

$$9. \vec{r}(t) = (1-t^2)\vec{i} + 2t^3\vec{j}, \quad t=2 \quad (-3, 8)$$

$$\vec{r}'(t) = -2t\vec{i} + 4t^2\vec{j}$$

$$\vec{r}'(2) = -2(2)\vec{i} + 4(2)^2\vec{j} = -4\vec{i} + 8\vec{j}$$

$$\|\vec{r}'(2)\| = \sqrt{(-4)^2 + 8^2} = \sqrt{16 + 64} = \sqrt{80} = 4\sqrt{5}$$

$$\vec{T}(2) = \frac{\vec{r}'(2)}{\|\vec{r}'(2)\|} = \frac{-4\vec{i} + 8\vec{j}}{4\sqrt{5}} = \frac{-4}{4\sqrt{5}}\vec{i} + \frac{8}{4\sqrt{5}}\vec{j} = \frac{-1}{\sqrt{5}}\vec{i} + \frac{2}{\sqrt{5}}\vec{j}$$

$$\vec{T}(2) = \boxed{\frac{-\sqrt{5}}{5}\vec{i} + \frac{2\sqrt{5}}{5}\vec{j}}$$

↑

$$\vec{r}'(t) = -2t\vec{i} + 4t^2\vec{j}$$

$$\|\vec{r}'(t)\| = \sqrt{(-2t)^2 + (4t^2)^2} = \sqrt{4t^2 + 16t^4} = \sqrt{2t^2} = 2t\sqrt{5}$$

$$\vec{T}(t) = \frac{\vec{r}'(t)}{\|\vec{r}'(t)\|} = \frac{-2t\vec{i} + 4t^2\vec{j}}{2t\sqrt{5}} = \frac{-1}{\sqrt{5}}\vec{i} + \frac{2}{\sqrt{5}}\vec{j} \quad \leftarrow$$

$$\vec{T}'(t) = \vec{0}$$

$\vec{N}$  - NONE

$$\vec{v} = \vec{r}' = -2t\vec{i} + 4t^2\vec{j}$$

$$\rightarrow \vec{a} = -2\vec{i} + 4t\vec{j}$$

$$a_T = \vec{a} \cdot \vec{T} = (-2\vec{i} + 4t\vec{j}) \cdot \left(\frac{-\sqrt{5}}{5}\vec{i} + \frac{2\sqrt{5}}{5}\vec{j}\right) = \frac{2\sqrt{5}}{5} + \frac{8\sqrt{5}}{5} = \frac{10\sqrt{5}}{5} = \boxed{2\sqrt{5}}$$

$$\|\vec{a}\| = \sqrt{(-2)^2 + 4^2} = \sqrt{4 + 16} = \sqrt{20} = 2\sqrt{5}$$

$$a_N = \sqrt{\|\vec{a}\|^2 - a_T^2}$$

$$= \sqrt{(2\sqrt{5})^2 - (2\sqrt{5})^2} = \boxed{0}$$