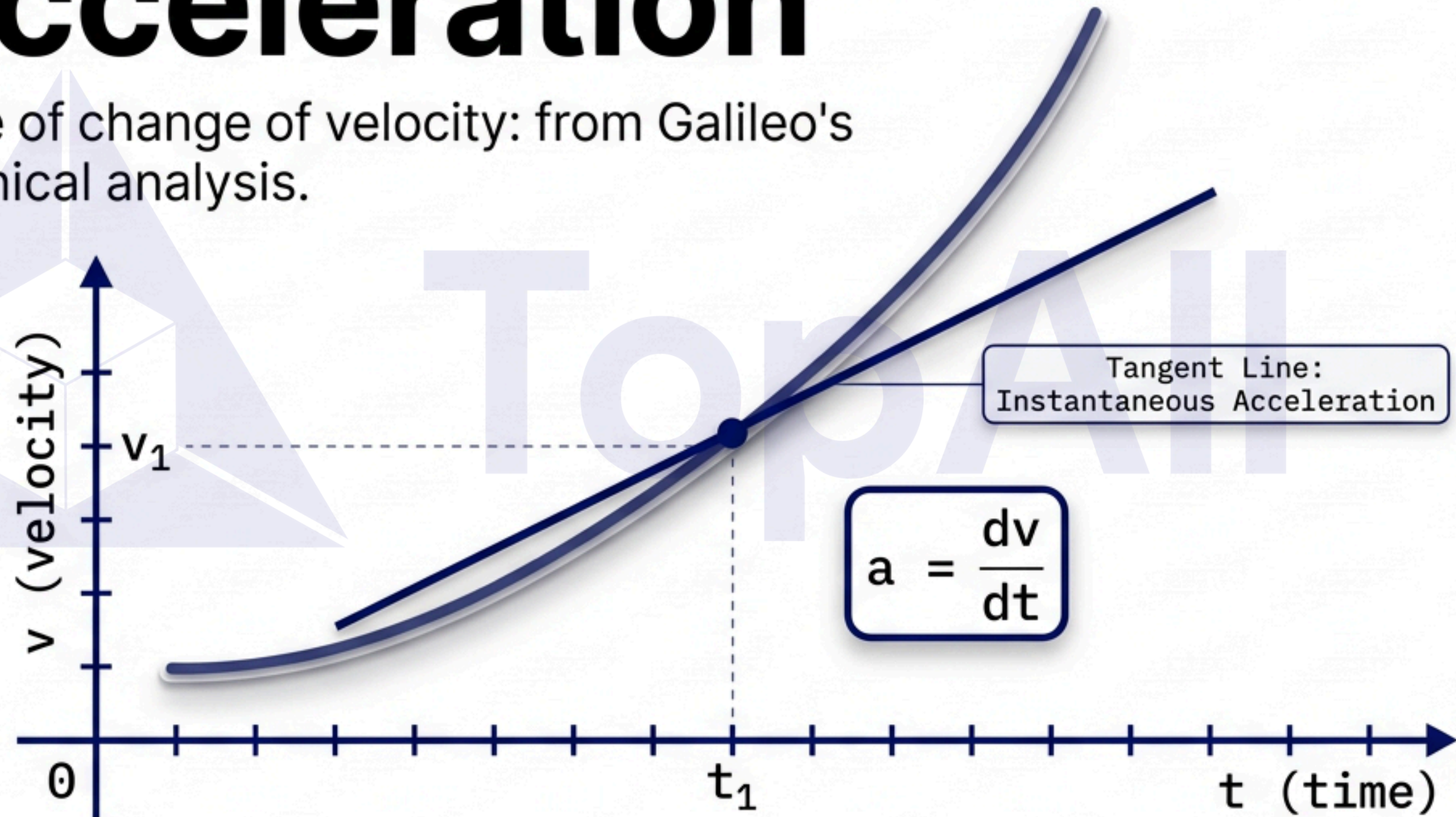


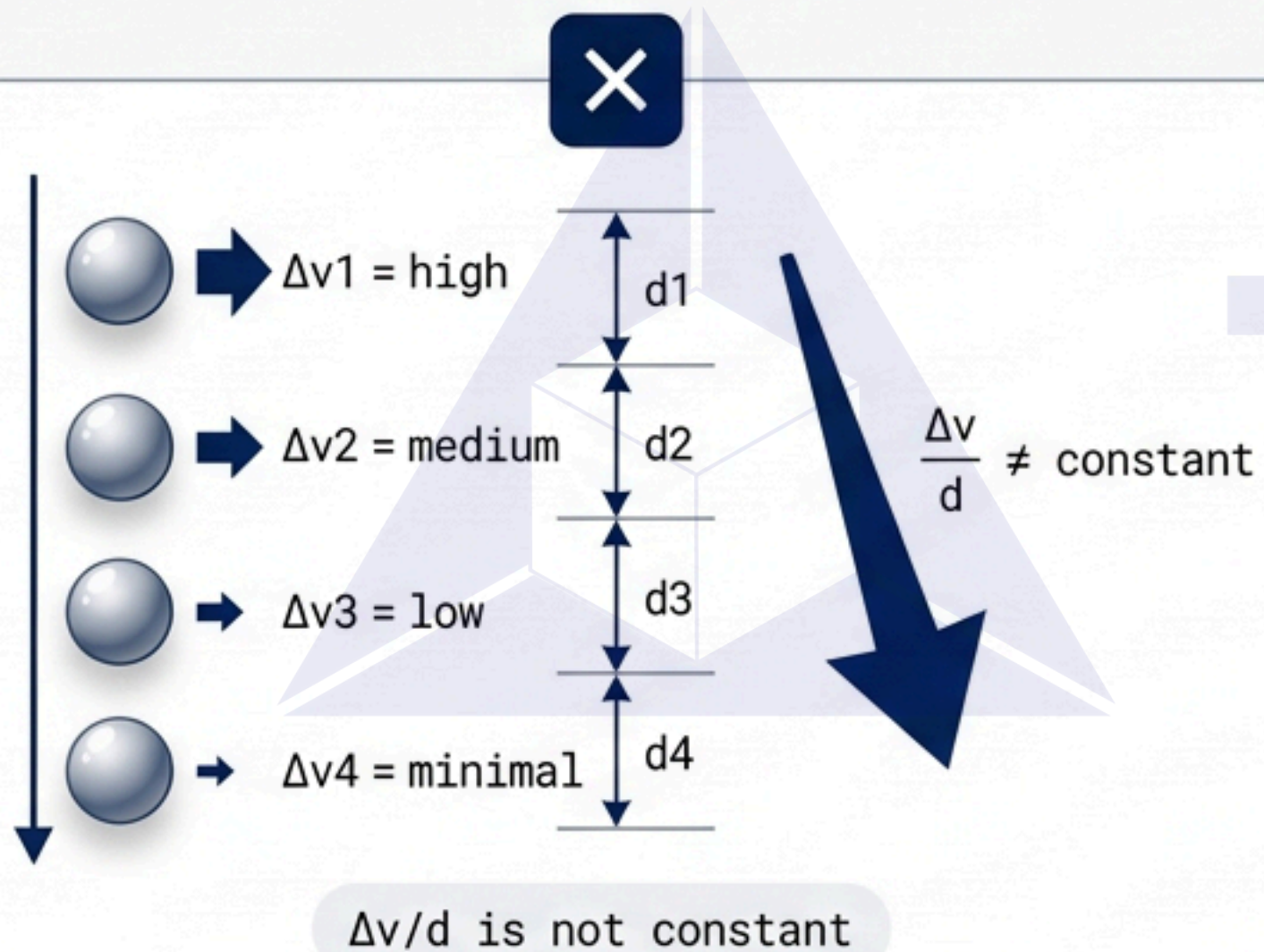
2.3 Acceleration

Defining the rate of change of velocity: