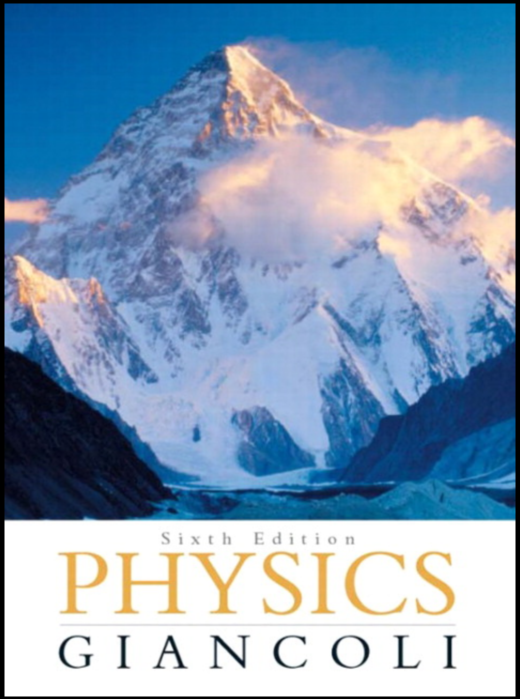


ConcepTest PowerPoints

Chapter 7

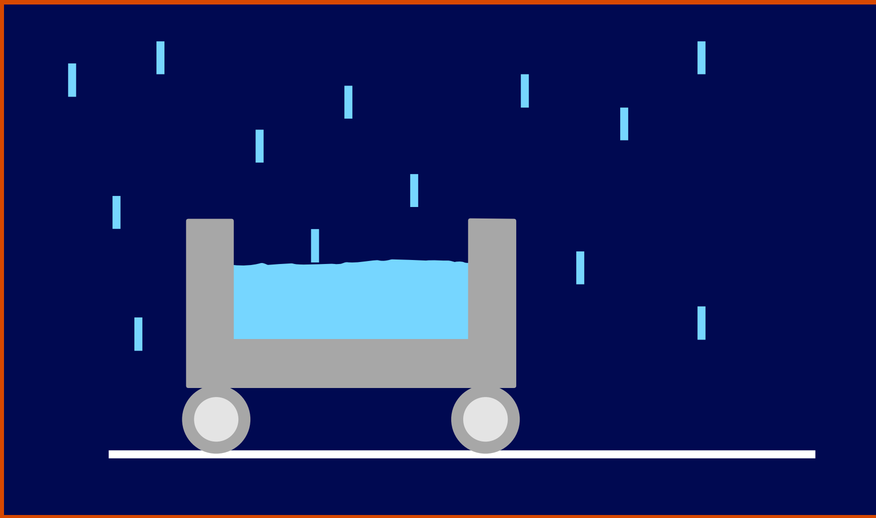
Physics: Principles with Applications, 6th edition

Giancoli

ConcepTest 7.1 Rolling in the Rain

An open cart rolls along a frictionless track while it is raining. As it rolls, what happens to the speed of the cart as the rain collects in it? (assume that the rain falls vertically into the box)

1) speeds up
2) maintains constant speed
3) slows down
4) stops immediately

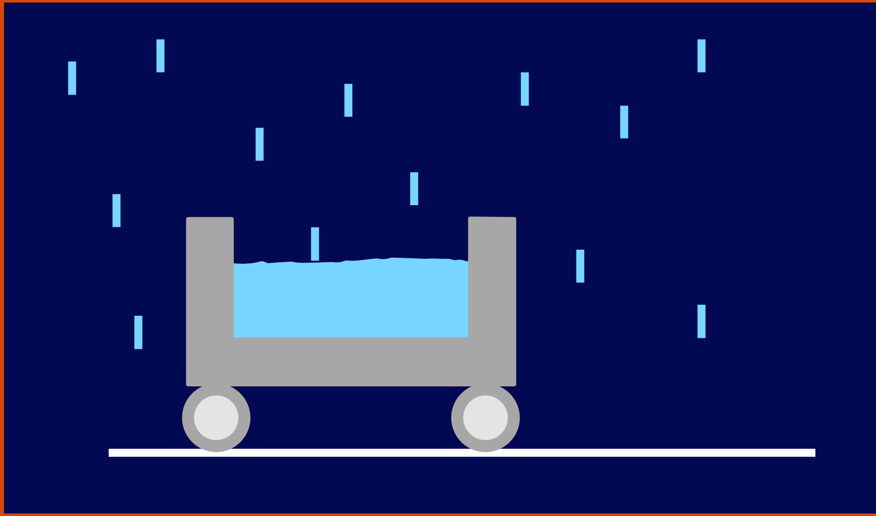


ConcepTest 7.1 Rolling in the Rain

An open cart rolls along a frictionless track while it is raining. As it rolls, what happens to the speed of the cart as the rain collects in it? (assume that the rain falls vertically into the box)

1) speeds up
2) maintains constant speed
3) slows down
4) stops immediately

Since the rain falls in vertically, it adds no momentum to the box, thus the box's momentum is conserved. However, since the mass of the box slowly ***increases*** with the added rain, its velocity has to ***decrease***.



Follow-up: What happens to the cart when it stops raining?

ConcepTest 7.2a Momentum and KE I

A system of particles is known to have a total kinetic energy of zero. What can you say about the total momentum of the system?

1) momentum of the system is positive
2) momentum of the system is negative
3) momentum of the system is zero
4) you cannot say anything about the momentum of the system

ConcepTest 7.2a Momentum and KE I

A system of particles is known to have a total kinetic energy of zero. What can you say about the total momentum of the system?

1) momentum of the system is positive
2) momentum of the system is negative
3) momentum of the system is zero
4) you cannot say anything about the momentum of the system

Since the total kinetic energy is zero, this means that all of the particles are at rest ($v = 0$). Therefore, since nothing is moving, the total momentum of the system must also be zero.

ConcepTest 7.2b Momentum and KE II

A system of particles is known to have a total momentum of zero. Does it necessarily follow that the total kinetic energy of the system is also zero?

1) yes
2) no

ConcepTest 7.2b Momentum and KE II

A system of particles is known to have a total momentum of zero. Does it necessarily follow that the total kinetic energy of the system is also zero?

1) yes
2) no

Momentum is a vector, so the fact that $p_{tot} = 0$ does not mean that the particles are at rest! They could be moving such that their momenta cancel out when you add up all of the vectors. In that case, since they are moving, the particles would have non-zero KE.

ConcepTest 7.2c Momentum and KE III

Two objects are known to have the same momentum. Do these two objects necessarily have the same kinetic energy?

1) yes

2) no

ConcepTest 7.2c Momentum and KE III

Two objects are known to have the same momentum. Do these two objects necessarily have the same kinetic energy?

1) yes
2) no

If object #1 has mass m and speed v, and object #2 has mass 1/2 m and speed 2v, they will both have the same momentum. However, since KE = 1/2 mv^2, we see that object #2 has twice the kinetic energy of object #1, due to the fact that the velocity is squared.

ConcepTest 7.3a Momentum and Force

A net force of 200 N acts on a 100-kg boulder, and a force of the same magnitude acts on a 130-g pebble. How does the rate of change of the boulder's momentum compare to the rate of change of the pebble's momentum?

1) greater than
2) less than
3) equal to

ConcepTest 7.3a Momentum and Force

A net force of 200 N acts on a 100-kg boulder, and a force of the same magnitude acts on a 130-g pebble. How does the rate of change of the boulder's momentum compare to the rate of change of the pebble's momentum?

1) greater than
2) less than
3) equal to

The rate of change of momentum is, in fact, the force. Remember that $F = \Delta p/\Delta t$. Since the force exerted on the boulder and the pebble is the same, then the rate of change of momentum is the same.

ConcepTest 7.3b Velocity and Force

A net force of 200 N acts on a 100-kg boulder, and a force of the same magnitude acts on a 130-g pebble. How does the rate of change of the boulder's velocity compare to the rate of change of the pebble's velocity?

1) greater than
2) less than
3) equal to

ConcepTest 7.3b Velocity and Force

A net force of 200 N acts on a 100 kg boulder, and a force of the same magnitude acts on a 130-g pebble. How does the rate of change of the boulder's velocity compare to the rate of change of the pebble's velocity?

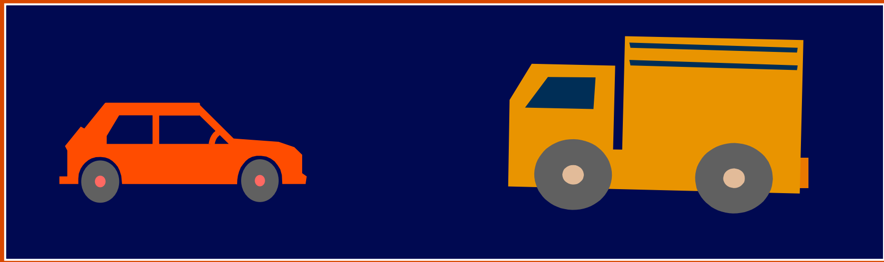
1) greater than
2) less than
3) equal to

The rate of change of velocity is the acceleration. Remember that $a = \Delta v/\Delta t$. The acceleration is related to the force by Newton's 2nd Law ($F = ma$), so the acceleration of the boulder is less than that of the pebble (for the same applied force) because the boulder is much more massive.

