PhyzExamples: Introduction to Motion

Physical Quantities • Symbols • Units • Brief Definitions

Position or Location • x • m • A point in space. When we identify the position of an object, we specify the location of its center of mass. The point that is the position or location of an object does not occupy any space. In one dimensional space, the position of an object is either positive or negative.

Clock Reading or Instant • t • s • A point in time. A clock reading or an instant does not last for any duration.

Displacement • Δx • m • The difference between where an object is now compared to where it was at a previous clock reading. "How far and in what direction." In one dimensional horizontal motion, the direction of displacement is either positive (to the left) or negative (to the right).

> **Distance** • Δx • m • The space between two positions measured in finite units. "How far." Unlike displacement, distance does not involve direction. Distance is always positive.

Interval • Δt • s • The time between two clock readings measured in finite units. Time progresses in only one "direction"; interval is always positive.

Velocity • v • m/s • The displacement through which an object moves in each unit of interval. (The rate at which position changes and the direction in which it changes.) "How fast and in what direction?" In one dimensional horizontal motion, the direction of velocity is either positive (to the right) or negative (to the left).

> **Speed** • v • m/s • The distance through which an object moves in each unit of interval. (The rate at which position changes.) "How fast." Unlike velocity, speed does not involve direction. Speed is always positive.

Acceleration • a • m/s^2 • The change in velocity an object experiences in each unit of interval. (The rate at which a body's velocity is changing.) In one dimensional horizontal motion, the direction of velocity is either positive (to the right) or negative (to the left).

Deceleration means "slowing down" or, more specifically, the rate at which a body loses speed. Do not confuse deceleration with negative acceleration; *they are not the same!*

> **Gravitational Acceleration** • g • 9.8m/s^2 on Earth; other values on other worlds. **Free fall** is motion in one dimension with uniform acceleration caused by "gravity."

Equations

$\Delta x = x_2 - x_1$ • displacement = second position – first position

$\Delta t = t_2 - t_1$ • interval = second clock reading – first clock reading

$v = (x_2 - x_1)/(t_2 - t_1)$ • Uniform Motion • velocity = (second position – first position) / (second clock reading – first clock reading)

$v = \Delta x/\Delta t$ • Uniform Motion • velocity = displacement / interval.

$a = (v_2 - v_1)/(t_2 - t_1)$ • Uniform Accelerated Motion • acceleration = (second velocity – first velocity) / (second clock reading – first clock reading)

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

Smooth Operations Examples

1. A caterpillar was munching on a ruler. At 8:24:02s, it was munching at the 24mm mark. At 8:24:58s, it was munching on the 57mm mark. What distance did the caterpillar munch through?

1. x_1=24mm x_2=57mm Δx=?
$\Delta x = x_2 - x_1$
Δx = 57mm – 24mm
$\underline{\Delta x = 33mm}$

2. A caterpillar was munching on a ruler. At 8:24:02s, it was munching at the 24mm mark. At 8:24:58s, it was munching on the 53mm mark. What interval did the caterpillar munch through?

2. t_1=8:24:02s t_2=8:24:58s Δt=?
$\Delta t = t_2 - t_1$
Δt = 8:24:58s – 8:24:02s
$\underline{\Delta t = 56s}$

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

3. x_1=24mm x_2=57mm v=?
t_1=8:24:02s t_2=8:24:58s
$v = (x_2 - x_1) / (t_2 - t_1)$
v = (57mm – 24mm) /
(8:24:58s – 8:24:02s)
$\underline{v = 0.59mm/s}$

4. A hungry caterpillar was munching on a ruler at the rate of 0.85mm/s. At 5:54:09s, it was munching at the 35mm mark. Where was it munching at 5:54:43s?

4. x_1=35mm x_2=? v=0.85mm/s
t_1=5:54:09s t_2=5:54:43s
$v = (x_2 - x_1) / (t_2 - t_1)$
$v \cdot (t_2 - t_1) = x_2 - x_1$
$x_2 = v \cdot (t_2 - t_1) + x_1$
x_2 = 0.85mm/s · (5:54:43s – 5:54:09s)
+ 35mm
$\underline{x_2 = 64mm}$