## Rectangular coordinates ($x$, $y$, $z$): Exercise

A particle moving in three-dimensions has a ***position*** vector (**r**) as a function of ***time*** ($t$) with coordinates given by

$$x(t) = 30\cos(2t),\quad y(t) = 40\sin(2t),\quad z(t) = 20t + 3t^2$$

where **r** is measured in millimeters and $t$ is in seconds.

Determine the magnitude of the ***velocity*** (**v**) and the ***acceleration*** (**a**) at time $t$ =2 s.



See Notes Page view for solution.

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$$\begin{cases} x = .30\cos 2t\ ; & y = 40\sin 2t\ ; & z = 20t + 3t^2 \\ \dot{x} = -60\sin 2t\ ; & \dot{y} = 80\cos 2t\ ; & \dot{z} = 20 + 6t \\ \ddot{x} = -120\cos 2t\ ; & \ddot{y} = -160\sin 2t\ ; & \ddot{z} = 6 \end{cases}$$

At $t = 2$ s:

$$\begin{cases} x = -19.61 \text{ mm}\ ; & y = -30.3 \text{ mm}\ ; & z = 52 \text{ mm} \\ \dot{x} = 45.4 \text{ mm/s}\ ; & \dot{y} = -52.3 \text{ mm/s}\ ; & \dot{z} = 32 \text{ mm/s} \\ \ddot{x} = 78.4 \text{ mm/s}^2\ ; & \ddot{y} = 121.1 \text{ mm/s}^2\ ; & \ddot{z} = 6 \text{ mm/s}^2 \end{cases}$$

$$r = (x^2 + y^2 + z^2)^{1/2} = 63.3 \text{ mm}$$

$$v = (\dot{x}^2 + \dot{y}^2 + \dot{z}^2)^{1/2} = 76.3 \text{ mm/s}$$

$$a = (\ddot{x}^2 + \ddot{y}^2 + \ddot{z}^2)^{1/2} = 144.4 \text{ mm/s}^2$$