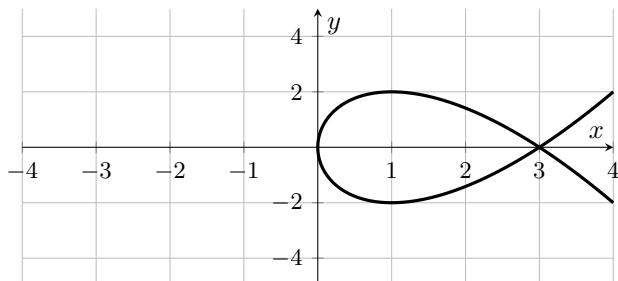


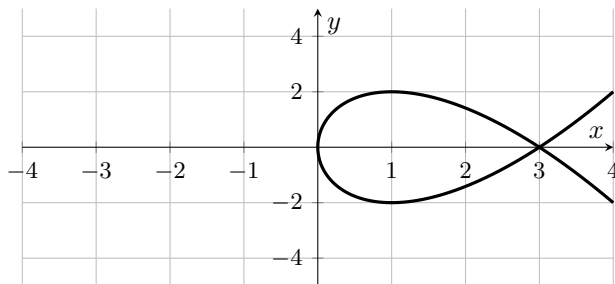
Question 3

Problem

At which points does $x = t^2$, $y = t^3 - 3t$ have tangent slope 0? Is the particle momentarily stopped there?



Question 3 – Solution



Solution

1. Differentiate both coordinates:

$$\frac{dx}{dt} = 2t, \quad \frac{dy}{dt} = 3t^2 - 3 = 3(t-1)(t+1).$$

2. A tangent has slope 0 when $dy/dt = 0$ and $dx/dt \neq 0$. Solve

$$3(t-1)(t+1) = 0,$$

which gives $t = -1$ and $t = 1$.

3. Check the horizontal velocity:

$$x'(-1) = -2 \neq 0, \quad x'(1) = 2 \neq 0.$$

Thus both parameter values give genuine horizontal tangents.

4. Find the corresponding points:

$$\mathbf{r}(-1) = (1, 2), \quad \mathbf{r}(1) = (1, -2).$$

The horizontal tangent lines are therefore $y = 2$ and $y = -2$.

5. A particle is momentarily stopped only when both velocity components are zero. At $t = \pm 1$, $dy/dt = 0$ but $dx/dt = \pm 2$ is nonzero, so the particle is moving horizontally rather than stopping.

6. Hence the requested points are

$$\boxed{(1, 2) \text{ and } (1, -2)},$$

and the particle is not momentarily stopped at either point.