4.5 Static and Kinetic Friction Forces

- 1) Normal Force Dependence
  - Coefficient of Friction

- 2) Surface dependence

- Direction

- Static Friction vs. Kinetic Friction
  - Mathematically

**Example 1:** A 60.0 kg crate rests on a level floor at a shipping dock. The coefficients of static and kinetic friction are 0.760 and 0.410, respectively. What horizontal pushing force is required to (a) just start the crate moving and (b) slide the crate across the dock at a constant speed?

**Example 2:** A 225-kg crate rests on a surface that is inclined above the horizontal at an angle of 20.0 deg. A horizontal force of 535 N directed parallel to the ground is required to get the crate started moving down the plane. What is the coefficient of static friction?

4.10 The Tension Force

- Tension & ropes:
  - **Example 3:** A 12.0 kg Lantern is suspended from the ceiling by two vertical wires. What is the tension in each wire?

  - **Example 4:** Ignoring friction, what would be the magnitude of the acceleration in this system?

  - **Conceptual Question 1:** A rope is used in a tug-of-war between two teams of five people each. Both teams are equally strong, so neither team wins. An identical rope is tied to a tree, and the same 10 people pull just as hard on the loose end as they did in the contest. In both cases, the people pull steadily with no jerking. Which rope, if either, is more likely to break?

4.11 Equilibrium Applications of Newton’s Laws of Motion

- Equilibrium
- Examples
- Equations

  - **Conceptual Question 2:** Can an object ever be in equilibrium if the object is acted on by only (a) a single nonzero force, (b) two forces that point in mutually perpendicular directions, and (c) two forces that point in directions that are not perpendicular?

  - **Conceptual Question 3:** A box hangs from a rope as illustrated. Can the rope be pulled tight enough to be completely horizontal?

Chapter 7. Impulse and Momentum

- Compare with Force Approach
• **The Law of Dynamics**
  o Momentum =
    ▪ Vector.
    ▪ Math tool – Conceptual tool.
    ▪ **Example 5.** What’s the momentum of a 68 kg (150 lbs) adult walking (4mph) 7.2 m/s East?
    ▪ **Example 6.** What’s the momentum of a 34 kg (75 lbs) kid running (8mph) 14.4 m/s West?

• **Conceptual Question 4:** Two identical automobiles have the same speed, one traveling east and one traveling west. Do these cars have the same momentum? Explain.

• **Ex 7.** Two arrows are fired horizontally with the same speed of 30.0m/s. Each arrow has a mass of 0.100 kg. One is fired due east and the other due south. Find the magnitude and direction of the total momentum of this two-arrow system. Specify the direction with respect to due east.

• **Newton’s 1st Law in terms of Momentum**

  7.1 **The Impulse – Momentum Theorem**
  • **Newton’s Second Law In terms of Momentum**
    o **Conceptual Question 5:** You have a choice. You may get hit head-on either by an adult moving slowly on a bicycle or by a child that is moving twice as fast on a bicycle. The mass of the child and bicycle is half that of the adult and bicycle. Considering only the issues of mass and velocity, which collision do you prefer? Or doesn’t it matter?
    o **Example 8:** A 62.0 kg person, standing on a diving board, dives straight down into the water. Just before striking the water, her speed is 5.50 m/s. At a time of 1.65 s after entering the water, her speed is reduced to 1.10 m/s. What is the average net force (magnitude and direction) that acts on her when she is in the water?
Phys 220 HW12 Statement  
Problems from Cutnell & Johnson 6th Ed., solutions from accompanying source.

40. A 6.00-kg box is sliding across the horizontal floor of an elevator. The coefficient of kinetic friction between the box and the floor is 0.360. Determine the kinetic frictional force that acts on the box when the elevator is (a) stationary, (b) accelerating upward with an acceleration whose magnitude is 1.20 m/s$^2$, and (c) accelerating downward with an acceleration whose magnitude is 1.20 m/s$^2$.

58. A mountain climber, in the process of crossing between two cliffs by a rope, pauses to rest. She weighs 535 N. As the drawing shows, she is closer to the left cliff than to the right cliff, with the result that the tensions in the left and right sides of the rope are not the same. Find the tensions in the rope to the left and the right of the mountain climber.

67. In the drawing, the weight of the block on the table is 422 N and that of the hanging block is 185 N. Ignoring all frictional effects and assuming the pulley to be massless, find (a) the acceleration of the two blocks and (b) the tension in the cord.

Ch. 7
2. Interactive LearningWare 7.1
(http://www3.interscience.wiley.com:8100/legacy/college/cutnell/0471151831/ilw/audio/ilw.html) provides a review of the concepts that are involved in this problem. A 62.0-kg person, standing on a diving board, dives straight down into the water. Just before striking the water, her speed is 5.50 m/s. At a time of 1.65 s after she enters the water, her speed is reduced to 1.10 m/s. What is the net average force (magnitude and direction) that acts on her when she is in the water?

12. An 85-kg jogger is heading due east at a speed of 2.0 m/s. A 55-kg jogger is heading 32° north of east at a speed of 3.0 m/s. Find the magnitude and direction of the sum of the momenta of the two joggers.