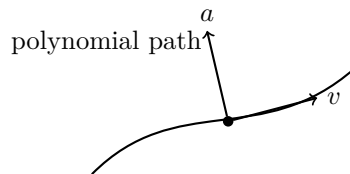


**Question 1**

A particle has position  $\vec{r}(t) = \langle t^2 - 2t, t^3 - 3t, 2t \rangle$ ,  $t \geq 0$ . Find velocity, acceleration, and speed at  $t = 2$ . Determine whether it is speeding up or slowing down then.

## Question 1 – Solution

**Strategy** Differentiate componentwise and use the sign of  $\vec{v} \cdot \vec{a}$ .



**Kinematics**

$$\vec{v} = \langle 2t - 2, 3t^2 - 3, 2 \rangle, \quad \vec{a} = \langle 2, 6t, 0 \rangle.$$

At  $t = 2$ ,  $\vec{v} = \langle 2, 9, 2 \rangle$ ,  $\vec{a} = \langle 2, 12, 0 \rangle$ , and

$\text{speed} = \|\vec{v}\| = \sqrt{89}.$

**Speeding test**  $\vec{v} \cdot \vec{a} = 4 + 108 = 112 > 0$ , so speed is increasing. The particle is 

speeding up

 at  $t = 2$ .