UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 125 / LeClair Spring 2009

Problem Set 3: random hints

1. A person standing at the top of a hemispherical rock of radius R kicks a ball (initially at rest on the top of the rock) to give it horizontal velocity $\vec{\mathbf{v}}_i$.

(a) What must be its minimum initial speed if the ball is never to hit the rock after it is kicked?

(b) With this initial speed, how far from the base of the rock does the ball hit the ground?

Place the origin at the center of the rock's base, with the ground being the x-axis. The rock can now be described by $y_r^2 + x^2 = R^2$, or in the upper right quadrant $y_r = \sqrt{R^2 - x^2}$, where the subscript r makes it clear we are talking about the rock. The projectile launched off of the top of the rock can be described by our favorite parabolic trajectory, noting that the starting height is R and the initial velocity is purely in the x direction (so $\theta = 0$), $y_p = R - gx^2/2v^2$.

You want the trajectory of the projectile $y_p(x)$ *not* to intersect the circle representing the rock $y_r(x)$. Set $y_p \geq y_r$, and solve for x. You should find a condition that determines whether x is real or imaginary. If x is real, the curves intersect, and the projectile hits the rock. If x is imaginary, the projectile does not hit the rock. This should give you a condition on v.

Once you've got that, take the minimal velocity to clear the rock, and use that in your equation $y_p(x)$. You know for the projectile to hit the ground, $y_p = 0$, so set $y_p = 0$ and solve for the corresponding x.

6. Here's a free-body diagram.

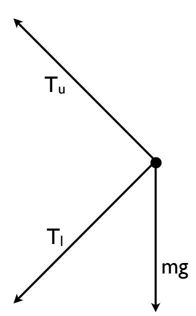

Figure 1: *You have two tensions and a weight. The sum of forces in the radial direction must give the centripetal force; the sum of forces in the vertical direction must be zero.*