matter -- both of the above are equivalent
4) get a large dog to bite the rope

ConcepTest 4.16c Tension III

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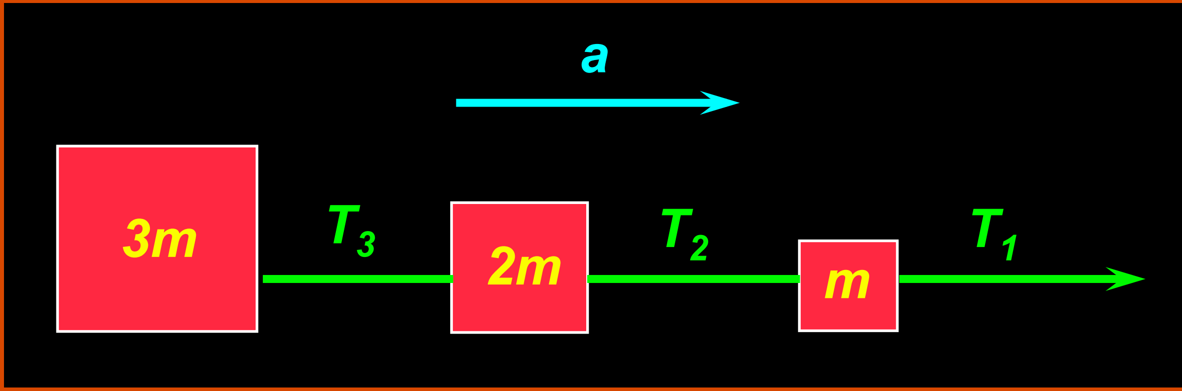
1) you and your friend each pull on opposite ends of the rope
2) tie the rope to a tree, and you both pull from the same end
3) it doesn't matter -- both of the above are equivalent
4) get a large dog to bite the rope

Take advantage of the fact that the tree can pull with almost any force (until it falls down, that is!). You and your friend should team up on one end, and let the tree make the effort on the other end.

ConcepTest 4.17 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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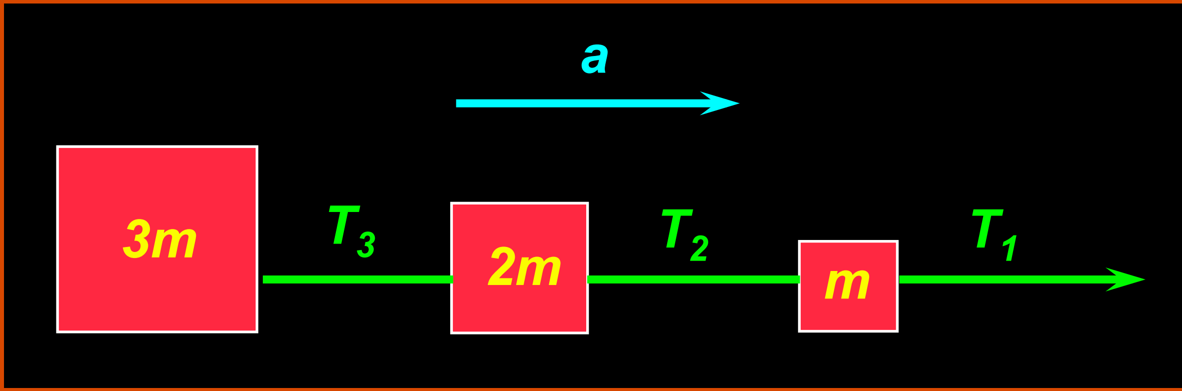
4) all tensions are zero
5) tensions are random

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.

