PhyzExamples: Motion

Physical Quantities • Symbols • Units • Brief Definitions

Position • x • m • A point in space.
Clock Reading • t • s • A point in time.
Distance • Δx • m • The space between two positions measured in finite units. "How far."
Displacement • $\Delta \mathbf{x}$ • m • Distance *and* direction of motion. "How far and which way."
Interval • Δt • s • The time between two clock readings measured in finite units.
Speed • v • m/s • The rate at which position changes. The distance through which an object moves in each unit of interval. "How fast." Initial and final speeds are designated v_0 and v, respectively. When spoken, v_0 is *v-naught*, pronounced "vee-nawt."
Velocity • $\mathbf{v}$ • m/s • Speed *and* direction of motion. "How fast and which way."
Acceleration • a • m/s^2 • The rate at which a body's velocity is changing. The change in velocity an object experiences in each unit of interval. The change can be an increase in speed, a decrease in speed, or a change in direction of motion. **Deceleration** means "slowing down" or, more specifically, the rate at which a body loses speed. While deceleration applies only to slowing down, there are no equivalent words that apply only to speeding up or changing direction. "Deceleration" is not an antonym of "acceleration" any more than "cat" is an antonym of "animal."
Gravitational Acceleration • g • $9.8\ m/s^2$ on Earth; other values on other worlds.
Free fall is motion in one dimension with uniform acceleration caused by "gravity."

Equations

$v = \Delta x/\Delta t$ • Uniform Motion • speed = distance / interval
$a = \Delta v/\Delta t$ • Uniform Accelerated Motion • acceleration = change in velocity / interval

Smooth Operations Examples

1. A caterpillar was munching on a ruler. At 8:24:02 s, it was munching at the 24-mm mark. At 8:24:58 s, it was munching on the 57-mm mark. How fast did the caterpillar move while munching?

1. $x_0 = 24$ mm $x = 57$ mm $v = ?$
$t_0 = 8{:}24{:}02$ s $t = 8{:}24{:}58$ s
$v = \Delta x/\Delta t = (x - x_0) / (t - t_0)$
$v = (57 \text{ mm} - 24 \text{ mm}) /$
$(8{:}24{:}58 \text{ s} - 8{:}24{:}02 \text{ s})$
$\underline{v = 0.59 \text{ mm/s}}$

2. A marathon runner runs 42 km in 10,800 s. What is the runner's average speed?

$\Delta x = 42{,}000$ m $\Delta t = 10{,}800$ s
$v = \Delta x / \Delta t$
$v = 42{,}000 \text{ m} / 10{,}800 \text{ s}$
$\underline{v = 3.9 \text{ m/s}}$

3. A skier starting from rest accelerates in a straight line down a slope at $2\ m/s^2$. How fast is he or she moving after 7 s?

3. $a = 2\ m/s^2$ $\Delta t = 7$ s
$a = \Delta v/\Delta t$
$\Delta v = a\Delta t$
$\Delta v = 2\ m/s^2 \cdot 7$ s
$\underline{\Delta v = 14 \text{ m/s}}$

4. At this point, our skier plows into a snow bank and comes to rest in 0.50 s. What magnitude of acceleration was involved?

4. $\Delta v = 14$ m/s $t = 0.5$ s
$a = \Delta v/\Delta t$
$a = 14 \text{ m/s} / 0.50 \text{ s}$
$\underline{a = 28\ m/s^2}$

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PhyzReference: Graphing Technique

PREPARE THE GRAPH SPACE

1. Use as much of the available graphing space as you can. Leave room for labeling the scale, quantity, and units of each axis.

2. Label the scale of each axis. Label the origin as 0 for both axes. Select a scale so that the range of data fills the graph. Make sure your scales are manageable. Maybe let four squares represent one whole unit of measurement (e.g., 1 meter or 1 volt). But don't make seven squares represent one unit. But again, fill as much of the page as is practical.

3. Label the quantity and units of each axis. Identify the quantity; abbreviate the units parenthetically. "Time (s)," or "*x* (cm)," for example.

