Problem Set #6
Section 4, Prof. Dylan Thurston
Due Friday, October 28, 2005

For this week, please hand in your homework by 5PM on Friday, to the box on the 4th floor of Mathematics Hall, outside of room 410.
Please complete and hand in the exercises; however, the exercises will not be graded.

1 Exercises

1. Section 13.3, exercises 1, 9, 15, 39.
2. Section 13.4, exercises 13, 17(a), 23, 29(a).

2 Homework

1. Find the osculating circles to the parabola \( y = x^2 \) at the points \((0, 0)\) and \((1, 1)\).
   Graph the osculating circles.

2. A projectile is fired at an angle of 45 degrees with a speed of 150 m/s. The acceleration due to gravity is 9.8 m/s\(^2\) downwards.
   (a) Find the distance along the ground to the point it lands.
   (b) Find an integral expression for the distance the projectile travels (i.e., the arc-length). You need not evaluate the integral, although it is possible.

3. Show that if a particle moves with constant speed, its velocity and acceleration vectors are orthogonal.

4. Let \( \vec{T}, \vec{N}, \) and \( \vec{B} \) be the tangent, normal, and binormal vectors to a curve parameterized by \( t \), and let \( k \) be the curvature.
   (a) Show that \( d\vec{B}/dt \) is perpendicular to \( \vec{B} \).
   (b) Show that \( d\vec{B}/dt \) is perpendicular to \( \vec{T} \). (Hint: Recall that \( \vec{B} = \vec{T} \times \vec{N} \). Differentiate this equation.)