from Galileo's insights to graphical analysis.

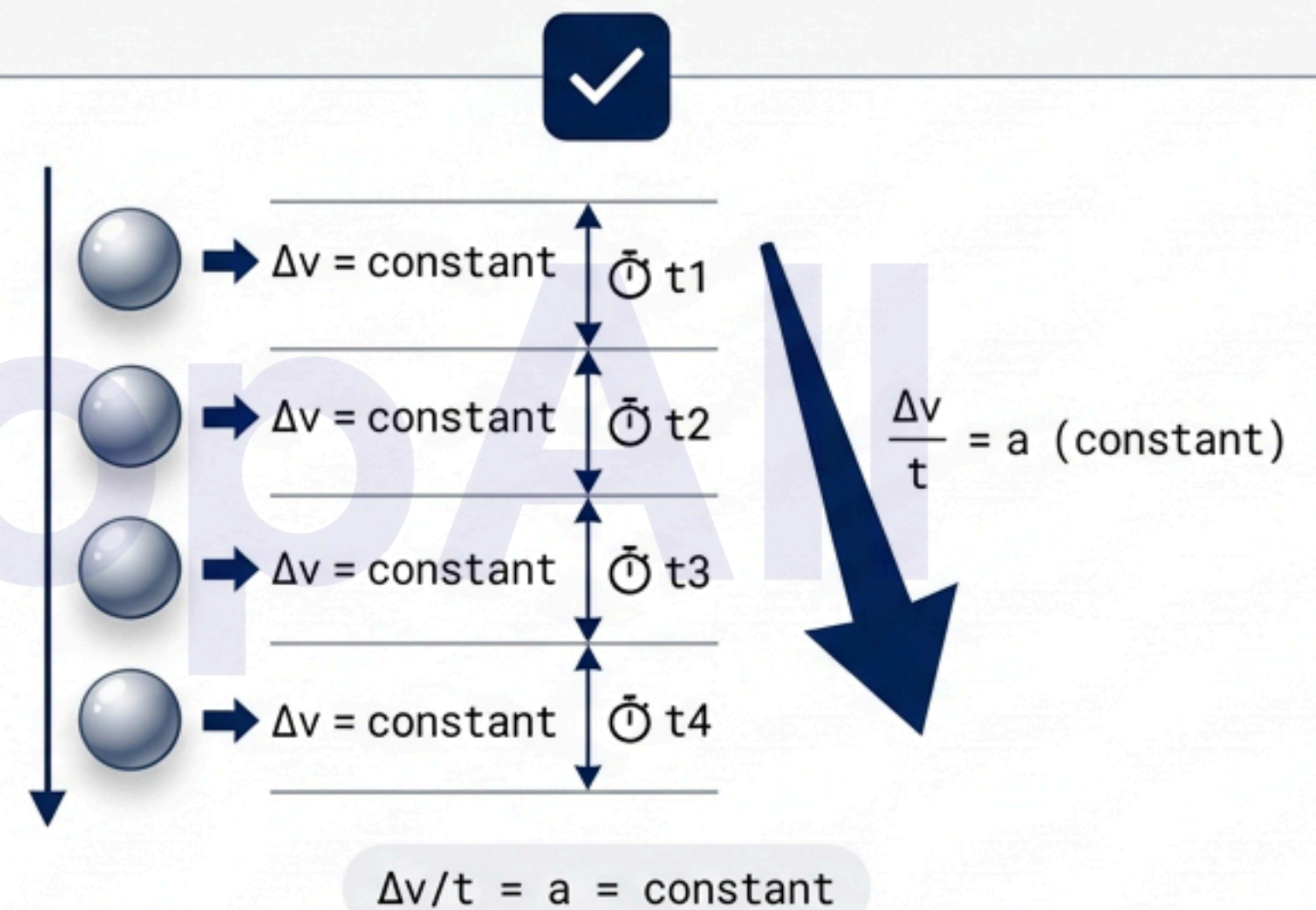


Galileo's Insight on Motion

Change with Distance?

