ConcepTest 8.19 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*

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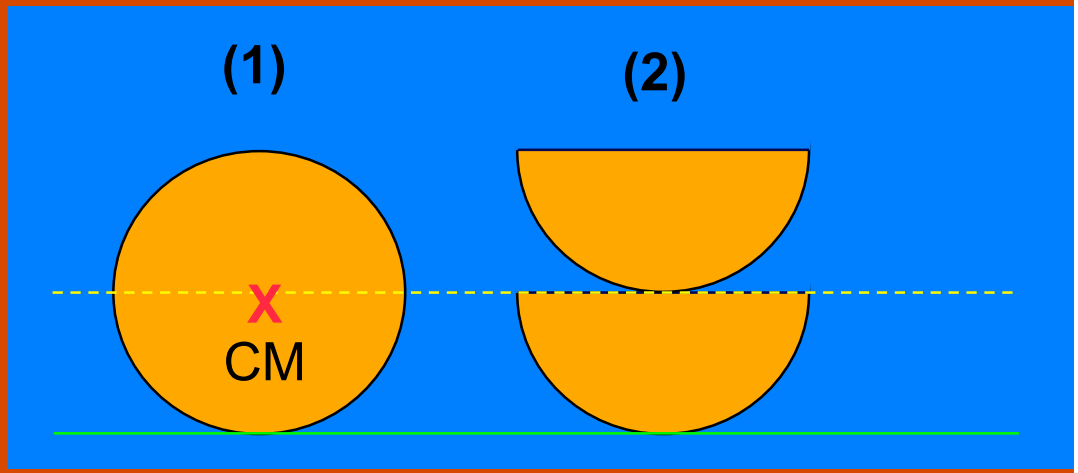
Let's say that A is at the origin ($x = 0$) and B is at some position x. Then the center of mass is at $x/2$ because A and B have the same mass. If $v = Dx/Dt$ tells us how fast the position of B is changing, then the position of the center of mass must be changing like $D(x/2)/Dt$, which is simply 1/2 v.

ConcepTest 8.20 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**



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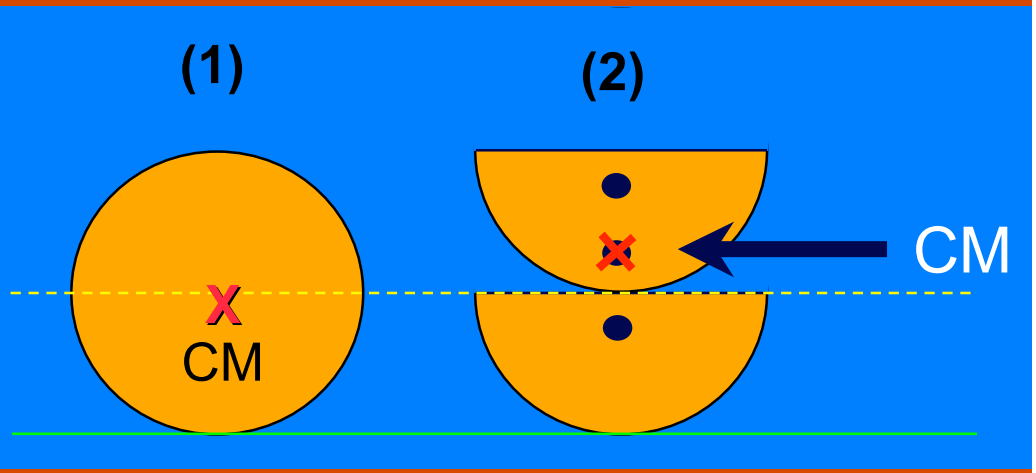
The CM of each half is closer to the top of the semi-circle than the bottom. The CM of the whole system is located at the midpoint of the two semi-circle CM's, which is higher than the yellow line.



ConcepTest 8.2b 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

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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 8.3a 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

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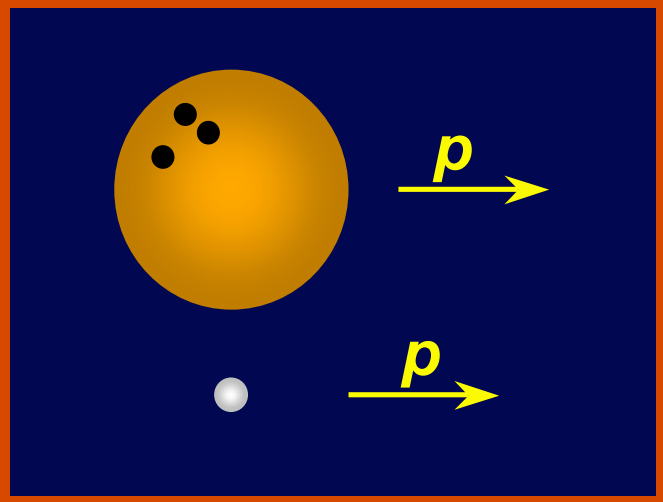
The rate of change of momentum is, in fact, the force. Remember that $F = \Delta p/\Delta t$. Since the force exerted on the boulder and the pebble is the same, then the rate of change of momentum is the same.

ConcepTest 8.9a 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



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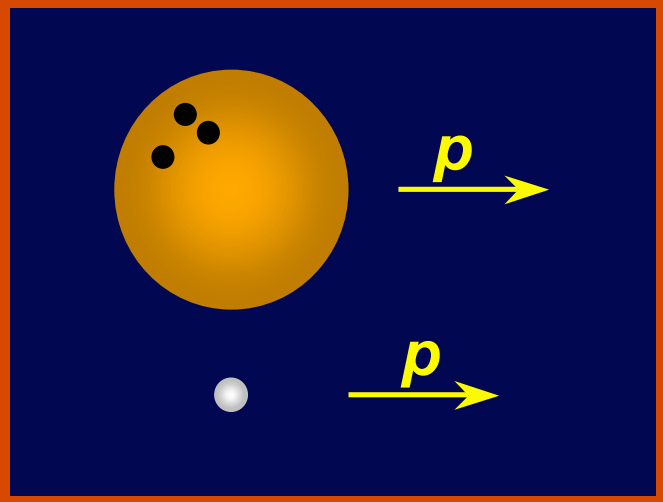
We know: $F_{av} = \dfrac{\Delta p}{\Delta t}$ so $\Delta p = F_{av}\,\Delta t$

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

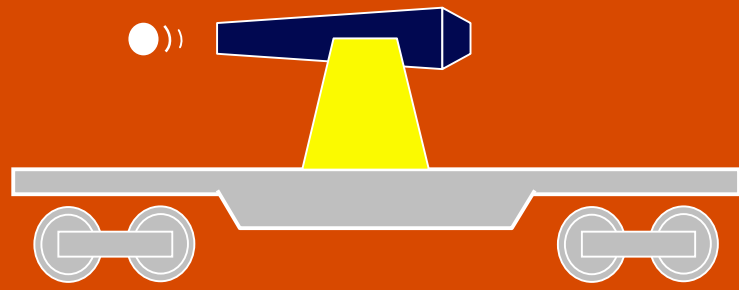
It will take the *same amount of time* to stop them.



ConcepTest 8.14b 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



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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.

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

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