PhyzExamples: 1D Algebraic Kinematics

1. A marathon runner runs 26 miles in 3 hrs. What is the runner's average speed in m/s?

$x = 26$ mi $= 42$ km $= 42{,}000$ m

$t = 3$ hr $= 10{,}800$ s

$v = x/t$

$v = 42{,}000 \text{ m} / 10{,}800 \text{ s}$

$\boxed{v = 3.9 \text{ m/s}}$

2. 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?

$v_0 = 0 \quad a = 2 \text{ m/s}^2 \quad t = 7 \text{ s}$

$v = v_0 + at \qquad [v_0 = 0]$

"starting from rest" means $v_0=0$

$v = (2 \text{ m/s}^2)\,(7 \text{ s})$

$\boxed{v = 14 \text{ m/s}}$

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

$v_0 = 14 \text{ m/s} \quad v = 0 \quad t = 0.5 \text{ s}$

"comes to rest" means v = 0

$v = v_0 + at$

$a = (v - v_0)/t$

$a = (0 - 14 \text{ m/s}) / 0.50\text{s}$

$\boxed{a = -28 \text{ m/s}^2}$

4. How far did the skier plow into the snow bank during the 0.50 s of deceleration?

$v_0 = 14 \text{ m/s} \quad v = 0 \text{ m/s} \quad t = 0.5 \text{ s}$

$x = {}^1/_2(v_0 + v)t \qquad [v_0 = 0]$

$= {}^1/_2\,(14 \text{ m/s}) \cdot 0.5 \text{ s}$

$\boxed{x = 3.5 \text{ m}}$

5. A stone is dropped from a height of 5 m. How long will it be in the air?

$y = 5 \text{ m} \quad v_0 = 0 \text{ m/s} \quad v = ? \quad a = 10 \text{ m/s}^2 \quad t = ?$

$y = v_0 t + {}^1/_2 a t^2$

$v_0 = 0$

$y = {}^1/_2 a t^2$

$t = \;(2y/a)$

$t = \;(2 \cdot 5\text{m}/10\text{m/s}^2)$

$\boxed{t = 1.0 \text{ s}}$

Use this equation because the WHO CARES quantity is v (we don't know v, and we don't need to know v)

6. A stone is dropped from a height of 5.0 m. What is its speed upon impact?

$y = 5 \text{ m} \quad v_0 = 0 \quad v = ? \quad a = 10 \text{ m/s}^2 \quad t = ?$

$v^2 = v_0^2 + 2ay$

$v^2 = 2ay$

$v = \;(2ay)$

$v = \;(2 \cdot 10\text{m/s} \cdot 5.0\text{m})$

$\boxed{v = 10\text{m/s}}$

Use this equation because the WHO CARES quantity is t (we don't know t, and we don't need to know t)

7. If a car goes from rest to 20 m/s in 5 s, how far did the car go during this acceleration?

$x = ? \quad v_0 = 0 \quad v = 20 \text{ m/s} \quad a = ? \quad t = 5 \text{ s}$

$x = {}^1/_2(v_0 + v)t \qquad [v_0 = 0]$

$x = {}^1/_2\,(20 \text{ m/s}) \cdot 5 \text{ s}$

$\boxed{x = 50 \text{ m}}$

8. What was the acceleration during those 5 s?

$v = v_0 + at$

$a = (v - v_0)/t \qquad [v_0 = 0]$

$a = (20 \text{ m/s}) / 5 \text{ s}$

$\boxed{a = 4 \text{ m/s}^2}$