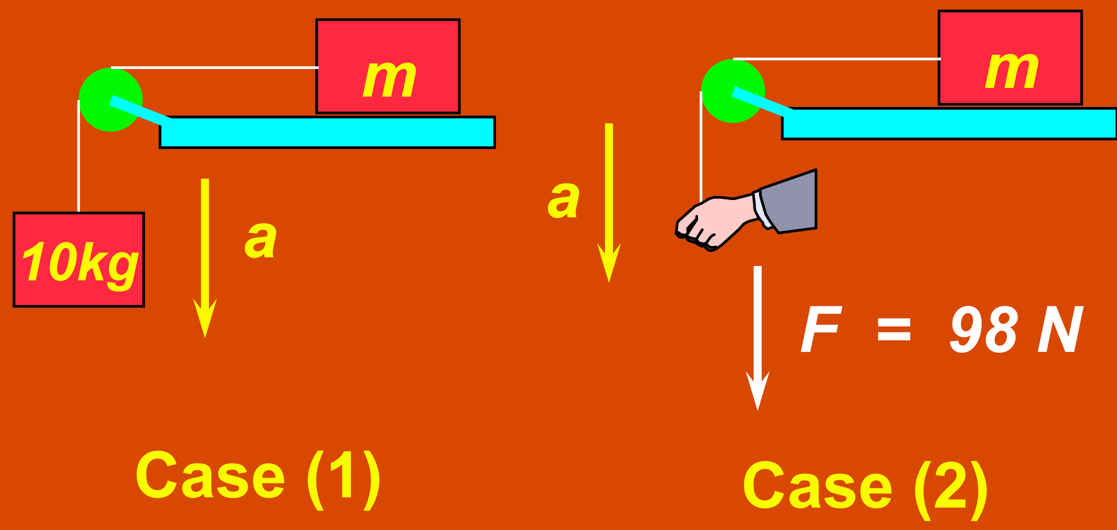


Follow-up: What is T_1 in terms of *m* and *a*?

ConcepTest 4.18 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*

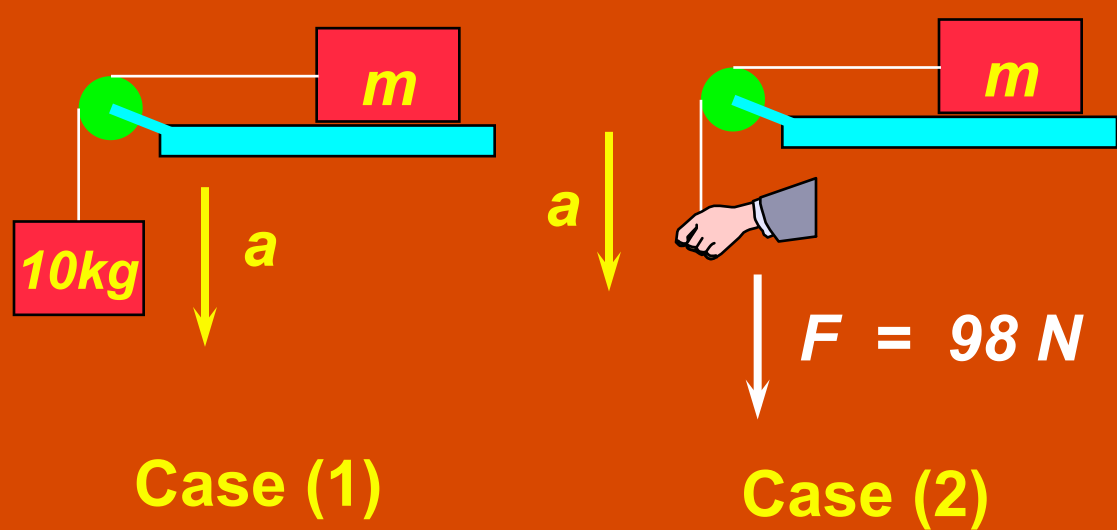


ConcepTest 4.18 Over the Edge

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*

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 4.19 Friction

A box sits in a pickup truck on a frictionless truck bed. When the truck accelerates forward, the box slides off the back of the truck because:

1) the force from the rushing air pushed it off
2) the force of friction pushed it off
3) no net force acted on the box
4) truck went into reverse by accident
5) none of the above

ConcepTest 4.19 Friction

A box sits in a pickup truck on a frictionless truck bed. When the truck accelerates forward, the box slides off the back of the truck because:

1) the force from the rushing air pushed it off
2) the force of friction pushed it off
3) no net force acted on the box
4) truck went into reverse by accident
5) none of the above

Generally, the reason that the box in the truck bed would move with the truck is due to friction between the box and the bed. If there is no friction, there is no force to push the box along, and it remains at rest. The truck accelerated away, essentially leaving the box behind!!