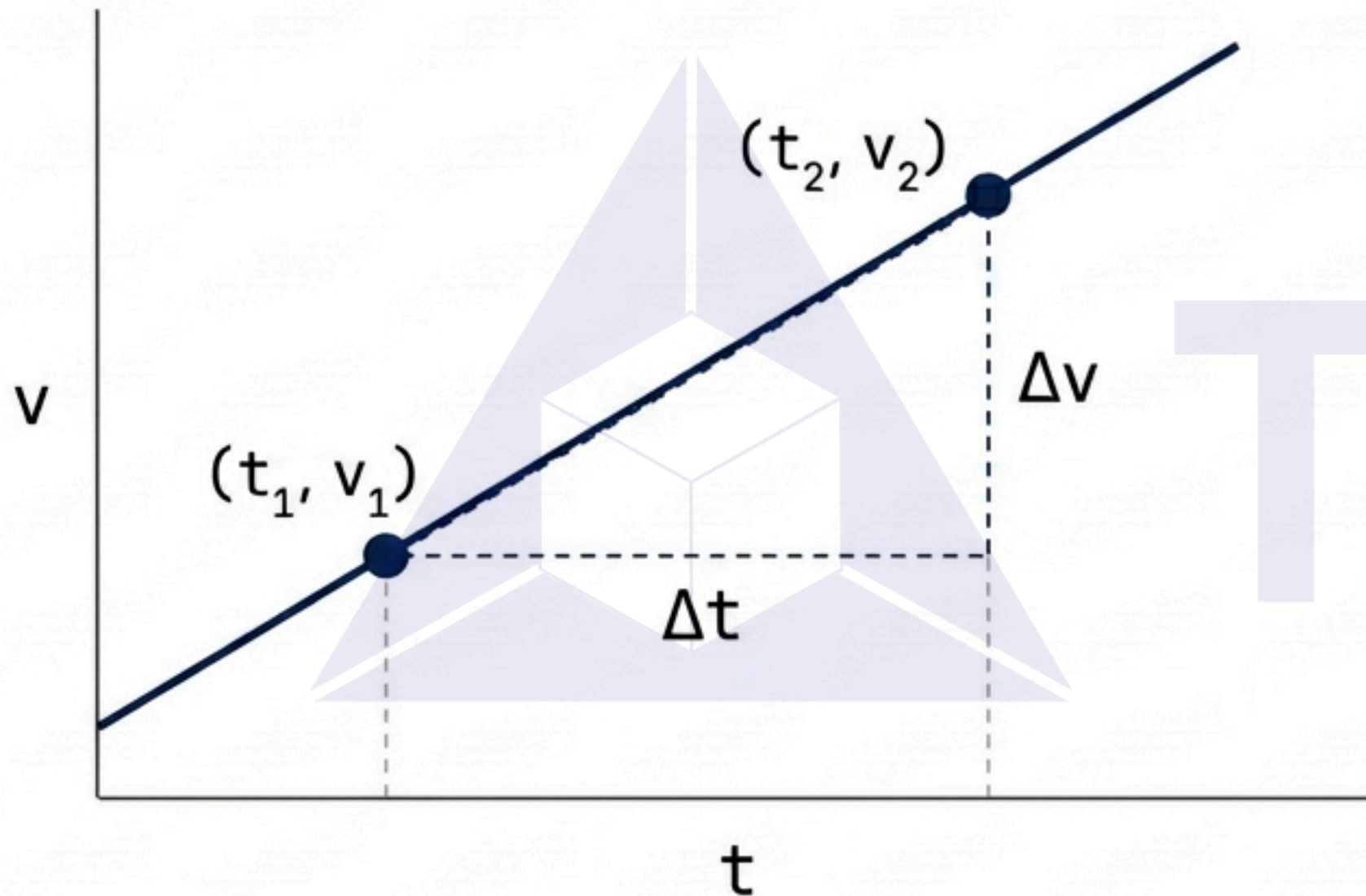


Change with Time



Acceleration is born: the rate of change of velocity with time is a constant of motion for all objects in free fall.

Average Acceleration



The average acceleration $\bar{a}$ over a time interval is defined as the change in velocity divided by the time interval. It represents the average change of velocity per unit time.

$$a = (v_2 - v_1) / (t_2 - t_1) = \Delta v / \Delta t$$

SI Unit: m s^{-2}



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$$E=mc^2$$



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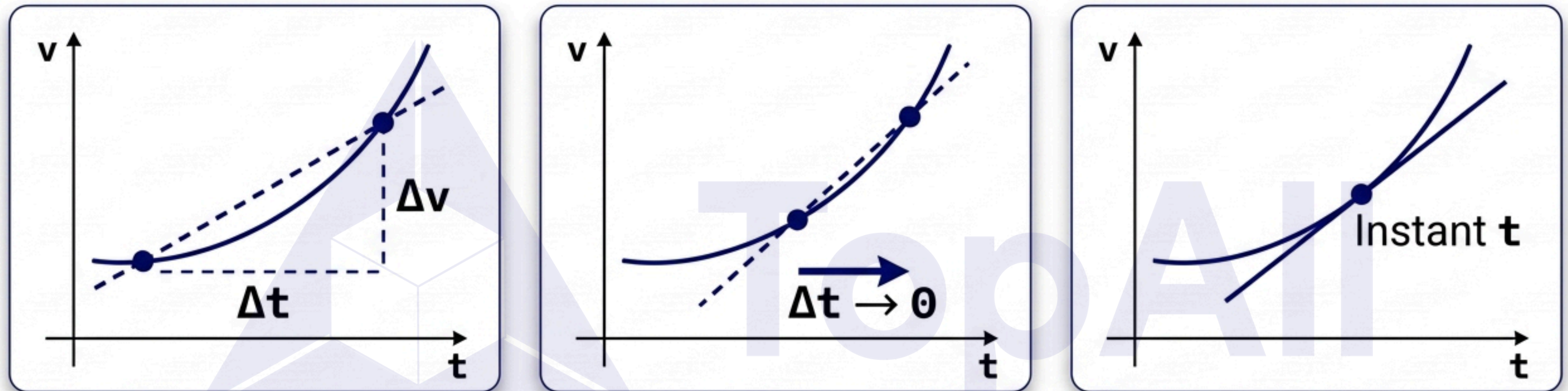
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Instantaneous Acceleration



