Section 13.4: Motion in Space: Velocity and Acceleration

Definition: Suppose a particle moves through space so that its position at time t is given by $\mathbf{r}(t)$.

(i) The velocity of the particle at time t is $\mathbf{v}(t) = \mathbf{r}'(t)$.

(ii) The speed of the particle at time t is $|\mathbf{v}(t)| = |\mathbf{r}'(t)|$.

(iii) The acceleration of the particle at time t is $\mathbf{a}(t) = \mathbf{v}'(t) = \mathbf{r}''(t)$.

Example 1: Find the velocity, acceleration, and speed of a particle with position function $\mathbf{r}(t) = \langle e^t, e^{-t} \rangle$ at $t = 0$. Find velocity and acceleration vectors for the given value of t.

Example 2: Find the velocity, acceleration and speed of a particle with position function $\mathbf{r}(t) = \langle e^t \cos t, e^t \sin t, t \rangle$.

Example 3: The acceleration of a particle at time t is given by $\mathbf{a}(t) = \langle t, t^2, \cos(2t) \rangle$. Given that $\mathbf{v}(0) = \langle 1, 0, 1 \rangle$ and $\mathbf{r}(0) = \langle 0, 1, 0 \rangle$, find $\mathbf{r}(t)$.