

## Conceptual Questions

### 8.1 Linear Momentum and Force

1.

An object that has a small mass and an object that has a large mass have the same momentum. Which object has the largest kinetic energy?

2.

An object that has a small mass and an object that has a large mass have the same kinetic energy. Which mass has the largest momentum?

3.

Professional Application

Football coaches advise players to block, hit, and tackle with their feet on the ground rather than by leaping through the air. Using the concepts of momentum, work, and energy, explain how a football player can be more effective with his feet on the ground.

4.

How can a small force impart the same momentum to an object as a large force?

### 8.2 Impulse

5.

Professional Application

Explain in terms of impulse how padding reduces forces in a collision. State this in terms of a real example, such as the advantages of a carpeted vs. tile floor for a day care center.

6.

While jumping on a trampoline, sometimes you land on your back and other times on your feet. In which case can you reach a greater height and why?

7.

Professional Application

Tennis racquets have “sweet spots.” If the ball hits a sweet spot then the player's arm is not jarred as much as it would be otherwise. Explain why this is the case.

### 8.3 Conservation of Momentum

8.

Professional Application

If you dive into water, you reach greater depths than if you do a belly flop. Explain this difference in depth using the concept of conservation of energy. Explain this difference in depth using what you have learned in this chapter.

9.

Under what circumstances is momentum conserved?

10.

Can momentum be conserved for a system if there are external forces acting on the system? If so, under what conditions? If not, why not?

11.

Momentum for a system can be conserved in one direction while not being conserved in another. What is the angle between the directions? Give an example.

12.

Professional Application

Explain in terms of momentum and Newton's laws how a car's air resistance is due in part to the fact that it pushes air in its direction of motion.

13.

Can objects in a system have momentum while the momentum of the system is zero? Explain your answer.

14.

Must the total energy of a system be conserved whenever its momentum is conserved? Explain why or why not.

#### **8.4 Elastic Collisions in One Dimension**

15.

What is an elastic collision?

#### **8.5 Inelastic Collisions in One Dimension**

16.

What is an inelastic collision? What is a perfectly inelastic collision?

17.

Mixed-pair ice skaters performing in a show are standing motionless at arms length just before starting a routine. They reach out, clasp hands, and pull themselves together by only using their arms. Assuming there is no friction between the blades of their skates and the ice, what is their velocity after their bodies meet?

18.

A small pickup truck that has a camper shell slowly coasts toward a red light with negligible friction. Two dogs in the back of the truck are moving and making various inelastic collisions with each other and the walls. What is the effect of the dogs on the motion of the center of mass of the system (truck plus entire load)? What is their effect on the motion of the truck?

### 8.6 Collisions of Point Masses in Two Dimensions

19.

Figure 8.14 shows a cube at rest and a small object heading toward it. (a) Describe the directions (angle  $\theta_1$ ) at which the small object can emerge after colliding elastically with the cube. How does  $\theta_1$  depend on  $b$ , the so-called impact parameter? Ignore any effects that might be due to rotation after the collision, and assume that the cube is much more massive than the small object. (b) Answer the same questions if the small object instead collides with a massive sphere.

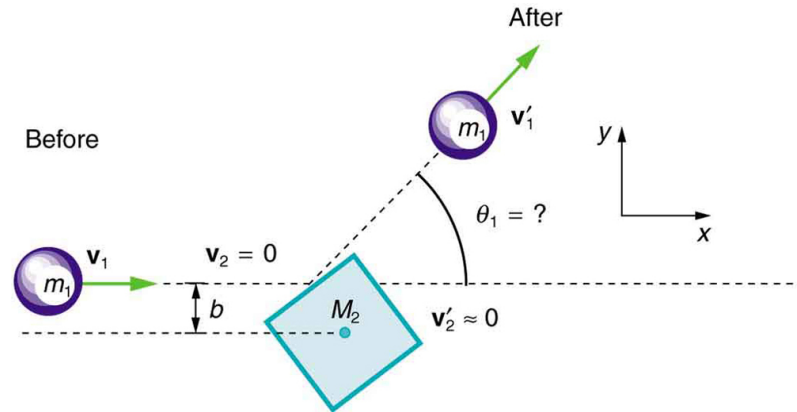


Figure 8.14 A small object approaches a collision with a much more massive cube, after which its velocity has the direction  $\theta_1$ . The angles at which the small object can be scattered are determined by the shape of the object it strikes and the impact parameter  $b$ .

### 8.7 Introduction to Rocket Propulsion

20.

Professional Application

Suppose a fireworks shell explodes, breaking into three large pieces for which air resistance is negligible. How is the motion of the center of mass affected by the explosion? How would it be affected if the pieces experienced significantly more air resistance than the intact shell?

21.

Professional Application

During a visit to the International Space Station, an astronaut was positioned motionless in the center of the station, out of reach of any solid object on which he could exert a force. Suggest a method by which he could move himself away from this position, and explain the physics involved.

22.

Professional Application

It is possible for the velocity of a rocket to be greater than the exhaust velocity of the gases it ejects. When that is the case, the gas velocity and gas momentum are in the same direction as that of the rocket. How is the rocket still able to obtain thrust by ejecting the gases?