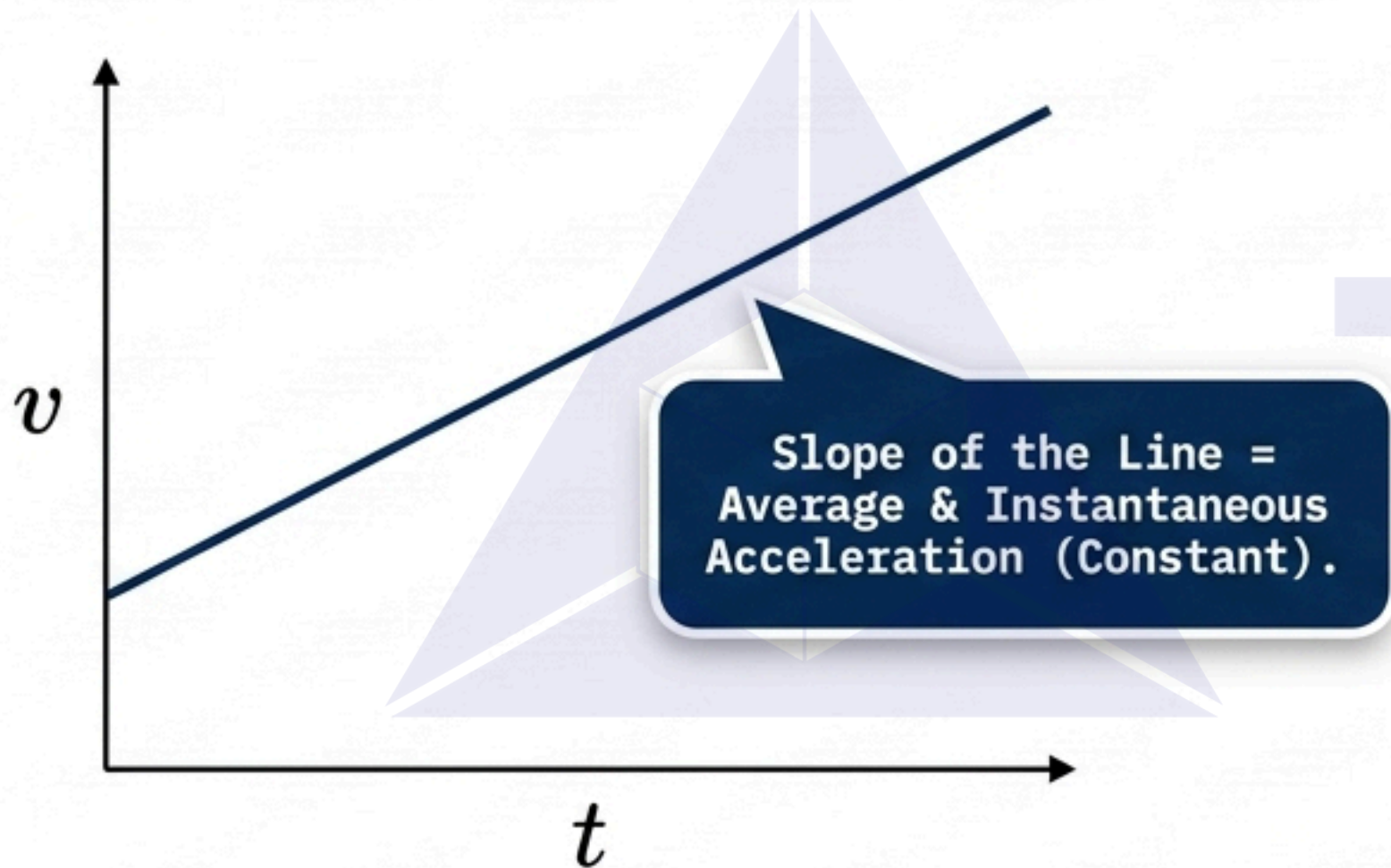
Acceleration at a specific instant is the limit of average acceleration as the time interval becomes infinitesimally small.

