Assignment V, PHYS 111 (General Physics I)
Fall 2021
Due Thursday, September 30th, 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 5:
Questions: 3, 11 Problems: 1, 7, 11, 17, 25, 37, 41, 45, 57, 67

Chapter 6:
Questions: 3, 5 Problems: 1, 7, 11, 15, 19, 23, 27, 29

Graded homework problems

1. A 4.00 kg mass moves under the simultaneous influence of the following three (constant) forces:

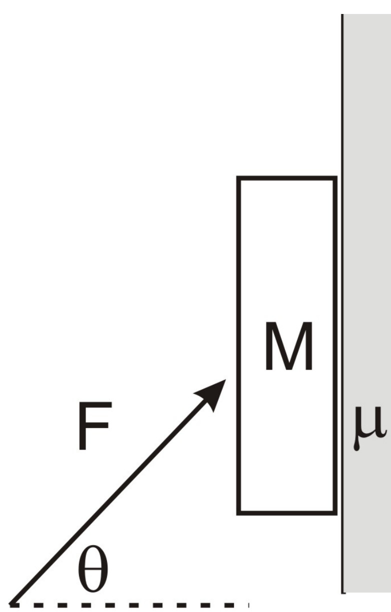
$$\vec{F}_1 = (3{:}00\ \mathrm{N})\hat{\imath} \quad (6{:}00\ \mathrm{N})\hat{\jmath}$$
$$\vec{F}_2 = (\quad 6{:}00\ \mathrm{N})\hat{\imath} + (10{:}00\ \mathrm{N})\hat{\jmath} + (2{:}00\ \mathrm{N})\hat{k}$$
$$\vec{F}_3 = (\quad 40{:}00\ \mathrm{N})\hat{k}$$

   The mass starts at position $\vec{r} = (\quad 2{:}00\ \mathrm{m})\hat{\imath} + (3{:}00\ \mathrm{m})\hat{k}$ and with initial velocity $\vec{v} = (\quad 2{:}00\ \mathrm{m/s})\hat{\imath} + (4{:}00\ \mathrm{m/s})\hat{\jmath}$.

   a) Find the (constant) values of a_x, a_y, and a_z for the mass.
   b) Develop expressions for $v_x(t)$, $v_y(t)$, and $v_z(t)$. (Make sure this makes sense given what you know for $\vec{v}$ at $t = 0$).
   c) Develop an expression for the position as a function of time [$x(t)$, $y(t)$, and $z(t)$]. (Make sure this makes sense given what you know for $\vec{r}$ at $t = 0$).
   d) Find the velocity of the mass at $t = 5$ s.
   e) Find the displacement between $t = 3$ s and $t = 7$ s.
   f) Find the average velocity between $t = 3$ s and $t = 7$ s

2. You want to hold a book of mass M up against a wall (see illustration below). Assume that the wall-book interface is frictionless and that an external force F is applied that pushes against the book at an angle above the horizontal as shown. Recall that to merely "hold" it against the wall, the vector sum of the forces on the book must be zero.

    a) There are 3 forces on the book. What are they?
    b) Carefully draw a free body diagram for the book. Make sure your vectors are approximately the correct lengths.
    c) If $M = 2$ kg and $F = 30$ N, what would be to hold the book stationary?
    d) What does have to be for arbitrary F and M to hold the book stationary? (Your answer should be in terms of F, M, and constants of nature.)
    e) If the book has a mass of 3 kg, you apply a force of 40 N, and $= 60$, what is the acceleration of the book? (Acceleration can be a scalar or a vector; here I'm looking for the vector, so give me magnitude and direction!)
    f) Now assume that instead of having the wall-book interface frictionless, the interface has coefficient of friction . (For this problem, we will let be both $_s$ and $_k$). In terms of M, , and , develop expressions for both the minimum and maximum magnitudes for the applied force F that keep the book stationary.



