Momentum

Physics Clicker Quizzes

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)

A speeds up

B maintains constant speed

C slows down

D stops immediately

C slows down

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*.

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

Yes

No

No

If object #1 has mass *m* and speed *v*, and object #2 has mass 1/2 *m* and speed 2*v*, 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.

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?

A **greater than**

B **less than**

C **equal to**

C 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.

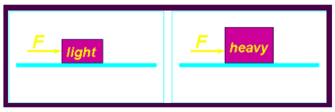
A net force of 200 N acts on a 100-kg boulder, and a force of the same magnitude acts on a 130-g pebble. How does the rate of change of the boulder's velocity compare to the rate of change of the pebble's velocity?

A greater than
B less than
C equal to

B less than

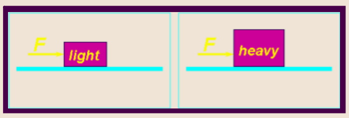
The rate of change of velocity is the acceleration. Remember that $a = \Delta v/\Delta t$. The acceleration is related to the force by Newton's 2nd Law ($F = ma$), so the acceleration of the boulder is less than that of the pebble (for the same applied force) because the boulder is much more massive.

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?



A the heavier one
B the lighter one
C both the same

C both the same



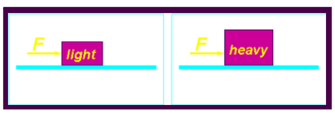
We know: $F_{av} = \dfrac{\Delta p}{\Delta t}$

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

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

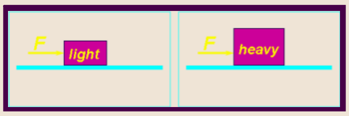
Both boxes will have the *same final momentum*.

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



A the heavier one
B the lighter one
C both the same

B the lighter one



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

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?

A the beanbag
B the rubber ball
C both the same

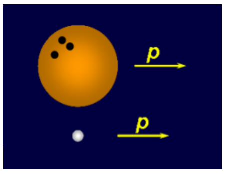
B the rubber ball

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:
$\Delta p = p_f - p_i = mv - (-mv) = 2mv$

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?



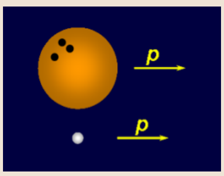
A the bowling ball
B the same time for both
C the ping-pong ball
D impossible to say

B the same for both

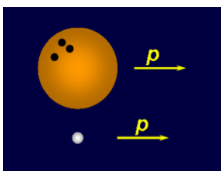
We know: $F_{av} = \frac{\Delta p}{\Delta t}$ so $\Delta p = F_{av} \Delta t$

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

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

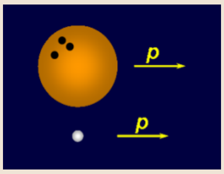


A bowling ball and a ping-pong ball are rolling toward you with the same momentum. If you exert the same force to stop each one, for which is the stopping distance greater?



A the bowling ball
B the same time for both
C the ping-pong ball
D impossible to say

C the ping-pong ball



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*.

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?

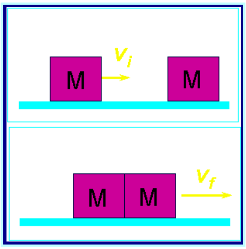
A greater than
B less than
C equal to

A greater than

This is exactly the same thing as in the 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 2*v*.

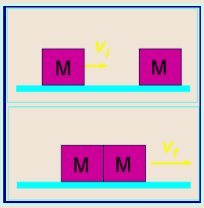
$$v_A - v_B = v'_B - v'_A$$

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?



A 10 m/s
B 20 m/s
C 0 m/s
D 15 m/s
E 5 m/s

E 5 m/s



The initial momentum is:

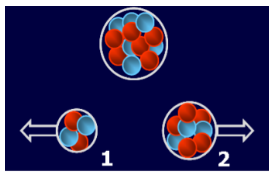
$M v_i = (10) M$

The final momentum must be the same!!

The final momentum is:

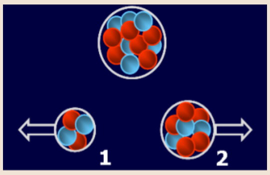
$M_{tot}\, v_f = (2M)\, v_f = (2M)\,(5)$

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



A the heavier one
B the lighter one
C both have the same momentum
D impossible to say

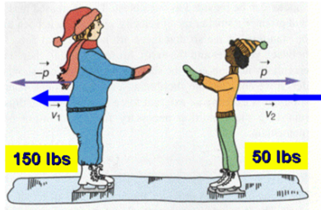
C both have the same



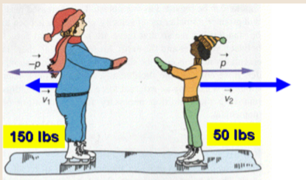
The initial momentum of the uranium was zero, so the final total momentum of the two fragments must also be zero. Thus the individual momenta are equal in magnitude and opposite in direction.

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?

A 2 m/s
B 6 m/s
C 9 m/s
D 12 m/s
E 18 m/s



E 18 m/s



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

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?

A the superball
B the blob of clay
C it doesn't matter - they will be equally effective
D neither - you couldn't hit the broad-side of a barn if your life depended on it!

A the superball

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