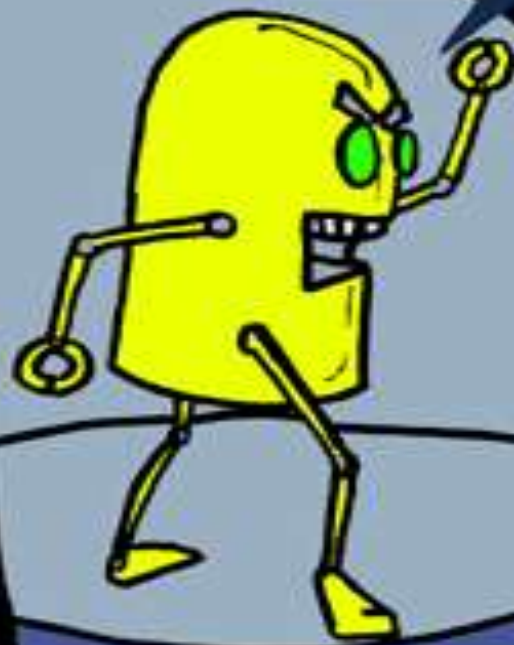


FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!



# Physics of Projectile Motion

FINALLY EARTH'S  
GREENHOUSE GAS



GHS Fizzix 2011

DT ([DT@DTFizzix.com](mailto:DT@DTFizzix.com))



The Stupid, It Burns

UNREGISTERED



my foxny.com



FINALLY EARTH'S  
PARADISE CASE





The Stupid, It Burns

# Projectile Motion

- Learn all these now.

FINALLY EARTH'S GREENHOUSE EFFECT HAS LOWERED! THE INVASION CAN BEGIN!

In a projectile motion, the only acceleration is gravitational one whose direction is always toward the center of the earth (downward).

*Show that a projectile motion is a parabola!!!*

$$v_{xi} = v_i \cos \theta_i$$

$$a = a_x i + a_y j \equiv -g j$$

$$v_{yi} = v_i \sin \theta_i$$

**a<sub>x</sub>=0**

$$x_f = v_{xi} t = v_i \cos \theta_i t \quad t = \frac{x_f}{v_i \cos \theta_i}$$

$$y_f = v_{yi} t + \frac{1}{2} (-g) t^2$$

$$= v_i \sin \theta_i t - \frac{1}{2} g t^2$$

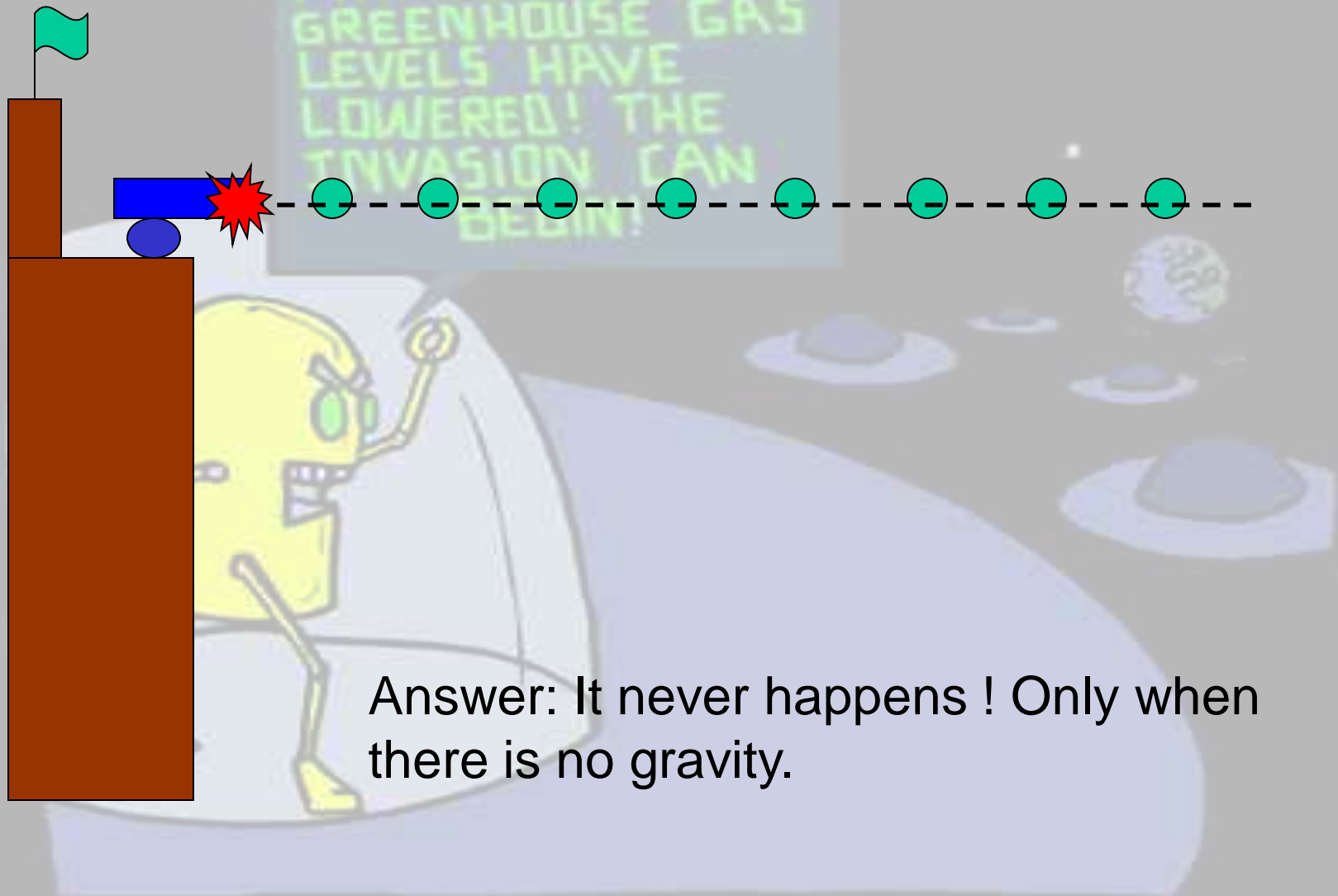
**Plug in the t above**

$$y_f = v_i \sin \theta_i \left( \frac{x_f}{v_i \cos \theta_i} \right) - \frac{1}{2} g \left( \frac{x_f}{v_i \cos \theta_i} \right)^2$$

$$y_f = x_f \tan \theta_i - \left( \frac{g}{2v_i^2 \cos^2 \theta_i} \right) x_f^2$$

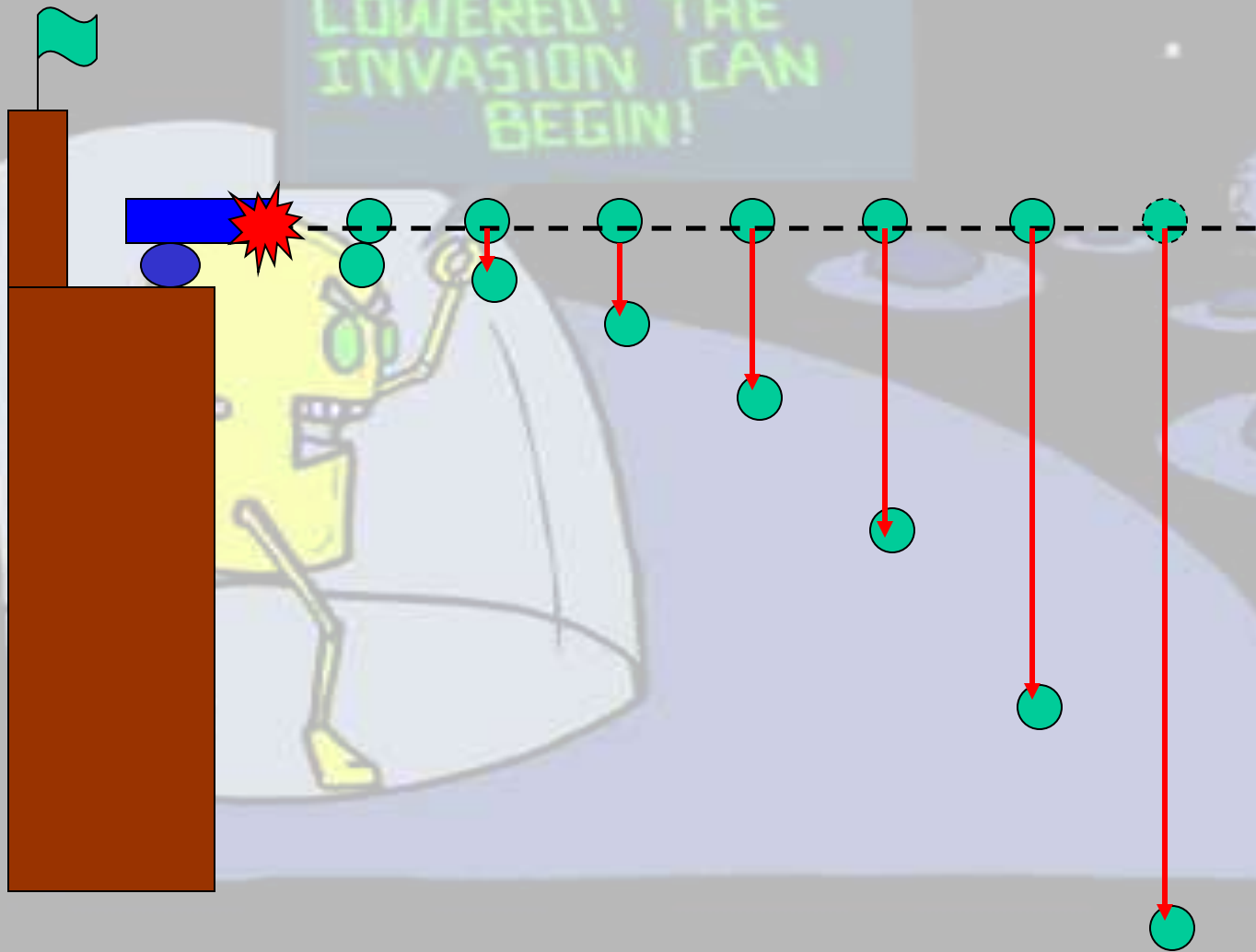
What kind of parabola is this?

# What's wrong with this picture ?

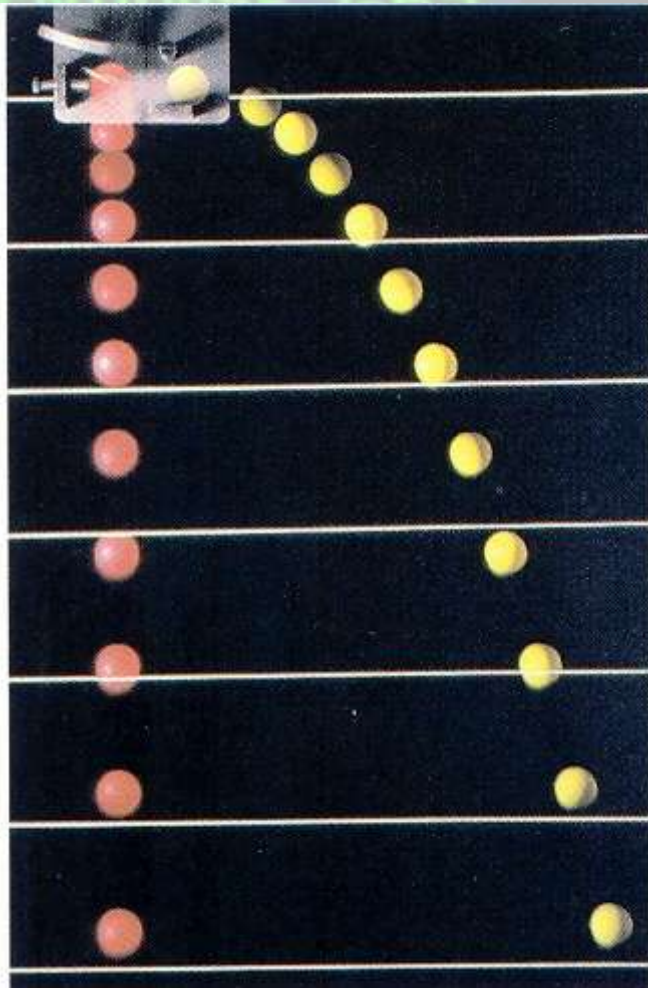


Answer: It never happens ! Only when there is no gravity.

