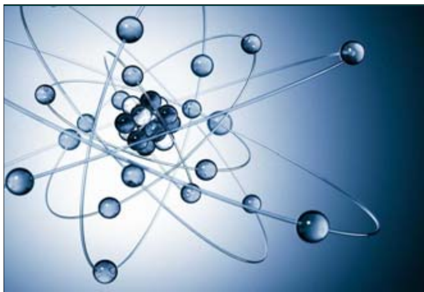
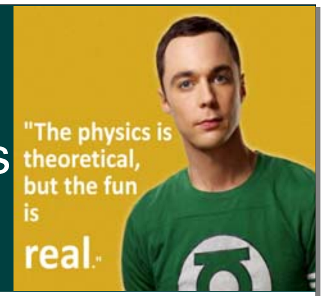


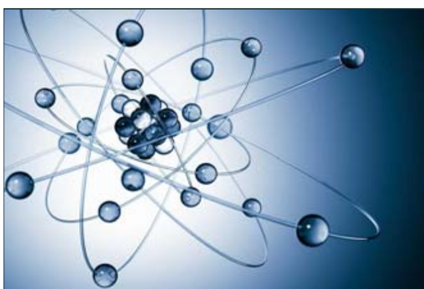
Unit 1: Kinematics

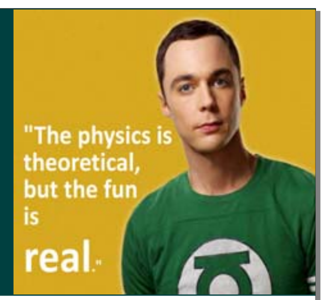


1.6 Applications of the Kinematics Equations

Steps for Solving Kinematics Problems:

1. Complete a variables list/draw a diagram if necessary.
2. Select the appropriate equation (ie. the one with one unknown variable that isn't on your list.)
3. Convert units if necessary.
4. Rearrange/"plug and chug." Sub in numbers and solve for unknown.
5. Box your final answer (correct with sig digs).





Ex.) A runner starts from rest and sprints to a speed of 6.00 m/s in 1.50 s. Assuming uniform acceleration, determine the distance ran.

$v_i = 0\,m/s$

$v_f = 6.00\,m/s$

$t = 1.50\,s$

$d = ?$

$$\Delta d = \left(\frac{v_i + v_f}{2}\right)t$$

$$\Delta d = \left(\frac{0\,m/s + 6.00\,m/s}{2}\right)(1.50\,s)$$

$$\boxed{\Delta d = 4.50\,m}$$

Ex.) The length of a primitive dartgun is 1.2 m. Upon leaving the barrel, a dart has a speed of 14 m/s. Assuming the dart is uniformly accelerated, how long does it take the dart to travel the length of the barrel?

$v_i = 0\,m/s$

$d = 1.2\,m$

$v_f = 14\,m/s$

$t = ?$

$$\Delta d = \left(\frac{v_i + v_f}{2}\right)t$$

$$1.2m = \left(\frac{0m/s + 14m/s}{2}\right)t$$

$$\frac{1.2m}{7m/s} = \frac{\cancel{7m/s} \cdot t}{\cancel{7m/s}}$$

$$\boxed{t = 0.17s}$$

Ex.) A driver of a car going 90.0 km/h sees the lights of a barrier 40.0 m ahead. It takes the driver 0.75 s before he applies the brakes at an average breaking acceleration of -10.0 m/s^2.

a) Will the car hit the barrier?

$v_i = 25\,m/s$

$> 40m \Rightarrow$ hits

$< 40m \Rightarrow$ doesn't hit

before brakes

$v = \frac{d}{t}$

$d = vt$

$d = (25m/s)(0.75s)$

$d = 18.75m$

after brakes

$v_i = 25\,m/s$

$v_f = 0\,m/s$

$a = -10\,m/s^2$

$d = ?$

$$a = \frac{v_f^2 - v_i^2}{2d}$$

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$d = \frac{(0m/s)^2 - (25m/s)^2}{(2)(-10m/s^2)}$$

$d = 31.25m$

$d_{total} = 50m$

$\therefore$ he hits the barrier.

b) What is the maximum speed the car can be moving at and not hit the barrier? Assume all other data does not change (use d = 18.75 m).

$d = 18.75\,m$

$V_f = 0\,m/s$

$V_i = ?$

$a = -10.0\,m/s^2$

$V_f^2 = V_i^2 + 2ad$

$-2ad \qquad -2ad$

$\sqrt{V_f^2 - 2ad} = \sqrt{V_i^2}$

$V_i = \sqrt{V_f^2 - 2ad}$

$V_i = \sqrt{(0\,m/s)^2 - 2(-10.0\,m/s^2)(18.75\,m)}$

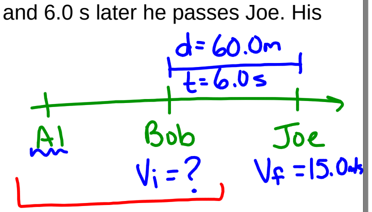
$V_i = 19.36\,m/s$

$\boxed{V_i = 70\,km/h}$

Pg. 53 #1-14.

Ex.) Three people are running a race, Al, Bob, and Joe. Al runs with a constant acceleration. First he passes Bob. 60.0 m and 6.0 s later he passes Joe. His velocity as he passes Joe is 15.0 m/s.

a) What is Al's speed as he passes Bob?