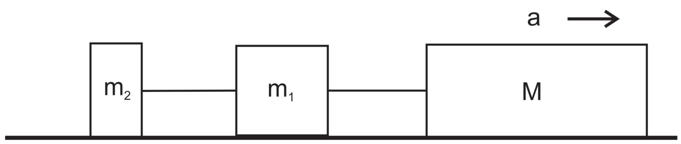
3. Three masses accelerate to the right as shown below. The rightmost mass has mass M, and the other two masses are m_1 and m_2 as shown. The three masses are connected by inextensible ropes of negligible mass. The masses slide on a flat frictionless surface. The rightmost mass accelerates with constant acceleration a. The entire force causing this motion is not shown, but acts directly on mass M only. (The other masses accelerate because they are pulled by ropes). Determine:

   a) The magnitude of the force applied to M to make this system move.

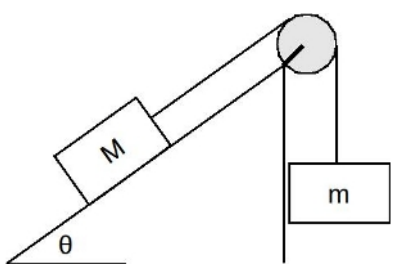
   b) The tension in the rope between M and m_1.

   c) The tension in the rope between m_1 and m_2.

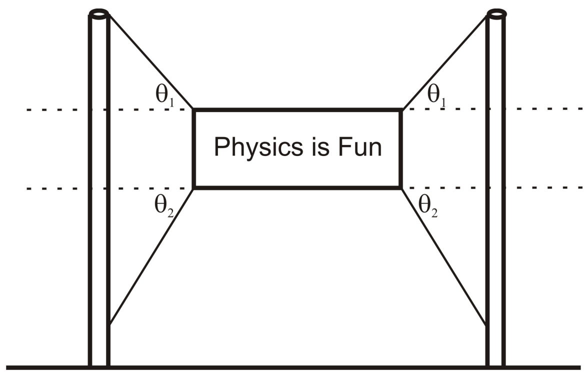
   d) The net force on m_1.



4. A triangular wedge of elevation angle supports a mass M. Connected to mass M via a (massless) string is a second mass m that hangs freely from a frictionless pulley as shown. The wedge is firmly attached to the Earth (it can't move) and the wedge/mass interface is assumed to be frictionless. $= 48$. Assume the hypotenuse of the wedge has a total length of 10 meters, and that the large mass M starts at the very top of the wedge with an initial velocity of 3 m/s down the slope of the incline. If $M = 3{:}00$ kg, what is the minimum mass m that would prevent the 3.00 kg block from reaching the bottom of the wedge? (Assume that the string is sufficiently long so that m stays below the pulley no matter what).



5. A sign of mass m is held up by four (massless) wires connected to sturdy poles as shown below. The top two wires make an angle of $_1$ above the horizontal at their attachment point with the sign. The bottom two wires make an angle of $_2$ below the horizontal at their attachment point with the sign.



a) Draw a free-body diagram for the sign.

b) Assume that the bottom two wires are cut. Find the tension in each of the top two wires. (You'll have to leave your answer in terms of m, g, and $_1$.)

c) Instead of cutting the bottom two wires, assume that the wire in the upper-right and the lower-left are cut (so that the only two remaining wires are in the upper-left and the lower-right). Draw a new free-body diagram for the sign. [In reality, cutting these cords will cause the sign to rotate. Ignore this. Assume the sign is very small – basically a point mass – so that cutting the two wires in question don't change the geometrical alignment of the sign].

d) If the wire in the upper-right and the lower-left are cut, show that the tension in the upper-left wire is equal to:

$$T = \frac{mg \cos\ _2}{\sin(\ _1\ \ \ _2)}$$

e) The above solution gives you a pretty crazy answer when $_2 > \ _1$; you get a negative tension. What does this crazy answer physically mean, and what does it tell you about the scenario?