# Why do projectiles fly in a parabola?



FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS  
LOW  
IN



FIN  
GR  
LEV  
LO  
IN



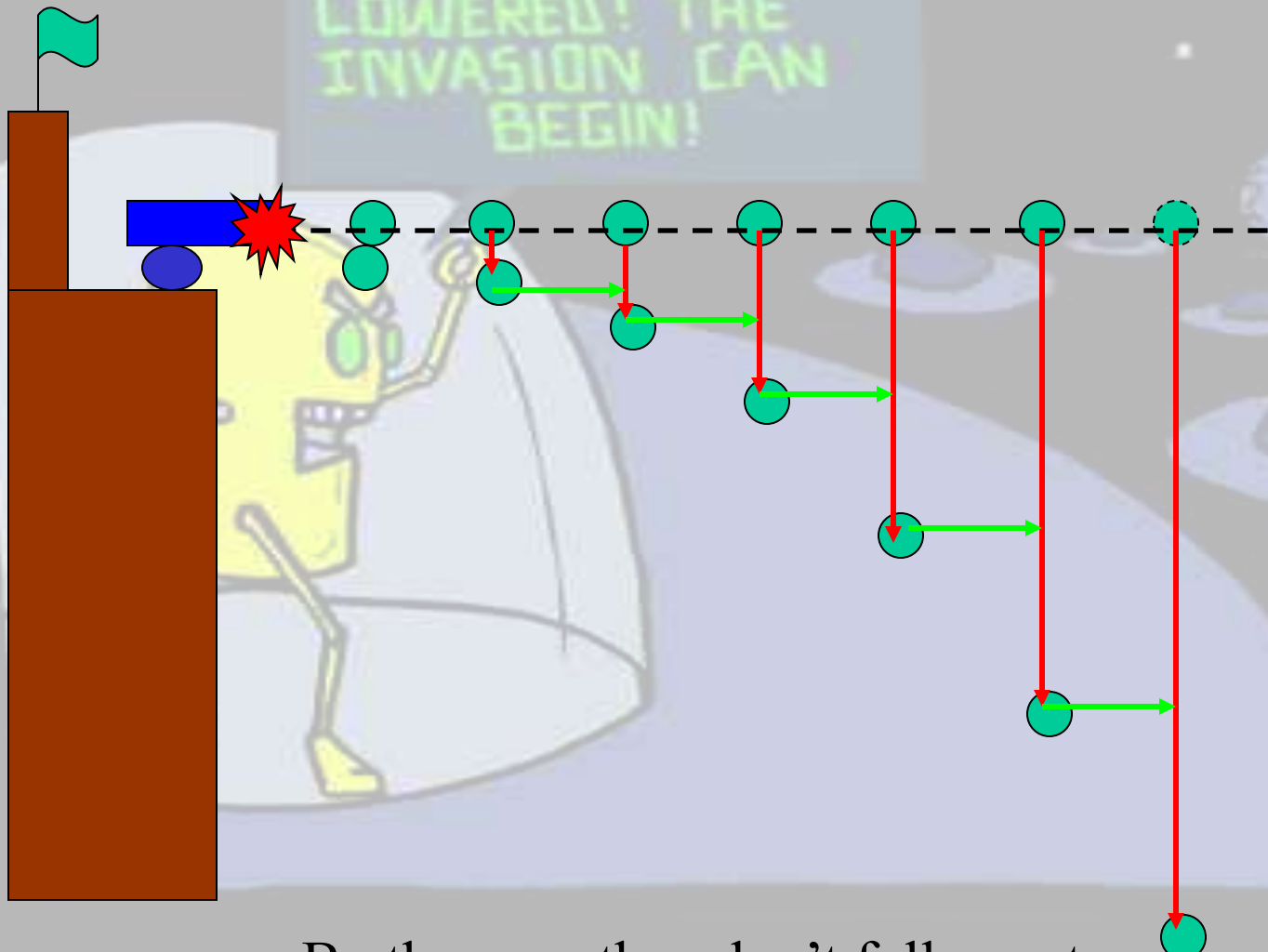
Reese Witherspoon



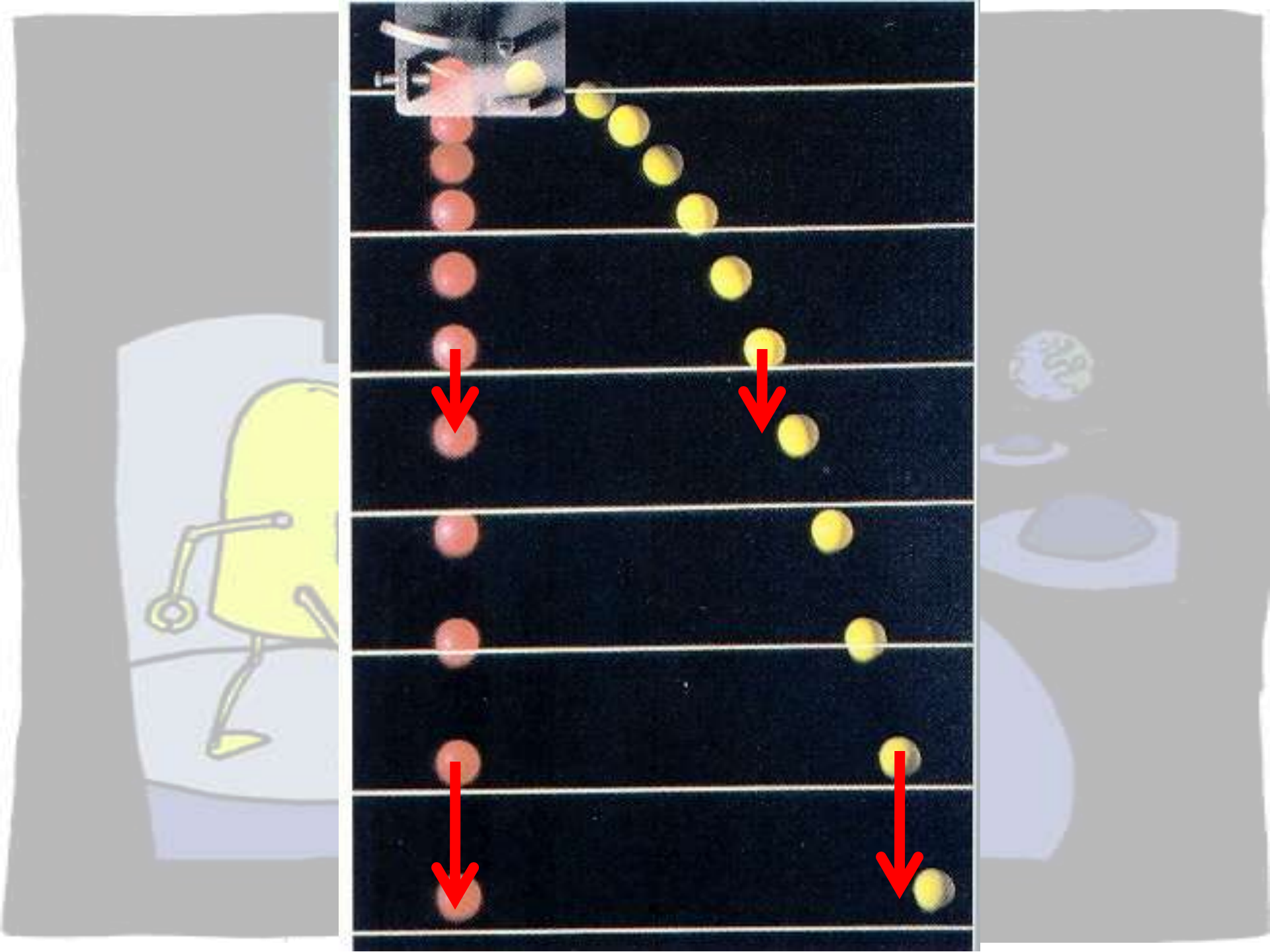
Reese Withouterspoon



# Why do projectiles fly in a parabola?



By the way, they don't follow a true parabolic path...



# FoxTrot

BILL AMEND

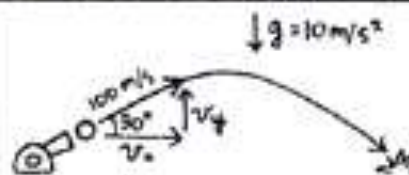
Name: Peter Fox



Date: Not as often as I'd like to, sadly.



1. A projectile is fired from a cannon at a 30-degree angle with the ground and an initial velocity of 100 m/sec. Assuming no air resistance and  $g = 10 \text{ m/sec}^2$ , calculate the time it will spend in the air.

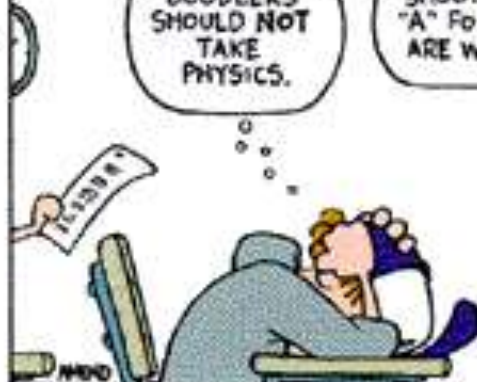


TIME'S UP, EVERYONE. PLEASE PASS YOUR TESTS FORWARD.

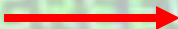


Doodlers SHOULD NOT TAKE PHYSICS.

SHOOTING FOR AN "A" FOR "APPALLING," ARE WE, MR. FOX?

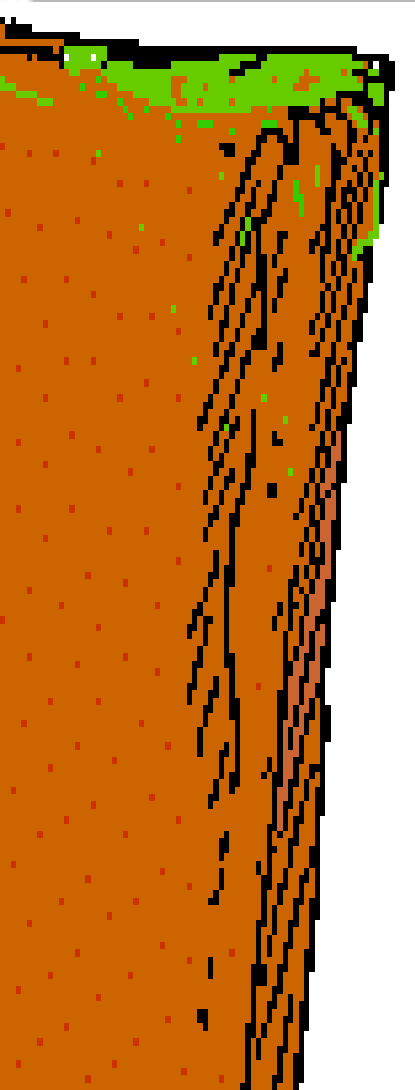


# PROJECTILE MOTION

$v_0$  

- Launch a projectile horizontally from the top of a cliff.

Draw the subsequent path of the projectile marking the position of the projectile at equal intervals of time.

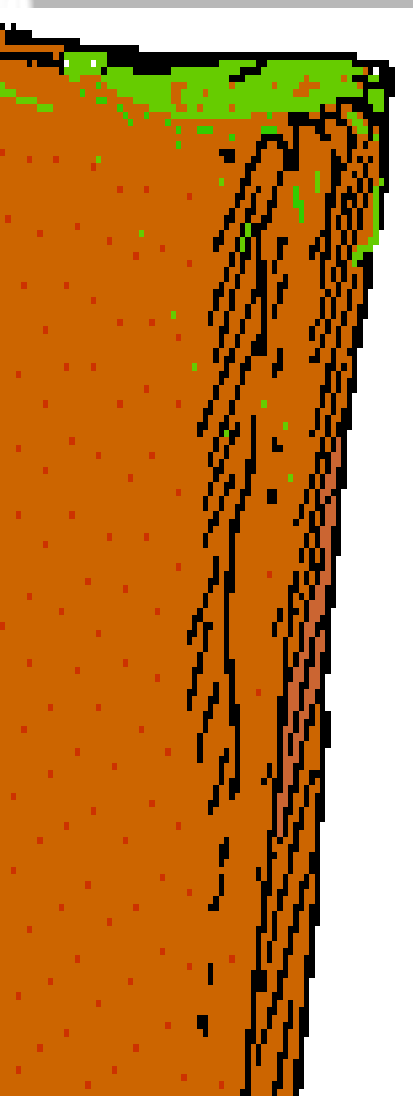


# PROJECTILE MOTION

FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN

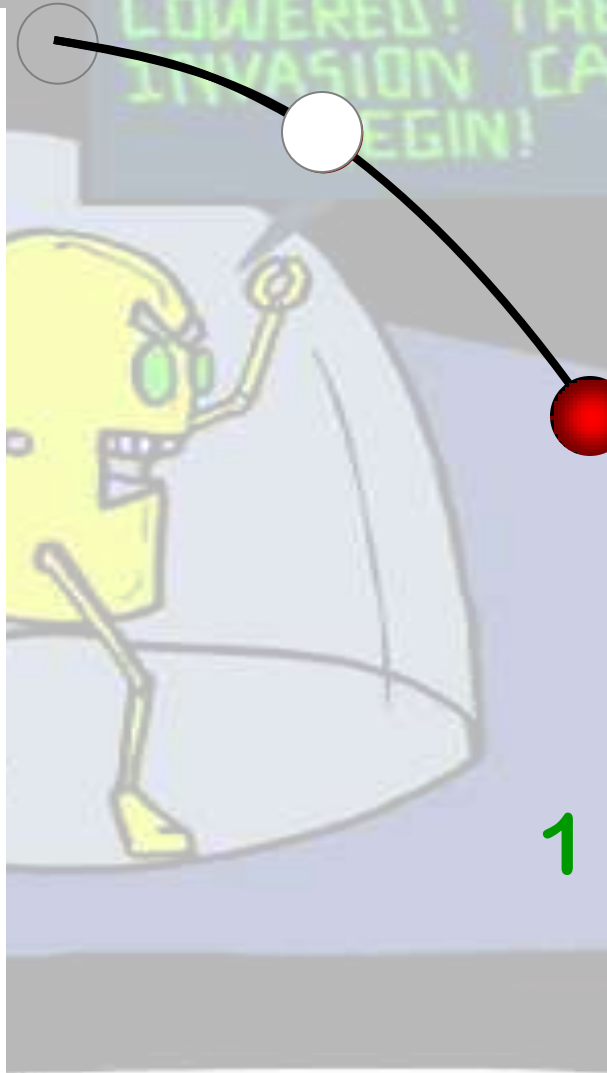


How much time has passed  
between subsequent  
positions? **unit of time**



# PROJECTILE MOTION

FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

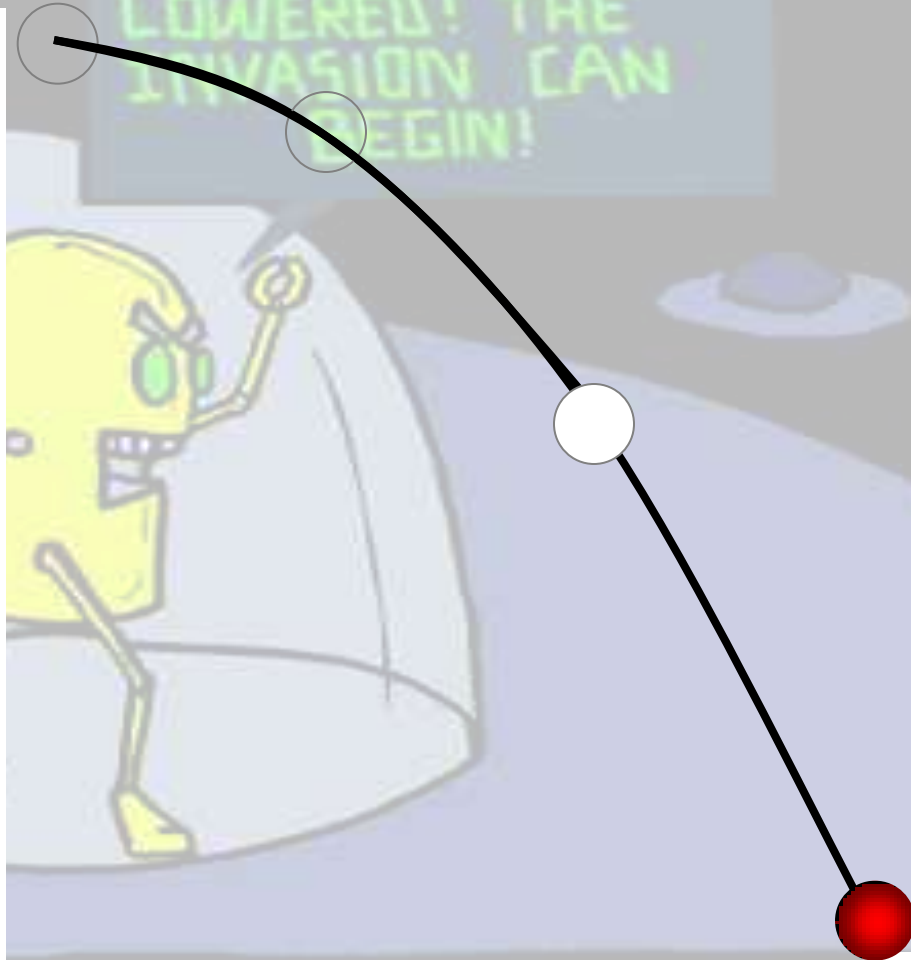


How much time has passed between subsequent positions?

1 unit of time

# PROJECTILE MOTION

FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

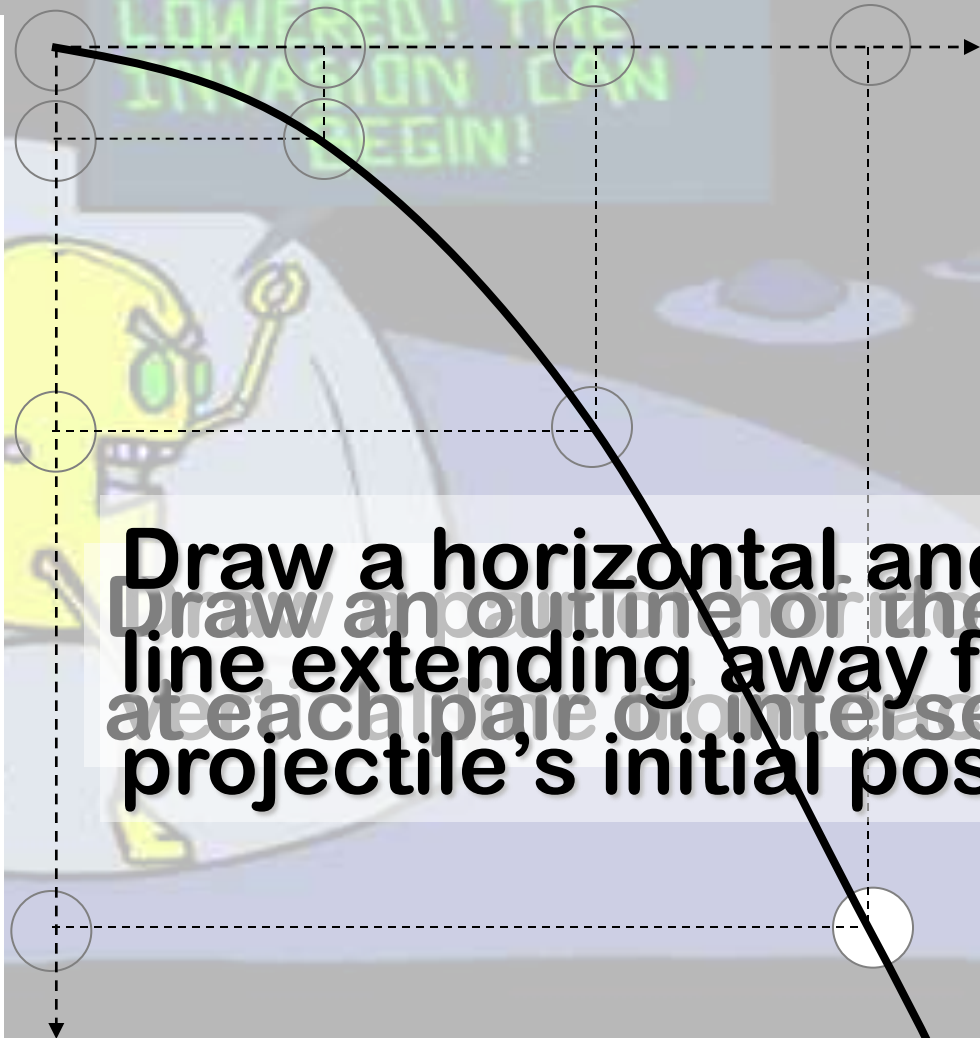


How much  
time has  
passed  
between  
subsequent  
positions?