ConcepTest 7.4 Collision Course

A small car and a large truck collide head-on and stick together. Which one has the larger momentum change?

1) the car
2) the truck
3) they both have the same momentum change
4) can't tell without knowing the final velocities

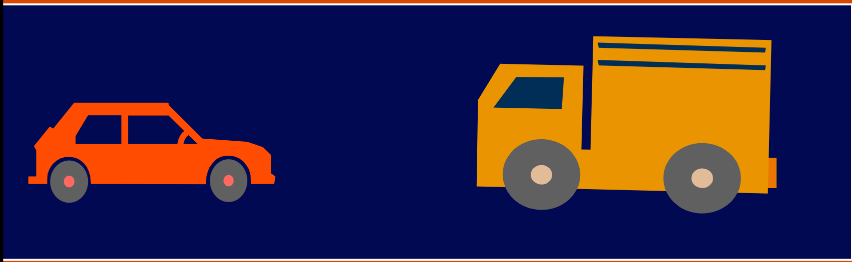


ConcepTest 7.4 Collision Course

A small car and a large truck collide head-on and stick together and come to a stop. Which one has the larger momentum change?

1) the car
2) the truck
3) they both have the same momentum change
4) can't tell without knowing the final velocities

Since the total momentum of the system is conserved, that means that $\Delta p = 0$ for the car and truck combined. Therefore, Δp_{car} must be equal and opposite to that of the truck ($-\Delta p_{truck}$) in order for the total momentum change to be zero. Note that this conclusion also follows from Newton's 3rd Law.

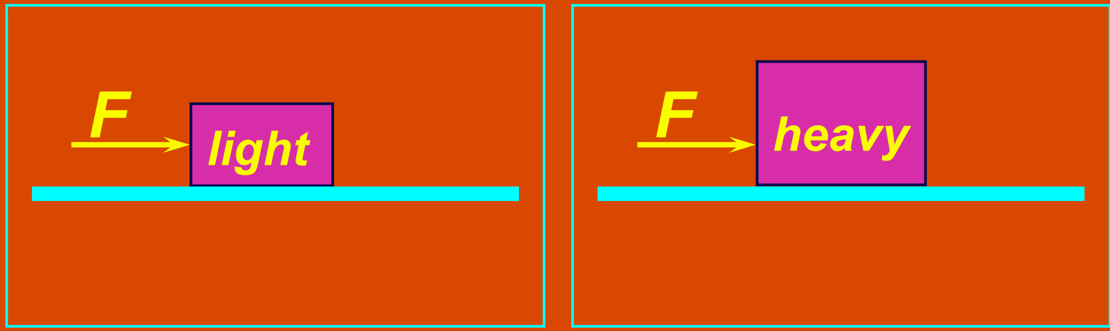


Follow-up: Which one feels the larger acceleration?

ConcepTest 7.5a Two Boxes I

Two boxes, one heavier than the other, are initially at rest on a horizontal frictionless surface. The same constant force *F* acts on each one for exactly *1 second*. Which box has more momentum after the force acts?

1) the heavier one
2) the lighter one
3) both the same



ConcepTest 7.5a Two Boxes I

Two boxes, one heavier than the other, are initially at rest on a horizontal frictionless surface. The same constant force *F* acts on each one for exactly *1 second*. Which box has more momentum after the force acts?

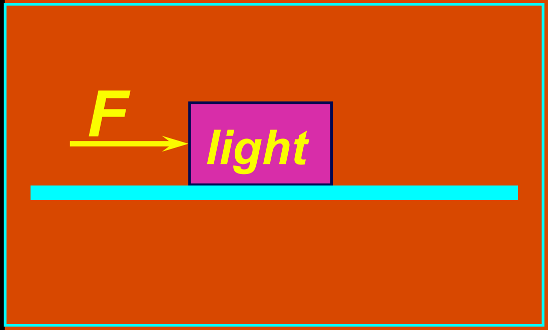
1) the heavier one
2) the lighter one
3) both the same

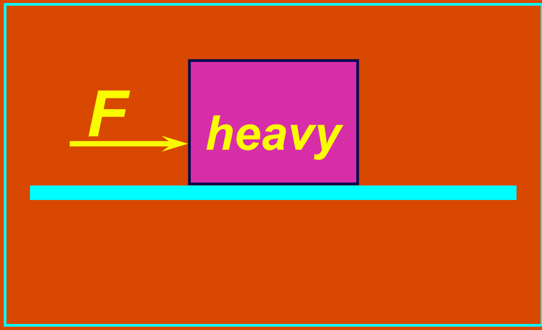
We know: $$F_{av} = \frac{\Delta p}{\Delta t}$$

so impulse $\Delta p = F_{av} \Delta t$.

In this case F and Δt are the *same* for both boxes !

Both boxes will have the *same final momentum*.





ConcepTest 7.5b Two Boxes II

In the previous question, which box has the larger velocity after the force acts?

1) the heavier one
2) the lighter one
3) both the same

ConcepTest 7.5b Two Boxes II

In the previous question, which box has the larger velocity after the force acts?

1) the heavier one
2) the lighter one
3) both the same

The force is related to the acceleration by Newton's 2^{nd} Law ($F = ma$). The lighter box therefore has the greater acceleration, and will reach a higher speed after the 1-second time interval.

Follow-up: Which box has gone a larger distance after the force acts?

Follow-up: Which box has gained more KE after the force acts?

ConcepTest 7.6 Watch Out!

You drive around a curve in a narrow one-way street at 30 mph when you see an identical car heading straight toward you at 30 mph. You have two options: hit the car head-on or swerve into a massive concrete wall (also head-on). What should you do?

1) hit the other car
2) hit the wall
3) makes no difference
4) call your physics prof!!
5) get insurance!

ConcepTest 7.6 Watch Out!

You drive around a curve in a narrow one-way street at 30 mph when you see an identical car heading straight toward you at 30 mph. You have two options: hit the car head-on or swerve into a massive concrete wall (also head-on). What should you do?

1) hit the other car
2) hit the wall
3) makes no difference
4) call your physics prof!!
5) get insurance!

In ***both*** cases your momentum will decrease to zero in the collision. Given that the **time** Δt of the collision is the same, then the **force exerted on *YOU*** will be the same!!

If a **truck** is approaching at 30 mph, then you'd be better off **hitting the wall** in that case. On the other hand, if it's only a **mosquito**, well, you'd be better off **running him down**...

ConcepTest 7.7 Impulse

A small beanbag and a bouncy rubber ball are dropped from the same height above the floor. They both have the same mass. Which one will impart the greater impulse to the floor when it hits?

1) the beanbag
2) the rubber ball
3) both the same

ConcepTest 7.7 Impulse

A small beanbag and a bouncy rubber ball are dropped from the same height above the floor. They both have the same mass. Which one will impart the greater impulse to the floor when it hits?

1) the beanbag
2) the rubber ball
3) both the same

Both objects reach the same speed at the floor. However, while the beanbag comes to rest on the floor, the ball bounces back up with nearly the same speed as it hit. Thus, the **change in momentum for the ball is greater, because of the rebound**. The impulse delivered by the ball is twice that of the beanbag.

For the beanbag: $\Delta p = p_f - p_i = 0 - (-mv) = mv$

For the rubber ball: $\Delta p = p_f - p_i = mv - (-mv) = 2mv$

Follow-up: Which one imparts the larger force to the floor?

ConcepTest 7.8 Singing in the Rain

A person stands under an umbrella during a rainstorm. Later the rain turns to hail, although the number of "drops" hitting the umbrella per time and their speed remains the same. Which case requires more force to hold the umbrella?

1) when it is hailing
2) when it is raining
3) same in both cases

ConcepTest 7.8 Singing in the Rain

A person stands under an umbrella during a rainstorm. Later the rain turns to hail, although the number of "drops" hitting the umbrella per time and their speed remains the same. Which case requires more force to hold the umbrella?

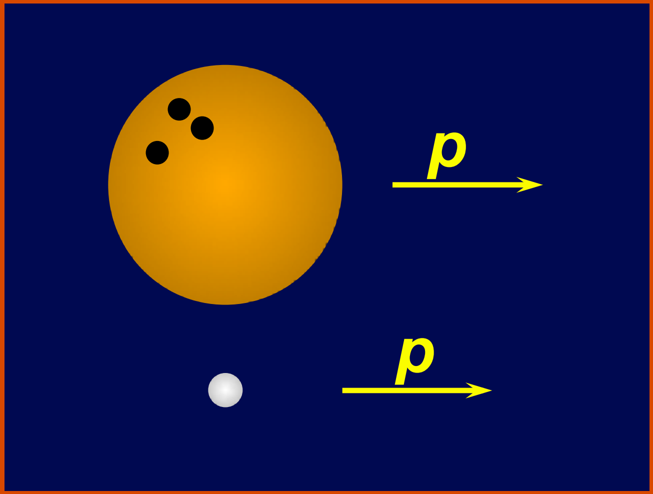
1) **when it is hailing**
2) **when it is raining**
3) **same in both cases**

When the raindrops hit the umbrella, they tend to splatter and run off, whereas the hailstones hit the umbrella and bounce back upwards. Thus, the change in momentum (impulse) is greater for the hail. Since $\Delta p = F \Delta t$, more force is required in the hailstorm. This is similar to the situation with the bouncy rubber ball in the previous question.

