- H.W #1 extended to tonight
- Group problems less time pressure
- webCT scores start to appear later this week
- Read 2.7

Now That we know How TO CALCULATE Acceleration, we want To ask more Questions

- How fast is it moving?
- How long did it accelerate?
- where is object at a particular time?

want TO RELATE

Position (X)
Velocity (V)
acceleration (a)
time (t)

For <u>constant</u> acceleration

$$a_{avg} = a$$

$$a = \frac{v_f - v_i}{t_f - t_i}$$

choose $t_i = 0$ start stopwatch

$t_f = t$

$V_i = V_0$ ← original

$V_f = V$

$$a = \frac{V - V_0}{t} \Rightarrow \boxed{V = V_0 + at} \quad (1)$$

$$V_{avg} = \frac{x_f - x_i}{t_f - t_i}$$

choose $x_f = x$

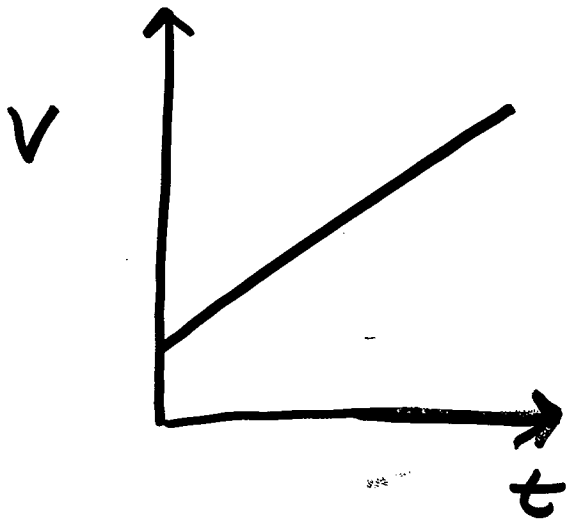
$x_i = x_0$

$t_f = t$

$t_i = 0$

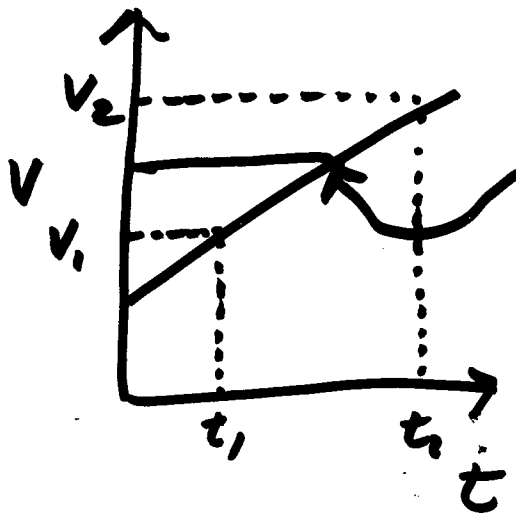
$$V_{avg} = \frac{x - x_0}{t}$$

$$x = x_0 + V_{avg}\, t$$



what is slope of line?

$$\text{slope} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta V}{\Delta t} = a \equiv \text{constant}$$



$$V_{avg} = \frac{V_1 + V_2}{2}$$

From before $X = X_0 + V_{avg}\, t$

$$\boxed{X = X_0 + \frac{1}{2}(V + V_0)\, t} \quad (2)$$

Can show 2 more relationships

$$X = X_0 + V_0 t + \frac{1}{2} a t^2 \quad (3)$$

$$V^2 = V_0^2 + 2a(X - X_0) \quad (4)$$

4 EQUATIONS
WHICH ONE TO USE?

1 $V = V_0 + at$

2 $X = X_0 + \frac{1}{2}(V_0 + V)t$

3 $X = X_0 + V_0 t + \frac{1}{2}at^2$

4 $V^2 = V_0^2 + 2a(X - X_0)$

EQ.	RELATES	DON'T KNOW variable
1	V, V_0, a, t	X, X_0
2	X, X_0, V_0, V, t	a
3	X, X_0, V_0, a, t	V
4	V, V_0, a, X, X_0	t

Kinematic equations

we will use these <u>alot</u>!

only valid when acceleration constant

what happens when $a = 0$

① $V = V_0 + at \Rightarrow V = V_0$

④ $V^2 = V_0^2 + 2a(x - x_0) \Rightarrow V^2 = V_0^2 \Rightarrow V = V_0$

② $x = x_0 + \frac{1}{2}(V + V_0)t \Rightarrow x = x_0 + Vt$

③ $x = x_0 + V_0 t + \frac{1}{2}at^2 \Rightarrow x = x_0 + Vt$

Now do lots of examples

1) DRAW picture
2) write down known variables
3) write down what variable question is asking about
4) identify which kinematic equation(s) relate knowns to the unknown
5) solve (put in numbers at end) use variables!
6) reasonable answer?
7) units

ex) A car can accelerate at $4.5\ m/s^2$. It starts from rest and accelerates in the negative x direction. After 8.0 seconds what is its speed and how far has it gone?

