

Physics of Projectile Motion

FINALLY EARTH'S
GREENHOUSE GAS



GHS Fizzix 2013

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Projectile Motion

- Learn all these now.

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

Show that a projectile motion is a parabola!!!

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

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

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

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

$a_x = 0$

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

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

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

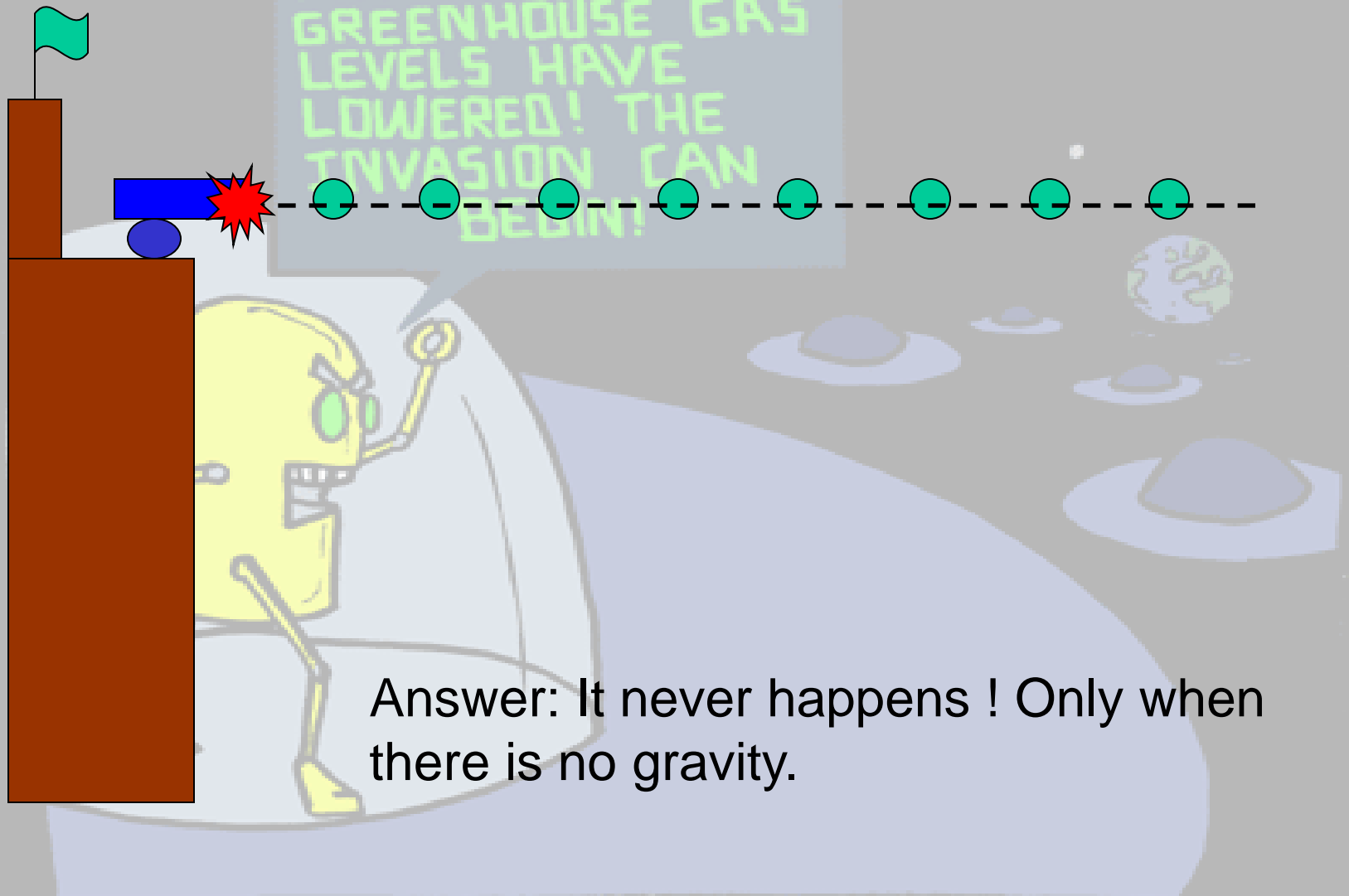
Plug in the t above

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

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

What kind of parabola is this?