ConcepTest 4.20 Antilock Brakes

Antilock brakes keep the car wheels from locking and skidding during a sudden stop. Why does this help slow the car down?

1) $\mu_k > \mu_s$ so sliding friction is better
2) $\mu_k > \mu_s$ so static friction is better
3) $\mu_s > \mu_k$ so sliding friction is better
4) $\mu_s > \mu_k$ so static friction is better
5) none of the above

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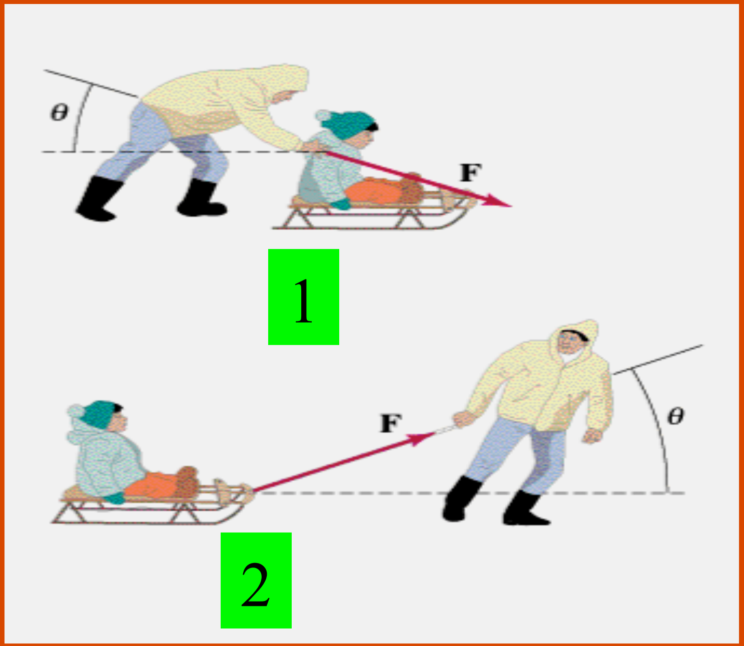
3) $\mu_s > \mu_k$ so sliding friction is better
4) $\mu_s > \mu_k$ so static friction is better
5) none of the above

Static friction is greater than sliding friction, so by keeping the wheels from skidding, the static friction force will help slow the car down more efficiently than the sliding friction that occurs during a skid.

ConcepTest 4.21 Going Sledding

Your little sister wants you to give her a ride on her sled. On level ground, what is the easiest way to accomplish this?

1) pushing her from behind
2) pulling her from the front
3) both are equivalent
4) it is impossible to move the sled
5) tell her to get out and walk



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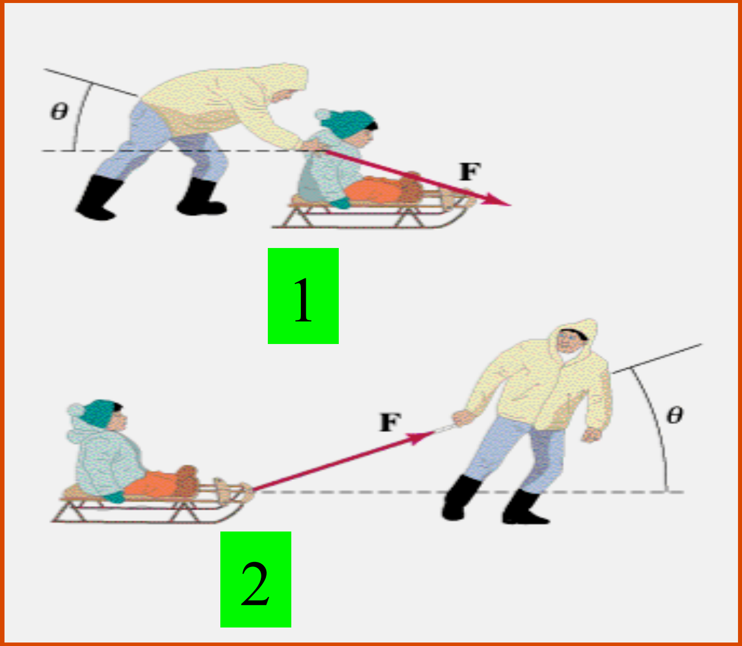
1) pushing her from behind
2) pulling her from the front
3) both are equivalent
4) it is impossible to move the sled
5) tell her to get out and walk