ConcepTest 7.9a Going Bowling I

A bowling ball and a ping-pong ball are rolling toward you with the same momentum. If you exert the same force to stop each one, which takes a longer time to bring to rest?

1) the bowling ball
2) same time for both
3) the ping-pong ball
4) impossible to say



ConcepTest 7.9a Going Bowling I

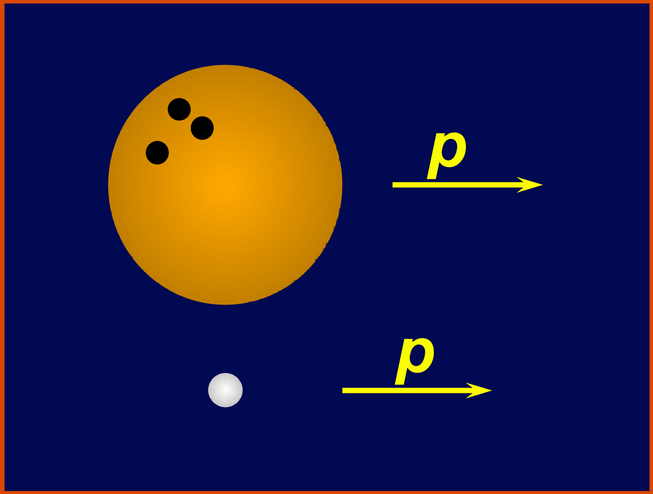
A bowling ball and a ping-pong ball are rolling toward you with the **same momentum**. If you exert the **same force** to stop each one, which takes a **longer time** to bring to rest?

1) the bowling ball
2) same time for both
3) the ping-pong ball
4) impossible to say

We know: $F_{av} = \dfrac{\Delta p}{\Delta t}$ so $\Delta p = F_{av}\Delta t$

Here, F and Δp are the ***same*** for both balls!

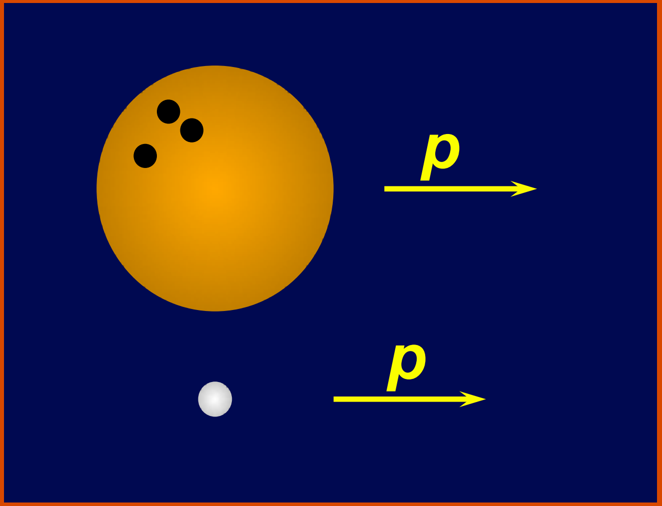
It will take the ***same amount of time*** to stop them.



ConcepTest 7.9b Going Bowling II

A bowling ball and a ping-pong ball are rolling toward you with the same momentum. If you exert the same force to stop each one, for which is the *stopping distance* greater?

1) the bowling ball
2) same distance for both
3) the ping-pong ball
4) impossible to say

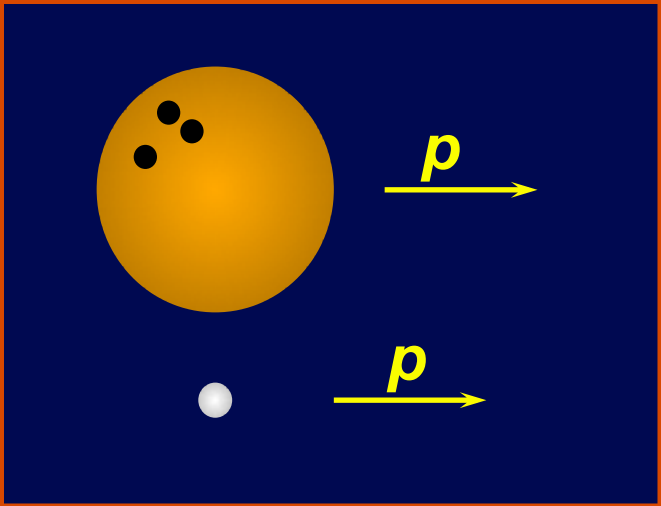


ConcepTest 7.9b Going Bowling II

A bowling ball and a ping-pong ball are rolling toward you with the **same momentum**. If you exert the **same force** to stop each one, for which is the ***stopping distance*** greater?

1) the bowling ball
2) same distance for both
3) the ping-pong ball
4) impossible to say

Use the work-energy theorem: **W = ΔKE**. The ball with **less mass** has the **greater speed (why?)**, and thus the **greater KE (why again?)**. In order to remove that KE, work must be done, where **W = *Fd***. Since the force is the ***same*** in both cases, the distance needed to stop the **less massive ball** must be ***bigger***.



ConcepTest 7.10a Elastic Collisions I

Consider two elastic collisions:

1) a golf ball with speed *v* hits a stationary bowling ball head-on.

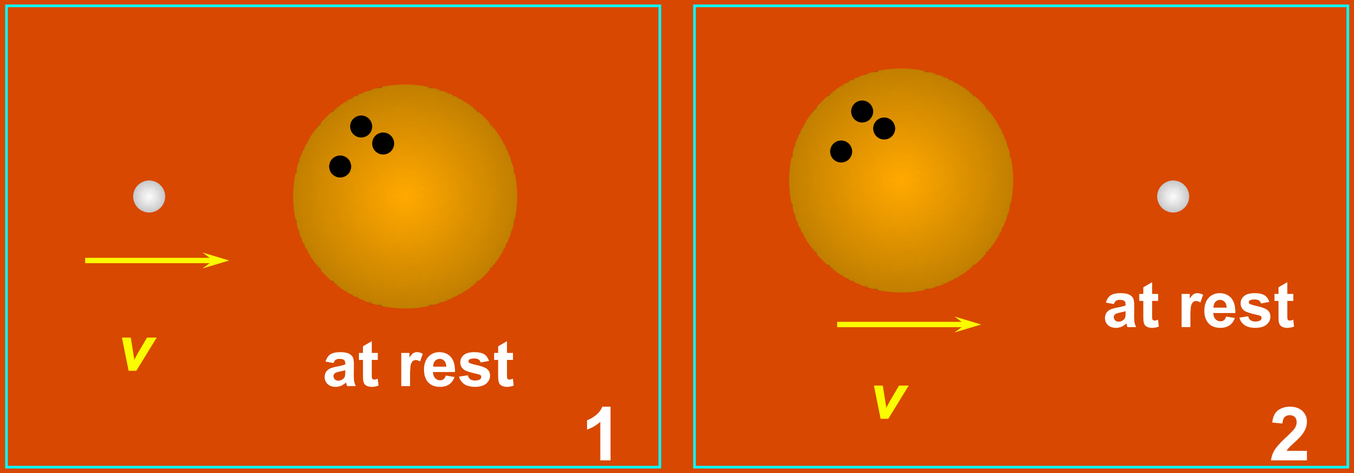
2) a bowling ball with speed *v* hits a stationary golf ball head-on.

In which case does the golf ball have the greater speed after the collision?

1) situation 1

2) situation 2

3) both the same



ConcepTest 7.10a Elastic Collisions I

Consider two elastic collisions:

1) a golf ball with speed *v* hits a stationary bowling ball head-on.

2) a bowling ball with speed *v* hits a stationary golf ball head-on. In which case does the golf ball have the greater speed after the collision?