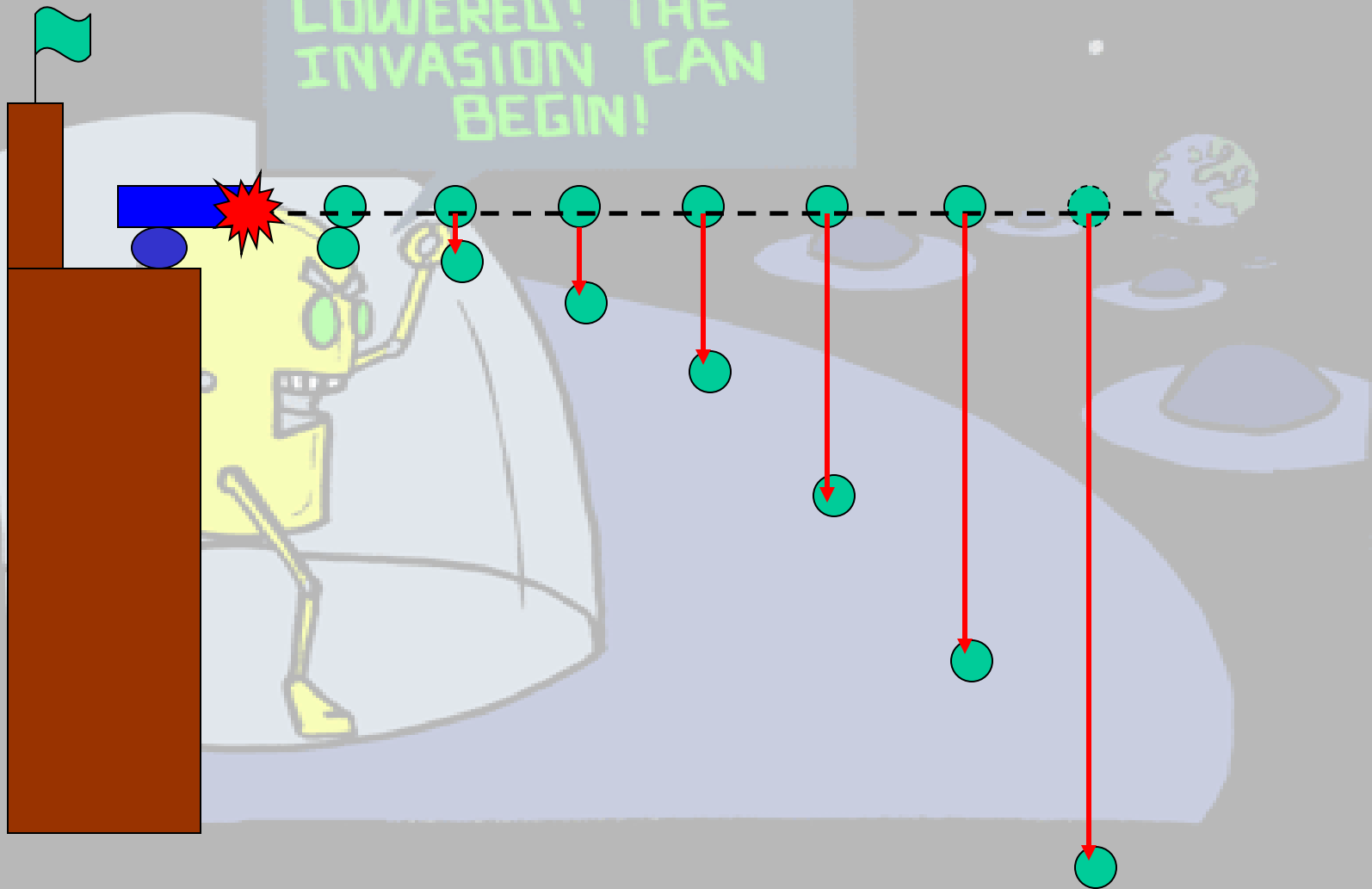
What's wrong with this picture ?



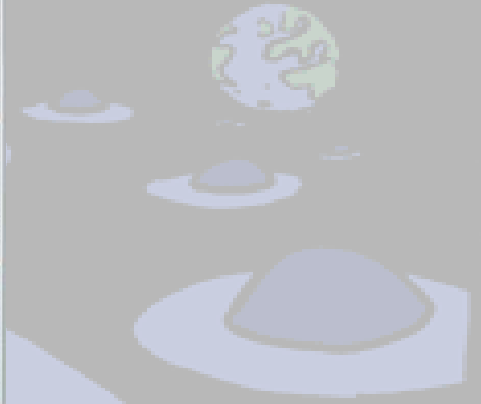
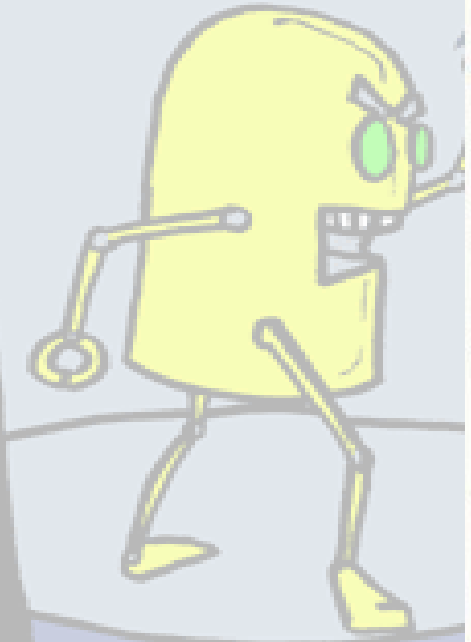
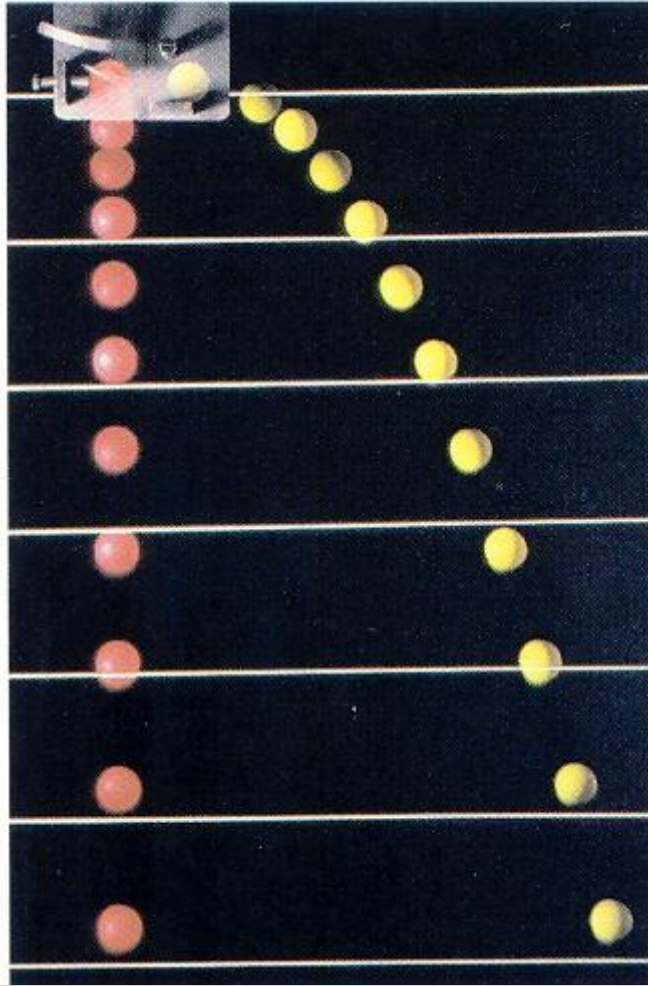
Answer: It never happens ! Only when there is no gravity.

Why do projectiles fly in a parabola?