4. Title the graph. You may choose to give the graph a descriptive title, such as "Motion of a Toy Car." But you should always include a title bearing the names of the quantities, such as "Position vs. Time." In such a title, the first quantity listed is the one represented on the vertical axis.

PLOT THE DATA

1. Make a small but visible mark at each data point. If the point (0, 0) is a valid data point, be sure to mark it, too.

2. Resist the urge to connect the dots.

3. When you are done, you will have a so-called "scatter graph."

DRAW A LINE OF BEST FIT FOR A LINEAR PLOT (IF ASKED TO DO SO)

1. A line of best fit is not found by connecting the data point dots. So do ***not*** connect the dots!

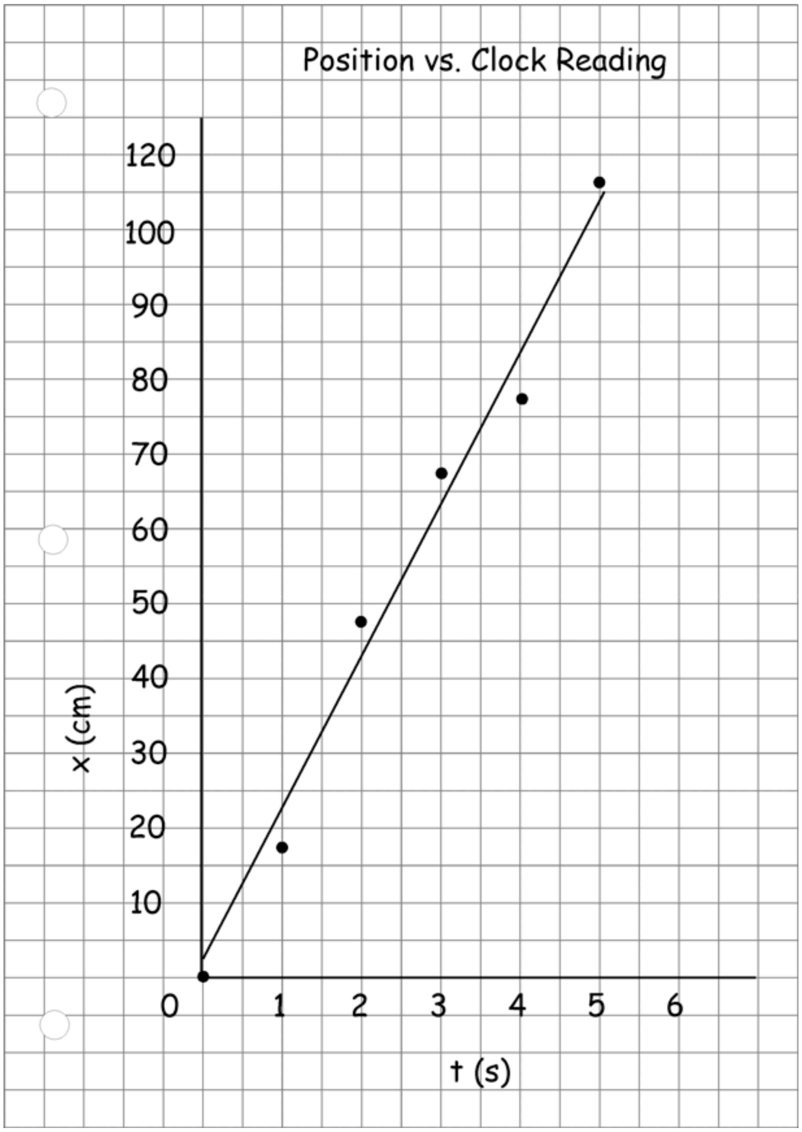
2. If plotting a linear "best-fit" line, make a single straight line that comes as close as possible to all the data points. The line may not pass through any of the actual data points (depending on the amount of scatter in the data). It need not pass through the origin or the final data point either.

3. If multiple plots are to be graphed on a single set of axes, be sure to label each best-fit line to distinguish it from the others.

USE THE LINE OF BEST FIT

1. Once the line of best fit has been drawn, use that line to calculate the slope.

2. Disregard the slope between any two particular data points. The line of best fit is the only line to use for data analysis. It is as if the original data no longer exists, and only the line remains.



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