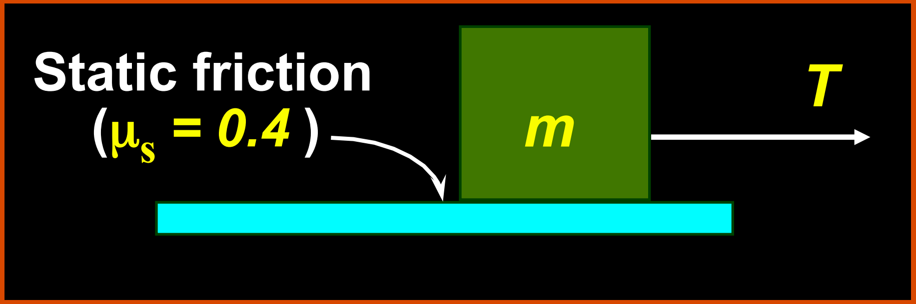
In Case 1, the force *F* is pushing down (in addition to *mg*), so the normal force is larger. In Case 2, the force *F* is pulling up, against gravity, so the normal force is lessened. Recall that the frictional force is proportional to the normal force.



ConcepTest 4.22 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



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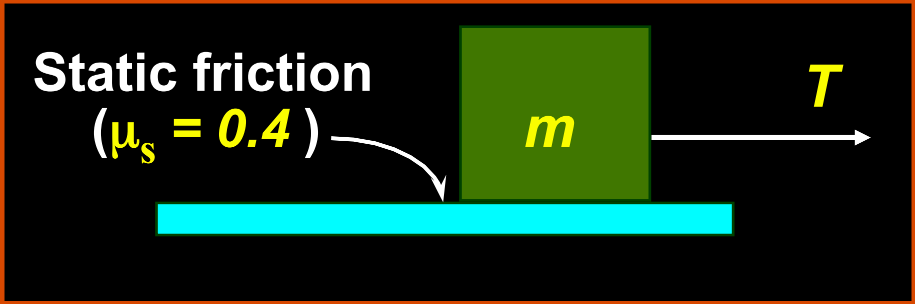
1) moves to the left
2) moves to the right
3) moves up
4) moves down
5) the box does not move

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.

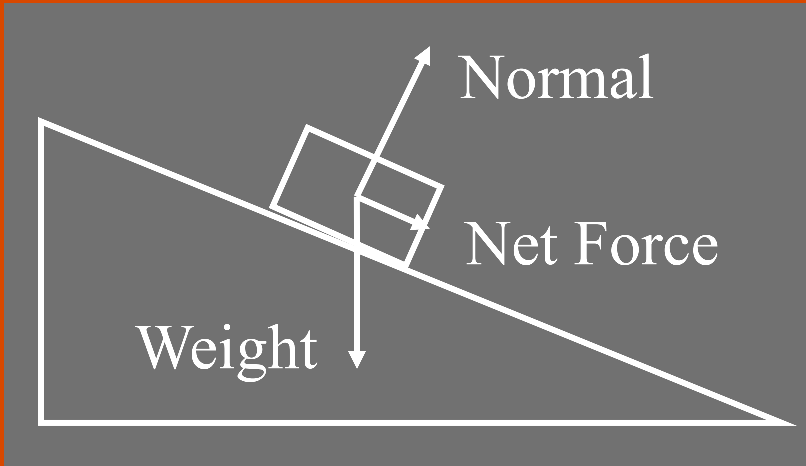


Follow-up: What happens if the tension is $35\ N$? What about $45\ N$?