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



FINALLY EARTH'S
GREENHOUSE GAS
LEVELS
LOW
IN



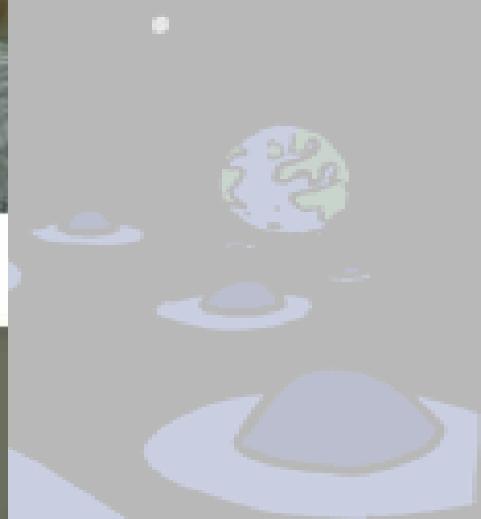
FIN
GR
LEV
LO
IN



Reese Witherspoon

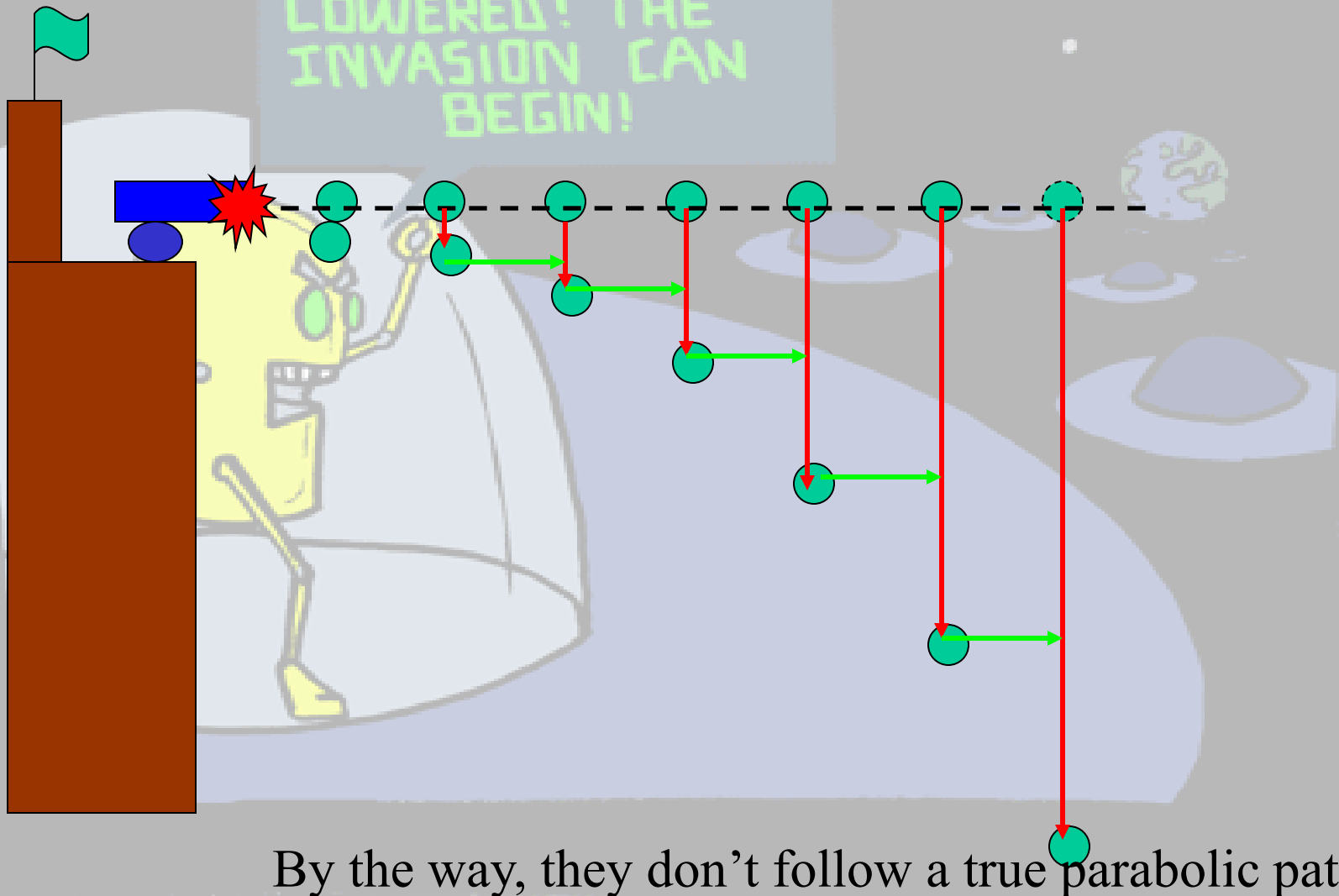


Reese Withouterspoon

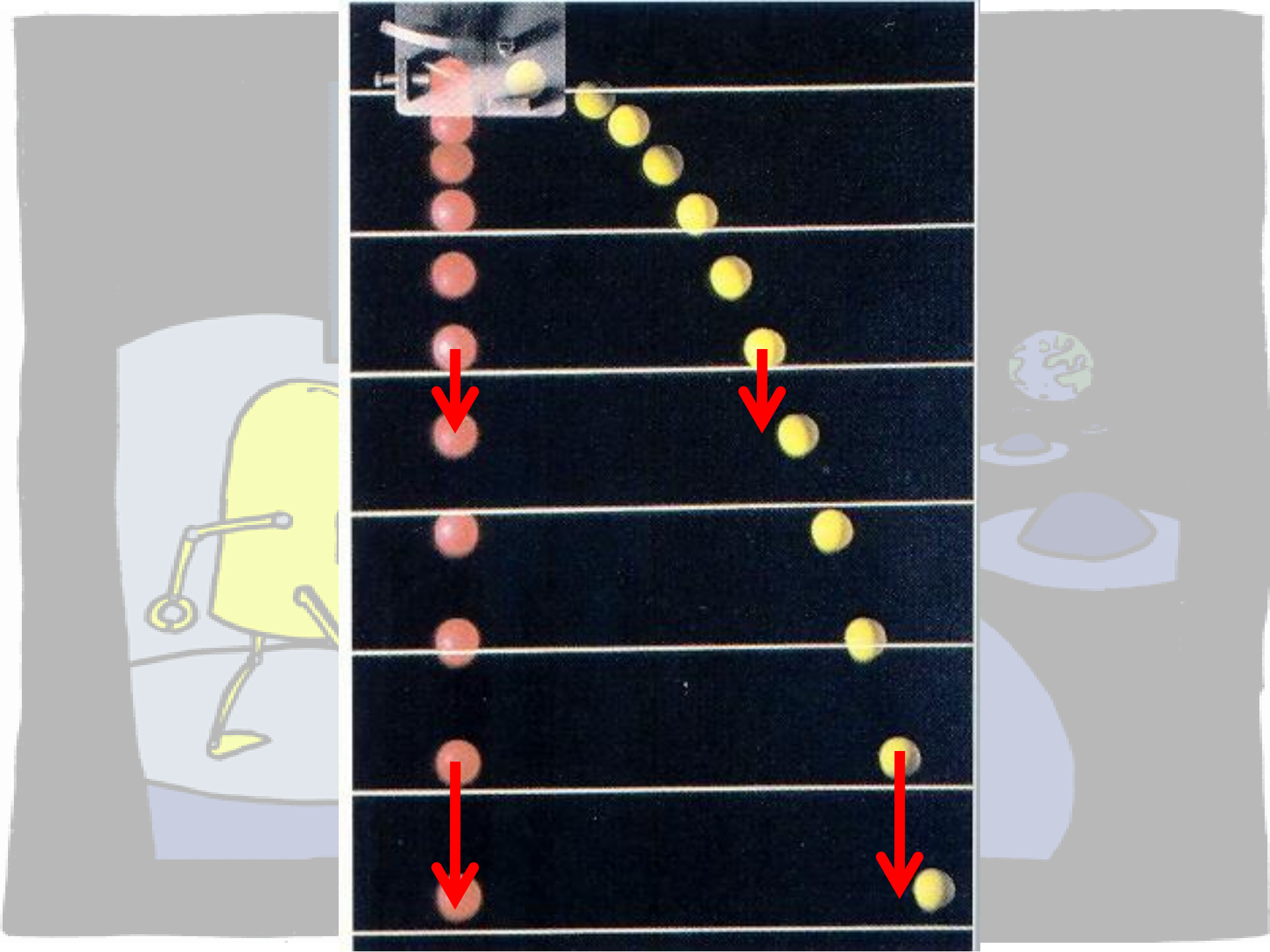


Why do projectiles fly in a parabola?

