

Part A: Choosing the Equation

For each problem, list the three knowns (watch for hidden knowns), the unknown, the variable you don't need, and the equation you would use.

1. Set up each problem, but don't solve it.

- A bike starts from rest and reaches 9.0 m/s in 6.0 s. How far does it travel?
- A bowling ball rolls at 4.0 m/s and slows down at 0.50 m/s^2 until it stops. How far does it roll?
- An elevator starts from rest and speeds up at 1.2 m/s^2 for 2.5 s. How fast is it moving?

a. $v_i = 0$ (from rest), $v_f = 9.0 \text{ m/s}$, $t = 6.0 \text{ s}$. Unknown: d . Not needed: a . Use $d = \frac{1}{2}(v_f + v_i)t$

b. $v_i = 4.0 \text{ m/s}$, $v_f = 0$ (stops), $a = -0.50 \text{ m/s}^2$ (slowing, so opposite sign). Unknown: d . Not needed: t . Use $v_f^2 = v_i^2 + 2ad$

c. $v_i = 0$ (from rest), $a = 1.2 \text{ m/s}^2$, $t = 2.5 \text{ s}$. Unknown: v_f . Not needed: d . Use $v_f = v_i + at$

Part B: Solving

List knowns, choose an equation, substitute with units, and box your answer.

$$v_f = v_i + at \quad d = v_i t + \frac{1}{2}at^2 \quad v_f^2 = v_i^2 + 2ad \quad d = \frac{1}{2}(v_f + v_i)t$$

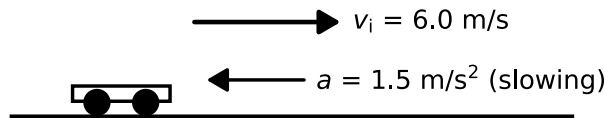
2. A drag racer starts from rest and speeds up at 8.0 m/s^2 for 4.0 s. How far does it travel?

Knowns: $v_i = 0 \text{ m/s}$, $a = 8.0 \text{ m/s}^2$, $t = 4.0 \text{ s}$. Unknown: d . Not needed: v_f

Equation: $d = v_i t + \frac{1}{2}at^2$

Substitute: $d = (0)(4.0 \text{ s}) + \frac{1}{2}(8.0 \text{ m/s}^2)(4.0 \text{ s})^2 = \frac{1}{2}(8.0 \text{ m/s}^2)(16 \text{ s}^2)$ **Answer: $d = 64 \text{ m}$**

3. A skateboarder rolling at 6.0 m/s hits a patch of rough pavement and slows down at 1.5 m/s^2 until she stops. How far does she roll on the rough pavement? How long does it take?



Knowns: forward is +. $v_i = 6.0 \text{ m/s}$, $v_f = 0 \text{ m/s}$ (stops), $a = -1.5 \text{ m/s}^2$

Distance (no t): $d = (v_f^2 - v_i^2)/2a = (0 - (6.0 \text{ m/s})^2) / (2 \times -1.5 \text{ m/s}^2) = (-36 \text{ m}^2/\text{s}^2) / (-3.0 \text{ m/s}^2) = 12 \text{ m}$

Time (no d): $t = (v_f - v_i)/a = (0 - 6.0 \text{ m/s}) / (-1.5 \text{ m/s}^2) = 4.0 \text{ s}$

4. A train enters a station at 18 m/s and slows steadily to 6.0 m/s over a distance of 240 m.

- What is the train's acceleration?
- How long does it take to slow down?

Knowns: $v_i = 18 \text{ m/s}$, $v_f = 6.0 \text{ m/s}$, $d = 240 \text{ m}$

a. No t : $a = (v_f^2 - v_i^2) / 2d = ((6.0 \text{ m/s})^2 - (18 \text{ m/s})^2) / (2 \times 240 \text{ m}) = (36 - 324) \text{ m}^2/\text{s}^2 / 480 \text{ m} = \mathbf{-0.60 \text{ m/s}^2}$ (negative: slowing down)

b. No a needed: $d = \frac{1}{2}(v_f + v_i)t$, so $t = 2d / (v_f + v_i) = 2(240 \text{ m}) / (6.0 \text{ m/s} + 18 \text{ m/s}) = 480 \text{ m} / 24 \text{ m/s} = \mathbf{20. \text{ s}}$

Check: $v_f = v_i + at = 18 \text{ m/s} + (-0.60 \text{ m/s}^2)(20. \text{ s}) = 6.0 \text{ m/s}$.

5. A cyclist moving at 4.0 m/s speeds up at 0.50 m/s^2 for 10.0 s. Find her final velocity and the distance she covers.

Knowns: $v_i = 4.0 \text{ m/s}$, $a = 0.50 \text{ m/s}^2$, $t = 10.0 \text{ s}$

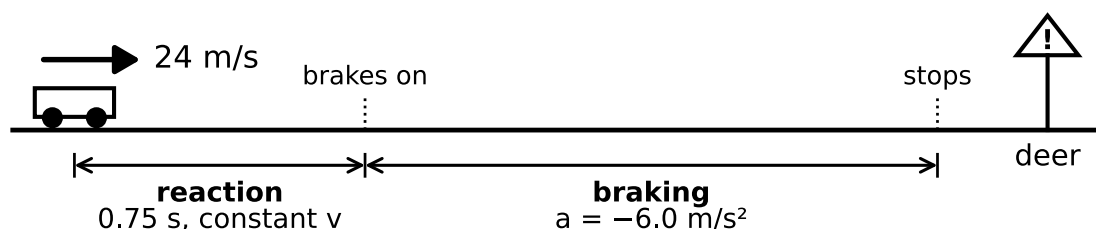
Final velocity: $v_f = v_i + at = 4.0 \text{ m/s} + (0.50 \text{ m/s}^2)(10.0 \text{ s}) = \mathbf{9.0 \text{ m/s}}$

Distance: $d = v_i t + \frac{1}{2}at^2 = (4.0 \text{ m/s})(10.0 \text{ s}) + \frac{1}{2}(0.50 \text{ m/s}^2)(10.0 \text{ s})^2 = 40. \text{ m} + 25 \text{ m} = \mathbf{65 \text{ m}}$

Check: $d = \frac{1}{2}(v_f + v_i)t = \frac{1}{2}(9.0 + 4.0)(10.0) = 65 \text{ m}$.

Part C: Stopping Distance

6. A driver moving at 24 m/s sees a deer in the road. It takes her 0.75 s to react before she hits the brakes. Then the car slows at 6.0 m/s^2 until it stops.



- How far does the car travel during the reaction time? (Hint: what is a while she reacts?)
- How far does the car travel while braking?
- What is the total stopping distance?

a. Constant velocity, so $a = 0$ (hidden known): $d = v_i t = (24 \text{ m/s})(0.75 \text{ s}) = \mathbf{18 \text{ m}}$

b. $v_i = 24 \text{ m/s}$, $v_f = 0$, $a = -6.0 \text{ m/s}^2$, no t : $d = (0 - (24 \text{ m/s})^2) / (2 \times -6.0 \text{ m/s}^2) = (-576 \text{ m}^2/\text{s}^2) / (-12 \text{ m/s}^2) = \mathbf{48 \text{ m}}$

c. Total = $18 \text{ m} + 48 \text{ m} = \mathbf{66 \text{ m}}$