1) situation 1

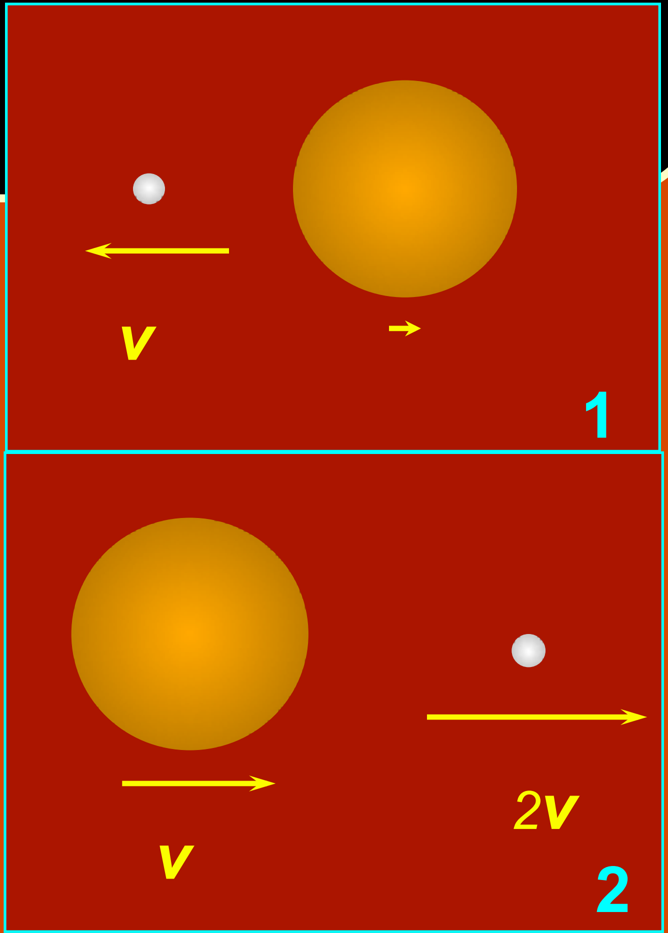
2) situation 2

3) both the same

Remember that the magnitude of the *relative velocity* has to be equal before and after the collision!

In case 1 the bowling ball will almost remain at rest, and the golf ball will bounce back with speed close to *v*.

In case 2 the bowling ball will keep going with speed close to *v*, hence the golf ball will rebound with speed close to 2*v*.



ConcepTest 7.10b Elastic Collisions II

Carefully place a small rubber ball (mass *m*) on top of a much bigger basketball (mass *M*) and drop these from some height *h*. What is the velocity of the smaller ball after the basketball hits the ground, reverses direction, and then collides with small rubber ball?

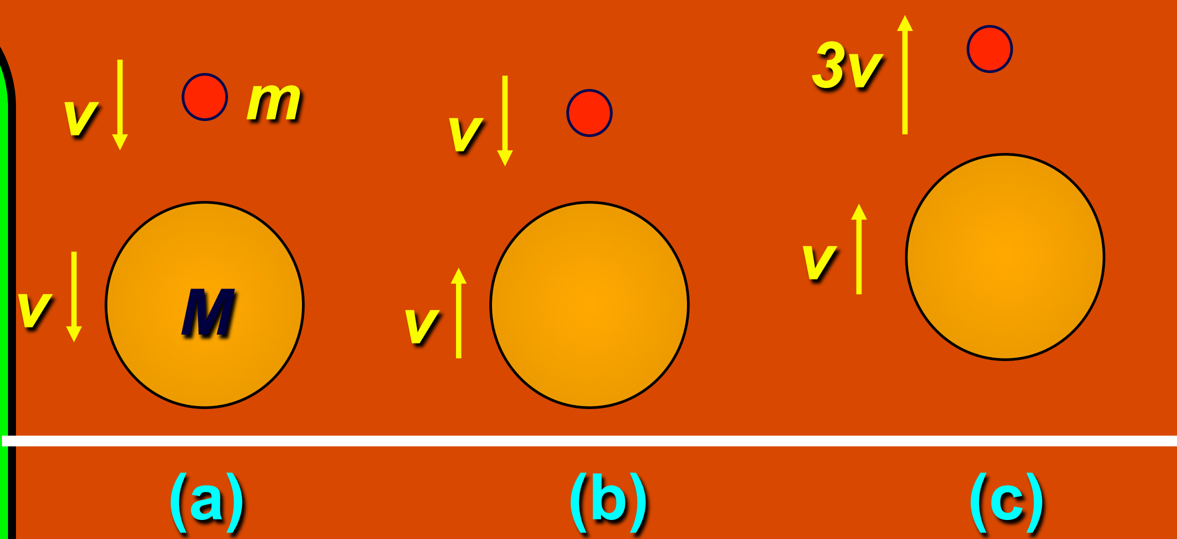
1) zero
2) v
3) 2v
4) 3v
5) 4v

ConcepTest 7.10b Elastic Collisions II

Carefully place a small rubber ball (mass *m*) on top of a much bigger basketball (mass *M*) and drop these from some height *h*. What is the velocity of the smaller ball after the basketball hits the ground, reverses direction, and then collides with small rubber ball?

1) zero
2) *v*
3) 2*v*
4) 3*v*
5) 4*v*

- Remember that ***relative velocity*** has to be equal before and after collision! Before the collision, the basketball bounces up with *v* and the rubber ball is coming down with *v*, so their relative velocity is *–2v*. After the collision, it therefore has to be *+2v*!!



Follow-up: With **initial drop height *h***, how high does the small rubber ball bounce up?

ConcepTest 7.11 Golf Anyone?

You tee up a golf ball and drive it down the fairway. Assume that the collision of the golf club and ball is elastic. When the ball leaves the tee, how does its speed compare to the speed of the golf club?

1) greater than
2) less than
3) equal to

ConcepTest 7.11 Golf Anyone?

You tee up a golf ball and drive it down the fairway. Assume that the collision of the golf club and ball is elastic. When the ball leaves the tee, how does its speed compare to the speed of the golf club?

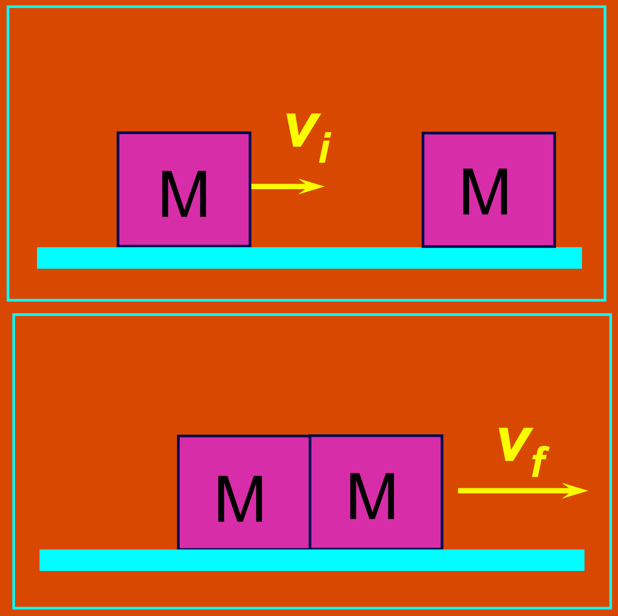
1) greater than
2) less than
3) equal to

This is exactly the same thing as situation #2 in a previous question. If the speed of approach (for the golf club and ball) is v, then the speed of recession must also be v. Since the golf club is hardly affected by the collision and it continues with speed v, then the ball must fly off with a speed of $2v$.

ConcepTest 7.12a Inelastic Collisions I

A box slides with initial velocity 10 m/s on a frictionless surface and collides inelastically with an identical box. The boxes stick together after the collision. What is the final velocity?

1) 10 m/s
2) 20 m/s
3) 0 m/s
4) 15 m/s
5) 5 m/s



ConcepTest 7.12a Inelastic Collisions I

A box slides with initial velocity **10 m/s** on a frictionless surface and collides inelastically with an identical box. The boxes stick together after the collision. What is the final velocity?

1) 10 m/s
2) 20 m/s
3) 0 m/s
4) 15 m/s
5) 5 m/s

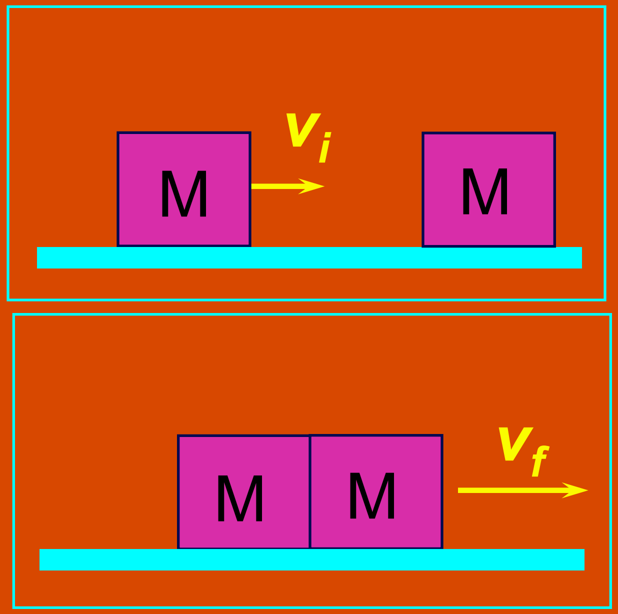
The initial momentum is:

$$M v_i = (10)\, M$$

The final momentum must be the same!!

