AP Physics
Instructor: Mr. Butler

Graphical Analysis of Rectilinear Motion
Applying Graphical Techniques

Position-Time Graph

a) **Position** of the object at any time is found by reading the y-axis value of a point on the curve that corresponds to that time.
b) The **displacement** of the object for some time interval is found by finding the change in position on the y-axis for the two points on the curve corresponding to that time interval.
c) Slope of secant line between two points on the curve represents the **average velocity** of the object during that time interval.
d) Slope of tangent line at a point on the curve represents the **instantaneous velocity** of the object at that instant in time.
e) The area under a position-time graph does not represent any kind of meaningful physical quantity.
f) The **acceleration** change in the slope will determine if the speed is changing and thus will tell if the object is accelerating.

Velocity-Time Graph

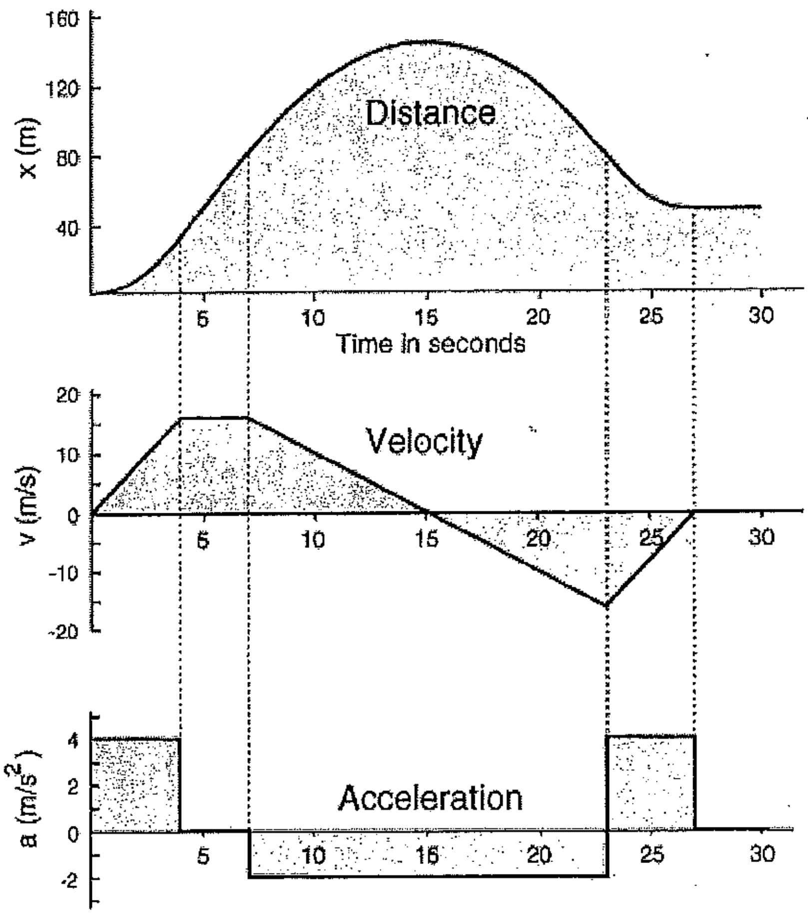
a) The **instantaneous velocity** at any time can be read directly from the y-axis that corresponds to the point on the curve for that time.
b) The **average acceleration** can be found from the slope of the secant line between two points on the curve represents the of the object during that time interval.
c) The **instantaneous acceleration** of the object is determined by finding the slope of the tangent line at a point on the curve at that time instant.
d) The **displacement** of the object for any time interval is determined by calculating the area under the curve between two points.

Acceleration-Time Graph

a) The **instantaneous acceleration** or the **change in acceleration** can be found by reading the values directly from the y-axis.
b) The slope of the secant and tangent lines on an acceleration-time graph represent a quantity called "**jerk**" or "**jolt**". We will not be studying this quantity.
c) The area under the curve between two points represents the **change in velocity** of the object during that interval of time.

Motion Graphs

Constant acceleration motion can be characterized by motion equations and by motion graphs. The graphs of distance, velocity and acceleration as functions of time below were calculated for one-dimensional motion using the motion equations in a spreadsheet. The acceleration does change, but it is constant within a given time segment so that the constant acceleration equations can be used. For variable acceleration (i.e., continuously changing), then calculus methods must be used to calculate the motion graphs



Slope (**X**-graph)
Represents the velocity of the object.