$$a = \lim_{(\Delta t \rightarrow 0)} \Delta v / \Delta t = dv/dt$$

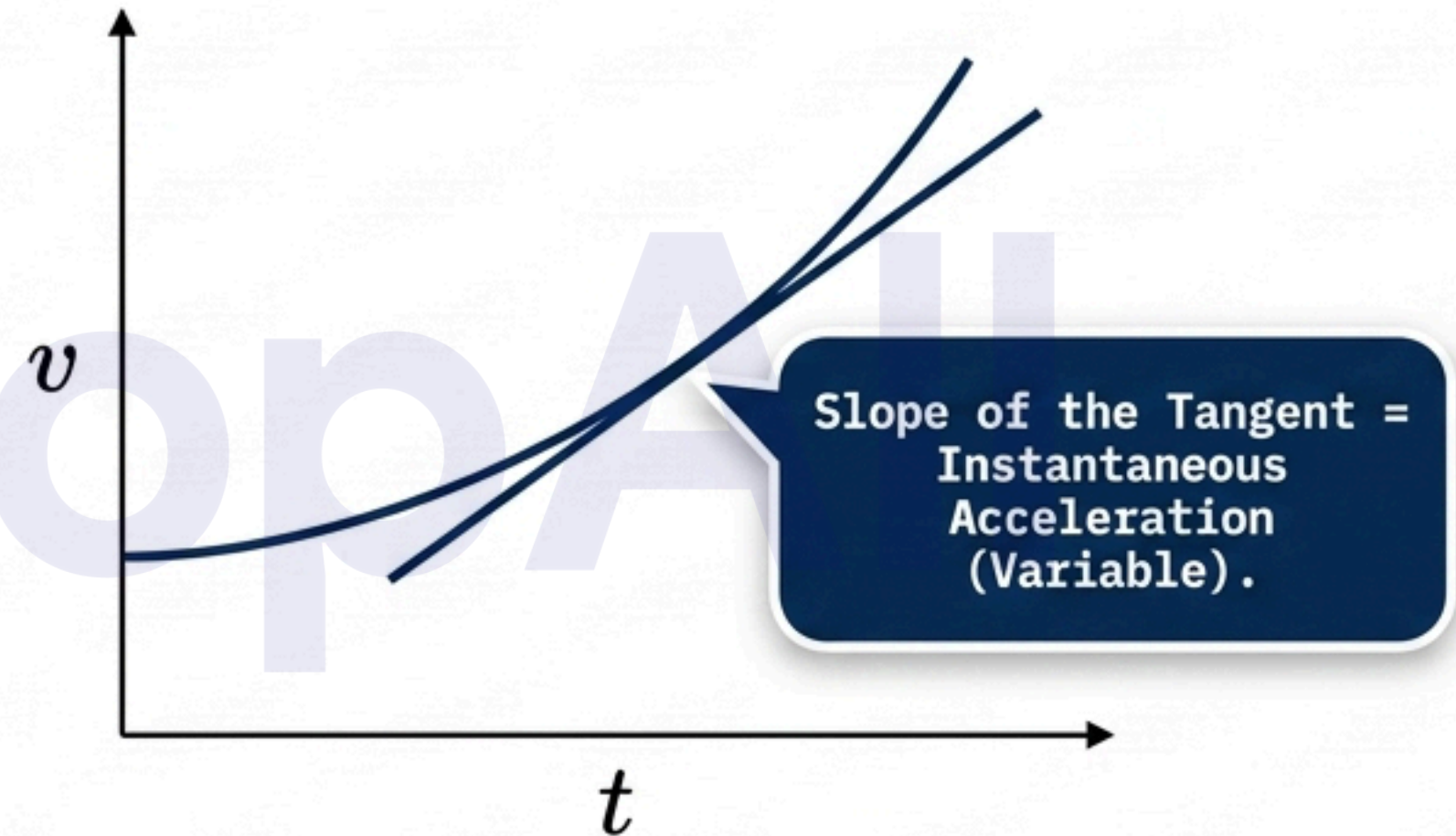
The differential coefficient of velocity with respect to time.

