Numerical Integration in Igor

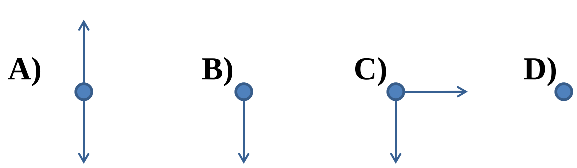
Tossing a ball in the air

or

What goes up must come down

Simple Case:
Toss a Ball *Straight Up* in the Air

When the ball is in the air, what is the force diagram for the ball?



E) None of These

Simple Case: Toss a Ball *Straight Up* in the Air

- What will the trajectory of the ball look like?

x vs. *t* *y* vs. *t* *x* vs. *y*

Simple Case: Toss a Ball *Straight Up* in the Air

Acceleration is…

A) constant **B)** proportional to t **C)** proportional to t^2

D) none of these

Acceleration is equal to… ***-g***

- Let's make a CONSTANT above the function
- Now we can make a wave for accel_m_s2

Simple Case: Toss a Ball *Straight Up* in the Air

Velocity is…

A) constant **B)** proportional to t **C)** proportional to t^2

D) none of these

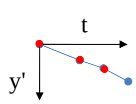
Velocity is related to *acceleration* by… ***a = dv/dt***

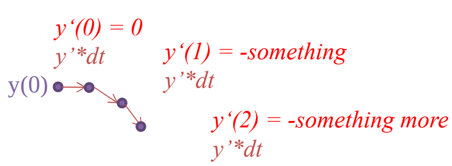
dv = a*dt

Integrating Acceleration → Velocity

We'll use Euler's Method:

$$y(i) = y(i-1) + y'(i)*dt$$





∫ *line = parabola*

Since we already "know" how to calculate the answer…

- Let's make a table to calculate (check) what we expect to get for velocity

Acceleration (m/s^2)	Time (s)	Velocity (m/s)
	0	
	1	
	2	
	3	

Since we already "know" how to calculate the answer…

- Let's make a table to calculate (check) what we expect to get for velocity

Acceleration (m/s^2)	Time (s)	Velocity (m/s)
-9.8	0	
-9.8	1	
-9.8	2	
-9.8	3	

Need an initial condition!

Let's just drop the ball. Then v_0 = ?

Since we already "know" how to calculate the answer…

- Let's make a table to calculate (check) what we expect to get for velocity

Acceleration (m/s^2)	Time (s)	Velocity (m/s)
-9.8	0	0.0
-9.8	1	
-9.8	2	
-9.8	3	

Since we already "know" how to calculate the answer…

- Let's make a table to calculate (check) what we expect to get for velocity

Acceleration (m/s^2)	Time (s)	Velocity (m/s)
-9.8	0	0.0
-9.8	1	- 9.8
-9.8	2	-19.6
-9.8	3	-28.4

How do we tell the computer how to do this calculation?

1. Use the *initial condition* to fill in the first element of the wave.

2. For every row in the rest of the wave, calculate $v_i = v_{i-1} + a_i*dt$

- In the function we can do step 1:
  - Create a variable v_0_m_s
  - make vel_m_s
  - set zeroth point of vel_m_s = v_0_m_s

Simple Case: Toss a Ball *Straight Up* in the Air

Position is…

A) constant **B)** proportional to t **C)** proportional to t^2

D) none of these

Position is related to *velocity* by … ***v = ds/dt***

ds = v*dt

How can we implement the position calculation?

A. Position *must* be calculated in a **different** function.

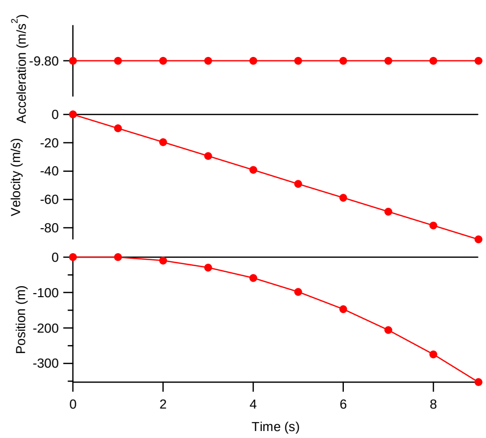
B. Position can be calculated in a ***separate*** for loop ***before*** calculating the velocity.

C. Position can be calculated in a ***separate*** for loop ***after*** the loop for calculating velocity.

D. Velocity and position can be calculated in the **same** for loop.

Let's make a plot!

- Make your axes like this
  - Spacing, alignment
  - Axis labels
  - Zero line for velocity, position
- Markers are nice, but not necessary



Next Steps

- Change v_0 and s_0 and see changes
- Generalize the function with input variables
- Assume that
  - $s_0 > 0$
  - the ground = 0
  - After the ball hits the ground it stays there for all remaining time