Slope (**V**-graph)
Represents the acceleration of the object.

Area (**V**-graph)
Represents the displacement of the object.

Area (a-graph)
Represents the change in velocity of the object.

A considerable amount of information about the motion can be obtained by examining the slope of the various graphs. The slope of the graph of position as a function of time is equal to the velocity at that time, and the slope of the graph of velocity as a function of time is equal to the acceleration. The slope of the graph of acceleration as a function of time corresponds to a quantity called the "jerk" which is a measure of the rate of change of the applied net force acting on the object.

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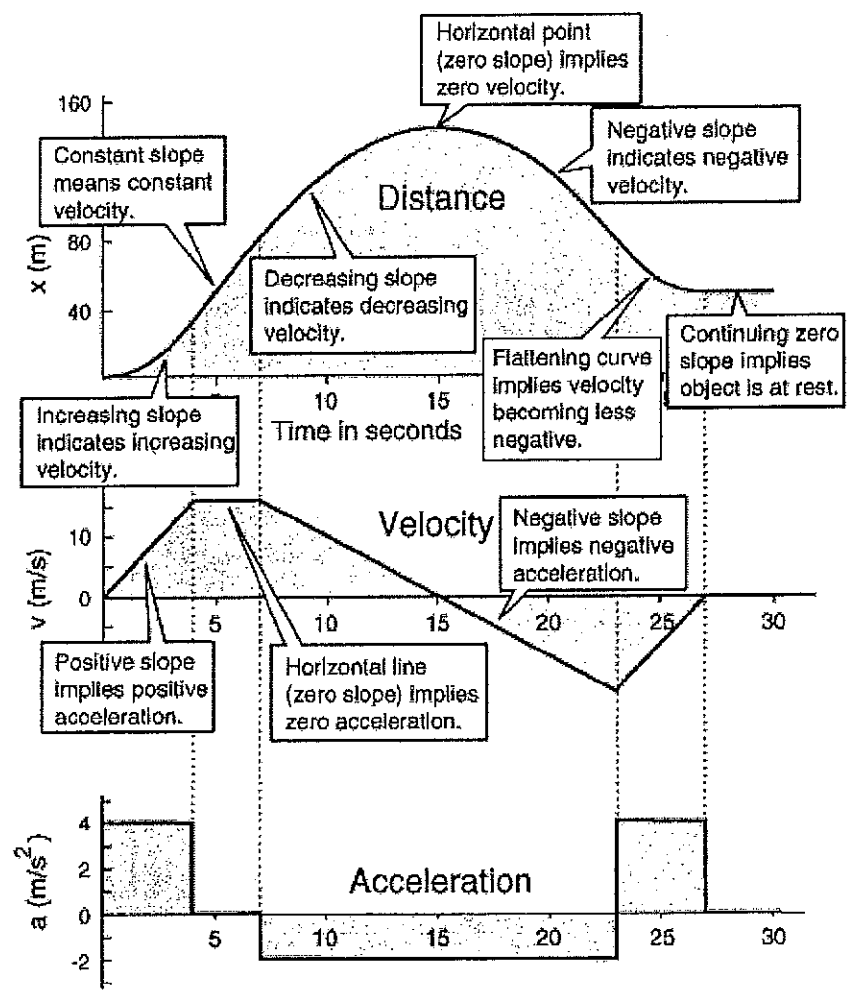
The Slopes of Motion Graphs

A considerable amount of information about the motion can be obtained by examining the slope of the various motion graphs. The slope of the graph of position as a function of time is equal to the velocity at that time, and the slope of the graph of velocity as a function of time is equal to the acceleration.



In this example where the initial position and velocity were zero, the height of the position curve is a measure of the area under the velocity curve. The height of the position curve will increase so long as the velocity is constant. As the velocity becomes negative, the position curve drops as the net positive area under the velocity curve decreases. Likewise the height of the velocity curve is a measure of the area under the acceleration curve. The fact that the final velocity is zero is an indication that the positive and negative contributions were equal.