Discussion Session 4
Forces II Worksheet

Here we continue the introduction to forces that we began in the Forces I worksheet. We begin, once again, with a number of conceptual questions before moving on to several calculational problems. This worksheet gives you more experience working with different kinds of forces, such as friction and the spring force.

1 Conceptual Questions

1. If someone told you that astronauts are weightless in orbit because they are beyond the pull of gravity, would you accept this statement? Explain.

2. Why does a pilot tend to black out when pulling out of a steep dive?

3. Is Hooke’s law always valid? Explain why or why not.

4. A mass wiggling up and down on a spring is an example of a harmonic oscillator. It oscillates because of the restoring force pulling the mass back towards equilibrium. Can you think of other examples of harmonic oscillators?

5. When we first discussed projectile motion, we neglected air resistance. Is this a good approximation to real motion? Explain why or why not.

6. Suppose that you were sliding a block along a frictional floor, but the frictional force was instead of opposite to the direction of motion, it was in the direction of motion. What would happen to the block?

7. The drag force acting on a metal ball falling through a viscous material, like honey, is proportional to the velocity, \( F_D = -bv \), where \( b \) is the drag coefficient. What variables should \( b \) depend on?
2 Forces II Problems

1. A car is traveling at 50.0 miles per hour on a horizontal highway.

   (a) If the coefficient of kinetic friction between the road and tires on a rainy day is 0.100, what is the minimum distance in which the car will stop?

   (b) What is the stopping distance when the surface is dry and \( \mu_k = 0.600 \)?

2. Consider a spring with spring constant \( k \) and equilibrium length \( L_0 \). One end of this spring is nailed to a tabletop. The other end of the spring is attached to a frictionless block of mass \( m \). A playful physicist sets the block in motion in such a way that the block starts moving in a circle around the nail at constant speed \( v \). How far is the nail from the block?

3. Because the Earth rotates about its axis, a point on the equator experiences a centripetal acceleration of 0.0337 m/s², whereas a point at the poles experiences no centripetal acceleration. If a person at the equator has a mass of 75.0 kg, calculate

   (a) the gravitational force (true weight) on the person and

   (b) the normal force (apparent weight) of the person.

   (c) Which force is greater? Assume that the Earth is a uniform sphere and take \( g = 9.800 \) m/s².

4. The windshield of your car makes an angle \( \theta \) with the horizontal. You are cruising down the highway when suddenly, the truck in front of you kicks up a huge frictionless ruby, which happens to bounce off your hood up onto your windshield, and does not bounce off. Thinking fast, you realize that the ruby will slide down your windshield (and out of your life) unless you accelerate forward. But you desperately want the ruby to stay in place, neither sliding up nor sliding down your windshield, at least until you can get off the highway. You estimate that the ruby feels a backward force due to wind resistance equal to one half the ruby’s weight. What must be your car’s acceleration, \( a \), to ensure that the ruby stays in place? Express your answer in terms of \( \theta \) and any other constants that you need.