

Problem 1: Instantaneous Velocity of a Moving Object

A test particle is released on a lab bench and allowed to move freely along a straight track.

The particle's **distance from a reference gate** at the start of the path is modeled by:

$$d(t) = 2t^3 - 5t^2 + 3t + 4$$

where $d(t)$ is in meters and t is in seconds.

What is the particle's **instantaneous velocity** at time $t = 2$ seconds? **Retain the sign** in your answer to indicate the direction of motion.

Problem 2: Instantaneous Velocity on a Nonlinear Track

Engineers are testing a robot that moves along a curved experimental track.

The robot's **distance from its charging station** is given by:

$$r(t) = -t^4 + 6t^3 - 9t^2 + 2t$$

where $r(t)$ is in meters and t is in seconds.

What is the robot's **instantaneous velocity** at $t = 1.5$ seconds? **Retain the sign** in your answer to indicate the direction of motion.

Problem 3: Velocity of a Racing Drone in Flight

A racing drone is launched straight upward from a platform and tracked over time.

Its **height above the launch pad** is modeled by the function:

$$h(t) = 4t^3 - 7t + 1$$

with $h(t)$ in meters and t in seconds.

What is the drone's **instantaneous vertical velocity** at time $t = 3$ seconds? **Retain the sign** in your answer to indicate whether the drone is rising or falling.

Problem 4: Velocity of a Particle in a Flow Channel

A small particle is drifting upward in a vertical flow channel as it is carried by a fluid stream.

Its height above the channel floor varies with time according to:

$$z(t) = 0.5t^4 - 2t^3 + t^2 + 5$$

Here, $z(t)$ is in centimeters and t is in seconds.

What is the particle's **instantaneous velocity** at $t = 2.5$ seconds? Retain the sign in your answer to indicate the direction of motion.

Problem 5: Instantaneous Speed of a Cable Car

A cable car begins moving up a mountain, and its progress is tracked from the **base station**.

Its **elevation above the base** as a function of time is given by:

$$y(t) = 3t^3 - t^2 + 2t + 10$$

where $y(t)$ is in meters and t is in minutes.

What is the cable car's **instantaneous velocity** at $t = 4$ minutes? Retain the sign in your answer to indicate whether it is moving upward or downward.