The final momentum is:

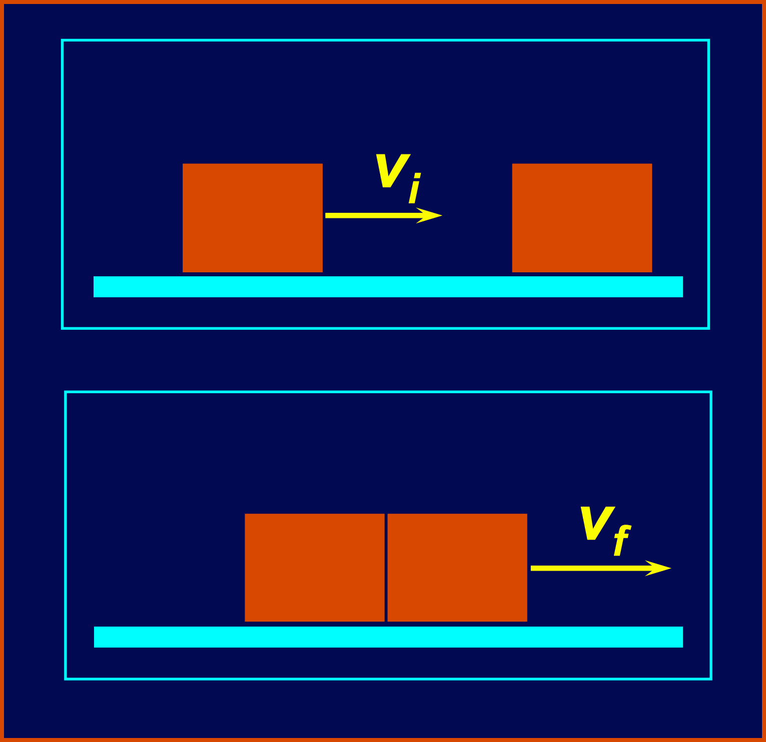
$$M_{tot}\, v_f = (2M)\, v_f = (2M)\,(5)$$



ConcepTest 7.12b Inelastic Collisions II

On a frictionless surface, a sliding box collides and sticks to a second identical box which is initially at rest. What is the final KE of the system in terms of the initial KE?

1) $KE_f = KE_i$
2) $KE_f = KE_i / 4$
3) $KE_f = KE_i / \sqrt{2}$
4) $KE_f = KE_i / 2$
5) $KE_f = \sqrt{2}\, KE_i$



ConcepTest 7.12b Inelastic Collisions II

On a frictionless surface, a sliding box collides and sticks to a second identical box which is initially at rest. What is the final KE of the system in terms of the initial KE?

1) $KE_f = KE_i$
2) $KE_f = KE_i / 4$
3) $KE_f = KE_i / \sqrt{2}$
4) $KE_f = KE_i / 2$
5) $KE_f = \sqrt{2}\, KE_i$

Momentum: $mv_i + 0 = (2m)v_f$

So we see that: $v_f = 1/2\, v_i$

Now, look at kinetic energy:

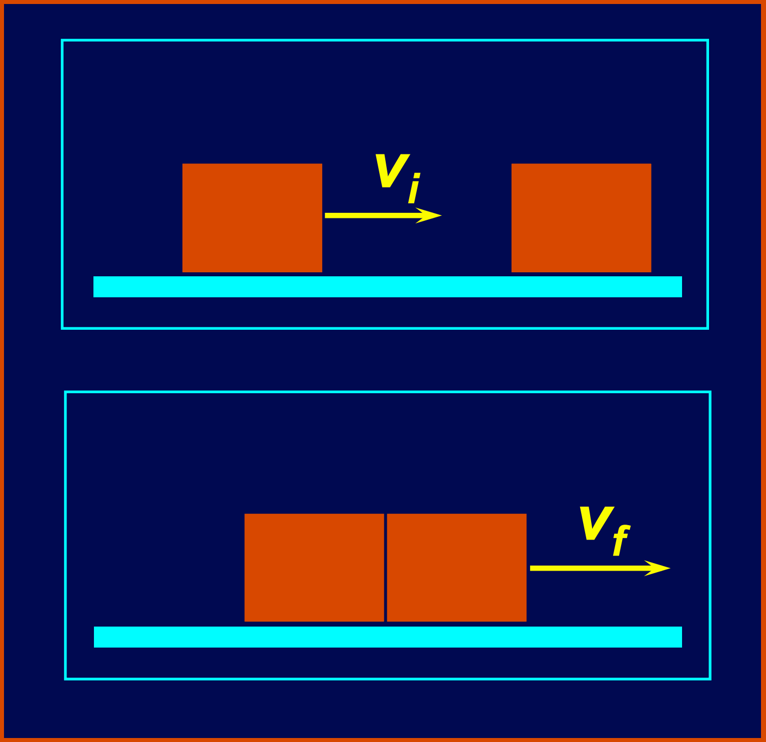
First, $KE_i = 1/2\, mv_i^2$

So: $KE_f = 1/2\, m_f v_f^2$

$= 1/2\, (2m)\, (1/2\, v_i)^2$

$= 1/2\, (\, 1/2\, mv_i^2\,)$

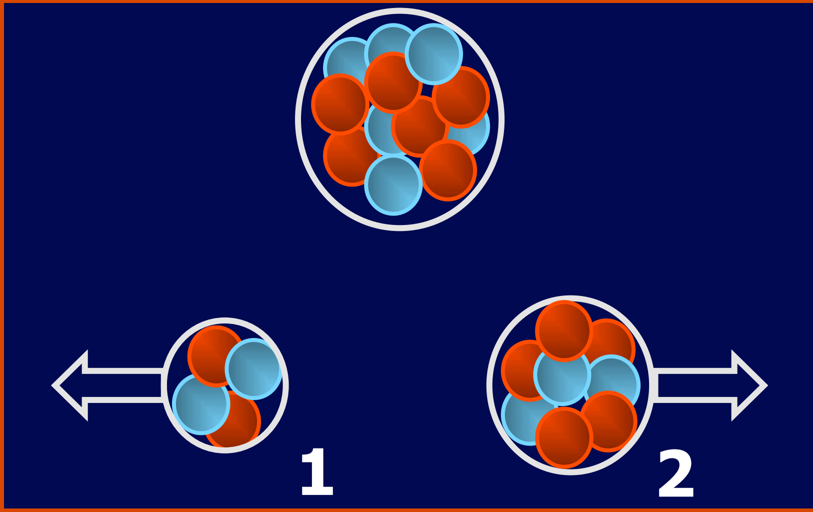
$= 1/2\, KE_i$



ConcepTest 7.13a Nuclear Fission I

A uranium nucleus (at rest) undergoes fission and splits into two fragments, one heavy and the other light. Which fragment has the greater momentum?

1) the heavy one
2) the light one
3) both have the same momentum
4) impossible to say

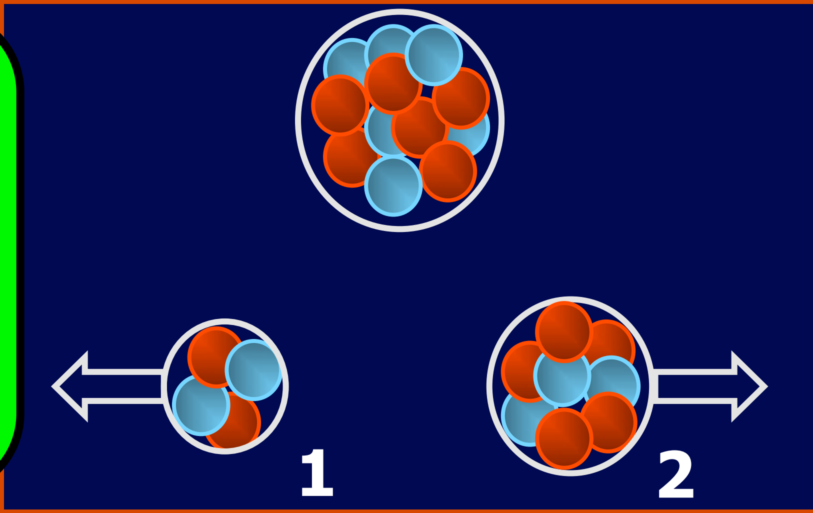


ConcepTest 7.13a Nuclear Fission I

A uranium nucleus (at rest) undergoes fission and splits into two fragments, one heavy and the other light. Which fragment has the greater momentum?

