

I. SUV vs. car

On a test track, a sports utility vehicle (SUV) of mass 2000 kg, traveling at 12 m/s, hits a stationary car of mass 1000 kg. The car crumples and stays in contact with the SUV; they move together as a unit.

- A. Answer this without doing calculations: Which vehicle, if either, undergoes a greater change in velocity during the collision? How do you know?
- B. Without using formulas, see if you can intuitively guess the post-collision speed of the two vehicles. Briefly explain your common-sense reasoning. If you get totally stuck, move on.
- C. Now calculate the post-collision speed using momentum conservation.
- D. If you got stuck in part B, do you now see a way that you could have “guessed” the post-collision speed? Explain.

II. Bowling ball vs. pin

A bowling ball rolls into a stationary bowling pin, which is much lighter than the ball.

- A. During the collision, is the force exerted by the ball on the pin greater than, less than, or equal to the force exerted by the pin on the ball? **Briefly explain.**
- B. During the collision, is the bowling ball's change in *speed* greater than, less than, or equal to the pin's change in speed? **Briefly explain.**
- C. During the collision, is the bowling ball's change in *momentum* greater than, less than, or equal to the pin's change in momentum? **Briefly explain.**
- D. A student makes the following argument about part C:

In the collision, the pin's momentum changes more than the ball's momentum, because the ball's motion hardly changes, while the pin's motion changes a lot; it bounces off the ball really fast.

How could you help this student reconcile his intuitive ideas about the “changes in motion” with the fact that the ball's momentum and the pin's momentum change by the same amount?