Name: _____ AP PHYSICS 1 Date: _____

KINEMATICS DAY 4: KINEMATIC EQUATIONS

WARMUP Day 3 Review

An object starts at +10 m/s and has a constant acceleration of -2.0 m/s² for 3.0 s. What is its final velocity?

□ **A.** +4.0 m/s □ **B.** +8.0 m/s

□ **C.** +16 m/s □ **D.** -6.0 m/s

Back up your check, units carried: $\Delta v = (-2.0\ \text{m/s}^2)(3.0\ \text{s}) =$ _____ — show how the units multiply.

Check one → convince your neighbor in one sentence.

Physics in the Wild — The Carrier Catapult: A fighter jet leaves an aircraft carrier at about 74 m/s after a deck run of only 94 m. No graph needed — one equation connects speed and distance: $a = v^2/(2\Delta x) = (74\ \text{m/s})^2/(2 \times 94\ \text{m}) \approx 29\ \text{m/s}^2$, about 3g. Today you get the three equations that solve any constant-acceleration problem — including ones where you know nothing about time.

THE KINEMATIC EQUATIONS (CONSTANT A ONLY!)

Equation	Missing variable	Units check
$v_f = v_i + at$	Δx	$(m/s^2)(s) = m/s$ ✓
$\Delta x = v_i t + \frac{1}{2}at^2$	v_f	$(m/s^2)(s^2) = m$ ✓
$v_f^2 = v_i^2 + 2a\Delta x$	t	$(m/s^2)(m) = m^2/s^2$ ✓

Bonus: $\Delta x = \frac{1}{2}(v_i + v_f)t$ — average velocity times time. Missing variable: a.

WE DO Exercise 1: From Rest

A car starts from rest and accelerates at 3.0 m/s² for 6.0 s. Find **(a)** its final velocity and **(b)** how far it travels. Carry units through every line.

CHOOSING THE RIGHT EQUATION

THE STRATEGY

1. List your knowns and the unknown you want (v_i, v_f, a, t, Δx).

2. Find the variable that appears *nowhere* in your list — neither known nor wanted.

3. Pick the equation that's missing exactly that variable.

YOU DO Exercise 2: Braking to a Stop

A car moving at 24 m/s brakes to a stop over 48 m. **(a)** Which kinematic equation fits (what's missing)? **(b)** Find the acceleration. **(c)** Now find how long the stop takes.

WE DO Exercise 3: No Clock Available

A sprinter moving at 8.0 m/s accelerates at 2.0 m/s² over a distance of 33 m. Find her final speed. *(Notice: no time given, no time wanted.)*

YOU DO Exercise 4: Average-Velocity Shortcut

A train slows steadily from 20 m/s to 5.0 m/s in 6.0 s. How far does it travel during those 6.0 s? *Hint: with constant a, the average velocity is just* $(v_i + v_f)/2$.

PRACTICE & THE CROSS-CHECK HABIT

Two classic traps: (1) These equations require *constant acceleration* — never use them across a phase change (that's Day 5). (2) In ½at², square *only* the time: ½(2 m/s²)(3 s)² = ½(2)(9) = 9 m, not ½(6)² = 18 m.

YOU DO **Exercise 5: Solve for Time**

Starting from rest with a = 2.0 m/s², how long does an object take to travel 64 m?

CHALLENGE **Exercise 6: Answer, Then Audit**

A car passes a sign moving at 12 m/s and accelerates at 2.0 m/s² for 5.0 s. **(a)** How far past the sign is it? **(b)** How fast is it going? **(c)** *Cross-check:* plug your answers into $v_f^2 = v_i^2 + 2a\Delta x$ and show both sides agree — units and all.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Final Velocity

An object at 4.0 m/s accelerates at 2.5 m/s² for 6.0 s. Find its final velocity.

P2 Braking Distance

A car moving at 30 m/s brakes with a = –7.5 m/s². How far does it travel before stopping?

P3 Distance from Rest

Starting from rest, an object accelerates at 4.0 m/s² for 5.0 s. How far does it go?

P4 Find the Acceleration

A cart enters a track at 5.0 m/s and covers 45 m in 3.0 s while accelerating uniformly. Find its acceleration.
Hint: which equation has no v_f in it?