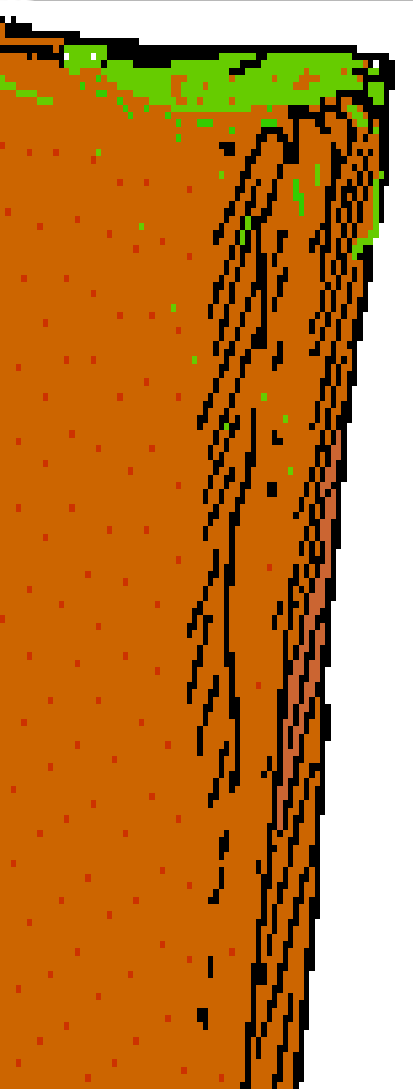
1 unit of time

# PROJECTILE MOTION

FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

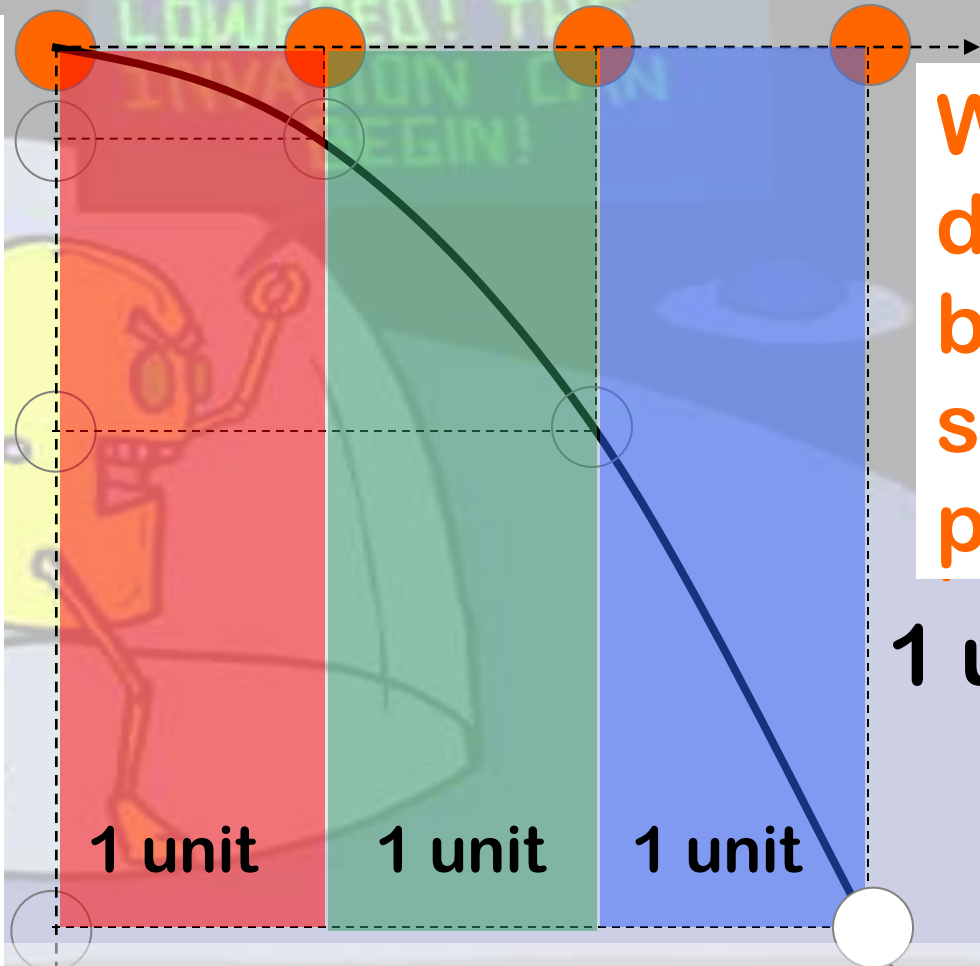
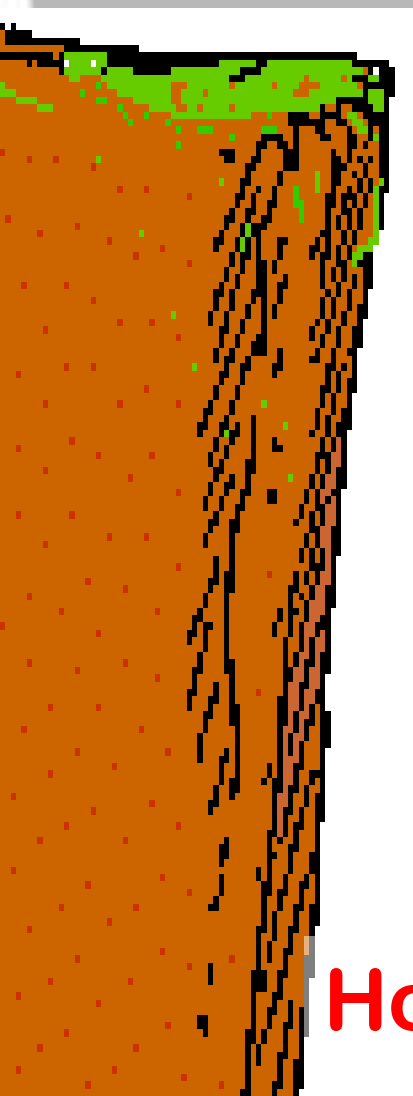


Draw a horizontal and vertical line extending away from the the projectile at each pair of intersecting lines at the projectile's initial position.



# PROJECTILE MOTION

Describe the horizontal displacements.



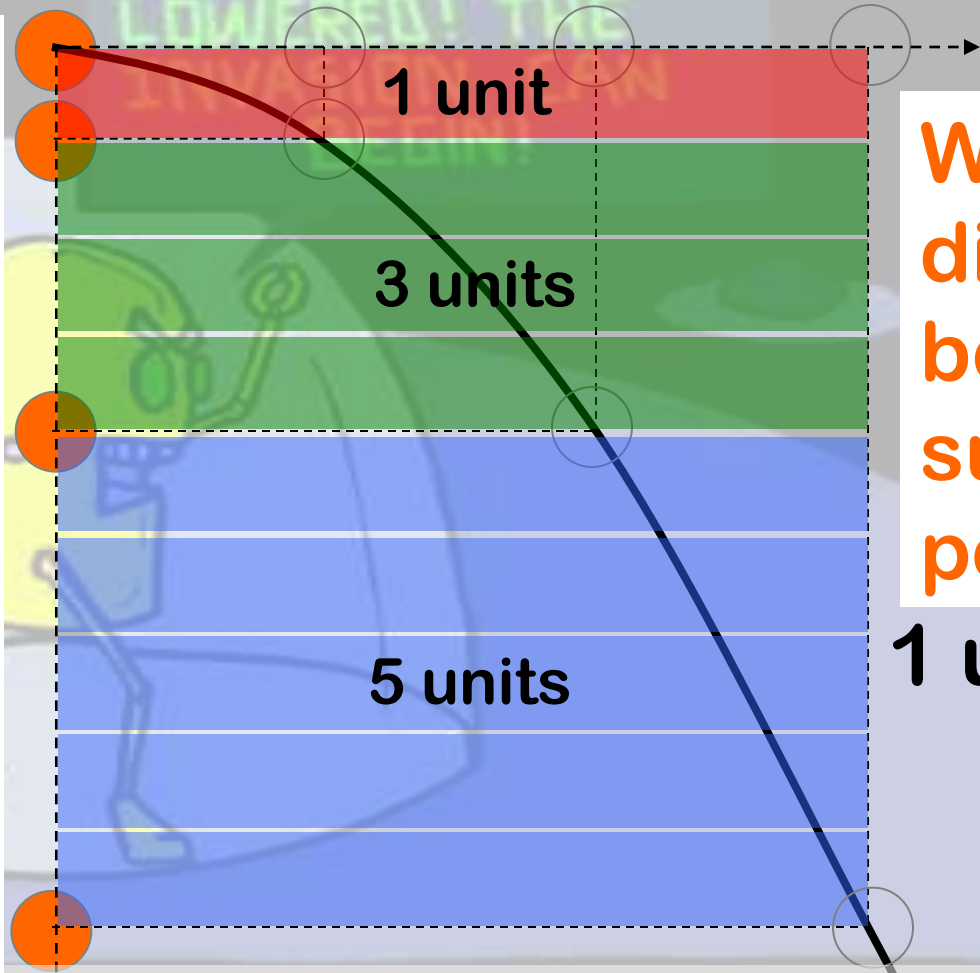
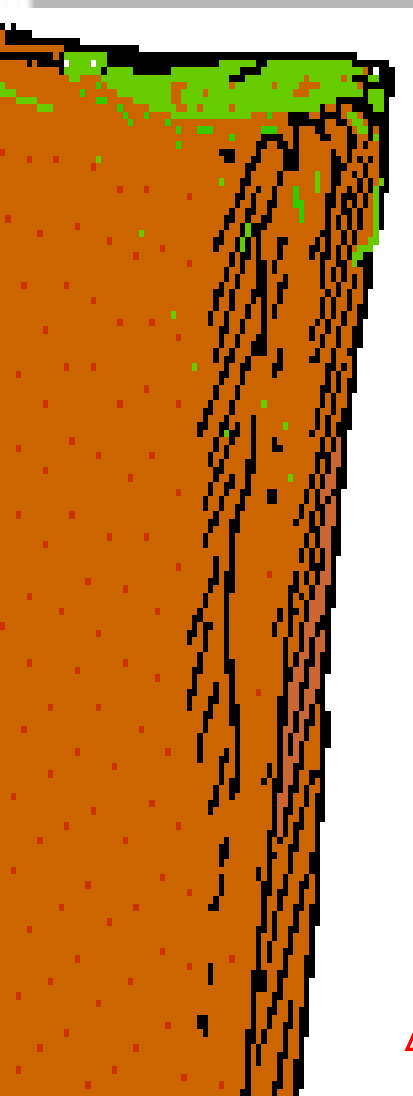
What's the displacement between subsequent positions?

1 unit of time

**Horizontal Displacements are EQUAL**

# PROJECTILE MOTION

Describe the vertical displacements.



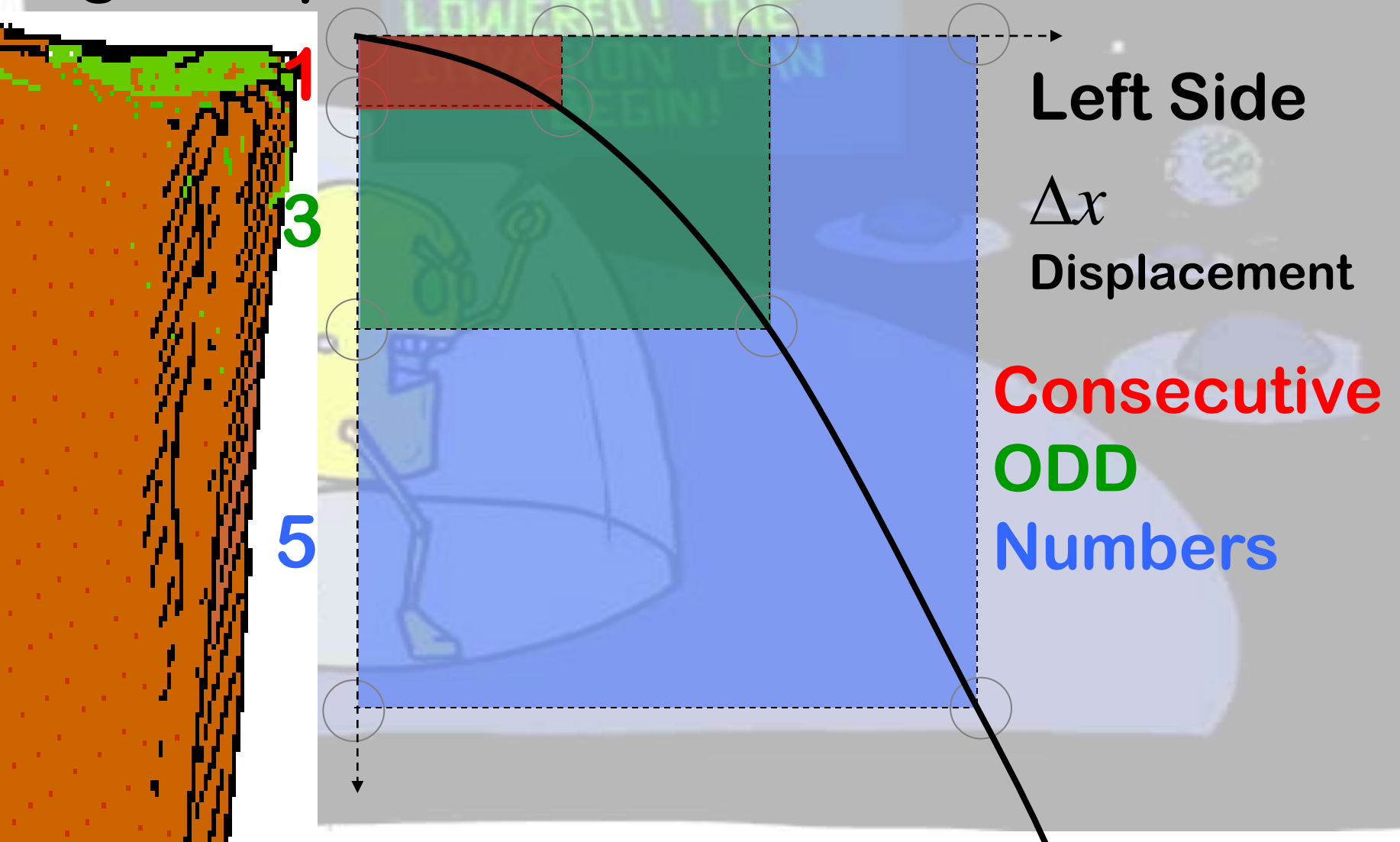
What's the displacement between subsequent positions?

