13.4 Videos Guide

13.4a

- Describing motion
  - Position: $\mathbf{r}(t)$
  - Velocity: $\mathbf{v}(t) = \boldsymbol{r}'(t)$
  - Speed: $|\mathbf{r}'(t)|$
  - Acceleration: $\mathbf{a}(t) = \mathbf{r}''(t)$

- Equations for the motion of a projectile in $\mathbb{R}^2$ with initial velocity v_0 and angle α with the horizontal
  - $x = (v_0 \cos\alpha)t, \qquad y = h_0 + (v_0 \sin\alpha)t - \frac{1}{2}gt^2$

Exercises:

13.4b

- Find the velocity, acceleration, and speed of a particle with the given position function. Sketch the path of the particle and draw the velocity and acceleration vectors for the specified value of t.
  $\mathbf{r}(t) = \langle t^2, \frac{1}{t^2} \rangle, \qquad t = 1$

13.4c

- Find the velocity and position vectors of a particle that has the given acceleration and the given initial velocity and position.
  $\mathbf{a}(t) = \sin t\,\mathbf{i} + 2\cos t\,\mathbf{j} + 6t\,\mathbf{k}, \qquad \mathbf{v}(0) = -\mathbf{k}, \qquad \mathbf{r}(0) = \mathbf{j} - 4\mathbf{k}$

13.4d

- Tangential and normal components of acceleration
  - $\mathbf{a} = a_T\mathbf{T} + a_N\mathbf{N}$, where $a_T = \frac{\mathbf{r}'\cdot\mathbf{r}''}{|\mathbf{r}'|}$ and $a_N = \frac{|\mathbf{r}'\times\mathbf{r}''|}{|\mathbf{r}'|}$

Exercises:

13.4e

- Find the tangential and normal components of the acceleration vector.
  $\mathbf{r}(t) = t\,\mathbf{i} + 2e^t\,\mathbf{j} + e^{2t}\,\mathbf{k}$

13.4f

- A projectile is fired from a tank with initial sped 400 m/s. Find two angles of elevation that can be used to hit a target 300 m away.