Chapter 4 Problem 26 †

Given
$\vec{r} = (3.0t^2\ \hat{\imath} + 5.0\ \hat{\jmath} - 6.0t\ \hat{k})\ m$

Solution
a) Find the velocity and acceleration as functions of time.

Velocity is defined as the time derivative of the position function. Therefore,

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{d}{dt}\left(3.0t^2\ \hat{\imath} + 5.0\ \hat{\jmath} - 6.0t\ \hat{k}\right)\ m$$

$$\vec{v} = \{6.0t\ \hat{\imath} - 6.0\ \hat{k}\}\ m/s$$

Acceleration is defined as the time derivative of the velocity function. Therefore,

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d}{dt}\left(6.0t\ \hat{\imath} - 6.0\ \hat{k}\right)\ m/s$$

$$\vec{a} = \{6.0\ \hat{\imath}\}\ m/s^2$$

b) What are its velocity and acceleration at time $t = 0\ s$.

Using the functions derived above, the velocity and acceleration at $t = 0\ s$ is

$$\vec{v}(0\ s) = \{6.0(0\ s)\ \hat{\imath} - 6.0\ \hat{k}\}\ m/s = -6.0\ \hat{k}\ m/s$$

$$\vec{a}(0\ s) = \{6.0\ \hat{\imath}\}\ m/s^2$$

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†Problem from University Physics by Ling, Sanny and Moebs (OpenStax)