

Section 2.3

$$2. (a) \vec{v} = \frac{d\vec{x}}{dt} = (3\cos t - 3t\sin t, 3\sin t + 3t\cos t, 4)$$

$$\therefore |\vec{v}| = \sqrt{25 + 9t^2}$$

$$(b) a_t = \frac{ds}{dt} \quad \frac{ds}{dt} = \left| \frac{d\vec{x}}{dt} \right| = \sqrt{25 + 9t^2}$$

$$\therefore a_t = \frac{9t}{\sqrt{25 + 9t^2}}, \quad a = \left| \frac{d^2\vec{x}}{dt^2} \right| = |(-6\sin t - 3t\cos t, 6\cos t - 3t\sin t, 0)|$$

$$= 3\sqrt{4 + t^2}$$

$$\therefore a_n^2 = a^2 - a_t^2$$

$$= \left(36 + 9t^2 - \frac{81t^2}{25 + 9t^2} \right)$$

$$\therefore a_n = \left(36 + 9t^2 - \frac{81t^2}{25 + 9t^2} \right)^{\frac{1}{2}}$$

$$(c) \vec{T} = \frac{\frac{d\vec{x}}{dt}}{\left| \frac{d\vec{x}}{dt} \right|} = \frac{(3\cos t - 3t\sin t, 3\sin t + 3t\cos t, 4)}{\sqrt{25 + 9t^2}}$$

$$(d) \kappa = \frac{a_n}{|\vec{v}|^2} = \frac{3(9t^4 + 52t^2 + 100)^{\frac{1}{2}}}{(9t^2 + 25)^{\frac{3}{2}}}$$