PH 221 Week 9

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

R9-1: 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.

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

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

R9-2: Ice Archer and Cadillac Crash

For this activity, we will be looking at two situations that mirror each other: a superelastic collision and a perfectly inelastic collision. We want to see how these situations are alike and how they are different.

(a) For each situations below, prepare a pictorial representation.

- Draw pictures of "before" and "after."
- Define symbols relevant to the problem.
- List known information, and identify the desired unknown.

(i) A 50 kg archer, standing on frictionless ice, shoots a 100 g arrow at a speed of 100 m/s. What is the recoil speed of the archer?

(ii) The parking brake on a 2000 kg Cadillac has failed, and it is rolling slowly, at 1 mph, toward a group of small, innocent children. As you see the situation, you realize there is just time for you to drive your 1000 kg Volkswagen head-on into the Cadillac and thus save the children. With what speed should you impact the Cadillac to bring it to a halt?

(b) For both of these situations, we want to apply conservation of momentum, but the details of why we can do this are slightly different. How can we justify conservation of momentum for the following systems?

(i) The archer and the arrow.

(ii) The Cadillac and the Volkswagen.

(c) Solve the two situations for the desired quantity. Make sure to solve symbolically before plugging in numbers.

(i) What is the recoil speed of the archer?

(ii) With what speed should you impact the Cadillac to bring it to a halt?

(d) Calculate the change in kinetic energy in both situations, and identify where the energy comes from or goes to.

(i) How much kinetic energy do the archer and arrow have after firing? Where did it come from?

(ii) How much kinetic energy did the two cars have before the collision? Where did it go?

(e) Identify and check 3 special cases for each of these situations. (You may notice that the three special cases in one situation are basically mathematically identical to the three in the other. You may find it interesting to match these together, as while the math is the same, the physical interpretations are quite distinct.)