Lecture 10

12.3. Velocity and Acceleration

Goals: (1) Describe the velocity and acceleration associated with a vector-valued function.

(2) Use a vector-valued function to analyze projectile motion.

Questions:

- What are parametric equations, curves, vectors, vector-valued functions?

12.3.1. **Velocity and acceleration**

(1) Definitions: Let $\vec{r}(t) = x(t)\vec{\imath} + y(t)\vec{\jmath}$ be a vector-valued function where $x(t)$ and $y(t)$ are twice-differentiable functions of t.
- **Velocity** = $\vec{v}(t) = \vec{r}'(t) = x'(t)\vec{\imath} + y'(t)\vec{\jmath}$
- **Speed** = $\|\vec{v}(t)\| = \|\vec{r}'(t)\| = \sqrt{[x'(t)]^2 + [y'(t)]^2}$
- **Acceleration** = $\vec{a}(t) = \vec{r}''(t) = x''(t)\vec{\imath} + y''(t)\vec{\jmath}$

(2) Example 1: finding velocity and acceleration (p. 851)
- Try exercises 11-20

(3) Examples 2, 3: sketching velocity and acceleration (p. 852)
- Try exercises 1-10

(4) Example 4: finding position (p. 853)
- Try exercises 23-28

12.3.2. **Projectile motion**

(1) The position function for a projectile is:

$$\vec{r}(t) = (v_0 \cos\theta)t\vec{\imath} + \left[h + (v_0 \sin\theta)t - \frac{1}{2}gt^2\right]\vec{\jmath}$$

where h is the initial height, v_0 is the initial speed, θ is the initial angle of elevation, and $g = 32$ feet per second per second (or 9.81 meters per second per second) is the *gravitational constant*. See Figure 12.17.

Note: Depending upon the unit "feet" or "meters", you should choose either $g = 32$ or $g = 9.81$ accordingly.

(2) Example 5: finding position function for a projectile (p. 854)

(3) Example 6: describing the path for a baseball (p. 855)

- Try exercises 29-44.

12.3.3. **Homework Set #10**

- Read 12.3 (pages 850-855).
- Do exercises on pages 856-858:
  1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 23, 27, 31, 37, 39, 41, 45, 65-68