

## 4.5: Exercises

### Exercise 4.5.1

A 71-kg man can throw a 1-kg ball with a maximum speed of 6 m/s relative to himself. Imagine that one day he decides to try to do that on roller skates. Starting from rest, he throws the ball as hard as he can, so it ends up moving at 6 m/s relative to him, but he himself is recoiling as a result of the throw.

- Assuming conservation of momentum, find the velocities of the man and the ball relative to the ground.
- What is the kinetic energy of the system right after the throw? (By the system here we mean the man and the ball throughout.) Where did this kinetic energy come from?
- Is the man's reference frame inertial throughout this process? Why or why not?
- Does the center of mass of the system move at all throughout this process?

### Exercise 4.5.2

Analyze [Exercise 3.6.1](#) from Chapter 3 from the point of view of the system's kinetic energy. In particular, answer the following questions:

- What is the total kinetic energy of the system before and after the collision? How much of this energy is translational (that is, center-of-mass kinetic energy), and how much is convertible?
- What kind of collision is this? (Elastic, inelastic, etc.) What is the coefficient of restitution?

### Exercise 4.5.3

Analyze [Exercise 3.6.2](#) from Chapter 3 from the point of view of the system's kinetic energy. In particular, answer the following questions:

- What is the coefficient of restitution for the collision described in part (a) of the problem, and how much kinetic energy is "lost" in that collision?
- What is the coefficient of restitution for the collision described in part (b) of the problem, and how much kinetic energy is "lost" in that collision?

### Exercise 4.5.4

A 0.012-kg bullet, traveling at 850 m/s, hits a 2-kg block of wood that is initially at rest, and goes straight through it. Assume that the final velocity of the bullet *relative to the block* is 400 m/s, and that the system is isolated.

- What is the coefficient of restitution for this collision?
- How much kinetic energy is "lost" in the collision? (c) What is the final velocity of the block?

### Exercise 4.5.5

A 2-kg object, moving at 1 m/s, collides with a 1-kg object that is initially at rest. Assume they form an isolated system.

- (a) What is the initial kinetic energy of the system? How much of this is center of mass energy, and how much is convertible?
- What is the maximum amount of kinetic energy that could be "lost" (converted to other forms of energy) in this collision?
- If 60% of the amount you calculated in part (b) is in fact converted into other forms of energy in the collision, what are the final velocities of the two objects?

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