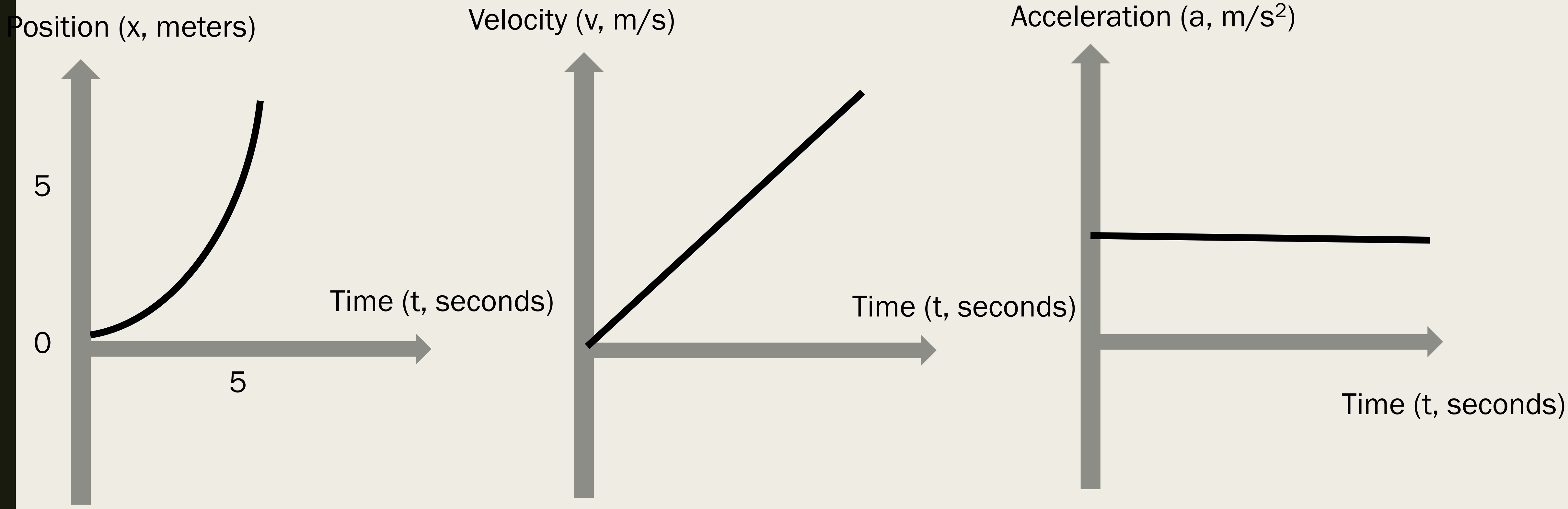
Storytelling by graph

time (t, s)	Position (x, m)
0	0
1	5
2	15
3	15
4	25
5	30

- Take out your Linear Graphs WS1
- In groups of 3
  1. Draw a position vs. time graph for the table
  2. Draw a velocity vs. time graph
  3. Calculate the displacement from the velocity vs. time graph
  4. Make up a story where this graph is feasible



"Object is accelerating in the positive x-direction"

Goals for today

- Discuss standard deviation
- Review for quiz tomorrow
- Go through our kinematics equations

Equations you will be given on the quiz

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t}$$

…And any conversions

Things I expect you to know

$$average\ speed = \frac{distance}{time} \qquad average\ velocity = \frac{displacement}{time}$$

- Answer some conceptual and numerical questions about **scalar/vector, distance/displacement, speed/velocity, instantaneous vs. average velocity,** and **acceleration**
- Make sure your units check out!

Conceptual question example

- Which of the following can be units for acceleration?
  - m/s
  - km/hr
  - m/s^2
  - mph

Things I expect you to know pt. 2

- *Describe the motion of an object given a position vs. time graph*
- *Given an object's motion, draw a position over time and a velocity over time graph*

EVERYTHING FROM HERE ON OUT WILL NOT BE ON YOUR QUIZ

So no worries here.

Kinematics vs dynamics

- **Kinematics** studies the motion of objects
- **Dynamics** studies the forces that cause that motion

Motion at constant acceleration

- If acceleration is constant (which in many practical situations it is)…
- Can use this fact to derive some pretty convenient relationships between acceleration, velocity, and position with respect to time

Motion at constant acceleration

$$v = \frac{\Delta x}{\Delta t}$$

$$\boldsymbol{a} = \frac{\Delta \boldsymbol{v}}{\Delta \boldsymbol{t}}$$

$$x_f = x_i + v\Delta t$$

$$v_f = v_i + a\Delta t$$

Example #1

- *Kira decelerates for 3.00 seconds from 12.0 m/s at a rate of -2.0 m/s each second. What is her final speed?*

$$v_f = v_i + a\Delta t$$

- v_f =12.0 m/s – (2.0 m/s^2)(3.00s)
- v_f =6.0 m/s

Motion at constant acceleration

- With a little simple calculus, can find acceleration's contribution to a change in position…
- $x_f = x_i + v_i \Delta t + \frac{1}{2} a \Delta t^2$
- Or $\Delta\, x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
- (For the full derivation check out http://physics.info/kinematics-calculus/)

- Extension from our California Screamin' ride problem – if the ride's acceleration is 6.2 m/s^2 at the beginning and goes from 0 to 25 m/s in 6.0 seconds, what is its final position if we say the initial position is 0? $x_f = x_i + v_i \Delta t + \frac{1}{2} a \Delta t^2$
- X_f=(0m)+(0m/s)(6s)+$\frac{1}{2}(6.2\text{m}/s^2)$(6s)^2
- 110m

- Minimum stopping distance is important in traffic design. The average human reaction time is 0.22 s, meaning there is a 0.22 s delay between when one decides to break and when he or she actually begins breaking. A typical car can decelerate at 6.0 m/s^2 in good conditions. Knowing this, calculate the total stopping distance in meters for a vehicle is traveling at 100. km/h.
- Ans. 71 m

But what if there's no time??

- $v_f^2 - v_i^2 = 2a\Delta x$

- Just like out of a DMV video – Kay is driving on a residential street at 16 m/s when she sees a ball roll into the road 12.0m ahead and she knows a child is soon to follow. What must be her deceleration in order to stop before hitting the ball or the following child?

$$v_f^2 - v_i^2 = 2a\Delta x$$

- $a = \frac{0-\left(\frac{16.0m}{s}\right)^2}{2*12.0m}$
- a= - 51.0 m/s^2

Your 4 kinematic equations

$$v_f = v_i + a\Delta t$$

$$x_f = x_i + v\Delta t$$

$$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$v_f^2 - v_i^2 = 2a\Delta x$$

Strategies for solving a kinematics problem

- *Draw it out first*
- *Figure out your* ***unknowns****/what you are solving for*
- *Write down your* ***knowns/givens***
- *Make sure everything is in the right* ***units***
- ***Find the equation*** *that best fits your unknowns and knowns*
- ***Solve****!*

Practice may not make you perfect, but it certainly makes you better!