

AP Physics 1 Kinematics

Burke Tutoring In Fremont

burketutoringinfremont.com

(510) 453-0350

Unit 1 one-page reference · Updated September 8, 2026 · $g = 9.8 \text{ m/s}^2$

Definitions

Displacement Δx	$x_f - x_i$. Has direction. Can be negative.
Distance	Total path length. Never negative.
Avg velocity	$\Delta x / \Delta t$
Avg speed	distance / Δt
Avg acceleration	$\Delta v / \Delta t$
Instantaneous v	Slope of the tangent to x vs t

Constant acceleration

$$v = v_0 + at$$

Leaves out Δx

$$\Delta x = v_0 t + \frac{1}{2}at^2$$

Leaves out v

$$v^2 = v_0^2 + 2a\Delta x$$

Leaves out t

$$\Delta x = \frac{1}{2}(v_0 + v)t$$

Leaves out a

Valid only while a is constant. If a changes, split the motion into stages and carry the end conditions forward.

Motion graphs

GRAPH	SLOPE	SIGNED AREA
x vs t	Velocity	Nothing
v vs t	Acceleration	Displacement
a vs t	Not assessed	Δv

Signed area gives displacement. Add the magnitudes instead to get distance. From rest at constant a, a plot of Δx against t^2 is linear with slope $a/2$.

Signs

- Same signs on v and a: **speeding up**
- Opposite signs on v and a: **slowing down**
- Negative a does not mean slowing down
- Pick a positive direction and never change it mid-problem

Free fall

- Up positive gives $a_y = -g = -9.8 \text{ m/s}^2$
- At the top of a toss, $v = 0$ but **a is still -g**
- Time up = time down, for equal heights
- Max height above launch = $v_{0y}^2 / 2g$
- Mass appears nowhere. It does not matter.

Projectiles

Two directions, one clock. The shared elapsed time is what links them.

Horizontal $v_{0x} = v_0 \cos \theta$, $a_x = 0$
 $\Delta x = v_{0x} t$

Vertical $v_{0y} = v_0 \sin \theta$, $a_y = -g$
 $\Delta y = v_{0y} t - \frac{1}{2}gt^2$

Level ground only: $T = 2v_{0y}/g$ and $R = v_0^2 \sin(2\theta)/g$.

Maximum range at 45° . Complementary angles give equal ranges.

Horizontal launch: $v_{0y} = 0$, so the fall time depends on the height alone.

Relative velocity, 1D

$$v_{A/B} = v_{A/\text{ground}} - v_{B/\text{ground}}$$

Reversing the subscripts reverses the sign

Six checks before you hand it in

1. Did I mark a positive direction on a sketch?
2. Is a constant over the interval I used?
3. Does the question want distance or displacement?
4. Did I pick the right root, and does its sign match the motion?
5. Are the units right after the arithmetic?
6. Is the answer physically sensible in size?

The mistake I see most. Setting $a = 0$ at the top of a toss because $v = 0$ there. Ask what the object is doing one instant later. It is moving downward, so its velocity changed, so a is not zero.