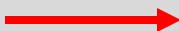
FINDING EARTH'S GREENHOUSE GAS LEVELS HAVE LOWERED! THE INVASION CAN BEGIN!




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

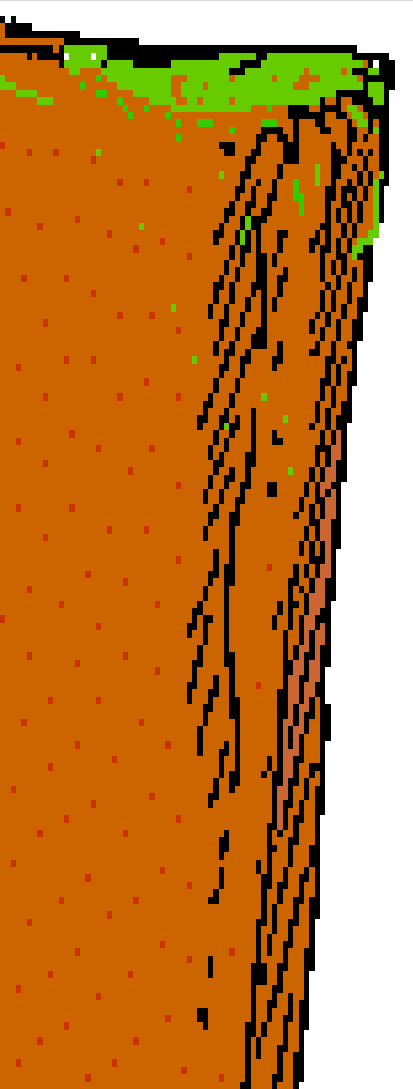


PROJECTILE MOTION

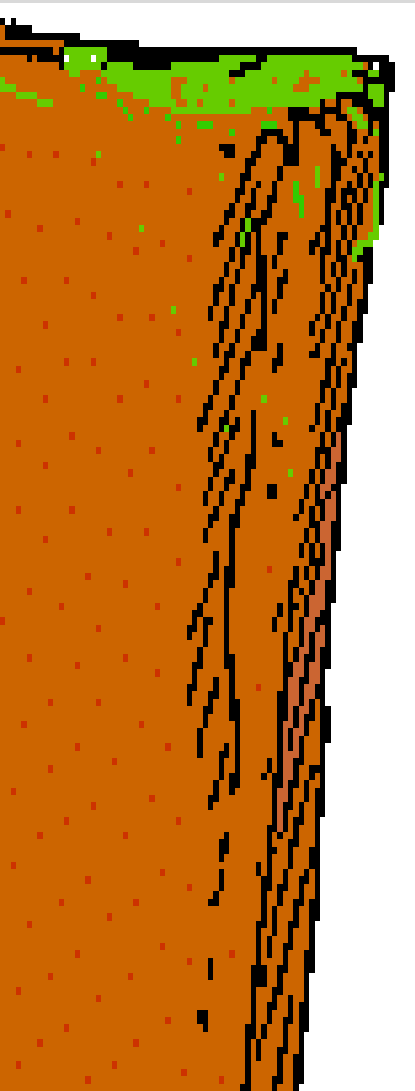
v_0 

-  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.