ConcepTest 4.23a Sliding Down I

A box sits on a flat board. You lift one end of the board, making an angle with the floor. As you increase the angle, the box will eventually begin to slide down. Why?

1) component of the gravity force parallel to the plane increased
2) coeff. of static friction decreased
3) normal force exerted by the board decreased
4) both #1 and #3
5) all of #1, #2, and #3



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4) both #1 and #3
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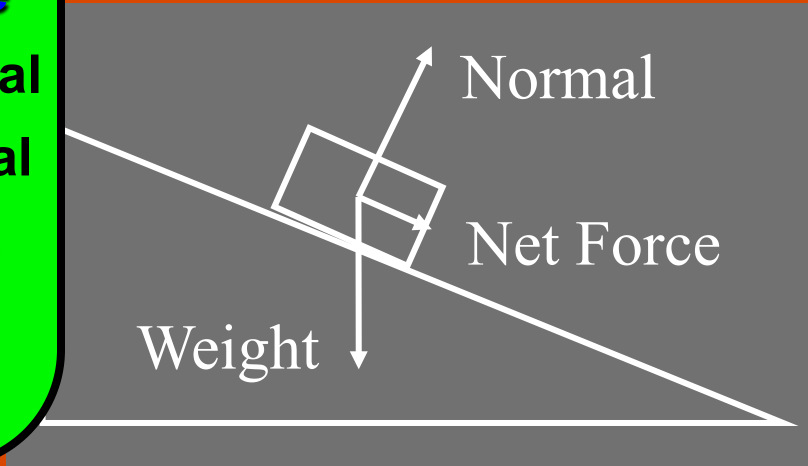
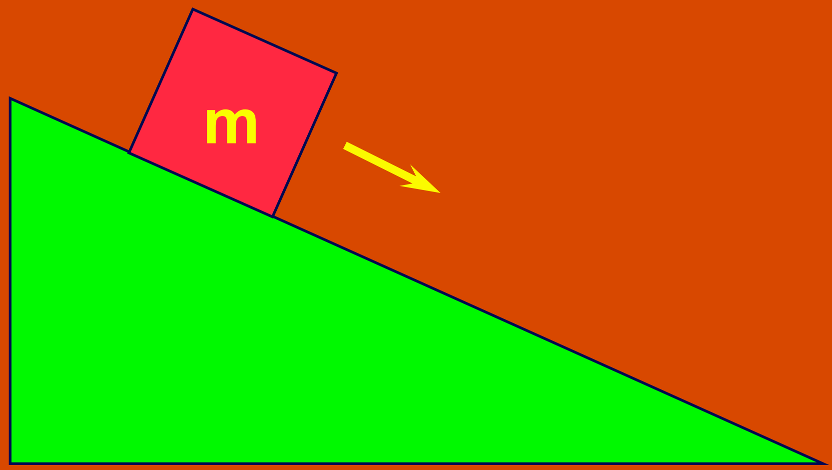
As the angle increases, the component of weight parallel to the plane increases and the component perpendicular to the plane decreases (and so does the Normal force). Since friction depends on Normal force, we see that the friction force gets smaller and the force pulling the box down the plane gets bigger.



ConcepTest 4.23b Sliding Down II

A mass *m* is placed on an inclined plane ($\mu > 0$) and slides down the plane with constant speed. If a similar block (same μ) of mass *2m* were placed on the same incline, it would:

1) not move at all
2) slide a bit, slow down, then stop
3) accelerate down the incline
4) slide down at constant speed
5) slide up at constant speed



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1) not move at all
2) slide a bit, slow down, then stop
3) accelerate down the incline
4) slide down at constant speed
5) slide up at constant speed

The component of gravity acting down the plane is **double** for *2m*. However, the normal force (and hence the friction force) is also **double** (the same factor!). This means the two forces still cancel to give a net force of zero.