PHYS 111K
HOMEWORK #2

Due : 8 Sept. 2015

All answers must show complete solutions. Make sure you use proper units during each stage of the
calculation. Consider for example a question asking you to compute the acceleration of an object
that starts from rest and reaches a speed of 30 m/s in 3 s, your answer should look like :

$$a \; = \; \frac{v_f - v_0}{t} \; = \; \frac{30\,m/s - 0\,m/s}{3\,s} \; = \; 30\,m\big/s^2$$

An answer consisting of

$$a = 30/10 \; = \; 3\,m\big/s^2$$

would lose credit both for lack of a complete solution (not showing the relevant equation you are
solving) and also for lack of units throughout.

1. If a particle is traveling along the positive x axis, can its acceleration vector point along the
negative x axis? Explain your answer.

2. This problem is sometimes called the ' Monk and the Monastery' problem in mathematical logic.
A monk leaves his office in a city one day exactly at noon and walks at a constant speed to the
monastery located a distance D away on the outskirts of town. Because it was a pleasant day, he
walked slowly and arrived at the monastery at 7 pm. The next day, he leaves the monastery at noon
and walks toward his office, following exactly the same route he took the day before. However,
because there is an impending storm, he walks much faster (but at a constant speed) and arrives at
his office at 3 pm.

   Is there any point along the path that he passes at the same time each day? Explain the reasoning
behind your answer. Construct a position vs. time graph, and plot each day' s motion on the same
graph. Use this graph to support your answer above. Finally, write the relevant equations of motion
and determine the time and location of this point, or show mathematically that such a point does not
exist.

3. Consider a river with parallel banks. A boat can travel at a speed of v in still water travels in a
river where the current flows always in the same direction and always at the speed V. The boat
travels a distance D downstream (in the direction of the current), reverses direction and travels back
to its starting point. Assuming no time elapses in reversing direction, show that the time to com-
plete the roundtrip is :

$$t \; = \; \frac{2\,D\,v}{v^2 - V^2}$$

What is the time needed to complete a trip if v = V. Explain why you obtain this result.

4. A rock is dropped from rest from a cliff of height H above a well. After a time T elapses (from the moment when the rock was dropped) the sound of the rock splashing into the water is heard by an oberver at the top of the cliff. If the (constant) speed of sound is c, derive an expression for the height of the cliff H in terms of T, c, and g (the acceleration due to gravity). (We will neglect all effects due to friction). Now, use this expression to determine the height of the cliff is the sound is heard 9.37 s after being dropped. Assume c = 343 m/s

5. You are the leader of a scientific expedition to a recently discovered exoplanet. One of your experiments involves firing a projectile vertically upward. Below is the graph of the height of the projectile as a function of time. t = 0 corresponds to the launch. From these data, determine the free fall acceleration on the planet and the initial speed of your projectile. Since there is no atmosphere on the planet, you are safe to ignore any effects of air friction. Time is measured in seconds; altitude in meters.