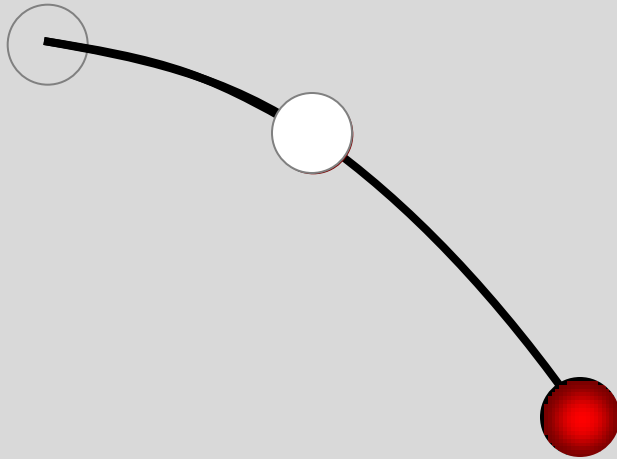
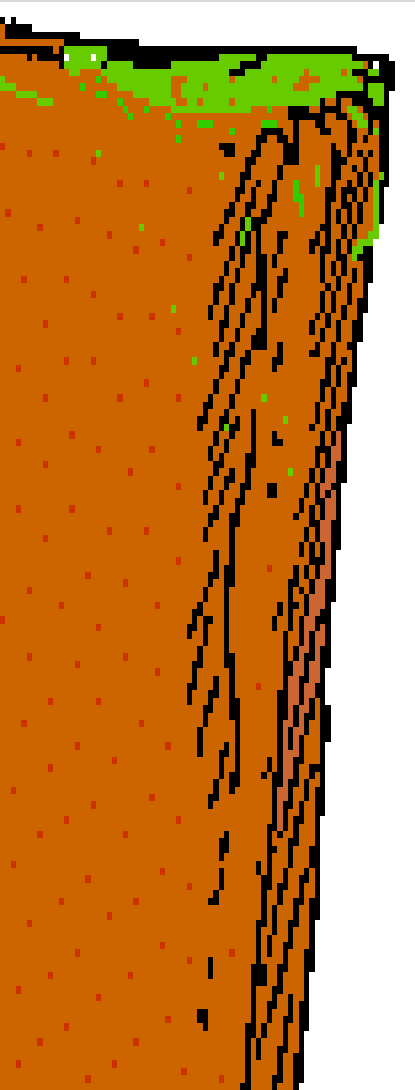
PROJECTILE MOTION



How much time has passed
between subsequent positions

1 unit of time

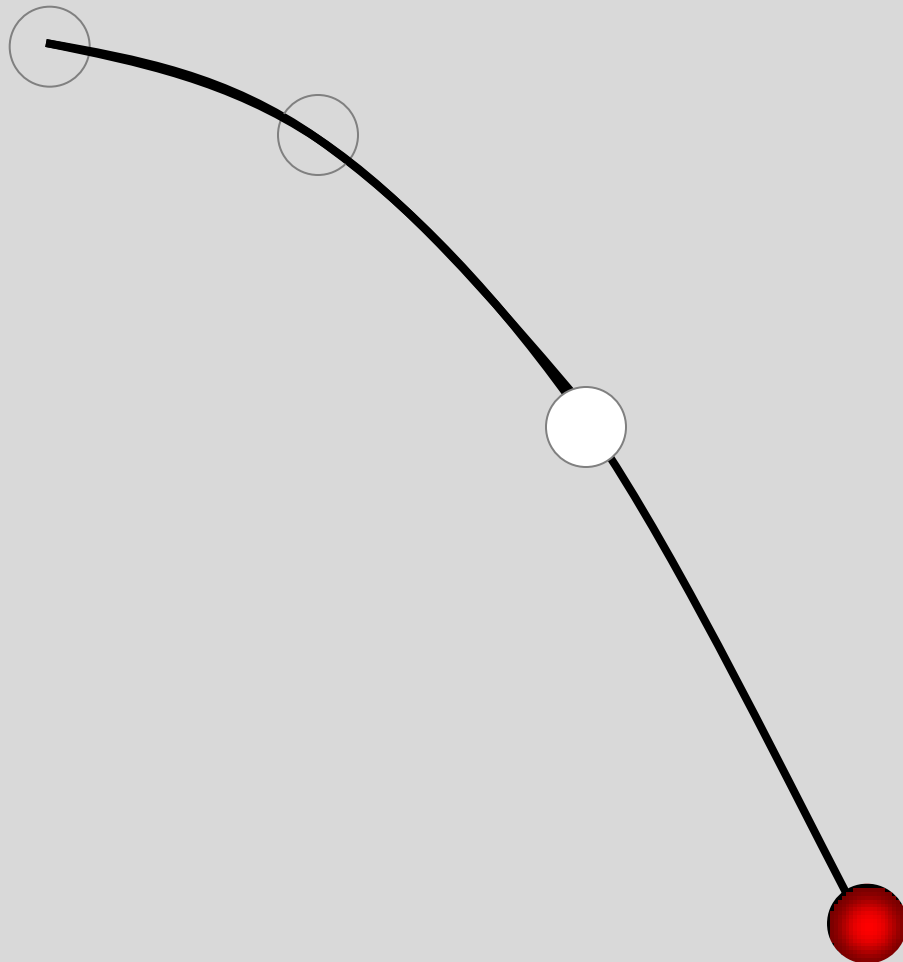
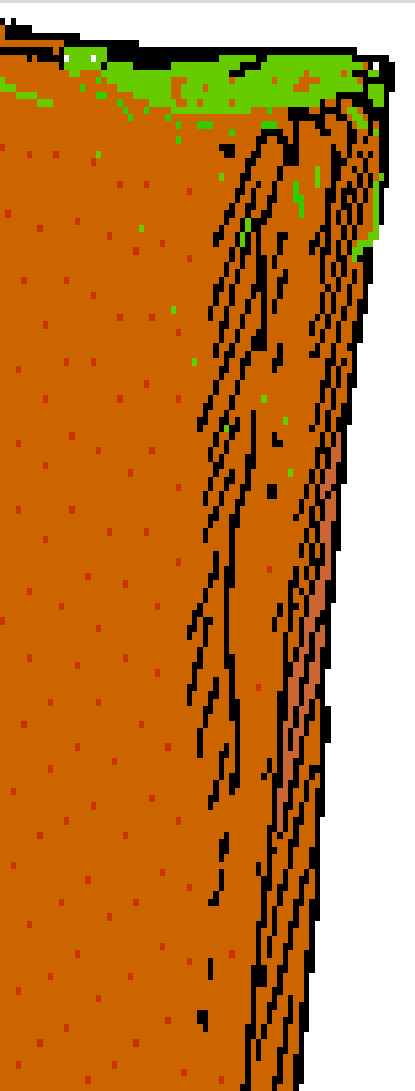
PROJECTILE MOTION



How much time has passed between subsequent positions?