1 unit of time

$\Delta x$ 's = Consecutive ODD #s

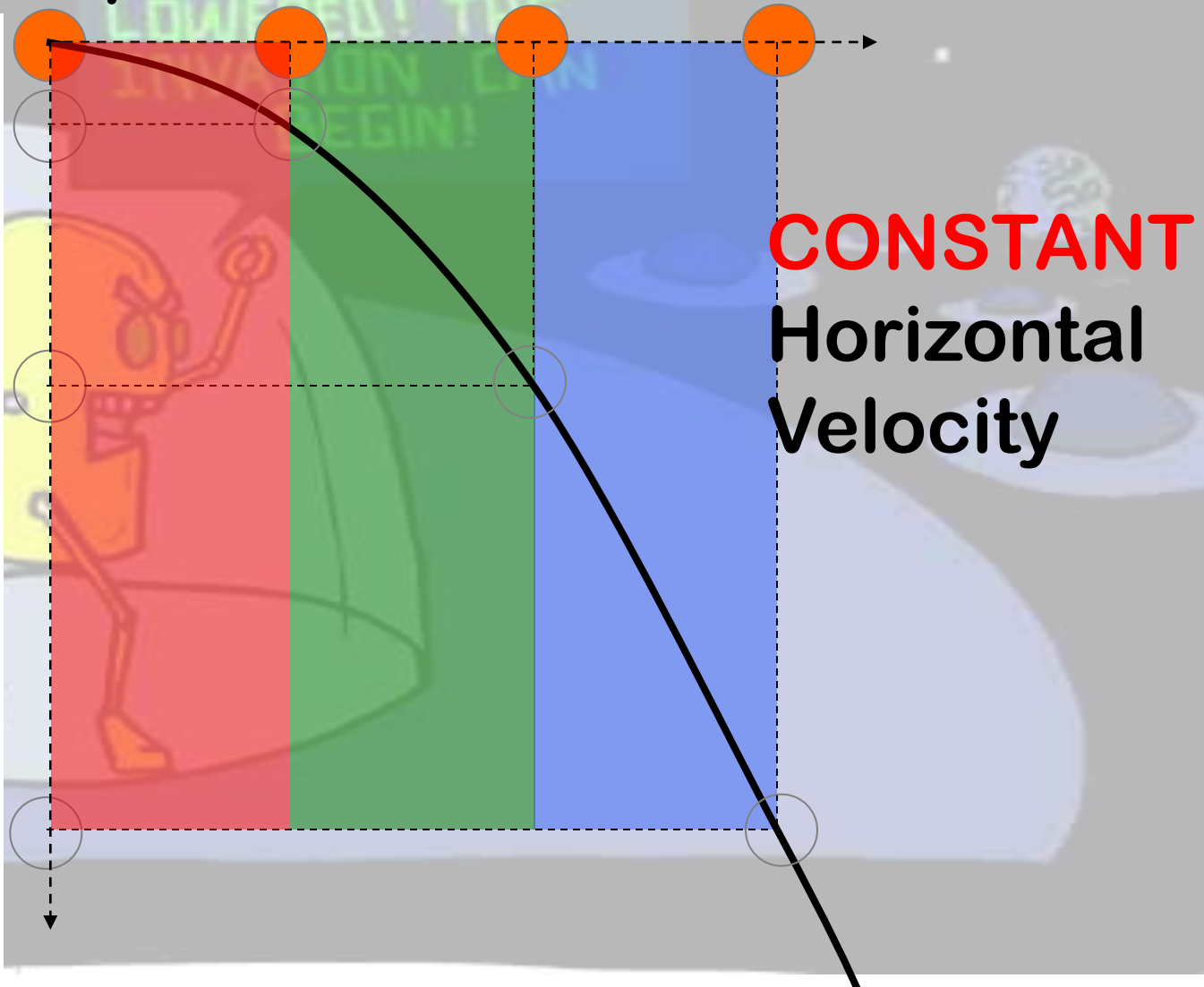
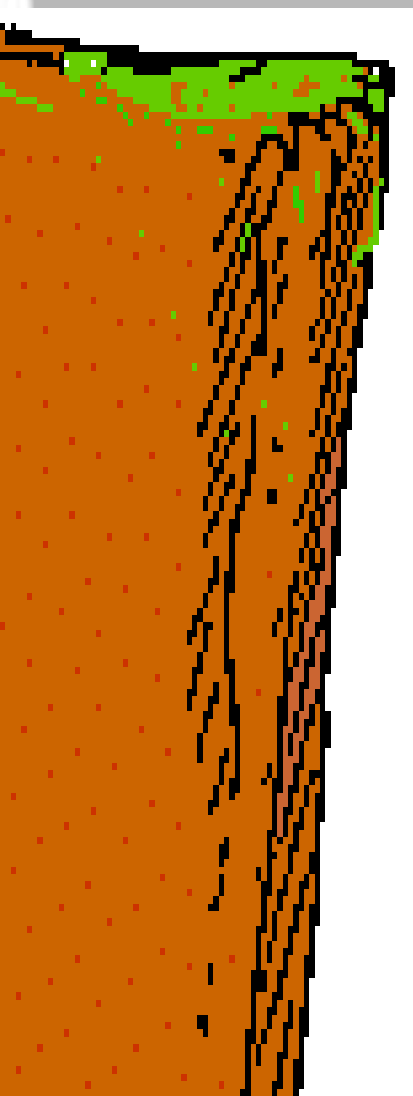
# PROJECTILE MOTION

What does each vertical side of a colored region represent?



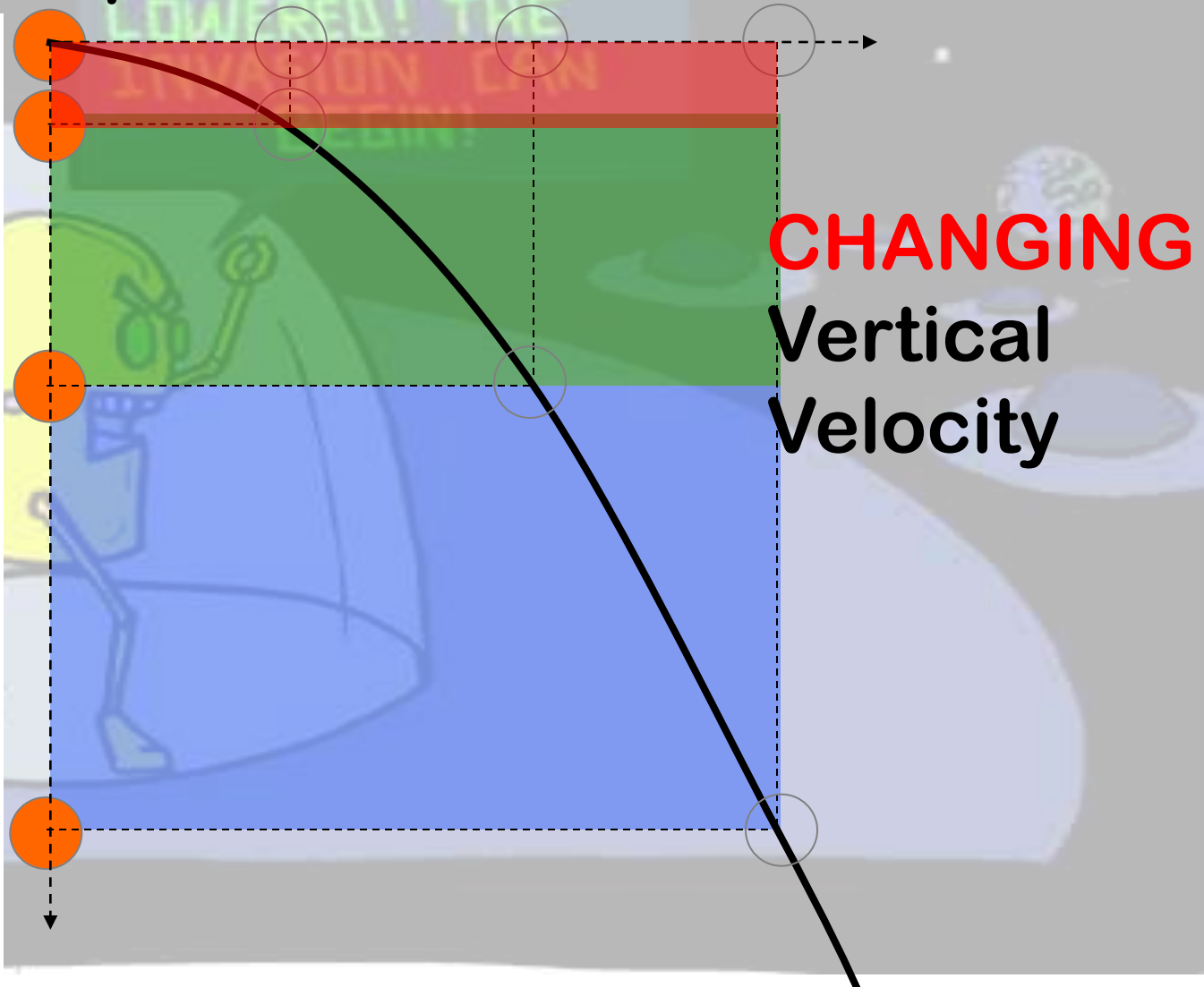
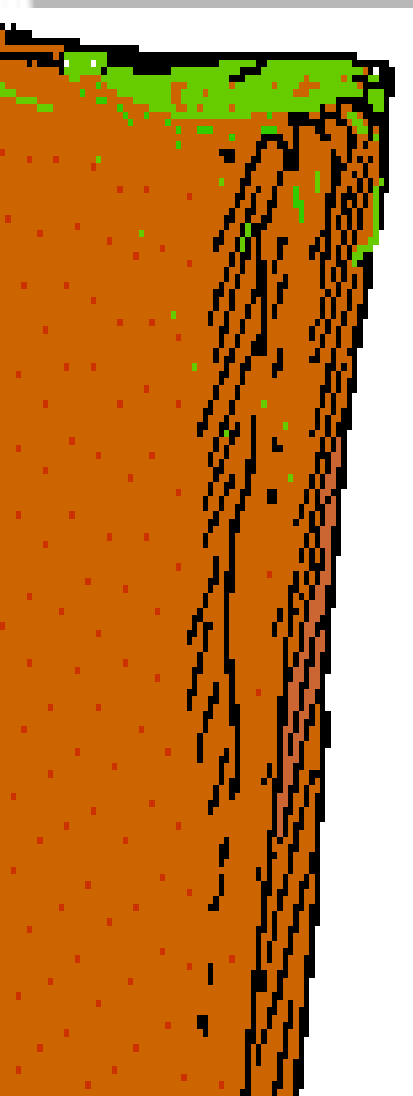
# PROJECTILE MOTION

Describe the motion of the projectile at subsequent positions.



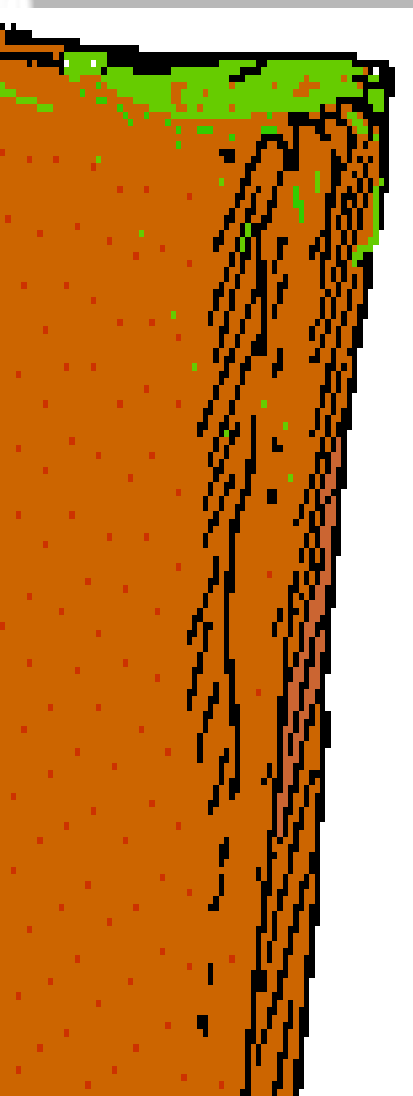
# PROJECTILE MOTION

Describe the motion of the projectile at subsequent positions.



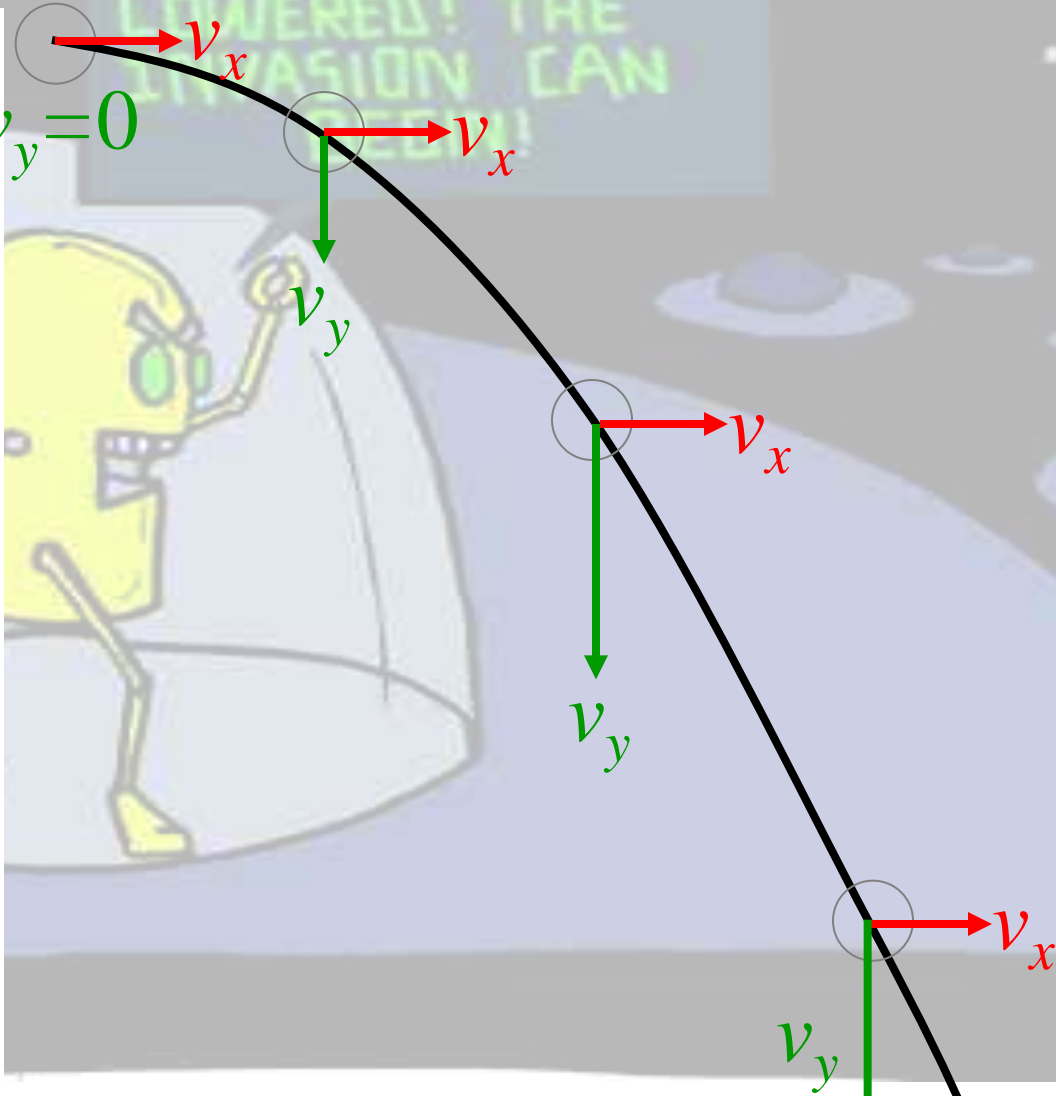
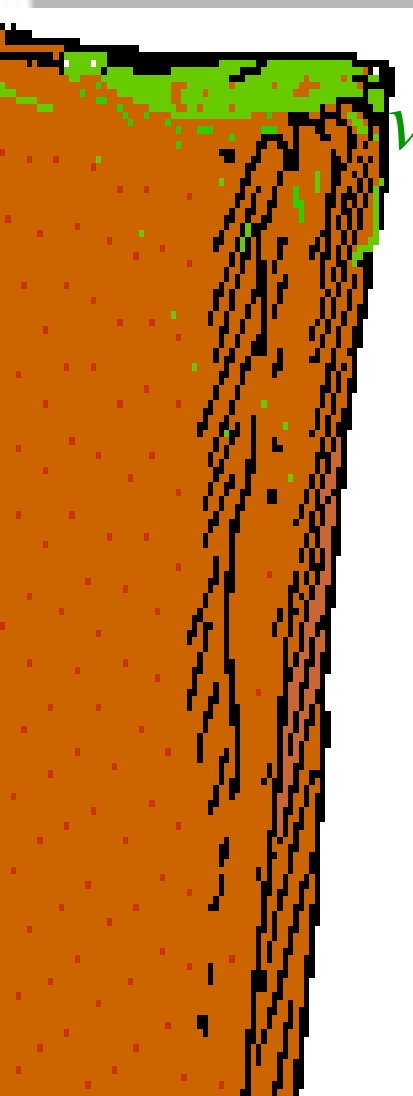
# PROJECTILE MOTION

Draw an arrow representing the **horizontal** velocity at each position.



