CHAPTER 10 Review

REFLECTING ON CHAPTER 10

- Vector components are parts of a vector that are at right angles to each other. They lie on the axes of a coordinate system. Since components are confined to one direction, they are can be added algebraically.
- Resolving a vector means separating it into its components.
- Relative velocity describes motion with respect to a specific coordinate system.
- Torque is the quantity that causes an object to rotate around a pivot point. Mathematically, torque is the product of the lever arm and force acting on the object. The lever arm is the perpendicular distance between the pivot point and the line along which the force acts.

$$\tau = r_{\perp}F$$

- Positive torque causes an object to rotate in the counterclockwise direction. Negative torque causes an object to rotate in the clockwise direction.
- The centre of mass is the point at which gravity acts on an object.
- An object is in static equilibrium if the sum of all of the forces and the sum of all of the torques acting on the object are zero.

$$\sum \tau = 0 \qquad \sum \vec{F} = 0$$

- If an object is in equilibrium around one pivot point, it is in equilibrium around any pivot point.
- Kinetic energy is conserved in elastic collisions.
- Kinetic energy is *not* conserved in inelastic collisions.

Knowledge/Understanding

1. The force, $\vec{F}$, in Newton's first and second laws represents what force?
2. Define "internal force," "external force," and "system" and describe a situation in which it is critical to know the difference.
3. Explain how to solve problems involving objects connected by ropes or cables that go over a pulley.
4. Describe a situation in which all of the forces acting on an object are zero but the object is not in static equilibrium. What type of changes in the object's motion can take place?
5. How do you determine the magnitude of the "lever arm" when solving a problem involving torque?
6. Give an example of an object that has both translational motion and rotational motion.
7. At the instant after a car crash, the force of friction acts on the cars, causing a change in their momentum. Explain how you can apply the law of conservation of momentum to car crashes.
8. Assume that you are provided with data for a collision between two masses that undergo a collision. Describe, step by step, how you would determine whether the collision was elastic or inelastic.
9. Under what conditions is a collision *completely inelastic*?
10. Explain how a forensic expert can determine the velocity of a bullet by using a ballistic pendulum.

Inquiry

11. Assemble a wooden inclined plane and a piece of wood that you will slide up the plane. Create a problem that asks for the force necessary to slide the piece of wood up the plane then carry out the calculations. Test your predictions determine the percent difference between your observe and calculated values. If the difference is relatively large, give possible reasons for the deviation.
12. Build a model of an elevator with counter-weights. Take data and calculate the amount of energy needed to raise the elevator a given distance with and without the counterweights.

13. Build a model of a sign similar to the one in Model Problem 2 on page 498. Determine the mass of each part of the sign and the angles between the poles or beams and cables in the model. Predict the tension in the rope or cable. Test your prediction. Calculate the percent difference between your calculated and observed values.

14. Design a method for testing the special cases of elastic collisions on pages 518 and 519. Carry out your tests and discuss how well your observations fit the theoretical predictions.

Communication

15. You are having a debate with your lab partner about the correct solution to a physics problem. He says that the normal force acting on an object moving along a surface is *always* equal and opposite to the force of gravity. You disagree with this definition.
    - **(a)** Provide the proper definition for the normal force acting on an object.
    - **(b)** Describe, with the aid of free-body diagrams, three situations in which the normal force acting on an object cannot be determined using your lab partner's definition.
    - **(c)** Describe, with the aid of a free-body diagram, a situation in which your lab partner's definition could apply.

16. Explain how a force of static friction between a specific object and surface can have a wide range of values.

17. Explain why you cannot really call the acceleration due to gravity, g, a constant.

18. Explain how Atwood's machine made it easier for him to calculate the acceleration due to gravity more accurately than he could by just observing a falling object.

19. A painter starts climbing up a ladder. The painter and ladder are in static equilibrium while he is on the first three rungs of the ladder. When he climbs onto the fourth rung, the base of the ladder gradually starts to slip backwards. Analyze the situation and explain how this can happen.

20. Describe one situation in which you can be analyzing motion involving a completely inelastic collision and still use the law of conservation of mechanical energy.

Making Connections

21. Choose some structure that you have seen recently, that relies on cables. For example, you could choose a bridge, construction crane, or ski lift. Do research to find out about the design of the structure and the amount of tension in the cables. What margin of safety do engineers use when choosing cables for the structure that you chose?