1 unit of time

PROJECTILE MOTION

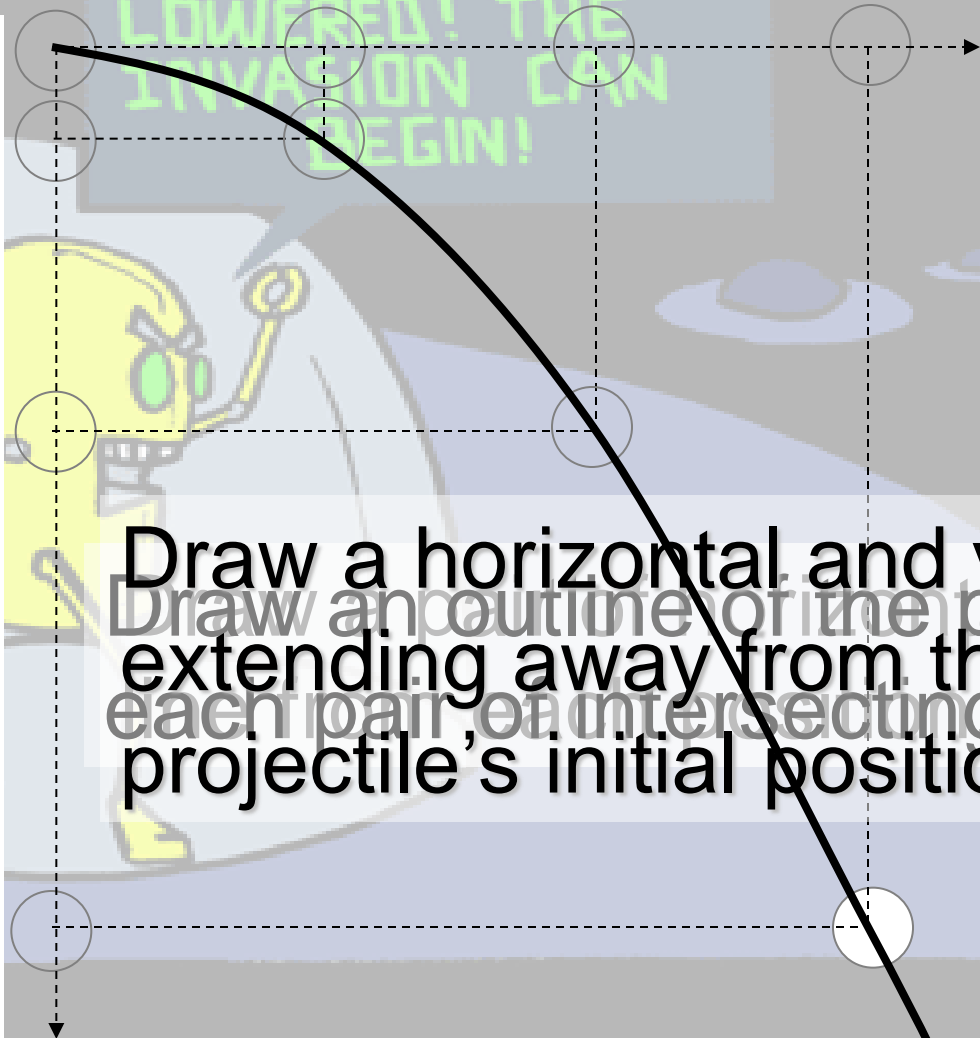


How much time has passed between subsequent positions?

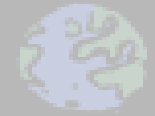
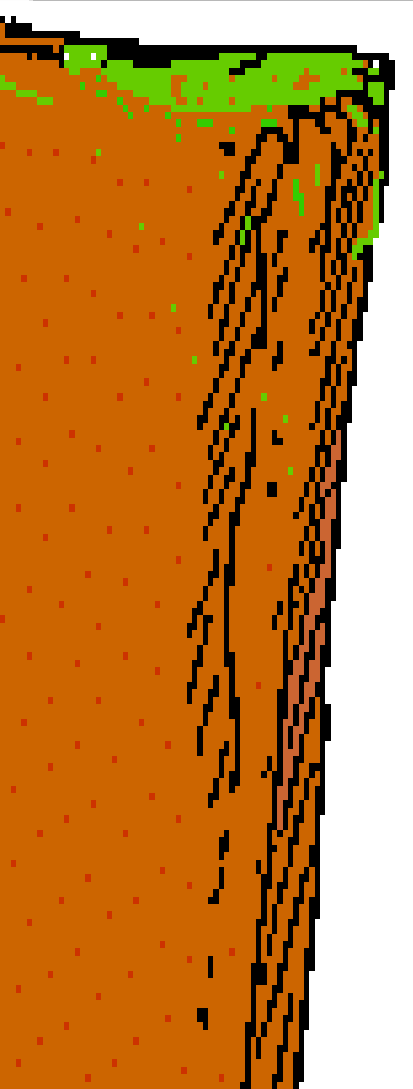
1 unit of time

