13.1, number 13: **The position vector of an object at time t is**

$$\overrightarrow{r}(t) = (t+1)\overrightarrow{i} + (t^2 - 1)\overrightarrow{j} + 2t\overrightarrow{k}.$$

Find the object's velocity vector and acceleration vector. Find the object's speed and direction of motion at time $t = 1$. Write $\overrightarrow{v}(1)$ as the object's speed at time $t = 1$ times a unit vector.

Answer: We compute $\overrightarrow{v}(t) = \overrightarrow{r}'(t)$; so

$$\boxed{v(t) = \overrightarrow{i} + 2t\overrightarrow{j} + 2\overrightarrow{k}}.$$

Also, $\overrightarrow{a}(t) = \overrightarrow{v}'(t)$; so,

$$\boxed{\overrightarrow{a}(t) = 2\overrightarrow{j}}.$$

At $t = 1$, $\overrightarrow{v}(1) = \overrightarrow{i} + 2\overrightarrow{j} + 2\overrightarrow{k}$. The speed of the vector at $t = 1$ is $|\overrightarrow{v}(1)| = \sqrt{1^2 + 2^2 + 2^2}$.

$$\boxed{\text{The speed of the vector at } t = 1 \text{ is } 3}.$$

$$\boxed{\begin{array}{l}\text{A unit vector that points in the direction of motion at } t = 1 \text{ is} \\ \frac{1}{3}(\overrightarrow{i} + 2\overrightarrow{j} + 2\overrightarrow{k}).\end{array}}$$

So

$$\boxed{\begin{array}{l}\overrightarrow{v}(1) = 3(\frac{1}{3}(\overrightarrow{i} + 2\overrightarrow{j} + 2\overrightarrow{k}))\text{where } 3 \text{ is the speed and } \frac{1}{3}(\overrightarrow{i} + 2\overrightarrow{j} + 2\overrightarrow{k}) \\ \text{is a unit vector in the direction of motion.}\end{array}}$$