1) the heavy one
2) the light one
3) both have the same momentum
4) impossible to say

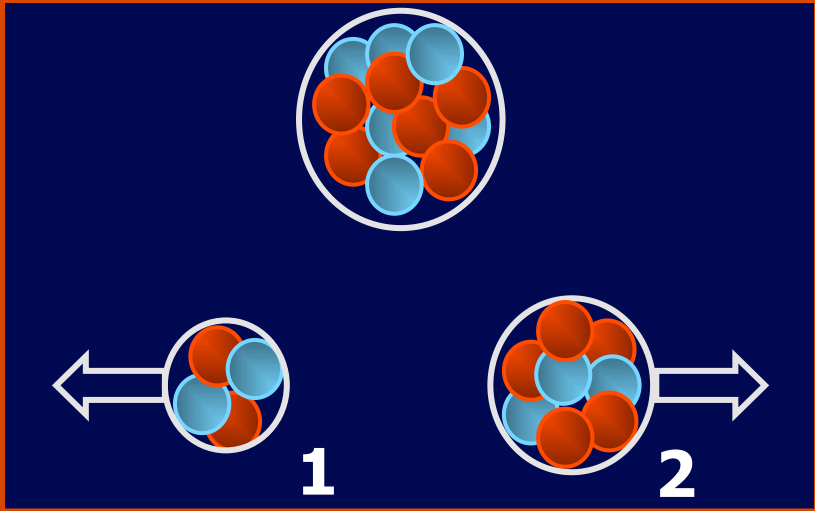
The initial momentum of the uranium was zero, so the final total momentum of the two fragments must also be zero. **Thus the individual momenta are equal in magnitude and opposite in direction.**



ConcepTest 7.13b Nuclear Fission II

A uranium nucleus (at rest) undergoes fission and splits into two fragments, one heavy and the other light. Which fragment has the greater speed?

1) the heavy one
2) the light one
3) both have the same speed
4) impossible to say

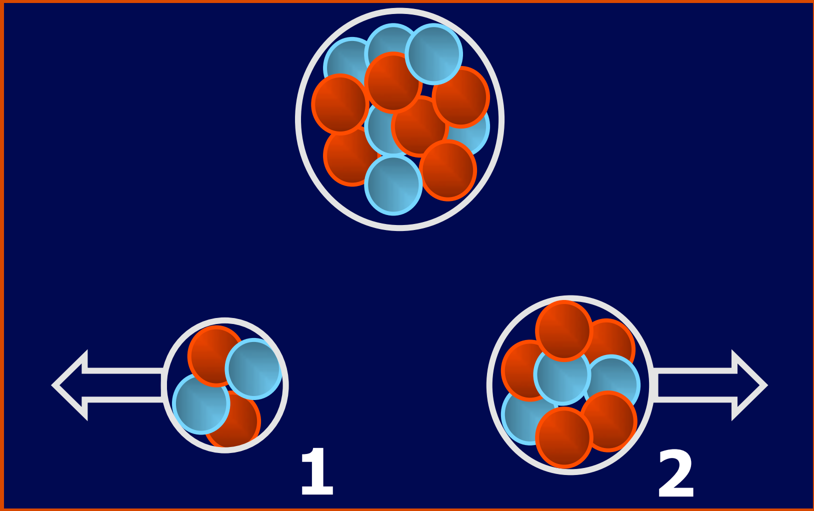


ConcepTest 7.13b Nuclear Fission II

A uranium nucleus (at rest) undergoes fission and splits into two fragments, one heavy and the other light. Which fragment has the greater speed?

1) the heavy one
2) the light one
3) both have the same speed
4) impossible to say

We have already seen that the individual momenta are equal and opposite. In order to keep the magnitude of momentum *mv* the same, the heavy fragment has the lower speed and the **light fragment has the greater speed**.



ConcepTest 7.14a Recoil Speed I

Amy (150 lbs) and Gwen (50 lbs) are standing on slippery ice and push off each other. If Amy slides at 6 m/s, what speed does Gwen have?

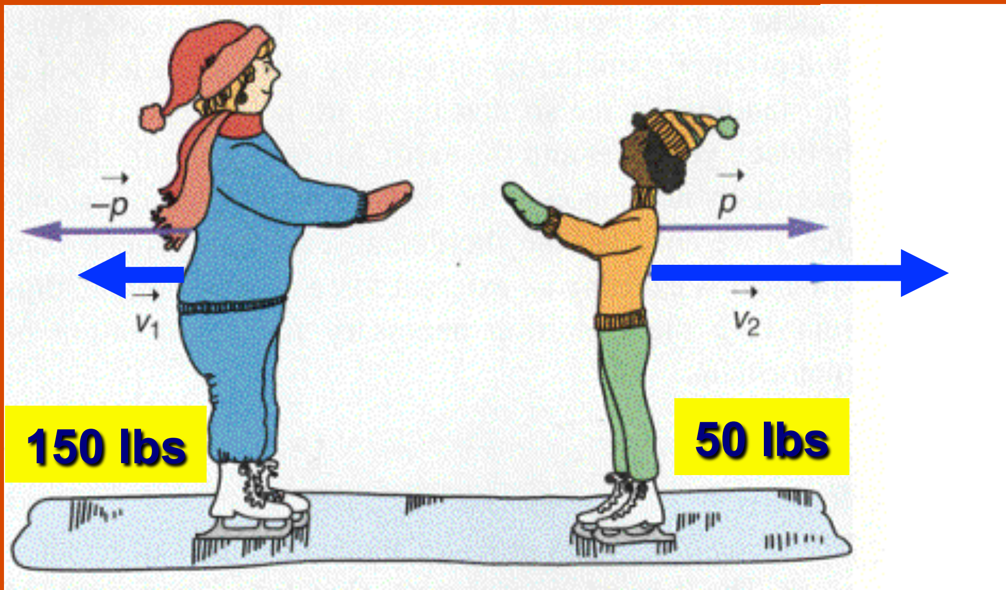
(1) 2 m/s

(2) 6 m/s

(3) 9 m/s

(4) 12 m/s

(5) 18 m/s



ConcepTest 7.14a Recoil Speed I

Amy (150 lbs) and Gwen (50 lbs) are standing on slippery ice and push off each other. If Amy slides at 6 m/s, what speed does Gwen have?

(1) 2 m/s

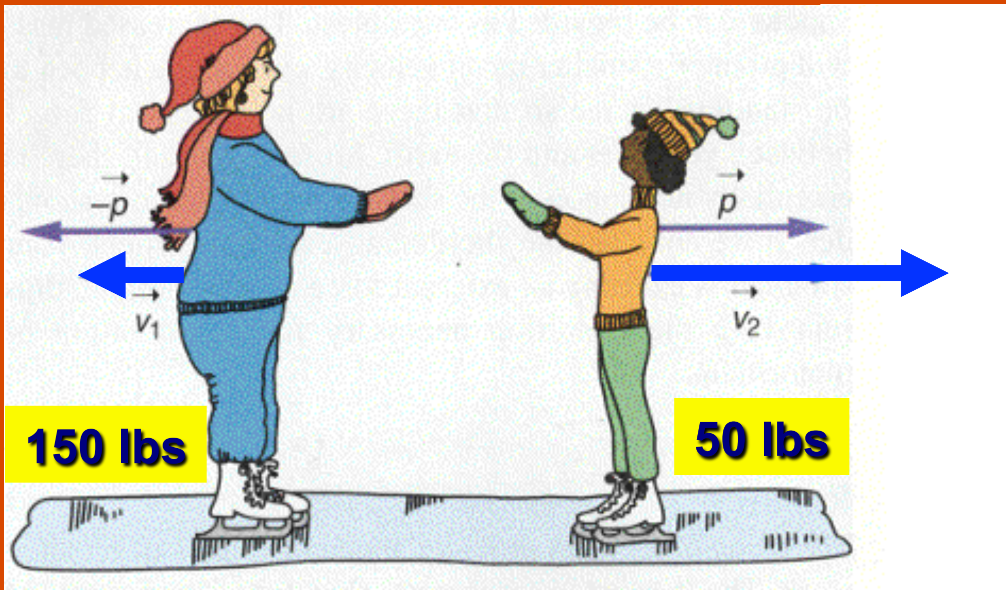
(2) 6 m/s

(3) 9 m/s

(4) 12 m/s

(5) 18 m/s

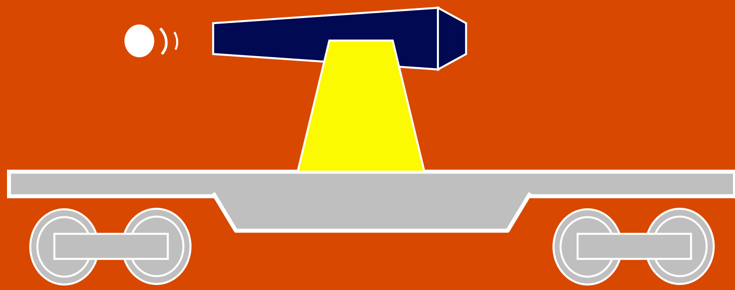
The **initial momentum is zero**, so the momenta of Amy and Gwen must be **equal and opposite**. Since $p = mv$, then if **Amy has 3 times more mass**, we see that **Gwen must have 3 times more speed**.



ConcepTest 7.14b Recoil Speed II

A cannon sits on a stationary railroad flatcar with a total mass of 1000 kg. When a 10-kg cannon ball is fired to the left at a speed of 50 m/s, what is the recoil speed of the flatcar?