PROJECTILE MOTION

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

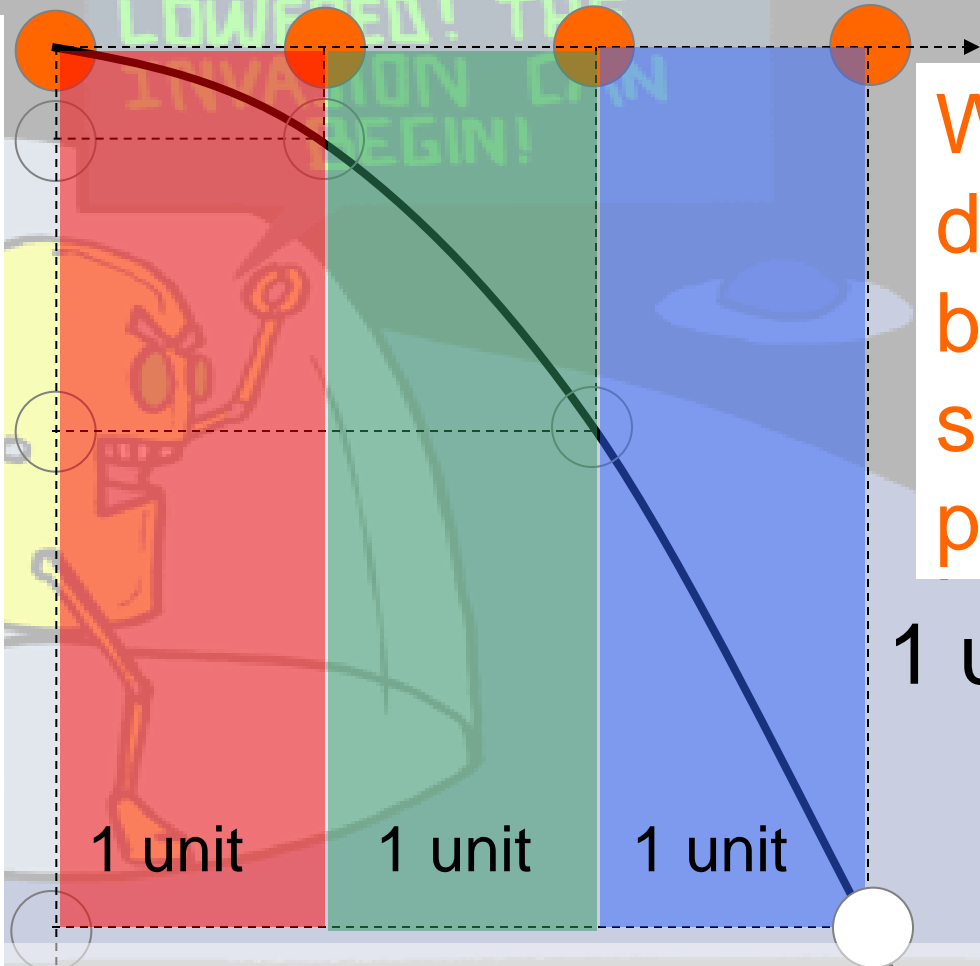
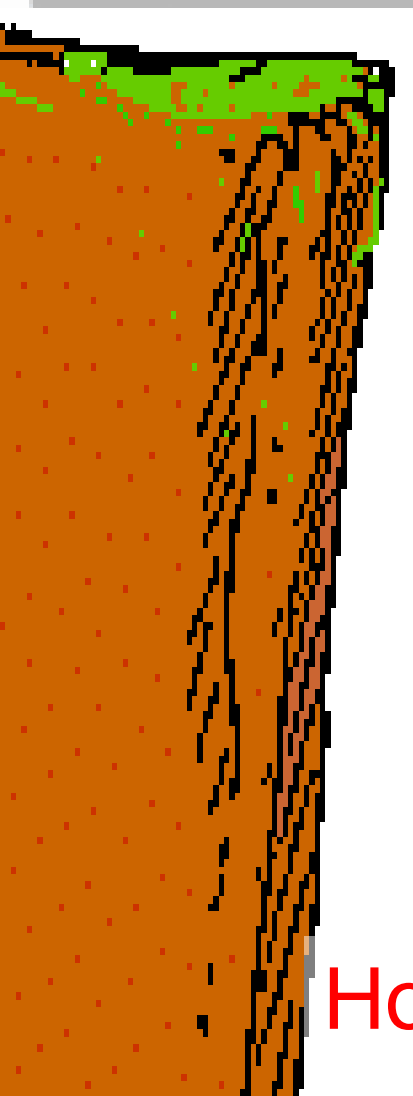


Draw a horizontal and vertical line extending away from the projectile's initial position. Draw an outline of the projectile at each pair of intersecting lines.



PROJECTILE MOTION

Describe the horizontal displacements.