Reading Acceleration from Graphs

Constant Acceleration

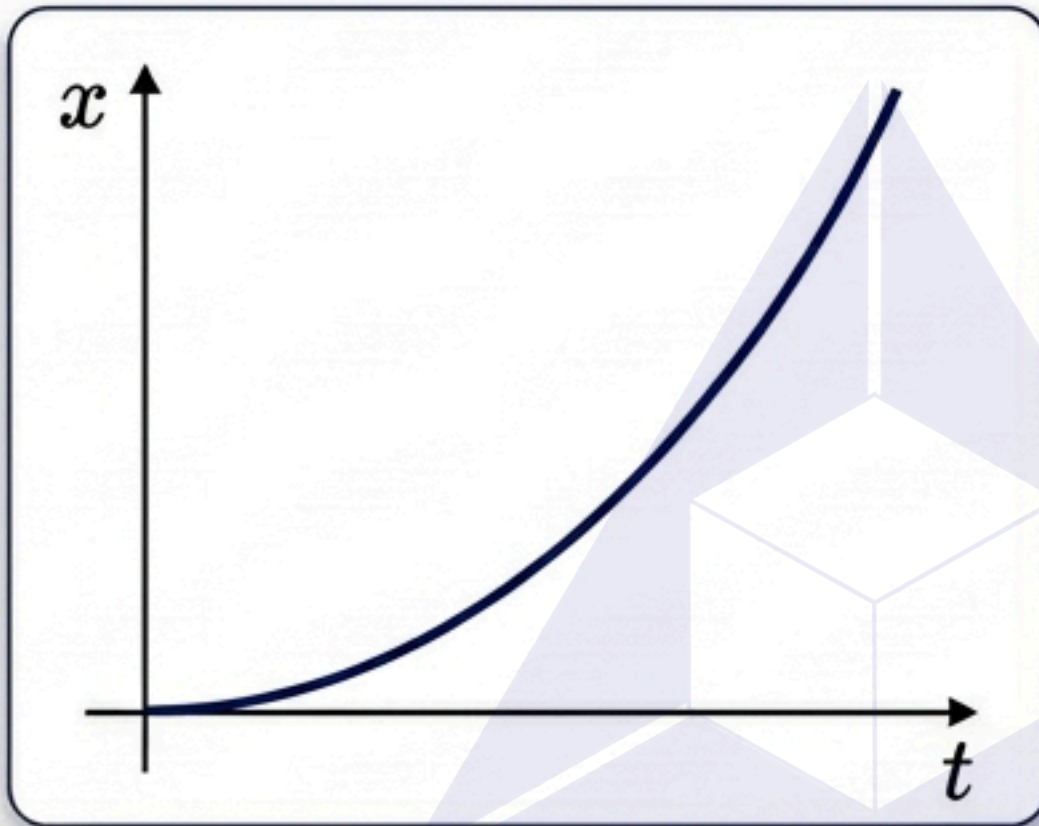


Variable Acceleration



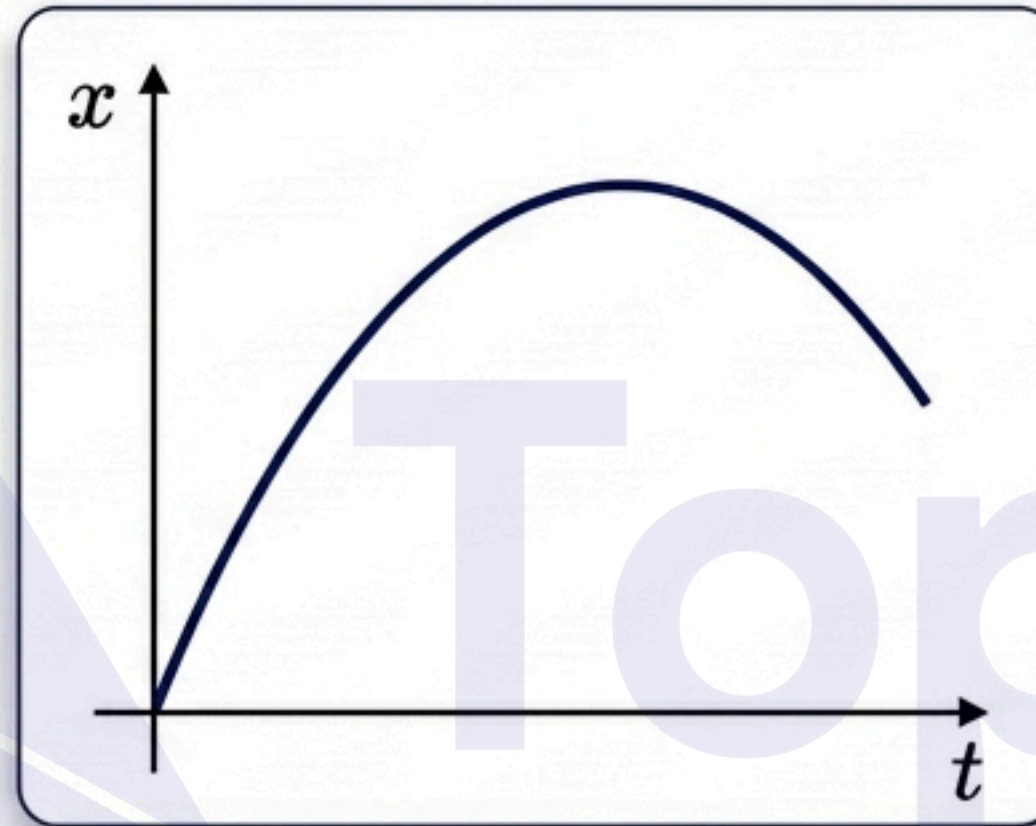
Acceleration is always the slope of the velocity-time curve.

Visualizing Acceleration in Position-Time



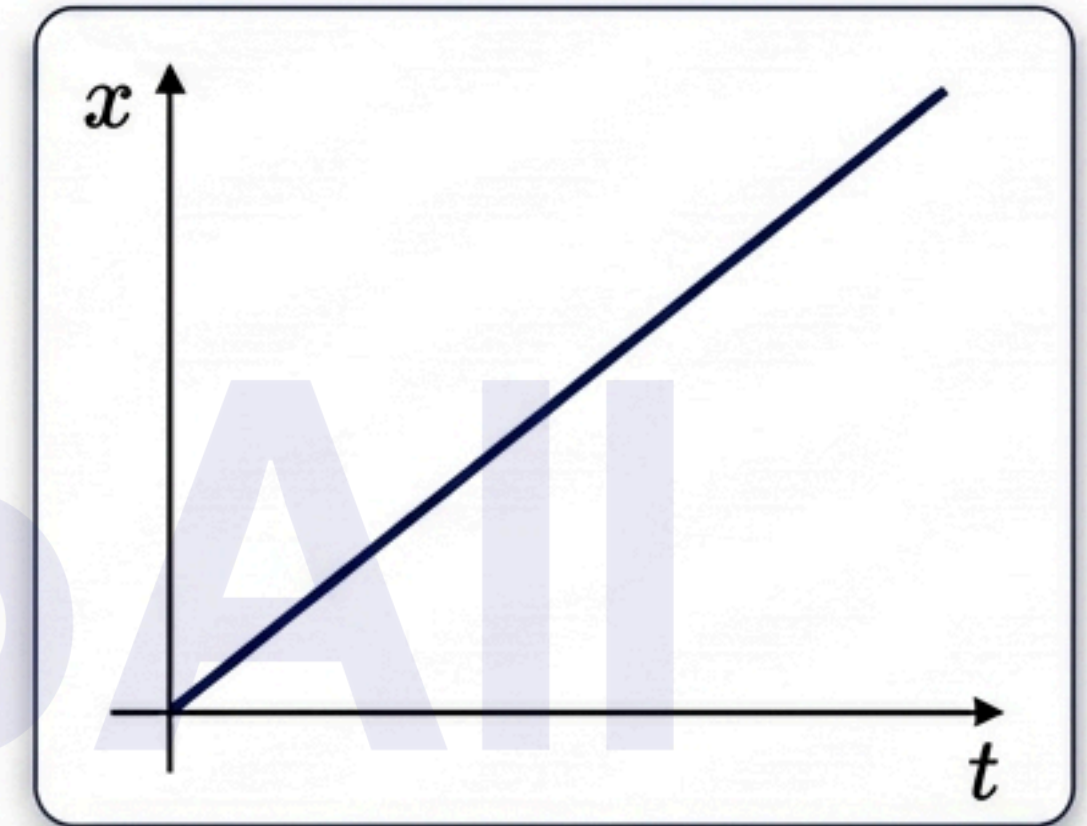
Positive Acceleration

Velocity (slope of x - t) is continuously increasing.



