

Comparing Pushed Particles

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This material is borrowed/adapted from Chapter 11 of the *Student Workbook for Physics for Scientists and Engineers*.

XX-1: Comparing Pushed Particles

Particle A has less mass than particle B. Both are pushed forward across a frictionless surface by equal forces for 1 s. Both start from rest.

(a) Compare the amount of work done on each particle. That is, is the work done on A greater than, less than, or equal to the work done on B? Explain.

The amount of work done by a force depends on the sizes of the force and the displacement of the object under that force. The same force is applied to both particles, but since A has less mass, it will accelerate more and have greater displacement. Therefore, the work done on A is greater.

(b) Compare the impulses delivered to particles A and B. Explain.

Because the same net force is applied over the same elapsed time, the impulses are the same.

(c) Compare the final speeds of particles A and B. Explain.

Let the particles move along the x -axis so we may discuss the components of their momenta. The same impulse J_x is delivered to both particles, and since they both start from rest, we know $p_{ix} = 0$. This gives

$$J_x = \Delta p_x = p_{fx} - \cancel{p_{ix}} = p_{fx}.$$

As such, both particles have the same final momentum:

$$p_{fx} = m_A v_{fA} = m_B v_{fB}.$$

However, since $m_A < m_B$, we must conclude that $v_{fA} > v_{fB}$.