CONSTANT ACCELERATION NOTES - p. 1

Constant accleration is due to a constant force applied to an object.

(1) $x = x(t) = \frac{1}{2}at^2 + v_0 t + x_o$ "Dangerous" Merton Rule

(2) $v_f = v(t) = at + v_0$ $\bar{v} = \dfrac{v_i + v_f}{2}$

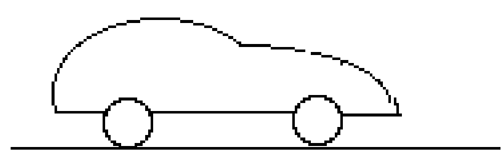
$a(t) = a$ (constant)

$d = rt$

(3) $v_f^2 = v_o^2 + 2a\Delta x$ (Notice that "d" stands for distance traveled and "r" stands for average speed.)

ex/ **The Stopping Distance Problem**

A car traveling with a velocity of 7m/s puts on the brakes and slows to a stop with a constant acceleration of -2m/s^2. What is the stopping distance?



Solution: Use equation (3) and notice that v_f = 0m/s...

$0^2 = 7^2 + 2(-2)\,\Delta x$ hence $4\Delta x = 49$ and $\Delta x = \boxed{12\text{m}} = d$

ex/ **The Stopping Time Problem**

The same car is traveling with the same 7m/s velocity and slows to a stop with a constant acceleration of -2m/s^2. What is the stopping time?

Solution: Use equation (2) and notice that v_f = 0m/s...

$0 = (-2)t + 7$ hence $t = \boxed{3.5\text{s}}$

ex/ **Galileo tosses a red ball!**

Galileo's Law of Falling Bodies notes among other things that in a vacuum, all bodies fall with the same, constant acceleration. That acceleration due to gravity is -9.8m/s^2 or -32ft/s^2. Actually, there is some variation in "g" depending upon where the object is dropped on the earth (a higher "g" at the north pole than at the equator). With this in mind let's look at equation (1) and consider...

CONSTANT ACCELERATION NOTES - p. 2

First of all, we will use a y-axis with up being the positive direction.
Next we will “picture” Galileo on top of an 8m high roof tossing a red ball straight up with a velocity of 6m/s. What can we say about the balll’s flight?

$y_f = y(t) = \frac{1}{2}at^2 + v_0 t + y_0$

or

$y = -4.9t^2 + 6t + 8$ (Make sure that you can picture Galileo firing the red ball

$v = -9.8t + 6$ ball upward while sitting on a roof top!)

(a) Where is the ball at 1 sec? $\mathrm{y}(1) = -4.9 + 6 + 8 = \boxed{9.1m}$

(b) What is the instantaneous velocity at 1 sec? $v(1) = -9.8(1) + 6 = \boxed{-3.8\,{}^{m}\!/\!{}_{s}}$

(c) What is the instantaneous speed at 1 sec? $|v(1)| = \boxed{3.8\,{}^{m}\!/\!{}_{s}}$

(d) How long is the ball in the air? (As the ball hits the ground, y = 0m)

$$y = 0 = -4.9t^2 + 6t + 8 \quad \text{Recall the quadratic formula: } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$t = \frac{-6 \pm \sqrt{193}}{2(-4.9)} \quad \Rightarrow \quad t_f = \boxed{2.03\sec}$$

(e) What is the maximum height reached by the ball? $(\mathrm{v}_{\mathrm{TOP}} = 0m/s)$

$v = -9.8t + 6 = 0 \;\Rightarrow\; t_{\mathrm{TOP}} = .61\sec$ to find maxH...

"plug in" $\mathrm{y}(.61) = \boxed{9.82m}$

A second method utilizes equation #3...

$0^2 = 6^2 + 2(-9.8)\Delta y \;\Rightarrow\; \Delta y = 1.8m$ hence...

$\mathrm{maxH} = y_0 + 1.8 = \boxed{9.8m}$ (Remember to add y_0 to Δy)

A third method utilizes the Merton Rule and d = rt...

$$\bar{\mathrm{v}} = \frac{6+0}{2} = 3m/s \text{ and d = rt} = (3m/s)(.61\sec) = 1.83m$$

$\mathrm{maxH} = y_0 + \Delta y = 8 + 1.83 = \boxed{9.83m}$