1) 0 m/s
2) 0.5 m/s to the right
3) 1 m/s to the right
4) 20 m/s to the right
5) 50 m/s to the right



ConcepTest 7.14b Recoil Speed II

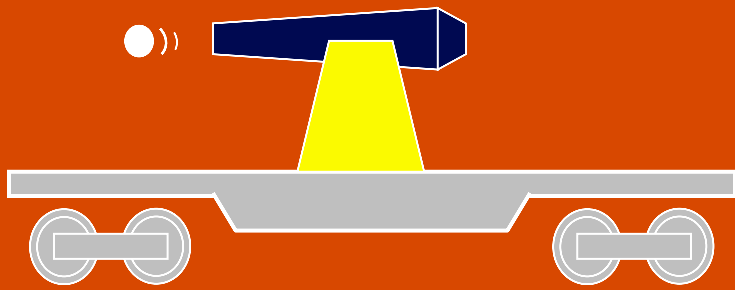
A cannon sits on a stationary railroad flatcar with a total mass of **1000 kg**. When a **10-kg** cannon ball is fired to the left at a speed of **50 m/s**, what is the recoil speed of the flatcar?

1) 0 m/s
2) 0.5 m/s to the right
3) 1 m/s to the right
4) 20 m/s to the right
5) 50 m/s to the right

Since the initial momentum of the system was zero, the final total momentum must also be zero. **Thus, the final momenta of the cannon ball and the flatcar must be equal and opposite.**

$p_{cannonball}$ = (10 kg)(50 m/s) = 500 kg-m/s

$p_{flatcar}$ = 500 kg-m/s = (1000 kg)**(0.5 m/s)**



ConcepTest 7.15 Gun Control

When a bullet is fired from a gun, the bullet and the gun have equal and opposite momenta. If this is true, then why is the bullet deadly? (whereas it is safe to hold the gun while it is fired)

1) it is much sharper than the gun

2) it is smaller and can penetrate your body

3) it has more kinetic energy than the gun

4) it goes a longer distance and gains speed

5) it has more momentum than the gun

ConcepTest 7.15 Gun Control

When a bullet is fired from a gun, the bullet and the gun have equal and opposite momenta. If this is true, then why is the bullet deadly? (whereas it is safe to hold the gun while it is fired)

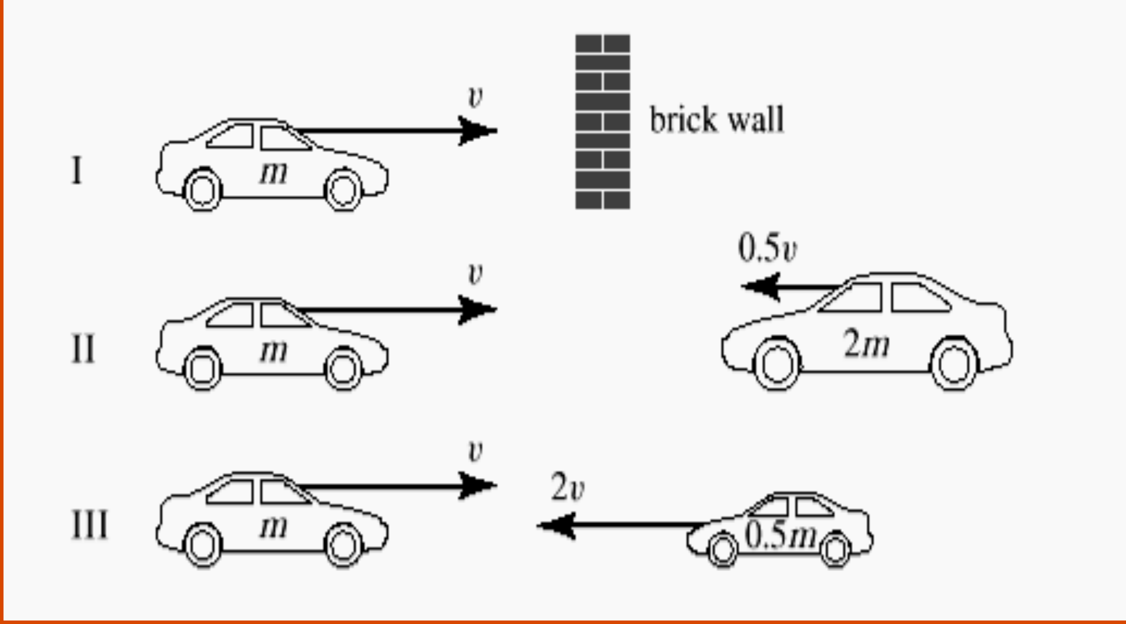
1) it is much sharper than the gun
2) it is smaller and can penetrate your body
3) it has more kinetic energy than the gun
4) it goes a longer distance and gains speed
5) it has more momentum than the gun

While it is true that the magnitudes of the momenta of the gun and the bullet are equal, the bullet is less massive and so it has a much higher velocity. Since KE is related to v^2, the bullet has considerably more KE and therefore can do more damage on impact.

ConcepTest 7.16a Crash Cars I

If all three collisions below are **totally inelastic**, which one(s) will bring the car on the left to a complete halt?

1) I
2) II
3) I and II
4) II and III
5) all three



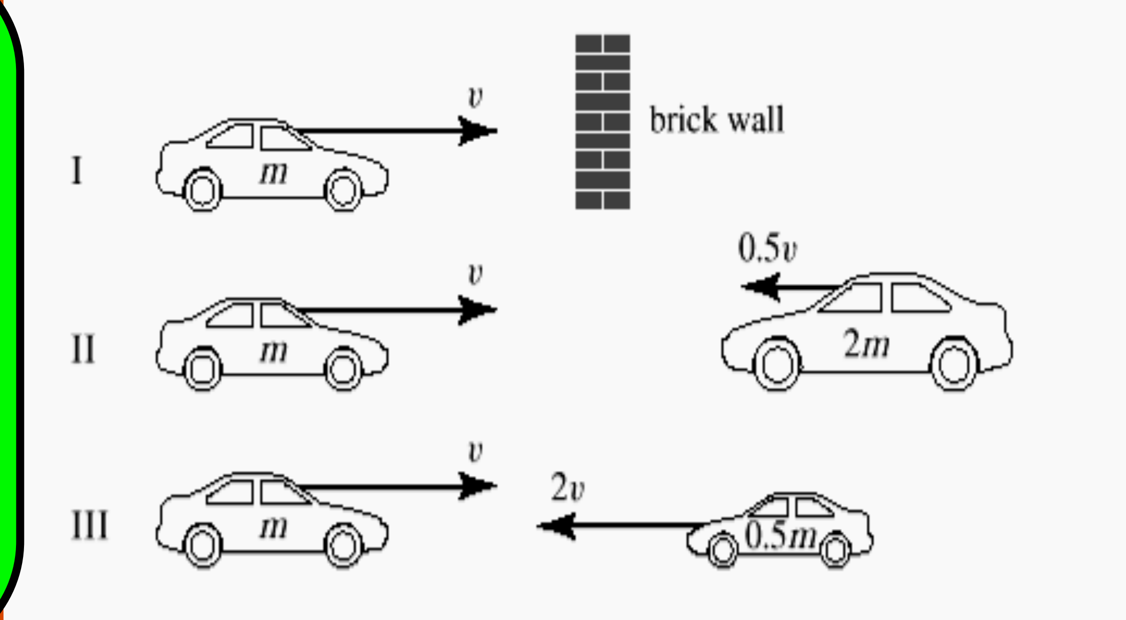
ConcepTest 7.16a Crash Cars I

If all three collisions below are **totally inelastic**, which one(s) will bring the car on the left to a complete halt?

1) I
2) II
3) I and II
4) II and III
5) all three

In case I, the solid wall clearly stops the car.

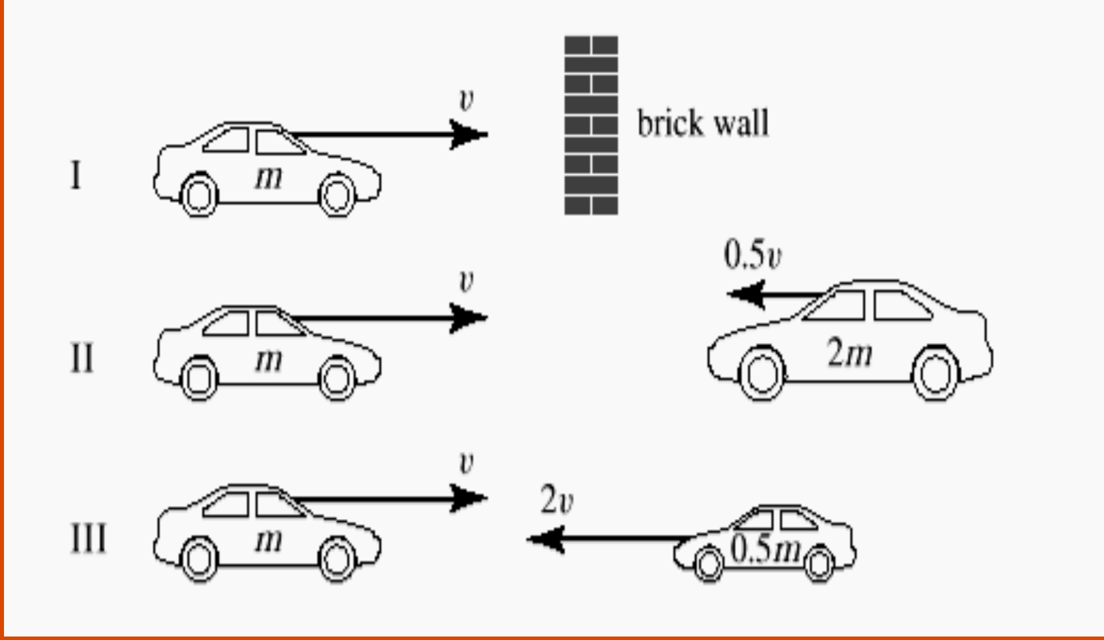
In cases II and III, **since $p_{tot} = 0$ before the collision**, then **p_{tot} must also be zero after the collision**, which means that the car comes to a halt in all three cases.



