General Physics 1–Honors (PHYS 101H): Problem Set 3

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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, or at least, state your starting point for your solution.
2. Write down or include 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 Newton's second law of motion and combining it with the equations for kinematics to problems in two dimensions. It will also help you to practice analysing the dynamics of circular 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 **15pts**

A mass m is attached via a massless string of length ℓ to the tip of a frictionless cone. The half-angle at the vertex of the cone is θ. If the mass moves around in a horizontal circle at speed v on the cone, find:

(a) The tension in the string;

(b) The normal force from the cone;

(c) The maximum speed for which the mass stays on the cone.

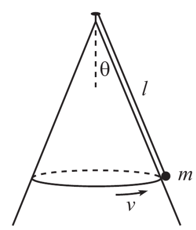

Figure 1: Diagram for Question 1.

Question 2 **15pts**

A mass m is connected to the end of a massless string of length ℓ. The top end of the string is attached to a ceiling that is a distance ℓ above the floor. Initial conditions have been set up so that the mass swings around in a horizontal circle, with the string always making an angle θ with respect to the vertical, as shown in Fig. 2. If the string is cut, what horizontal distance does the mass cover between the time the string is cut and the time the mass hits the floor?

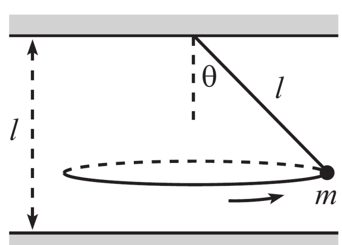

Figure 2: Diagram for Question 2.

Question 3 **20pts**

A block with mass m is projected up along the surface of a plane inclined at an angle θ to the horizontal. The initial speed is v_0, and the coefficients of both static and kinetic friction are $\mu_S = \mu_K = 1$. The block reaches a high point and then slides back down to its starting point.

(a) Show that θ must be greater than $45°$ for the block to slide back down from its high point (and not just remain at rest at the high point).

(b) Assuming that $\theta > 45°$, find the times of the up and down motions.