Negative Acceleration

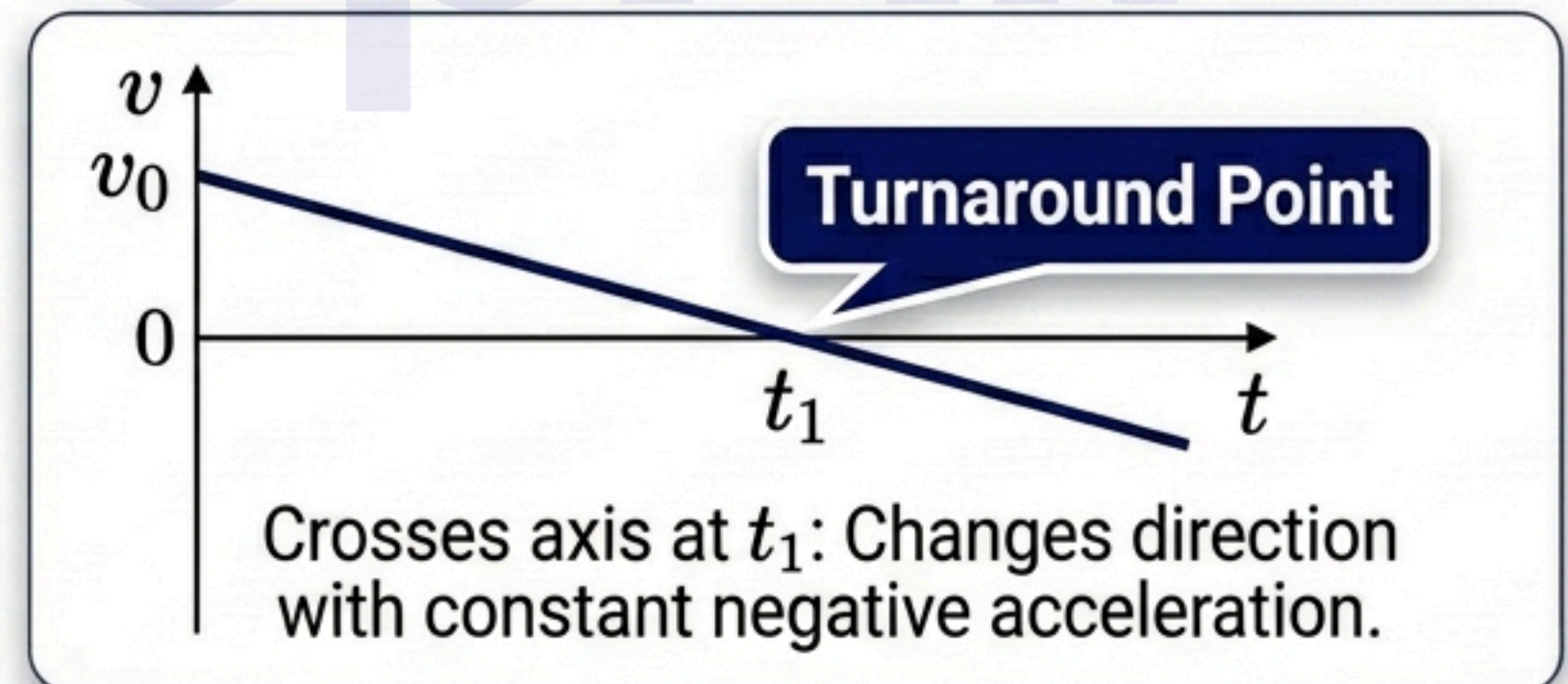
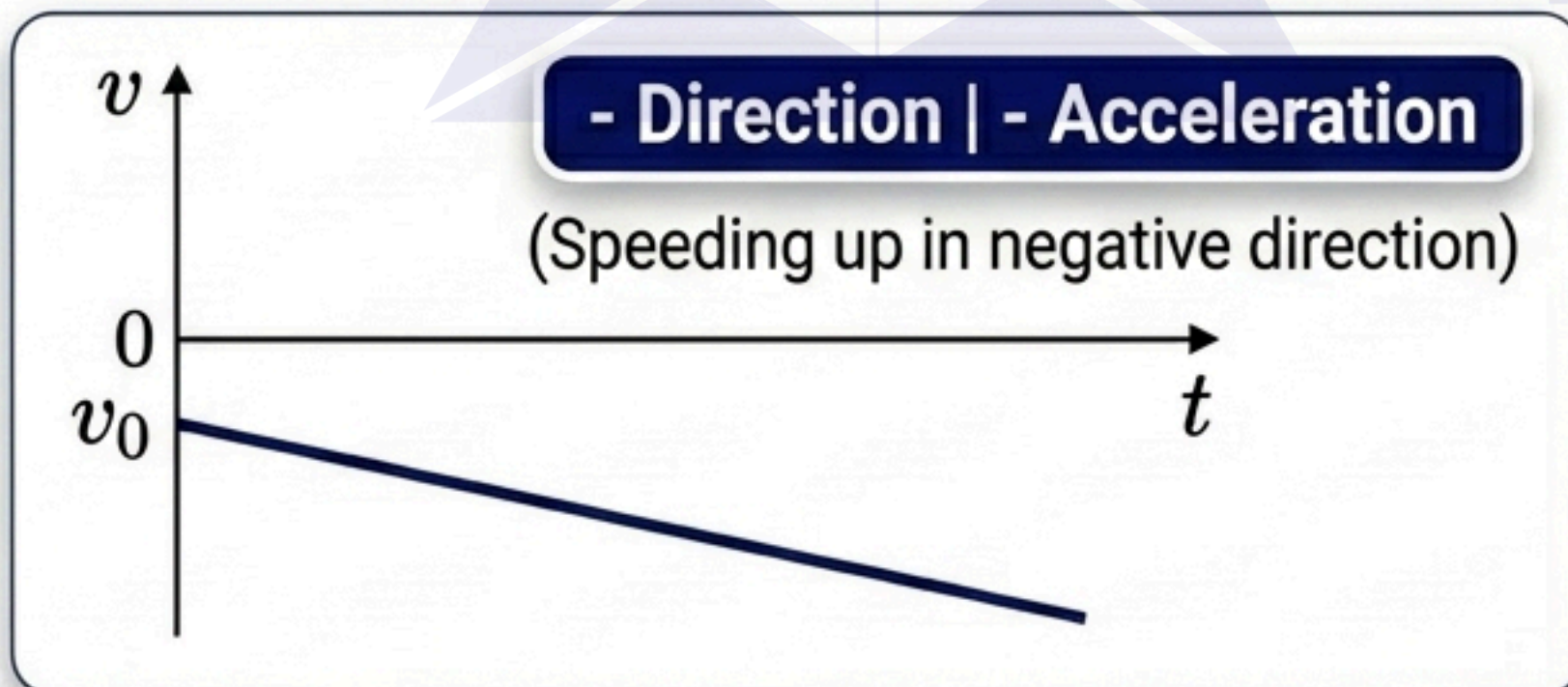
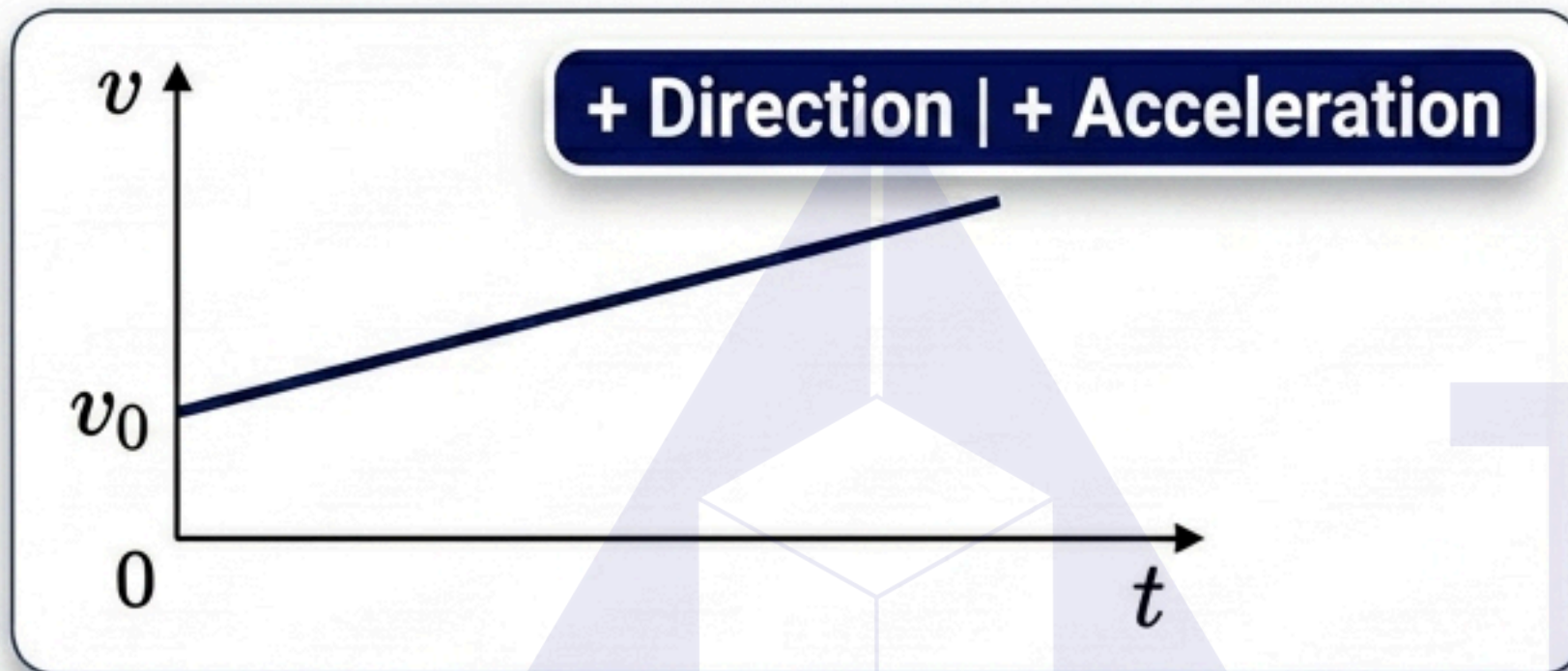
Velocity is continuously decreasing.



Zero Acceleration

Velocity is constant.

Cases of Constant Acceleration



Displacement from Velocity-Time Graphs



An interesting feature of any velocity-time graph: the area under the curve represents the total displacement over the given time interval.

$$\text{Area} = \text{base} \times \text{height} = T \times u = uT = \text{Displacement}$$

$$\text{Area} = \text{Displacement} \mid \text{Slope} = \text{Acceleration}$$



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