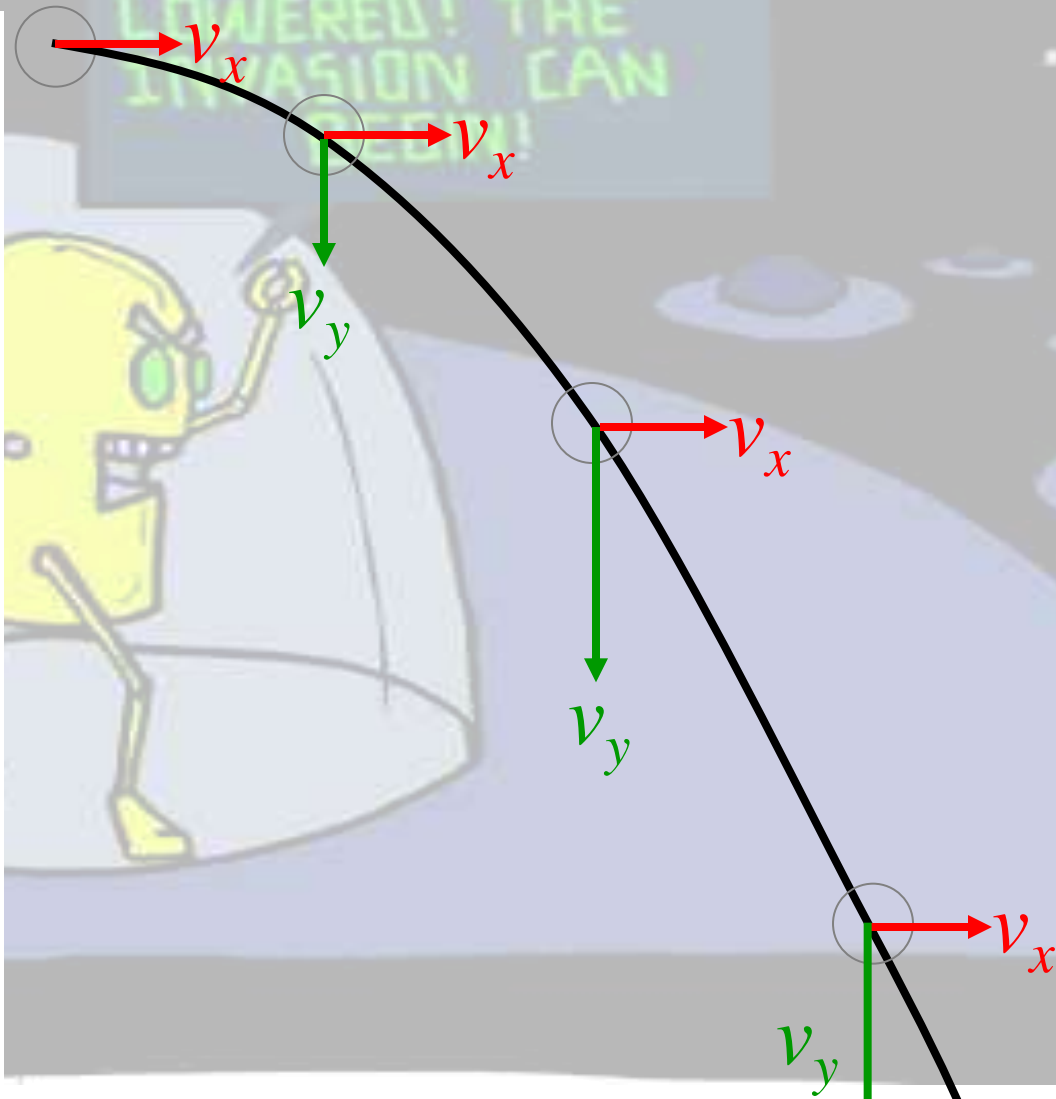
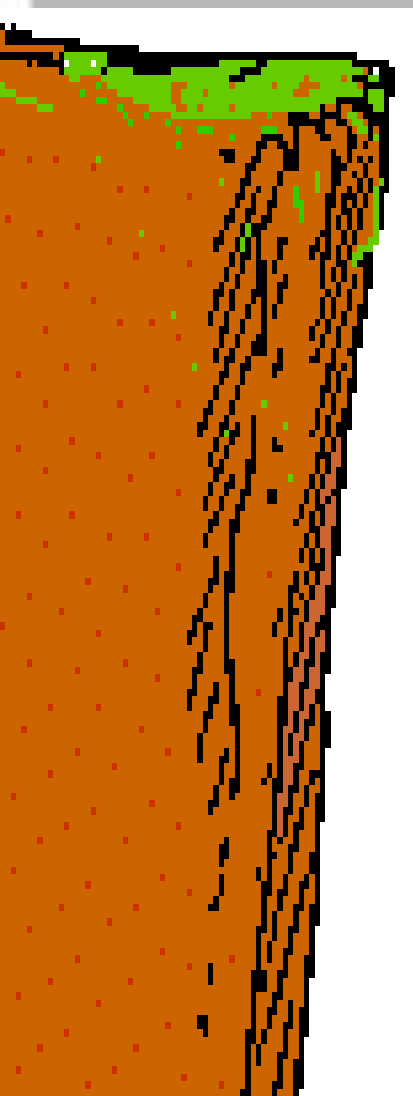
# PROJECTILE MOTION

Draw an arrow representing the **vertical** velocity at each position.



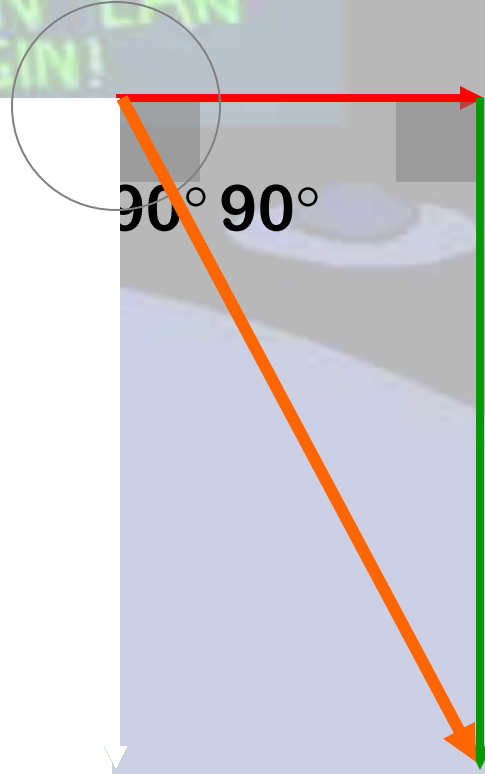
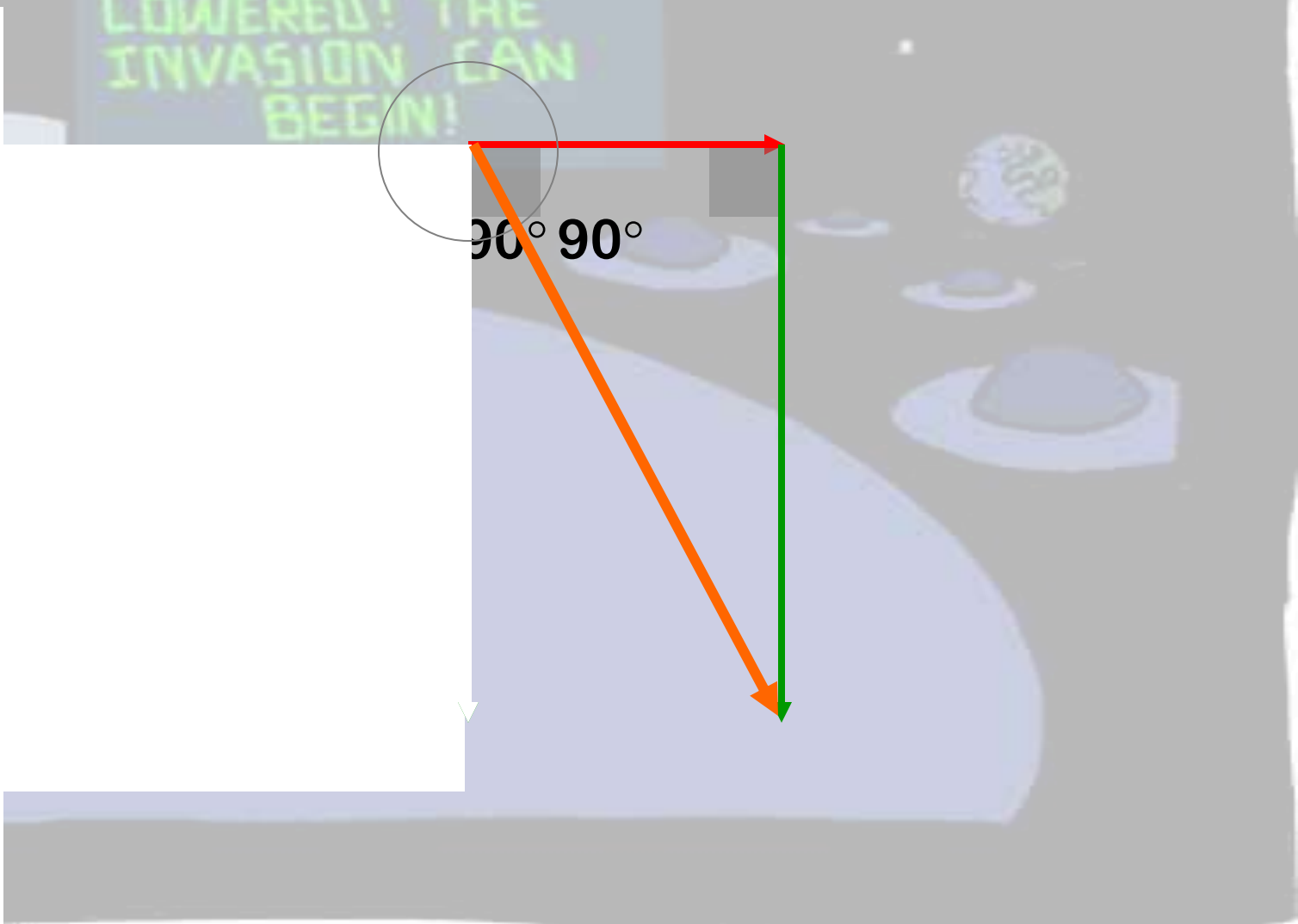
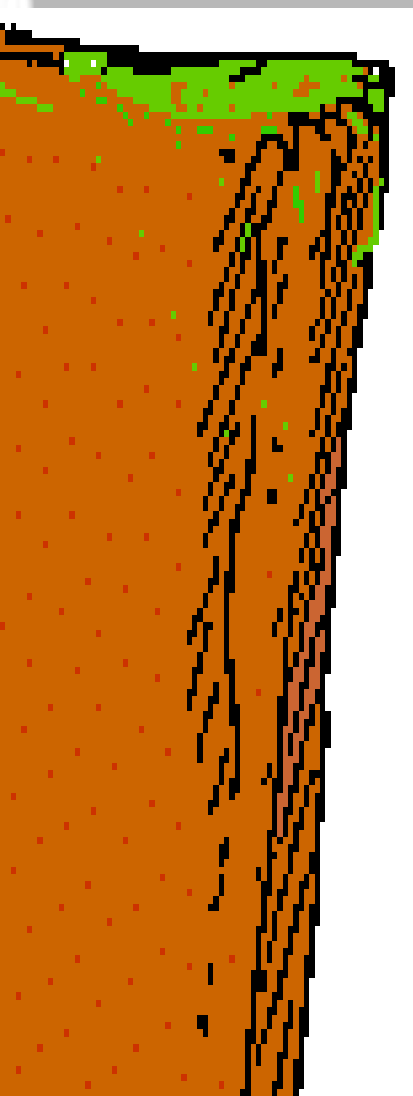
# PROJECTILE MOTION

Draw an arrow representing the **speed** at each position.



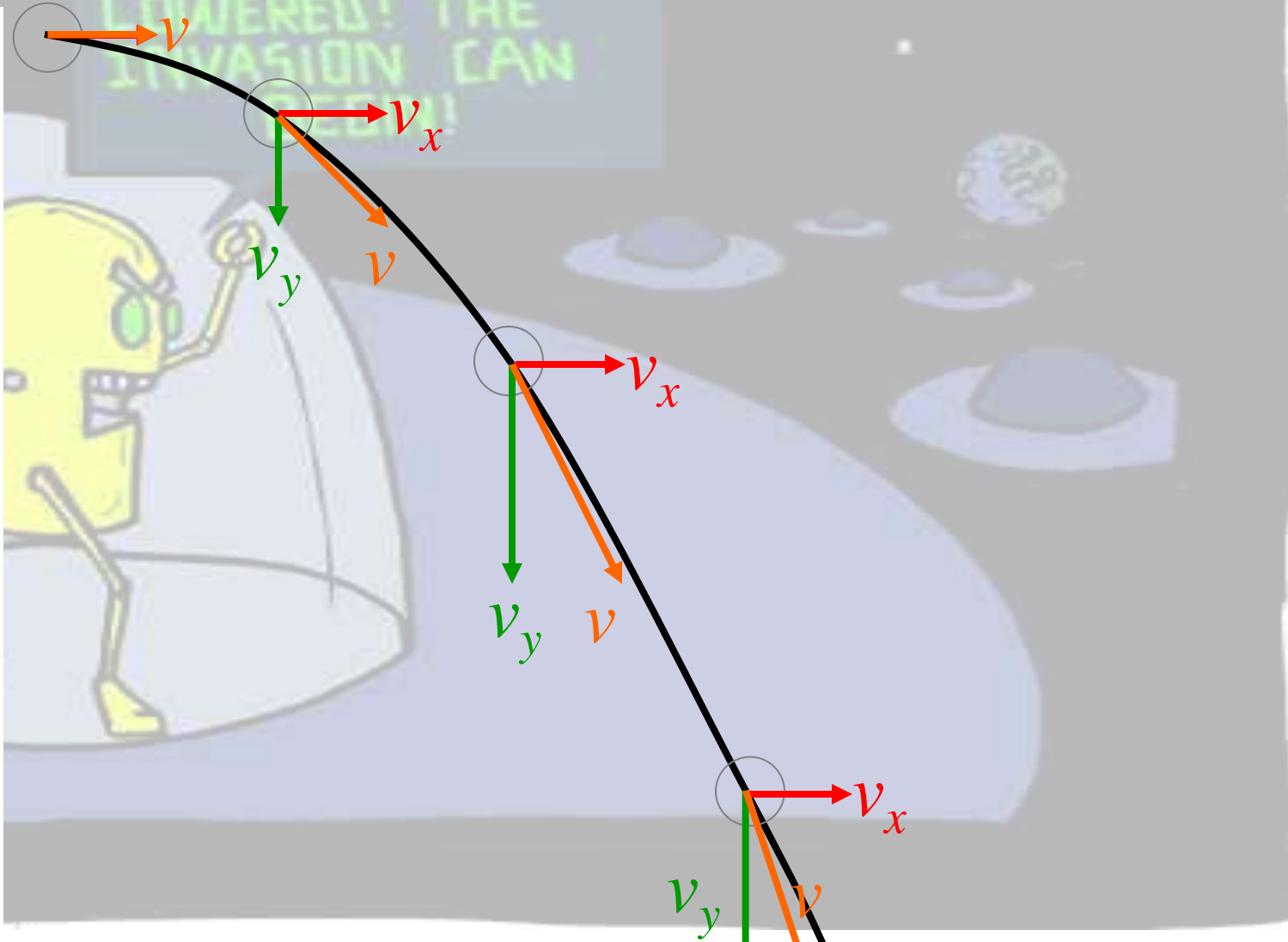
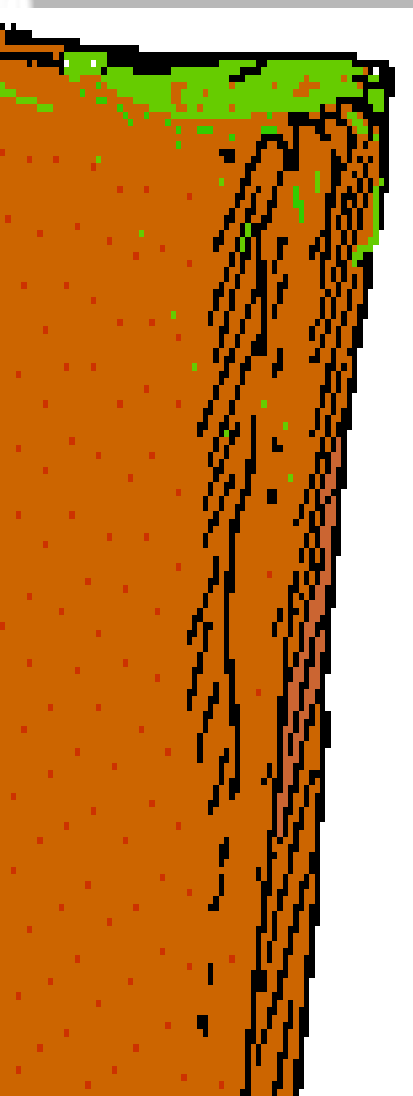
# PROJECTILE MOTION

Use your knowledge of right triangles to draw in the speed.



