**VI.3: Impulse and Momentum**

*"Remember happiness doesn't depend upon who you are or what you have; it depends solely on what you think.”* – Dale Carnegie

*“Most folks are about as happy as they make up their minds to be.” –* Abraham Lincoln *“A ship in the harbor is safe, but that is not what ships are built for.”* **–** William Shedd *“You miss 100% of the shots that you don’t take.”* – Wayne Gretsky

# Problem Solving

Most calculations of impulse are rather straightforward. Remember that impulse is a vector

quantity and you must, for example, use the *x* component of the force to find the *x* component of the impulse. You might also be given sufficient information to calculate the initial and final

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linear momentum of a particle. Then, use *F* *t*  *mvf*  to calculate the impulse.

Many problems of this chapter can be worked using the principle of conservation of linear momentum. If you suspect the principle can be used, first check for external forces: if there are none or if they add to zero, total linear momentum is conserved. Write the momentum at the beginning of some interval in terms of the velocities and masses of the particles involved. Do the same for the momentum at the end of the interval. Equate the two expressions and solve for the unknown quantities.

Collision problems are more complicated. First decide if the collision is one- or two- dimensional. A head-on collision is always one-dimensional. So is a completely inelastic two- body collision with one object initially at rest. If the objects move along different lines, whether initially or finally, the collision is two-dimensional.

First consider one-dimensional collisions. Since total linear momentum is always conserved in collisions, nearly every problem solution begins by writing the equation for conservation of linear momentum. There is only one such equation for a one-dimensional collision. Always use symbols, not numbers, even for given quantities. Make a list of the quantities given in the problem statement and a list of the unknowns. If there is only one unknown, the linear momentum conservation equation can be solved immediately for it.

For two-dimensional collisions there are two linear momentum conservation equations, one for each component. Select a coordinate system and write the linear momentum conservation equations in terms of the masses, speeds, and angles between the velocities and a coordinate axis.

## Questions and Example Problems

### Question 1

An ice boat is coasting along a frozen lake. Friction between the ice and the boat is negligible, and so is air resistance. Nothing is propelling the boat. From a bridge, someone jumps straight down and lands in the boat, which continues to coast straight ahead. (a) Does the horizontal momentum of the boat change? (b) Does the speed of the boat increase, decrease, or remain the same? Explain your answers.

### Problem 1

A 0.150 kg baseball is dropped from rest. If the magnitude of the baseball’s momentum is 0.680 kg m/s just before it lands on the ground, from what height was it dropped?

**Problem 2**

A 5.0 kg cat is running northward at 4.50 m/s, while at the same time a 20.0 kg dog is running eastward at 3.00 m/s. Their 70.0 kg owner has the same momentum as the two pets taken together. Find the magnitude and direction of the owner’s velocity.