Assignment VI, PHYS 111 (General Physics I)
Fall 2021
Due Thursday, October 7th, 2021

Just as a reminder – in each homework assignment, I will list suggested homework problems out of the book. These are worth practicing – some may even appear on exams verbatim – but since they are in the text, finding answers on-line should be straightforward and these textbook problems will not be graded. I suggest you do them – many of them will be easier than the graded homework and they would be a good thing to tackle in your SI sessions to get comfortable with the content.

After the suggested book problems, I will give a list of problems that I myself wrote. *SOME* of these problems will be graded, but you won't know which ahead of time. The ones that I grade will be the same for everyone in the class.

I will supply you with an answer key to all of the problems that I wrote – even the ones that I did not grade.

As always, please legibly write (or type) your answers on separate paper. Incorrect answers with no work will earn nearly no credit, and consistent correct answers with no work are suspicious – many of these problems your professor can't do in his head, so it is unusual if you can. Please show all relevant work.

To help with this homework, you should read the associated sections of your text and watch the videos associated with the lectures on the course webpage: http://larsenml.people.cofc.edu/phys111_fall21.html.

(Ungraded) suggested textbook practice problems

(All problems are odd problems (that have answers in the back of the book) out of Halliday, Resnick, and Walker, 10th Ed.)

Chapter 7:
Questions: 1, 3, 9
Problems: 1, 5, 7, 9, 13, 15, 19, 23, 27, 31, 41, 51, 53, 55, 63, 69
Chapter 8:
Questions: 5, 9, 11
Problems: 1, 5, 7, 11, 13, 19, 21, 23, 29, 31, 39, 43, 47, 53, 55

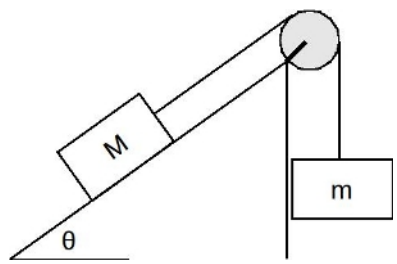
Graded homework problems

1. The figure below should look familiar (from the last homework). The setup to the problem is a bit different this time, though, so read carefully. A triangular wedge of elevation angle $\theta = 50°$ supports a mass M. Connected to mass M via a (massless) rope is a second mass m that hangs freely from a frictionless pulley as shown. As was the case last time, the wedge is firmly attached to the Earth (it can't move). This time, however, the interface between mass M and the wedge has friction. Let the coefficient of static friction between the wedge and mass M be given by μ_s. Let $M = 20.0$ kg and $\mu_s = 0.10$. (Since I gave you concrete numbers, all parts of this problem should have a numerical answer).

   a) What is the minimum mass m that will prevent mass M from sliding down the slope?

   b) What is the maximum mass m that will prevent mass M from sliding up the slope?

   c) If mass m is 3 kg larger than the value calculated in part (b) above and the coefficient of kinetic friction between M and the ramp is 0.08, then what is the resulting tension in the rope?



2. A 7.50-kg block is pushed up an incline that is raised 35° above the horizontal (much like the above picture, but without the hanging block and pulley). The kinetic coefficient between the block and the incline is 0.15. The block is pushed with a purely horizontal force (parallel to the floor, *not* parallel to the contact interface between the wedge and the block). The resulting acceleration of the block is 1.3 m/s^2 up the incline and – for all parts of this problem – the block is already moving up the slope.

   a) What was the magnitude of the applied force?

   b) How large is the normal force supplied by the wedge on the block? (What is its magnitude)?