ConcepTest 7.16b Crash Cars II

If all three collisions below are **totally inelastic**, which one(s) will cause the most damage (in terms of lost energy)?

1) I
2) II
3) III
4) II and III
5) all three

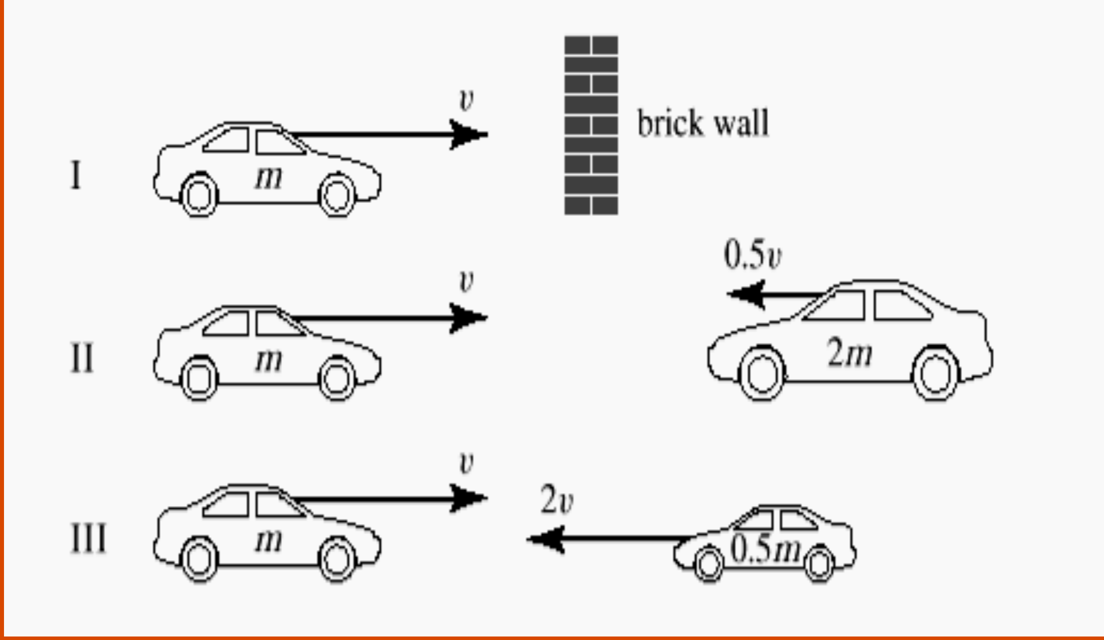


ConcepTest 7.16b Crash Cars II

If all three collisions below are **totally inelastic**, which one(s) will cause the most damage (in terms of lost energy)?

1) I
2) II
3) III
4) II and III
5) all three

The car on the left loses the same KE in all 3 cases, but in **case III**, the car on the right loses the most KE because *KE = 1/2 m v²* and the car in **case III** has the **largest velocity**.



ConcepTest 7.17 Shut the Door!

You are lying in bed and you want to shut your bedroom door. You have a superball and a blob of clay (both with the same mass) sitting next to you. **Which one would be more effective to throw at your door to close it?**

1) the superball
2) the blob of clay
3) it doesn't matter -- they will be equally effective
4) you are just too lazy to throw anything

ConcepTest 7.17 Shut the Door!

You are lying in bed and you want to shut your bedroom door. You have a superball and a blob of clay (both with the same mass) sitting next to you. Which one would be more effective to throw at your door to close it?

1) the superball
2) the blob of clay
3) it doesn't matter -- they will be equally effective
4) you are just too lazy to throw anything

The superball bounces off the door with almost no loss of speed, so its Δp (and that of the door) is 2*mv*.

The clay sticks to the door and continues to move along with it, so its Δp is *less* than that of the superball, and therefore it imparts less Δp to the door.

ConcepTest 7.18 Baseball Bat

Where is center of mass of a baseball bat located?

1) at the midpoint
2) closer to the thick end
3) closer to the thin end (near handle)
4) it depends on how heavy the bat is

ConcepTest 7.18 Baseball Bat

Where is center of mass of a baseball bat located?

1) at the midpoint
2) closer to the thick end
3) closer to the thin end (near handle)
4) it depends on how heavy the bat is

Since most of the mass of the bat is at the thick end, this is where the center of mass is located. Only if the bat were like a uniform rod would its center of mass be in the middle.

ConcepTest 7.19 Motion of CM

Two equal-mass particles (A and B) are located at some distance from each other. Particle A is held stationary while B is moved away at speed *v*. **What happens to the center of mass of the two-particle system?**

1) it does not move
2) it moves away from A with speed *v*
3) it moves toward A with speed *v*
4) it moves away from A with speed 1/2 *v*
5) it moves toward A with speed 1/2 *v*

ConcepTest 7.19 Motion of CM

Two equal-mass particles (A and B) are located at some distance from each other. Particle A is held stationary while B is moved away at speed v. **What happens to the center of mass of the two-particle system?**

1) it does not move
2) it moves away from A with speed v
3) it moves toward A with speed v
4) it moves away from A with speed 1/2 v
5) it moves toward A with speed 1/2 v

Let's say that A is at the origin ($x = 0$) and B is at some position x. Then the center of mass is at $x/2$ because A and B have the same mass. If $v = \Delta x/\Delta t$ tells us how fast the position of B is changing, then the position of the center of mass must be changing like $\Delta(x/2)/\Delta t$, which is simply 1/2 v.

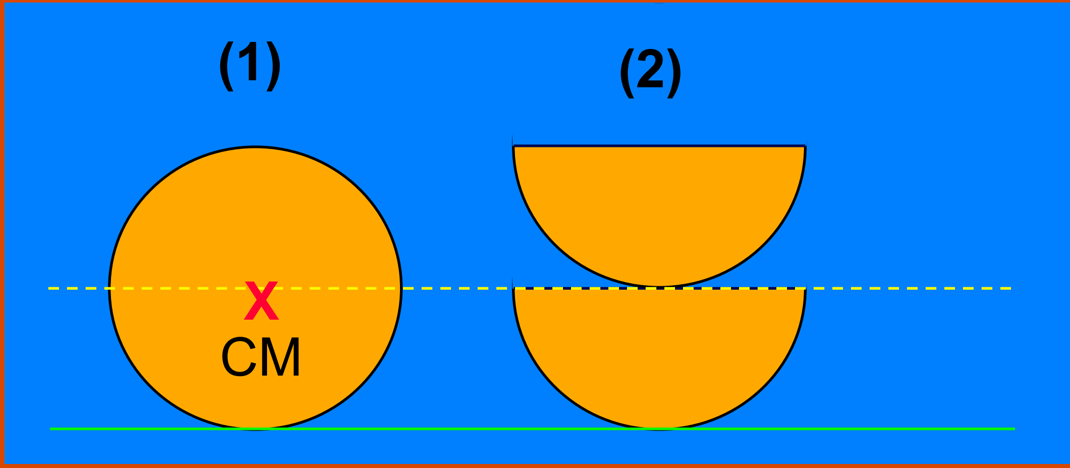
ConcepTest 7.20 Center of Mass

The disk shown below in (1) clearly has its center of mass at the center.

Suppose the disk is cut in half and the pieces arranged as shown in (2).

Where is the center of mass of (2) as compared to (1) ?

1) higher
2) lower
3) at the same place
4) there is no definable CM in this case



ConcepTest 7.20 Center of Mass

The disk shown below in (1) clearly has its center of mass at the center.

Suppose the disk is cut in half and the pieces arranged as shown in (2).

Where is the center of mass of (2) as compared to (1) ?

1) higher
2) lower
3) at the same place
4) there is no definable CM in this case

The CM of each half is closer to the top of the semi-circle than the bottom. The CM of the whole system is located at the **midpoint of the two semi-circle CM's**, which is **higher** than the yellow line.