

## Physics 113 - Fall 2002 - workshop module 3

### Newton's Laws

1. A dog musher asks his dogs to pull the sled. The dogs refuse, referring to Newton's 3rd Law in their defense. They feel that since the sled will pull on them with the same force that they exert on it, they won't be able to go anywhere. They say, "If we can never exert a forward force on the sled which is greater than the backward force it exerts on us, how can we ever get the sled moving?" Discuss the validity of this defense with your group, and construct a counter-argument using Newton's Laws.
2. If a mosquito hits your windshield, which is greater, the force of your car on the mosquito, or the force of the mosquito on your car? Which accelerates more during the collision, the car or the mosquito? Justify your answers carefully!
3. A heavy lifting crane is being used to stack cargo containers on the deck of a ship. The heaviest container weighs 10 tons (= 20,000 pounds = 89,000 Newtons). How much force should the crane's cable be able to support if it lifts this container with an upward acceleration of  $1 \text{ m/s}^2$ ?
4. In choosing a coordinate system to use along with a free-body diagram, what should you be considering?
5. Would you be willing to sip hot coffee out of an open cup while riding in a car traveling at constant speed in a straight line on a smooth road? What about if the driver slammed on the brakes? Would you be willing to sip hot coffee while riding in a car traveling around a sharp curve?

Most of you probably gave different answers for these three questions. Why? What is it that differs in the three situations?

Let's look at this in a little more detail. Your leader will supply the group with a clear plastic water bottle that is filled halfway with water. Slide it across the table (or walk with it in your hand) at a slow constant speed. Observe the level of the water. Now accelerate it abruptly. What happens to the water level? Why?

*A hint that might help you analyze this (there may be other ways!):* How can you tell the difference between being on the surface of the earth feeling gravity pull you toward the floor or being in space (away from all planets and stars) with the floor accelerating toward you at  $9.8 \text{ m/s}^2$ ?

When you are in a car on a smooth road moving at a constant speed, are you aware of the motion? What about if the car is accelerating or turning? Does this tell you anything about the way in which your body senses motion?

6. A stockroom worker pushes a small crate with mass  $9.40 \text{ kg}$  on a horizontal surface with a constant speed of  $4.50 \text{ m/s}$ . The coefficient of kinetic friction between the crate and the surface is  $0.20$ . (a) What horizontal force must be applied by the worker

to maintain the motion? (b) If the force calculated in part (a) is removed, how soon does the crate come to rest?

7. Which of the following situations results in a greater tension in the string? In both cases, the strings can be considered massless and the pulleys frictionless. Prove your answer using Newton's Laws.

