Roller Coasters: Theory, Design, and Properties
Short Term 2005
Intermediate Physics Homework: Circular Motion

1. Consider an object moving counterclockwise around a circle on this page. Which direction does the angular velocity vector point?

2. Find the expression that gives centripetal force in terms of mass, radius of curvature, and *angular* speed.

3. Consider a cosine curve. We would like to determine the force on a coaster at the bottom of the track.
   a) Parameterize the curve.
   b) Assume the particle starts at rest at the top of the curve. What is its initial mechanical energy (potential and kinetic)?
   c) Now we give the particle a "little" push and it rolls down the hill. What is the value of v^2 at the bottom of the hill?
   d) Calculate the curvature at the bottom of the curve. (You can use the result from last night's homework, or rederive it.)
   e) Using your answers from parts (*c*) and (*d*), and giving the coaster a mass of 10 kg, find the centripetal force at the bottom of the curve.
   f) Determine the force of gravity in the normal direction at the bottom of the curve. (It should be a scalar).
   g) Put it all together! We assume there are only two forces acting in the normal direction: gravity, and the normal force of the track on the coaster. We know the sum of these forces should give the centripetal force. Using your answers from parts (*e*) and (*f*), determine the force of the track on the coaster at the bottom of the hill.