PHY 211 Homework 2

Due February 12, 2020

Problem 1. Answer the following short problems.

(a) Andrea, a 63.0 kg sprinter, starts a race with an acceleration of $4.200\,\mathrm{m/s^2}$. What is the net external force on her?

(b) A cleaner pushes a 4.50 kg laundry cart in such a way that the net external force on it is 60.0 N. Calculate the magnitude of his cart's acceleration.

Problem 2. A person with a mass of 60 kg stands in an elevator. Draw a free-body diagram for the person, and indicate the magnitude of each of the forces acting on the person, in each of the following situations:

(a) The elevator is at rest;

(b) the elevator is accelerating upward at 5 $\mathrm{m/s^2}$;

(c) the elevator is accelerating downward at 5 $\mathrm{m/s^2}$.

Problem 3. Go visit an elevator and ride it up and down. When it's accelerating upward, do you feel lighter or heavier? What about when it's accelerating downward? Based on your observations and your answers to problem 2, is there any connection between how heavy you feel and any of the forces that you drew in your free-body diagrams?

Problem 4. A 1 kg book sits on a horizontal frictionless table in outer space, where there is no gravity. A 9.8 N force acts diagonally downward on the book; there is a 30 degree angle between that force and the vertical.

(a) Draw a free-body diagram for the book.

(b) What are the components of the external force parallel to and perpendicular to the surface? Draw a right triangle on your free-body diagram whose hypotenuse is the force and the legs are the components, as we usually do.

(c) What magnitude must the normal force have? Remember, the normal force has whatever magnitude that it must have to stop the book from moving "through" the table.

(d) What is the acceleration of the book?

Problem 5. Now, back to Earth, where there is gravity. A 1 kg book sits on a frictionless inclined plane, tilted at an angle of 30° above the horizontal. *Hint:* If you have trouble with this problem, look at the free-body diagram you drew for the last problem and rotate it by thirty degrees.

(a) Draw a free-body diagram for the book.

(b) What are the components of the gravitational force parallel to and perpendicular to the ramp? Draw a right triangle on your free-body diagram whose hypotenuse is the book's weight and the legs are the components, as we usually do. Note that the components will both be diagonal relative to the horizontal/vertical axes.

(c) What magnitude must the normal force have? Remember, the normal force has whatever magnitude that it must have to stop the book from moving "through" the ramp.

(d) What is the acceleration of the book down the ramp? Hint: If you have done the previous problem, this one should be easy; you do not need to show mathematics if you can explain how your answers relate!

Problem 6. Suppose two children push horizontally, but in exactly opposite directions, on a third child in a wagon. The first child exerts a force of 75.0 N, the second exerts a force of 90.0 N, friction is 12.0 N, and the mass of the third child plus wagon is 23.0 kg.

(a) Draw a free body diagram for the system of interest.

(b) Calculate the acceleration.

Problem 7. A sled sits on the snow. Three people are pulling on it with ropes. The first rope points 45° north of east, and a person pulls it with a force of 200 N. Another rope points southward, and someone pulls it with a force of 300 N. The third rope points 30° north of west, and the last person pulls it with a force of 100 N.

(a) Draw a free-body diagram, showing the forces of the three ropes. (Note: this should be a *top-down* view, so gravity and the force of the ground will not appear since they point into and out of the page.)

(b) You would like to stop the sled from moving. In which direction, and with what force, should you pull the fourth rope?