$\Delta \vec{d} = \left(\frac{\vec{V_i} + \vec{V_f}}{2}\right)t$

$60.0m = \left(\frac{V_i + 15.0m/s}{2}\right)(6.0s)$

$60.0m = (\vec{V_i} + 15.0m/s) \cdot \frac{1}{2} \cdot 6.0s$

$60.0m = 3\vec{V_i} + 45m/s$

$-45 \qquad -45$

$\frac{15}{3} = \frac{\cancel{3}\vec{V_i}}{\cancel{3}}$

$\boxed{\vec{V_i} = 5.0\,m/s\ [forward]}$

(c) $V_i = 0\,m/s$

$V_{f_{Al}} = V_{i_{Bob}} = 5.0\,m/s$

$\vec{a} = 1.7\,m/s^2$

b) What is Al's acceleration?

$\vec{V}_{i_{Bob}} = 5.0\, m/s$

$\vec{V}_f = 15.0\, m/s$

$\vec{d} = 60.0\, m$

$t = 6.0\, s$

$\vec{a} = ?$

$\boxed{2 \text{ ways}}$

$\Delta\vec{d} = \vec{V}_f t - \frac{1}{2}\vec{a}t^2$

$60.0m = (15.0)(6.0) - \frac{1}{2}\vec{a}(6.0)^2$

$60 = 90 - 18\vec{a}$

$-90 \quad -90$

$\frac{-30}{-18} = \frac{-18a}{-18}$

$\boxed{\vec{a} = 1.7\, m/s^2}$

$\vec{a} = \frac{\vec{V}_f^2 - \vec{V}_i^2}{2d}$

$a = \frac{15^2 - 5^2}{(2 \cdot 60)}$

c) How far back did Al have to start to catch Bob?

$\vec{V}_i = 0\, m/s$

$\vec{V}_f = 5.0\, m/s$

$\vec{a} = 1.6\, m/s^2$

$\vec{d} = ?$

$\vec{V}_f^2 = \vec{V}_i^2 + 2\vec{a}\vec{d}$

$(5.0)^2 = (\cancel{0.0})^2 + 2(1.\bar{6})\vec{d}$

$25 = 3.\bar{3}\,\vec{d}$

$\boxed{\vec{d} = 7.5\, m \text{ [back]}}$

Ex.) As a traffic light turns green, a police car starts with a constant acceleration of 6.00 m/s². At the instant the cop begins to accelerate, a speeding truck with constant velocity at 21.0 m/s passes by in the next lane.

a) How far will the police car travel before it overtakes the truck? Find $d_{cop} = d_{truck}$

Police

$\vec{a} = 6.00 m/s^2$

$\vec{V_i} = 0 m/s$

$\vec{d} = ?$

$\Delta\vec{d} = \cancel{\vec{V_i}t} + \frac{1}{2}at^2$

$d_{cop} = \frac{1}{2}(6.00 m/s^2)t^2$

Truck

$d = vt$

$d_{truck} = 21.0t$

$d_{cop} = d_{truck}$

$3t^2 = 21t$

$-21t \quad -21t$

$3t^2 - 21t = 0$

$3t(t-7) = 0$

$t = 0 \quad \boxed{t = 7.0 s}$

$\boxed{\vec{d} = 147 m}$

b) How fast will the police car be travelling when it overtakes the truck?

$\vec{V_i} = 0 m/s$

$\vec{a} = 6.00 m/s^2$

$\vec{d} = 147 m$

$t = 7.0 s$

$\vec{V_f} = ?$

$\vec{V_f} = \sqrt{0^2 + 2(6.00)(147)}$

$\boxed{\vec{V_f} = 42.0 m/s}$

$\vec{V_f} = 151 km/h$

Ex.) A moped, starting from rest, has an acceleration of +2.60 m/s². After the moped has travelled 120 m, it slows down to a stop with an acceleration of -1.50 m/s². What is the total displacement of the moped?

A B

$\vec{d} = 120\text{m}$

$\vec{a} = +2.60 \text{m/s}^2$

Start $v_{i_A} = 0$ $\boxed{v_{f_A} = v_{i_B}}$ stop $v_{f_B} = 0$

(A) $\vec{v}_{f_A}^{\,2} = \vec{v}_{i_A}^{\,2} + 2\vec{a}\vec{d}$

$\vec{v}_{f_A} = \sqrt{0^2 + 2(2.60\text{m/s}^2)(120\text{m})}$

$\vec{v}_{f_A} = 24.979\ldots \text{m/s}$

(B) $\vec{v}_{i_B} = 24.979\ldots \text{m/s}$

$\vec{v}_{f_B} = 0 \text{m/s}$

$\vec{a} = -1.50 \text{m/s}^2$

$\vec{d} = ?$

$\vec{a} = \frac{\vec{v}_f^{\,2} - \vec{v}_i^{\,2}}{2\vec{d}}$

$\vec{d} = \frac{\vec{v}_f^{\,2} - \vec{v}_i^{\,2}}{2\vec{a}}$

$\vec{d} = \frac{0^2 - (24.979\ldots)^2}{(2 \cdot -1.50)}$

$\vec{d} = 208\text{m}$

$\vec{d}_{total} = \vec{d}_A + \vec{d}_B = 120\text{m} + 208\text{m}$

$= \boxed{328\text{m}}$