Question Identical constant forces push two identical objects A and B continuously from a starting line to a finish line. If A is initially at rest and B is initially moving to the right,

1. Object A has the larger change in momentum.
2. Object B has the larger change in momentum.
3. Both objects have the same change in momentum
4. Not enough information is given to decide.

Answer 1: Both objects have the same mass, are pushed the same distance, by the same constant force, so they have the same acceleration. Since object B has an initial speed the time interval needed to reach the finish is less than the corresponding time interval for object A which started from rest. Therefore the change in velocity of object B is less than the corresponding change in velocity for object A. Hence object A has a larger change in momentum.
Concept Question: Ping-Pong Ball and Bowling Ball

Introduce graphical solution

Suppose a ping-pong ball and a bowling ball are rolling toward you. Both have the same momentum, and you exert the same force to stop each. How do the distances needed to stop them compare?

1. It takes a shorter distance to stop the ping-pong ball.
2. Both take the same distance.
3. It takes a longer distance to stop the ping-pong ball.

Answer: 3. Both the initial momentum and the force acting on the two objects are equal. Therefore the initial velocity and the acceleration of the ping-pong ball is greater than the bowling ball by the ratio of the bowling ball mass to the ping-pong ball mass.

\[
m_{\text{ping-pong}} v_{0, \text{ping-pong}} = m_{\text{bowling}} v_{0, \text{bowling}} = p_x
\]

\[
m_{\text{ping-pong}} a_{\text{ping-pong}} = m_{\text{bowling}} a_{\text{bowling}} = F_x
\]

Since both the force acting on each object and the change in momentum is the same, the impulse acting on each ball is the same. Therefore, the time interval it takes to stop each object is the same.

Since the displacement is equal to

\[
\Delta x = \left( v_{x,0} - \frac{a_x \Delta t}{2} \right) \Delta t
\]

The ratio

\[
\frac{\Delta x_{\text{ping-pong}}}{\Delta x_{\text{bowling}}} = \frac{m_{\text{bowling}}}{m_{\text{ping-pong}}}
\]

hence the ping-pong has the greater displacement.
The greatest acceleration of the center of mass will be produced by pushing with a force $F$ at

1. Position 1
2. Position 2
3. Position 3
4. All the same

**Answer 4**