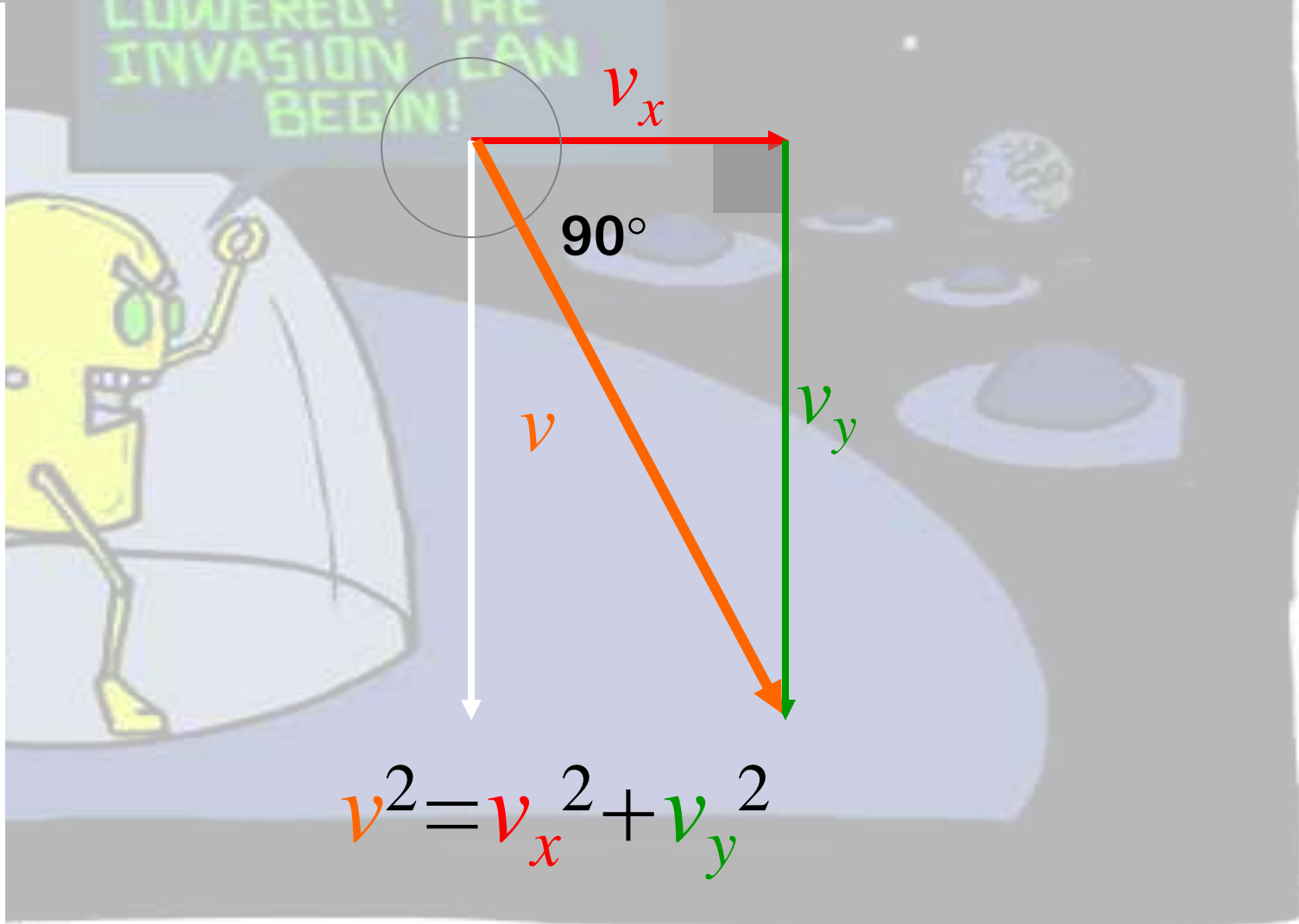
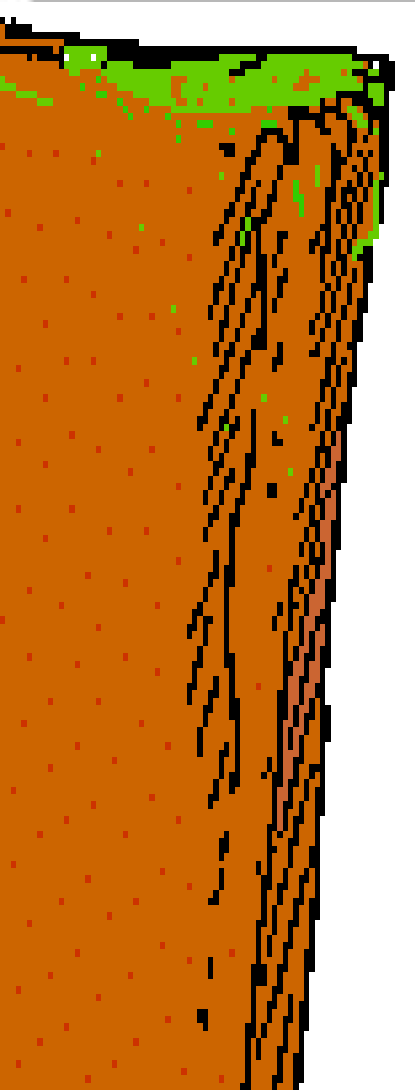
# PROJECTILE MOTION

Draw an arrow representing the **speed** at each position.



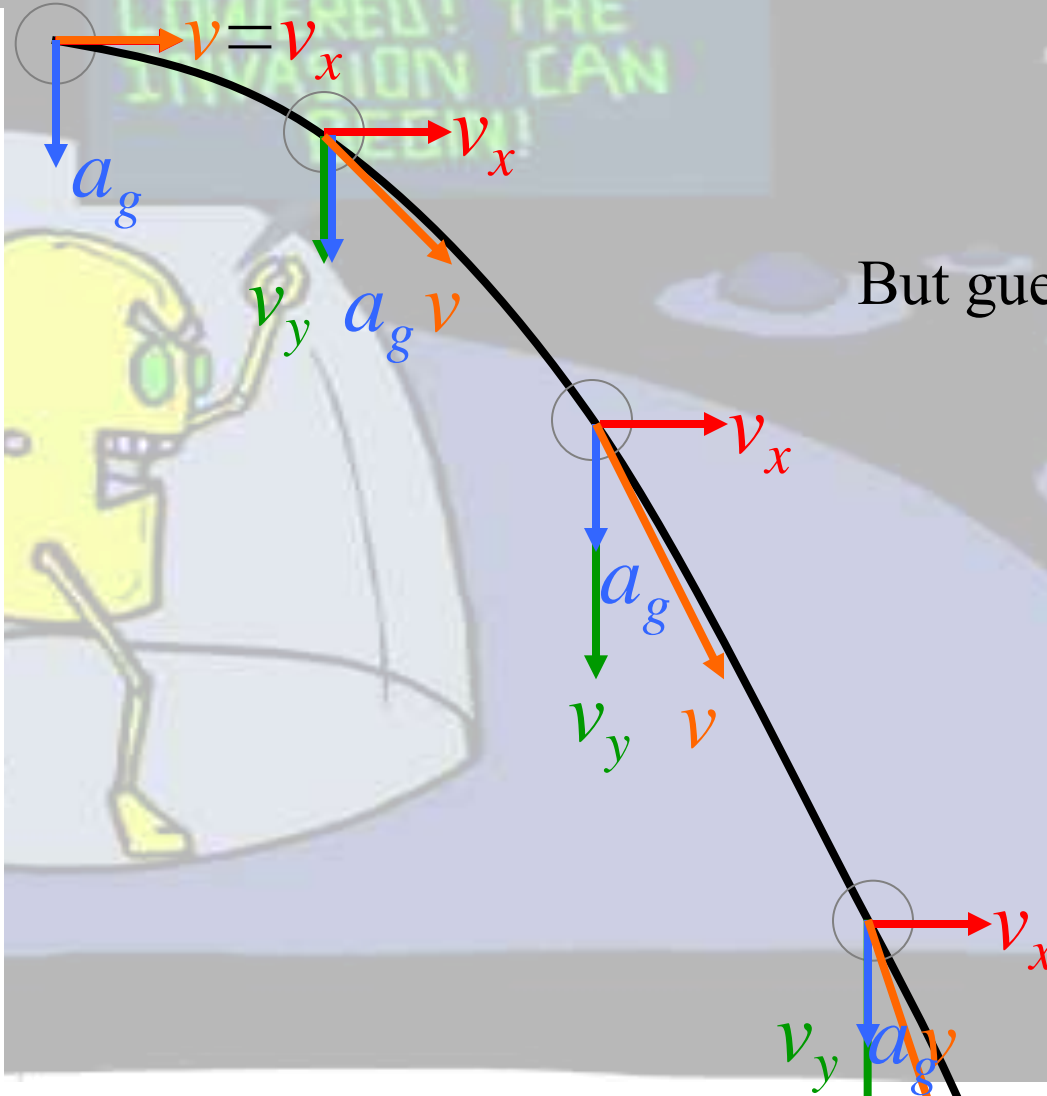
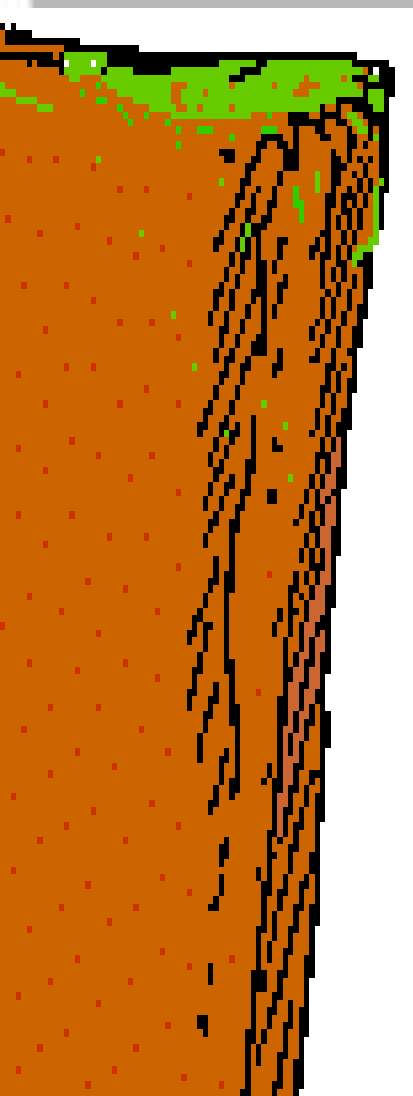
# PROJECTILE MOTION

Use your knowledge of the Pythagorean theorem calculate the speed.



# PROJECTILE MOTION

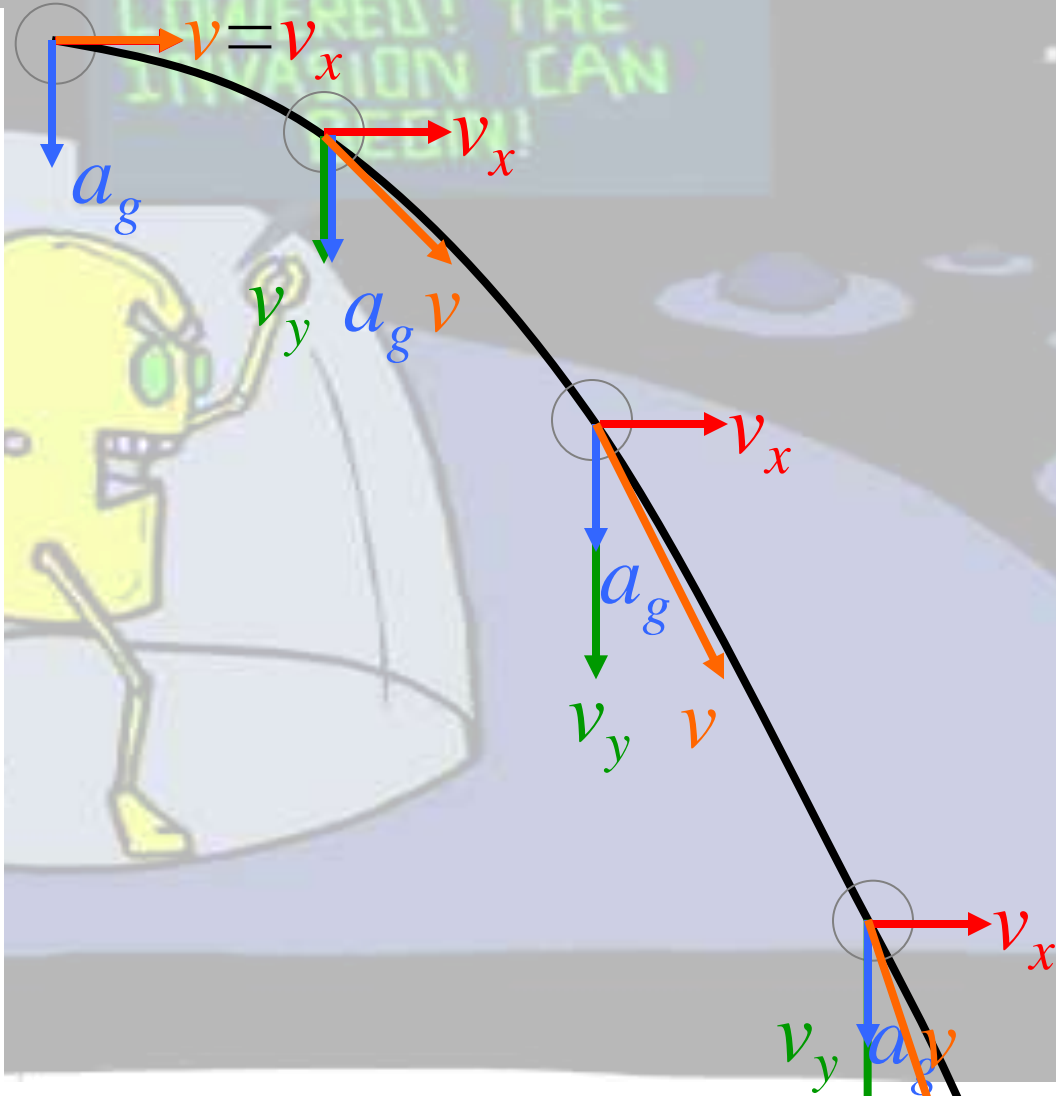
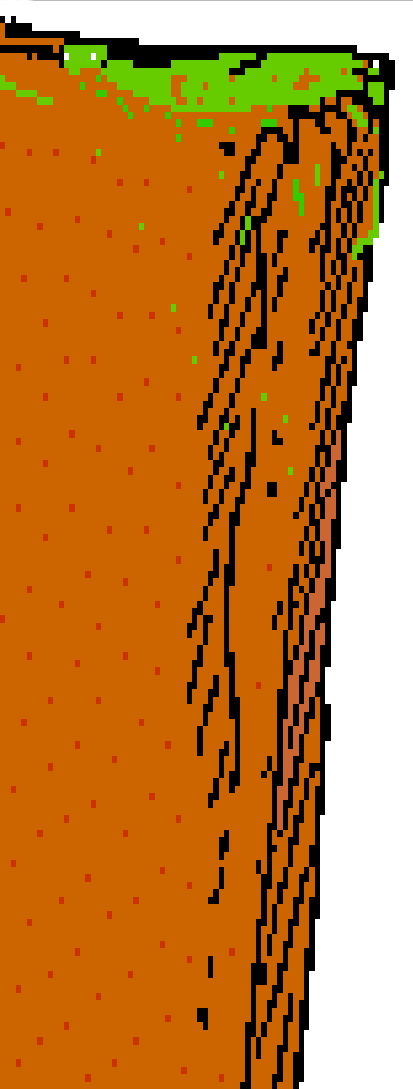
Draw an arrow representing the **acceleration** at each position.