3. The Large Hadron Collider in Switzerland is the largest machine in the world. It is a machine that accelerates subatomic particles to very high Kinetic energies. Currently, the LHC can accelerate particles to about 13 TeV.

   a) What is 13 TeV in Joules?

   b) If a baseball had a Kinetic Energy of 13 TeV, how fast would it be moving? (You might be surprised by your answer).

   c) If you gave an electron an energy of 13 TeV, how fast would it be moving? (Your answer here won't be right....the formula for Kinetic Energy we know is actually only valid for speeds small compared to the speed of light. A refinement of this relationship will be introduced if you take PHYS 230. For now, report the speed as your current equation for Kinetic Energy says it would be, but realize that your answer really isn't right – nothing can move faster than light (3×10^8 m/s).)

4. A car of mass 1500 kg is initially moving at a speed of 30 m/s.

   a) How much Kinetic Energy does the car have?

   b) The engine suddenly turns off and the car skids onto a frozen lake. On this frozen lake, the driver slams and holds the breaks, causing the tires to slide over the ice with a coefficient of kinetic friction of 0.3 (and, as such, the car starts to slow down). How far does the car travel on the ice before it loses half of its initial speed?

   c) Same scenario as part (b), but now we want to know how far does the car travel on the ice until it loses half of its initial kinetic energy?

   d) How far does the car travel before it loses all of its kinetic energy (e.g. it reaches a stop).

   e) Based on your answers to parts b-d, what can you say about the kinetic energy as a function of traveled distance? Sketch a graph of K as a function of d.

   f) Based on your answers to parts b-d, what can you say about the kinetic energy as a function of time? Sketch a graph of K as a function of t.

5. Do two different observers necessarily agree on the kinetic energy of an object? Why or why not? If your answer is "no", give me an example of a scenario where two observers would disagree on the kinetic energy of an object.

6. A 95.0 kg firefighter slides down a pole while a constant kinetic frictional force of 285 N opposes his motion. The firefighter starts from rest 5.50 meters above ground level.

   a) Calculate the work done on the firefighter by gravity as he slides down the pole.

   b) Calculate the work done on the firefighter by the kinetic frictional force as he slides down the pole.

   c) Calculate the firefighter's speed just before hitting the ground.

7. A block with mass M is released on a frictionless wedge with the bottom of the block height h above the level portion of the track shown below. The track is rough between points A and B, but elsewhere all surfaces are frictionless. As the block traverses the distance d between points A and B it loses mechanical energy E_1 ($E_1 < Mgh$). The spring constant of the spring affixed to the wall is k. Leave all of your answers to this problem symbolically in terms of M, h, g, E_1, and k.

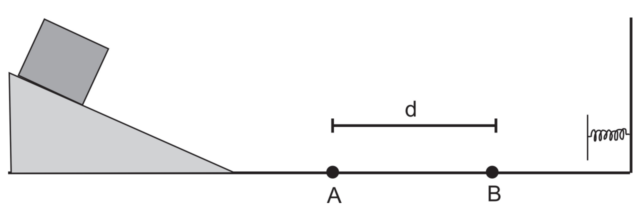
   a) Find the speed of the block at point A the first instant it passes through point A.

   b) Find the speed of the block at point B the first instant it passes through point B.

   c) What is the maximum compression of the spring during the motion of the block?

   d) What is the coefficient of kinetic friction between the block and the rough portion of the track?

   e) Assuming $E_1 < \frac{Mgh}{2}$, how high would the block reach on the first "return trip" up the triangular wedge?



8. A 4.2 kg block is accelerated from rest by a compressed spring of spring constant 732 N/m. The block leaves the spring at the spring's relaxed length and then travels over a horizontal floor with a coefficient of kinetic friction $\mu_k = 0.17$. The frictional force stops the block in distance $D = 11.2$ m. Leave all your answers to this problem numerical (with appropriate units!)

   a) What is the increase in the thermal energy of the block-floor system at the end of the whole process?

   b) What is the maximum kinetic energy of the block?

   c) What is the original compression distance of the spring?

   d) What was the initial velocity of the block right after breaking contact with the spring?

   e) What is the velocity of the block when it has traveled $D/2 = 5.6$ m from the spring?