

Problem 4

A particle initially located at the origin has an acceleration of  $\mathbf{a} = 3.00\hat{j} \text{ m/s}^2$  and an initial velocity of  $\mathbf{v}_i = 5.00\hat{i} \text{ m/s}$ . Find (a) the vector position and velocity at any time  $t$  and (b) the coordinates and speed of the particle at  $t = 2.00 \text{ s}$ .

$$a) \quad \vec{r} = \vec{r}_i + \vec{r}_j$$

$$\begin{aligned} \vec{r}_i &= \vec{r}_i(t=0) + \vec{v}_{0i}t + \frac{1}{2}\vec{a}_i t^2 \\ &= 0 + 5 \text{ m/s } t\hat{i} + \frac{1}{2}(0)t^2 = 5 \text{ m/s } t\hat{i} \end{aligned}$$

$$\begin{aligned} \vec{r}_j &= \vec{r}_j(t=0) + \vec{v}_{0j}t + \frac{1}{2}\vec{a}_j t^2 \\ &= 0 + 0t + \frac{1}{2}3. \text{ m/s}^2 t^2\hat{j} = \frac{3}{2} \text{ m/s}^2 t^2\hat{j} \end{aligned}$$

$$\vec{r} = 5 \text{ m/s } t\hat{i} + \frac{3}{2} \text{ m/s}^2 t^2\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{d}{dt} \left\{ 5 \text{ m/s } t\hat{i} + \frac{3}{2} \text{ m/s}^2 t^2\hat{j} \right\} = 5 \text{ m/s } \hat{i} + \frac{3}{2} \text{ m/s}^2 2t\hat{j}$$

$$\vec{v} = 5 \text{ m/s } \hat{i} + 3 \text{ m/s}^2 t\hat{j}$$

$$b) \quad @ \quad t = 2 \text{ sec}$$

$$\begin{aligned} \vec{r}(t=2) &= 5 \text{ m/s } (2\text{s})\hat{i} + \frac{3}{2} \text{ m/s}^2 (2\text{s})^2 \\ &= 10 \text{ m}\hat{i} + 6 \text{ m}\hat{j} \end{aligned}$$

$$\vec{v}(t=2) = 5 \text{ m/s } \hat{i} + 3 \text{ m/s}^2 (2 \text{ sec})\hat{j} = 5 \text{ m/s } \hat{i} + 6 \text{ m/s } \hat{j}$$

$$|\vec{v}| = \sqrt{5^2 + 6^2} = 7.81 \text{ m/s}$$