$a = -4.5\ m/s^2$ $\quad V_0 = 0\ m/s$

$t = 8.0\ s$ $\quad x_0 = 0\ m/s$

speed

x $\Rightarrow V = V_0 + at$

$= 0 + (-4.5\ m/s^2)(8.0s) =$

$-36\ m/s$

$+36\ m/s$

$x: x_0 + v_0 t + \frac{1}{2} a t^2$

$0 + 0 + \frac{1}{2}(-4.5\ m/s^2)(8.0s)^2 =$

$-144\ m$

ex) A ship is traveling with a speed of 3250 m/s. It slows down at a rate of $10\ m/s^2$. What is the ship's velocity after it has traveled 215 km

$V_0 = 3250\ m/s$

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

$X = 215\ km = 215000\ m$

$X_0 = 0$

Find V

$$V^2 = V_0^2 + 2a(X - X_0)$$

$$V^2 = (3250\ m/s)^2 + 2(-10\ m/s^2)(215{,}000\ m)$$

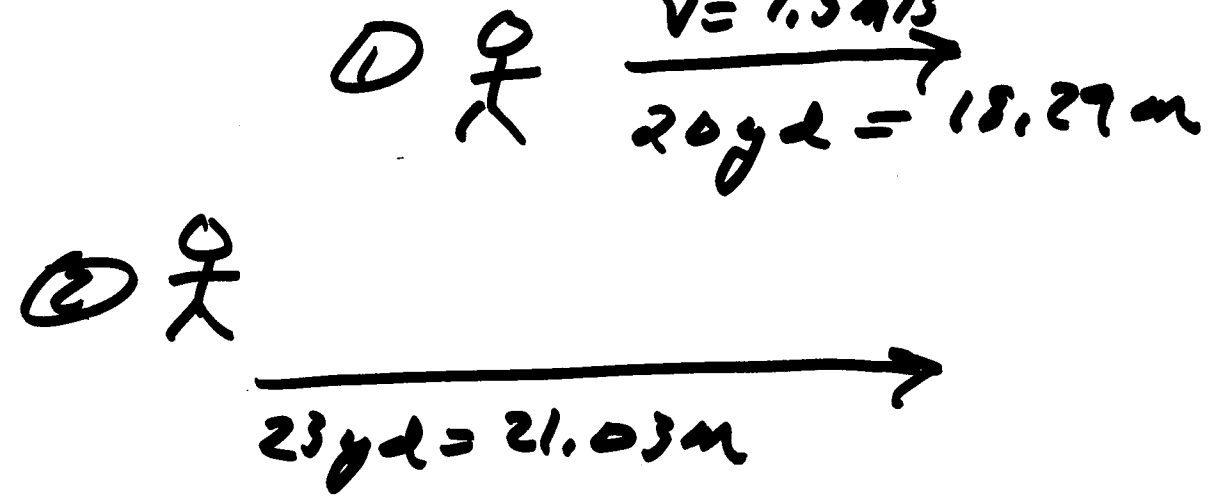
$$\underline{V = 2.5 \times 10^3\ m/s}$$

Interactive Question

Starting from rest, a roller coaster that is confined to move along a straight line is accelerated at a rate of 4 m/s^2. After 10 seconds how far will the roller coaster have traveled?

A) 20 m
B) 40 m
C) 100 m
D) 200 m
E) 400 m

ex| A person picks up a football at the 20 yard line and runs toward the end zone at a speed of 7.3 m/s. A person standing on the 23 yard line wants to stop a touchdown. what must be the person's minimum acceleration to stop the touch down? (constant acceleration)



① x_1 v_1 $a = 0$

② x_2 $v_0 = 0$

Find a

let's Find time

$x = x_0 + vt$ $\quad x_0 = 0$

$$t = \frac{x - x_0}{v} = \frac{18.29\,m}{7.3\,m/s} = 2.5\,s$$

$$x = \cancel{x_0}^{0} + \cancel{v_0}^{0} t + \frac{1}{2} a t^2$$

$x - x_0$

$$a = \frac{2x}{t^2} = \frac{2 \cdot 21.03\,m}{(2.5\,s)^2}$$

$$a = 4.7\,m/s^2$$

Reasonable?