But guess what...

# PROJECTILE MOTION

FINALLY EARTH'S GREENHOUSE GAS LEVELS HAVE LOWERED! THE INVADATION CAN BEGIN!



# Kinematics Equations

You can still use all these...but just be sure to keep you keep the x and y dimensions separated!

EQUATION	"WHO CARES" QUANTITY				
$v = v_0 + at$	$x$				
$x = v_0t + \frac{1}{2}at^2$		$v$			
$x = \frac{1}{2}(v_0 + v)t$			$a$		
$v^2 = v_0^2 + 2ax$				$t$	
$x = vt - \frac{1}{2}at^2$					$v_0$

# Projectile Motion

- You gotta 'Keep 'em separated....'

## The X-stuff

Horizontal Motion

$$a_x = 0$$

$$v_x = v_{0x} = \text{constant}$$

$$x = v_{0x}t$$

## The Y stuff

Vertical Motion

Assume upwards is positive.

$$a_y = -g = -9.81 \text{ m/s}^2$$

$$v_y = v_{0y} + a_y t = v_{0y} - gt$$

$$y = v_{0y}t + \frac{1}{2}a_y t^2 = v_{0y}t - \frac{1}{2}gt^2$$

$$v_y^2 = v_{0y}^2 + 2a_y y = v_{0y}^2 - 2gy$$

# Projectile Examples

- Tennis ball
- Golf ball
- Football
- Softball
- Soccer ball
- bullet
- Hockey puck
- Basketball
- Volleyball
- Arrow
- Shot put
- Javelin

These are all examples of things that are **projected**, then go off under the influence of gravity

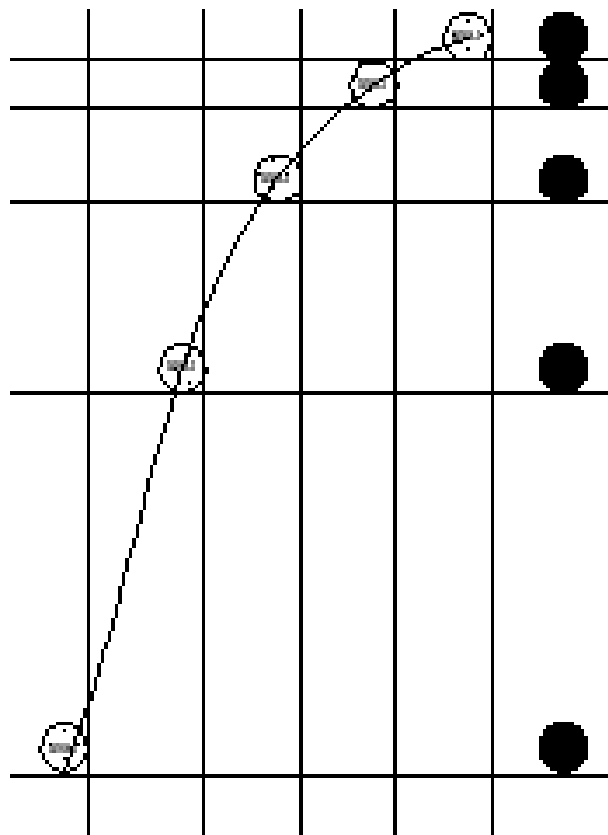
# Not projectiles

- Jet plane
- Rocket
- Car (unless it loses contact with ground)

FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED. THE  
INVASION CAN  
BEGIN!



# FINALLY EARTH'S GREENHOUSE GAS



the flow, or measure, of time; divide this of segments,  $bc$ ,  $cd$ ,  $de$ , representing equal in the points  $b$ ,  $c$ ,  $d$ ,  $e$ , let fall lines which are

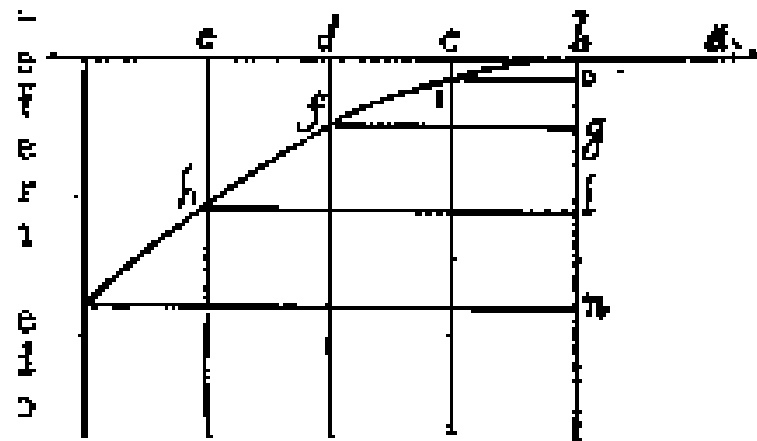
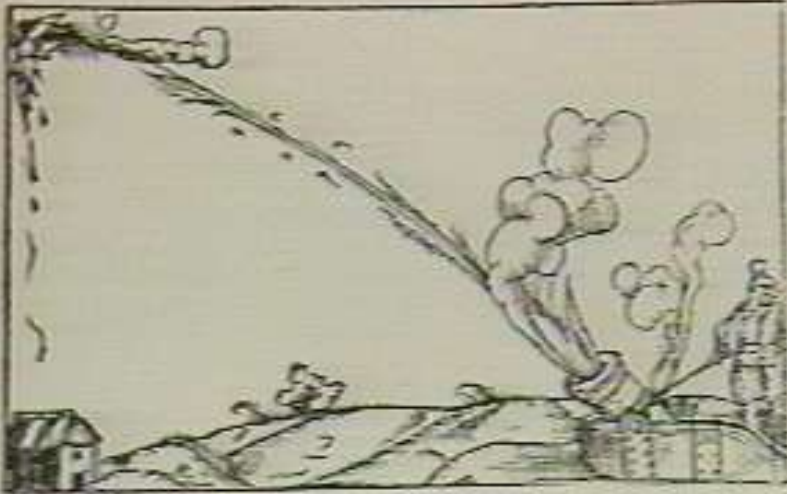


Fig. 108

these same lines. Accordingly we see that from  $b$  to  $c$  with uniform speed, it also falls through the distance  $ci$ , and at the end of the itself at the point  $i$ . In like manner at the

# A History of Projectile Motion

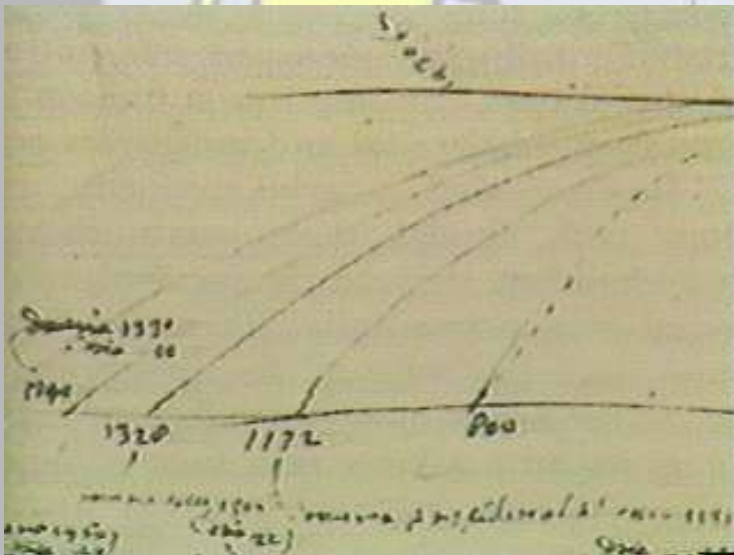


## Aristotle:

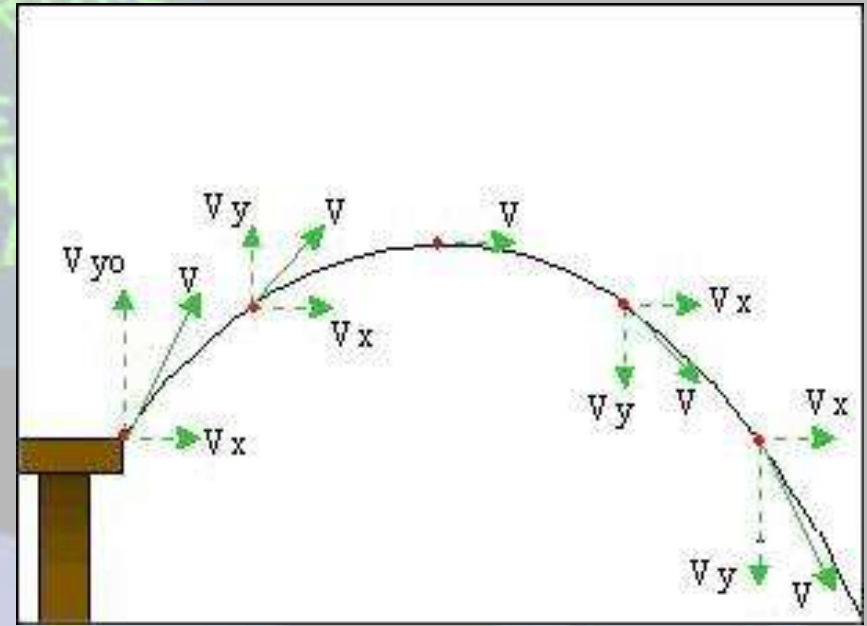
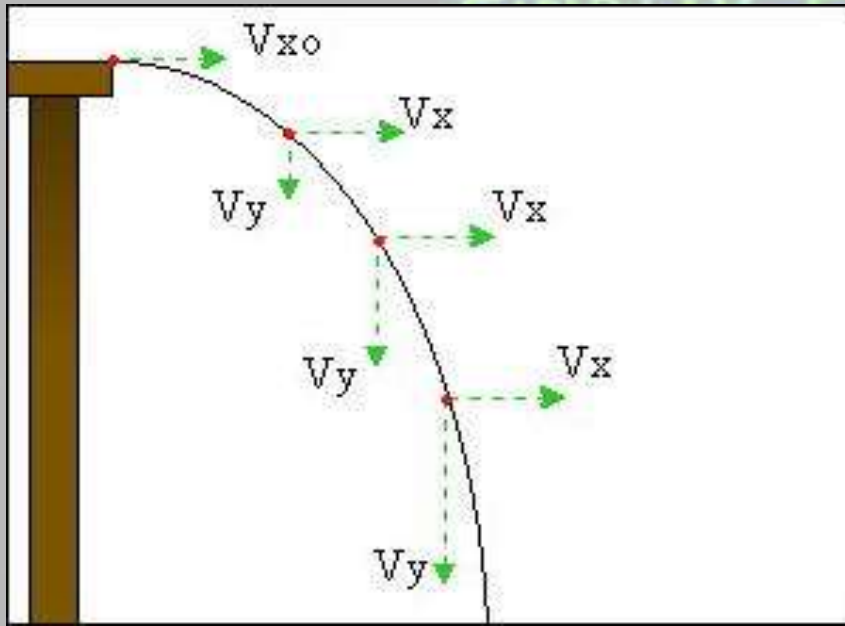
The canon ball travels in a straight line until it loses its 'impetus'.

## Galileo:

- a result of *Free Fall Motion* along y-axis and *Uniform Motion* along x-axis.



# Projectile Motion = Sum of 2 Independent Motions



1. Along x, the projectile travels with constant velocity.

$$\mathbf{v}_x = \mathbf{v}_{xi} \quad x = v_{xi}t$$

2. Along y, the projectile travels in free-fall fashion.

$$v_y = v_{yi} - gt \quad y = v_{yi}t - (1/2)gt^2 \quad , g = 9.8 \text{ m/s}^2$$

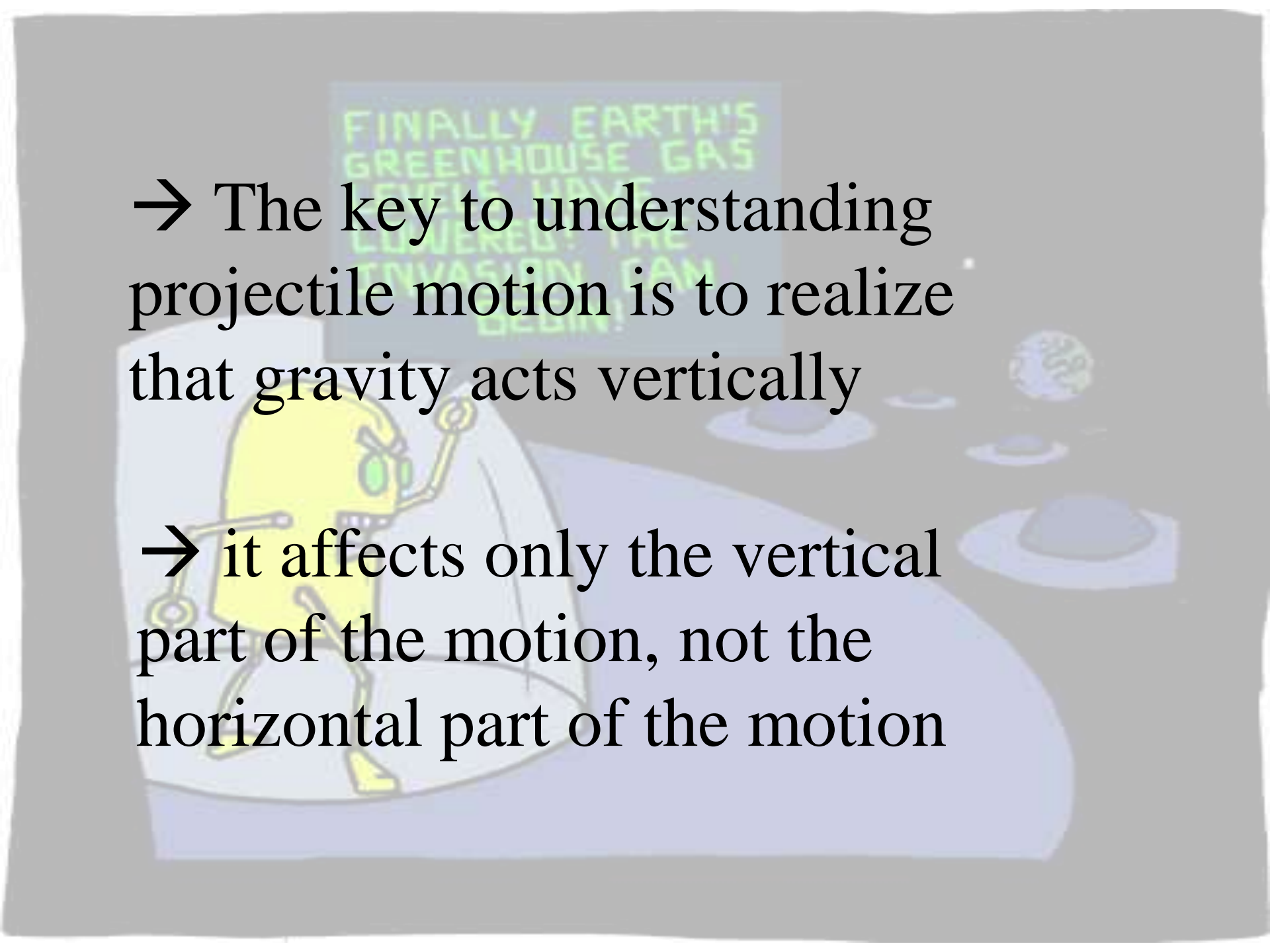
Projectile motion = a combination of uniform motion along x and uniformly accelerated motion (free fall) along y.



FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

## Animations

- First One (Online)
- Second One (QT, NA  
now)

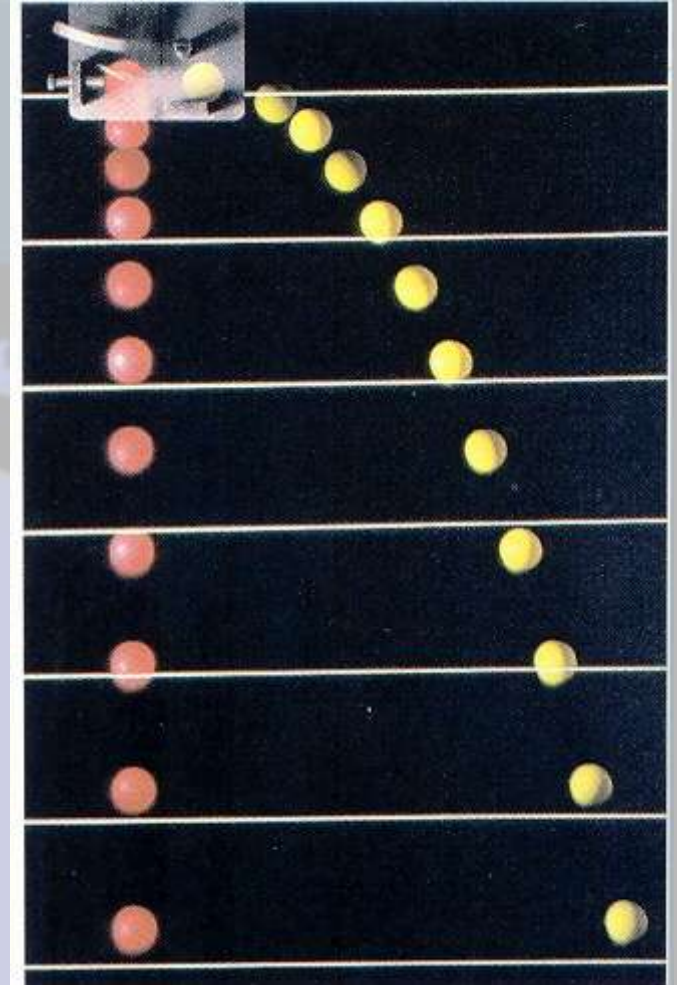


→ The key to understanding projectile motion is to realize that gravity acts vertically

→ it affects only the vertical part of the motion, not the horizontal part of the motion

# Demonstration

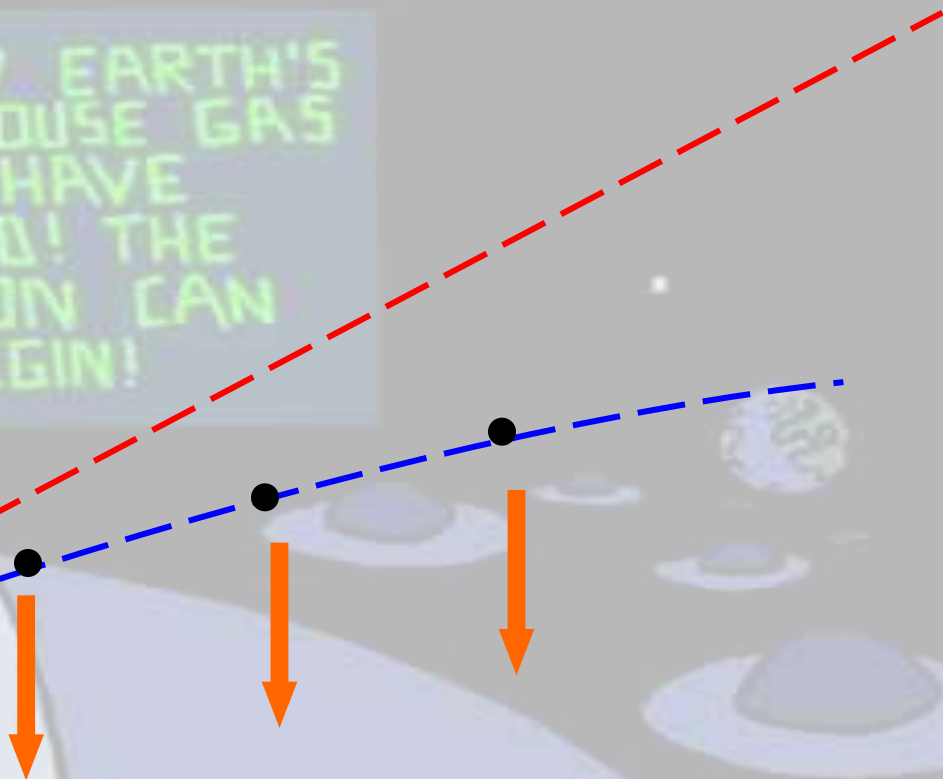
- We can see that the horizontal and vertical motions are independent!
- The red ball falls vertically
- The yellow ball was given a kick to the right.
- They track each other vertically step for step and hit the ground at the same time



FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!



In the absence of gravity a bullet would follow a straight line forever. With gravity it **FALLS AWAY** from that straight line!



FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

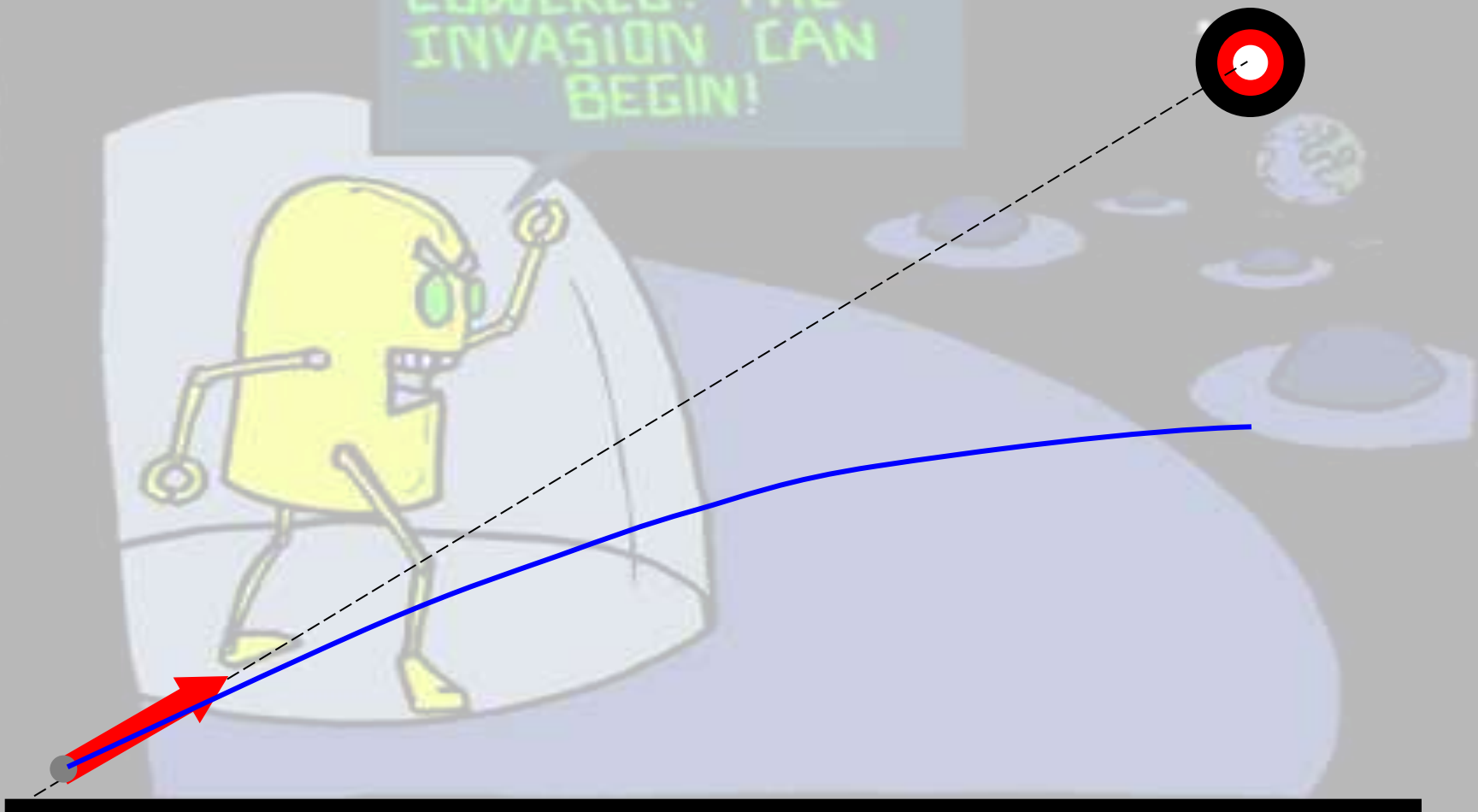
Sim 1 (OL)

Sim 2 (OL)

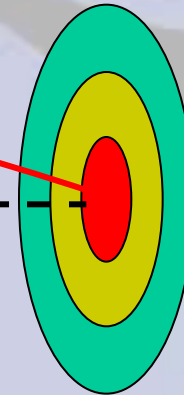
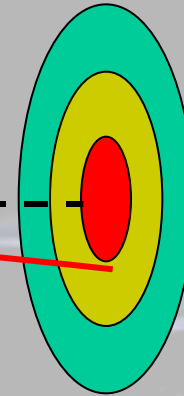


FINALLY EARTH'S  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

# Shoot the Monkey



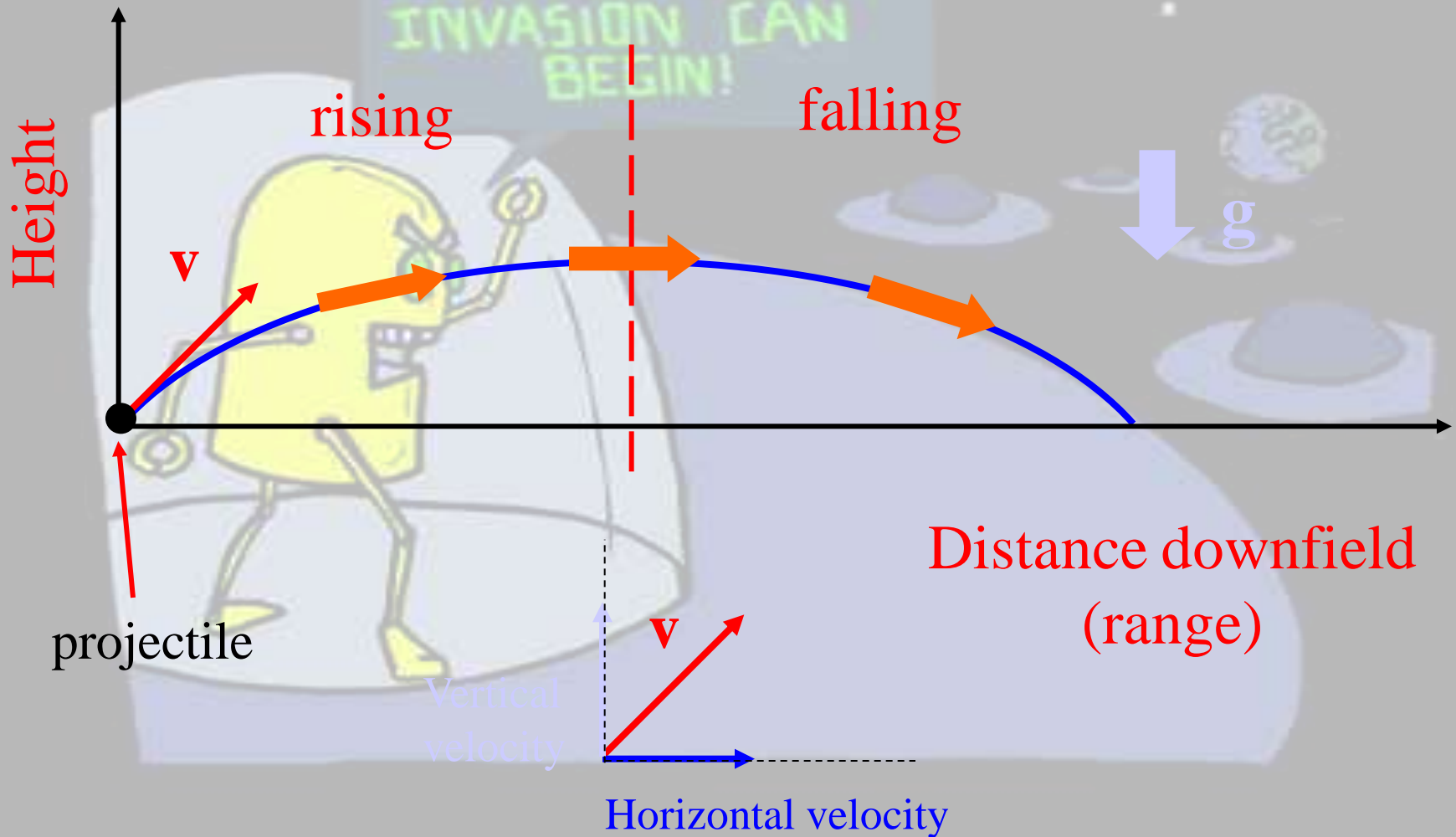
Hitting the target – aim high, not directly at the target



**BULLSEYE!**

FINALLY! EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE BEEN  
LOWERED! THE  
INVASION CAN  
BEGIN!

# Path of the Projectile



FINALLY EARTH'S

**FAIL**

How does the harmless worm affect its being baked microwave?



**CONCLUSION**



Based on the data the worm exploded the best!

**TITLE**

**WORMS IN A MICRO-WAVE!**



**PROCEDURE**

- A) Supplies (paper bowl, washcloth, worms, & microwave & camera)
- B) Then, put the worms in the microwave, set the microwave for 30 sec. min
- C) Let the worms sit until they get so hot they burst!
- D) Take worms out when done. Take pictures & smell.
- E) Smell worms & then see what others think!  

**DATA**

Seconds to Burst!



**HYPOTHESES**

I Predict that the Patest worm will blow up the quickest & blow up more GLITS!



FINALLY EARTH'S  
GREENHOUSE GAS  
LEVELS HAVE  
LOWERED! THE  
INVASION CAN  
BEGIN!

# Interactive

- [http://galileo.phys.virginia.edu/classes/109N/more\\_stuff/Applets/ProjectileMotion/java/pplet.html](http://galileo.phys.virginia.edu/classes/109N/more_stuff/Applets/ProjectileMotion/java/pplet.html)
- <http://jersey.uoregon.edu/vlab/Cannon/>