22. The muscles in your body are attached to bones quite close to pivot points such as your elbow, knee, or hip joint. How does this type of connection affect the amount of force that the muscle must exert on the bone to lift or throw objects with your hands or kick something with your feet?

Problems for Understanding

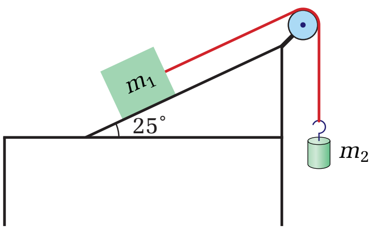
23. You want to paddle your kayak to the east which is straight across a river that flows south at 2.1 m/s. You can paddle at a speed of 2.6 m/s relative to the water.
    - **(a)** What direction should you point the kayak so that you will land at a point directly across the river?
    - **(b)** What will your velocity be relative to the shore?
    - **(c)** If the river is 45 m wide, how long will it take you to paddle across?

24. For each of the following sets of forces, find the equilibrant (the force that makes the net force zero).
    - **(a)** 95 N[W77°N], 63 N[W12°S], and 34 N[W81°S]
    - **(b)** 55 N[E17°N], 15 N[E86°S], and 63 N[W31°N]
    - **(c)** 105 N at 45° counterclockwise from the positive x axis, 134 N at 84° clockwise from the positive x axis, 95.5 N at 72° counterclockwise from the negative x axis, and 117 N at 8.0° clockwise from the negative x axis.

25. Three huskies are pulling a dog sled. The mass of the driver, sled, and supplies is 145 kg.

Snowy is pulling with a force of 83 N at 15.5° to the left of forward. Buster is pulling with a force of 75 N at 9.0° right of forward and Prince is pulling with a force of 77 N at 12° right of forward. The sled is moving forward at a constant velocity. What is the coefficient of kinetic friction between the sled and the snow?

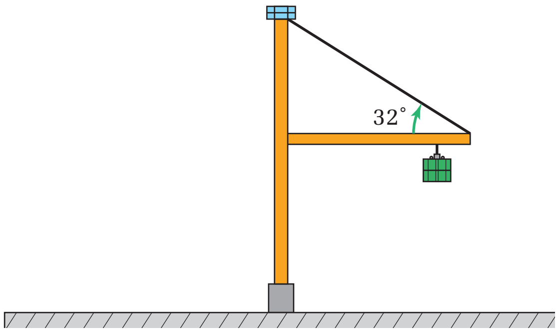
26. In the diagram, m_1 has a mass of 47 kg and m_2 has a mass of 35 kg. The coefficients of friction between m_1 and the surface of the inclined plane are $\mu_s = 0.42$ and $\mu_k = 0.19$.



(a) If the masses are held in place and then released, will they start to move?
(b) If the answer to (a) is yes, what will be the acceleration of the masses?
(c) If the answer to (a) is no, how much mass would you have to add to m_2 to cause the masses to begin to move?
(d) If the answer to (a) was no and you added the mass that you calculated in (c), what would be the acceleration of the masses?

27. Mountain climbers have placed a 3.6 kg uniform ladder across an icy crevasse. The edges of the crevasse are 4.1 m apart. The first climber starts to cross the crevasse on the ladder and reaches a point 1.8 m from the edge. The mass of the climber and her gear is 87 kg. With what force is the ice on each side of the crevasse pushing up on the ladder?

28. A crane with a movable pulley system on a horizontal arm is moving a large container. The 355 kg container is hanging from a cable that is 6.15 m out on the 7.50 m arm. The arm has a mass of 345 kg. A cable that is attached to its end makes an angle 32.0° with the horizontal arm.



(a) What is the tension in the cable supporting the arm?
(b) What force does the vertical part of the crane exert on the boom at the point of contact?

29. In billiards, the 0.165 kg cue ball is hit toward the 0.155 kg eight ball, which is stationary. The cue ball travels at 6.2 m/s forward and, after impact, rolls away at an angle of 40.0° counterclockwise from its initial direction, with a velocity of 3.7 m/s. What are the velocity and direction of the eight ball?

30. A 750 g red ball travelling 0.30 m/s[E] approaches a 550 g blue ball travelling 0.50 m/s[W]. They suffer a glancing collision. The red ball moves away at 0.15 m/s[E30.0°S] and the blue ball moves away in a northwesterly direction.
(a) What is the final velocity of the blue ball?
(b) What percentage of the total kinetic energy is lost in the collision?