General Physics 1–Honors (PHYS 101H): Problem Set 7

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Overview

The written Problem Sets will help you gain experience with how to present your solutions to university-level physics problems. This will be necessary for your midterm and final exams, as well as future courses thoughout your undergraduate career. Present your solutions legibly and as logically as you can. What this means in practice is the following:

1. Write down what quantities you know.
2. Write down the relevant equations.
3. When carrying out manipulations or substituting values into equations, try to write each equality on separate lines. For example:

$$\begin{aligned} x(t_0) &= \frac{1}{2}at_0^2 + v_0t_0 + x_0 \\ &= \frac{1}{2} \cdot 9.8 \cdot 1.0^2 + 1.5 \cdot 1.0 + 0.7 \\ &= \boxed{7.1\,\mathrm{m}}. \end{aligned}$$

4. Circle or underline your final answers to identify them clearly (see the equation above)..

I will post solutions that will also provide one possible model for how to present solutions.

Some hints:

1. Only substitute values at the end of your calculation and try to carry out all manipulations symbolically.
2. Double check the order of magnitude of your answer.
3. Double check the units of your answer.
4. Double check the number of significant figures of your answer (do not give more significant figures than the question provides for physical quantities).

This Problem Set, in particular, will provide practice in applying conditions of static equilibrium and studying orbital motion.

This Problem Set is worth 50 points; there are three questions in this Problem Set.

Instructions

Read these instructions carefully. You must submit your Problem Set as a **single PDF** file (it is best to use an app like Adobe Scan to make your solutions legible), with the file name `lastname_hwXX.pdf` (replace `lastname` with your last name and `XX` with the problem set number). If you do not submit your Problem Set according to these instructions, you will be deducted five points.

Question 1 **10pts**

A ladder leans against a vertical wall, making an angle θ with the horizontal. The coefficient of static friction between the ladder and both the floor and the wall is $\mu \leq 1$. What is the minimum value of the angle θ (expressed in terms of μ) for which it is possible for the ladder not to fall? Assume that the maximum value of θ occurs when the friction forces take on their maximum values.

Question 2 **20pts**

Two children are balanced on a horizontal, stationary seesaw. One child, Alpha, sits at the furthest righthand end of the seesaw, a distance a from the middle of the seesaw. The second child, Zelda, sits at a distance b to the left of the middle of the seesaw.

(a) If Alpha has a mass m_A, find Zelda's mass.

(b) Suppose that Alpha's younger sibling, Alexa, joins Zelda on the lefthand side of the seesaw, and sits at the far left end. Assume that the Alexa's mass is half that of Alpha and find Alexa's initial linear acceleration.

(c) Find the position where Zelda must sit to ensure that all three children can balance the seesaw horizontally at rest.

Question 3 **20pts**

(a) A satellite with mass m is in a circular orbit with radius R around a planet with mass M, which is assumed to be fixed in place. What is the total energy of the statellite, expressed in terms of G, m, M, and R?

(b) Assume now that the satellite has been given a kick so that its orbit is an ellipse, with the closest approach to M is R and the furthest distance is nR (n is a given numerical factor). This is illustrated in figure 1. What is the total energy of the satellite now?

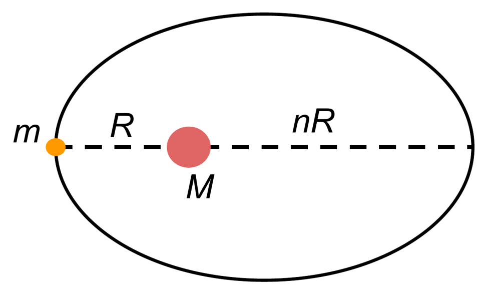

Figure 1: Diagram for Question 3.

(c) Check and comment on the $n \to 1$, $n \to \infty$, and $n \to 0$ limits.