**Assignment VIII, PHYS 111 (General Physics I)**
**Fall 2021**
**Due Thursday, October 28th, 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.

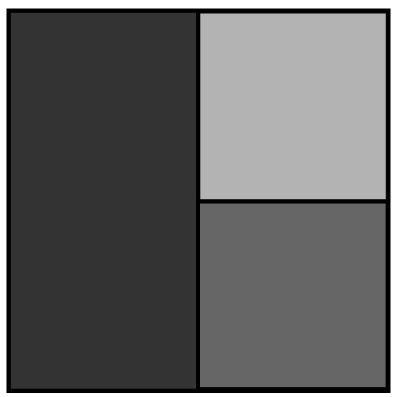
## (Ungraded) suggested textbook practice problems

(All problems are odd problems (that have answers in the back of the book) out of Halliday, Resnick, and Walker, 10th Ed.) Some problems from previous chapters that are related to recent lecture content have been included.

Chapter 4:
Problems: 57, 59, 61, 63, 65
Chapter 9:
Problems: 1, 3, 5, 7
Chapter 10:
Problems: 1, 3, 5, 7, 9, 13, 15, 17, 19, 21, 25, 27, 29, 85

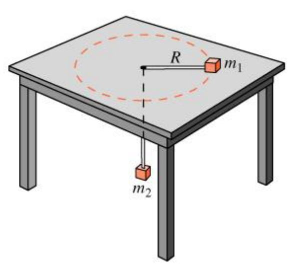
## Graded Homework Problems

1. Consider the figure below; three thin plates having dimensions $2LxL$, $LxL$, and $LxL$ are glued together as shown (the depth of these plates are small, identical, and – to solve this problem – unimportant). Using a coordinate system where the geometric center of the compound object is the origin and the line bisecting the two $LxL$ blocks is the $+x$ axis, find the center of mass of this system if the upper-right plate is made of a uniform plate of Aluminum (density = 2700 kg/m$^3$), the lower-right plate is made of a uniform plate of Silver (density = 10500 kg/m$^3$), and the left plate is made of a uniform plate of Nickel (density = 8900 kg/m$^3$). Your answer will be a vector that will have each component written as a decimal multiple of $L$ (so your answer should look something like $0.1234L\hat{\imath} - 0.4321L\hat{\jmath}$, though that's not the right answer).

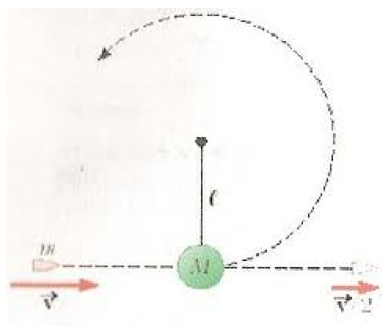


2. A misbehaving car engine starts idling fast, at 1100 rpm (rotations per minute or, equivalently, revolutions per minute). If, after turning the car off, the engine stops running completely in 0.9 seconds, what is the rotational acceleration of the engine during this "turning-off" process? You may assume $\alpha$ is constant.

3. A block of mass $m_1$ slides in a circular path of radius $R$ on a frictionless table. The mass is connected via an inextensible massless string to a mass $m_2$ hanging (at a fixed height) below the table. What is the speed of $m_1$? (Your answer has to be in terms of $m_1$, $m_2$, $R$, and fundamental constants ONLY.)



4. A bullet of mass $m$ and initial speed $v$ passes completely through an initially stationary mass at the end of a (massless) string with the mass at the bottom having mass $M$ and the string having length $\ell$. The bullet emerges with speed $\alpha v$. ($\alpha$ is an unspecified constant somewhere between 0 and 1). What is the minimum value of $v$ such that the mass will barely swing through a complete vertical circle? (Note, the picture below assumes $\alpha = \frac{1}{2}$, but I want to do a more general problem here – the speed coming out should be $\alpha v$, not necessarily $v/2$.) Your answer should be in terms of $m$, $M$, $\alpha$, $\ell$, and/or fundamental constants ONLY.




5. A car tire with a 28 inch diameter is rolling (without slipping), helping to support a car that is driving down the road at an initial speed of 40 miles per hour. If the car decelerates with $a = -3\ \text{m/s}^2$, what is the angular deceleration of the car tire on its axis?

6. An astronaut is tested in a centrifuge-like setup that consists of a pod held at a fixed radius of 12 m from an axis of rotation. The system is designed to start at $t = 0$ and has an angular position $\theta(t) = (0.18\ \text{rad/s}^2)t^2$.

   a) Find an expression for $\omega(t)$.
   b) Find an expression for $\alpha(t)$.
   c) What is the astronaut's angular velocity after 3.5 seconds?
   d) What is the astronaut's speed after 3.5 seconds?
   e) According to a google search, the highest acceleration ever survived by a human is 214 g's of acceleration. At what time after beginning to rotate will this device reach that acceleration?
   f) Let's say that the system accelerates for 20 seconds, then holds at the angular velocity it reaches after 20 seconds for an additional 15 seconds, and then slows down with a constant angular acceleration of $-0.1\ \text{rad/s}^2$ until it stops. How many total rotations does this device complete in this scenario?
   g) What is the average speed experienced by the astronaut in part (f) from the beginning of the run to the very end?