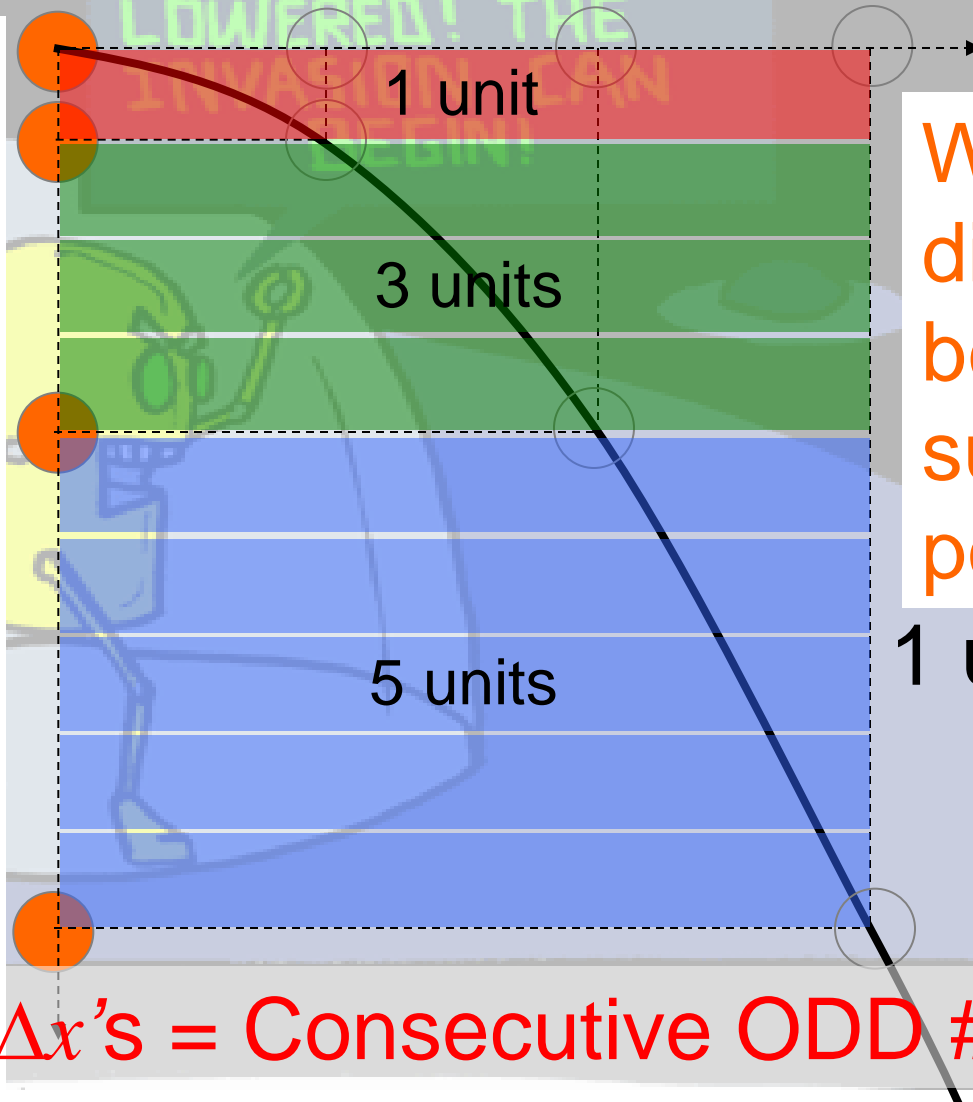
What's the displacement between subsequent positions?

1 unit of time

Horizontal Displacements are EQUAL

PROJECTILE MOTION

Describe the vertical displacements.

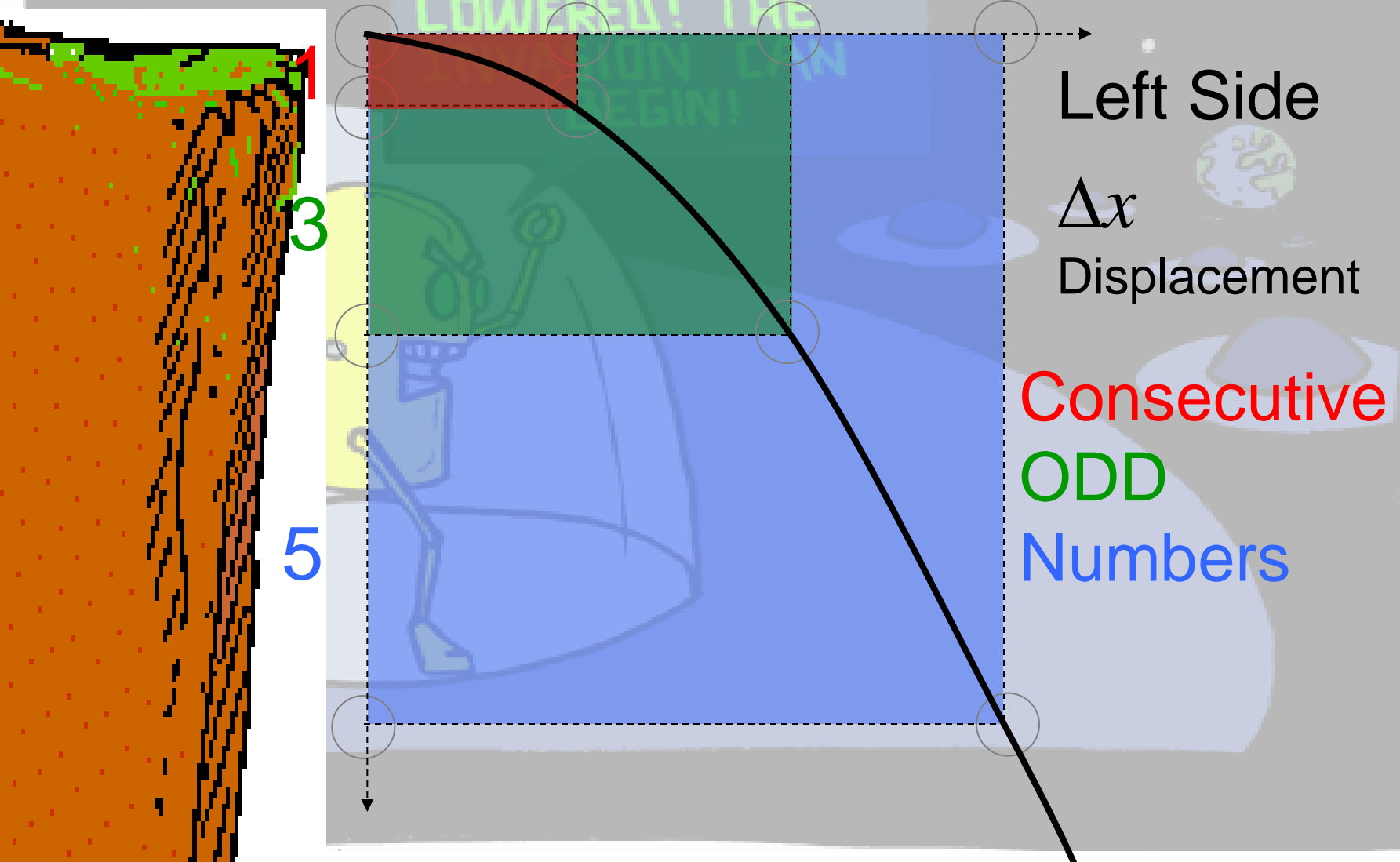


What's the displacement between subsequent positions?

1 unit of time

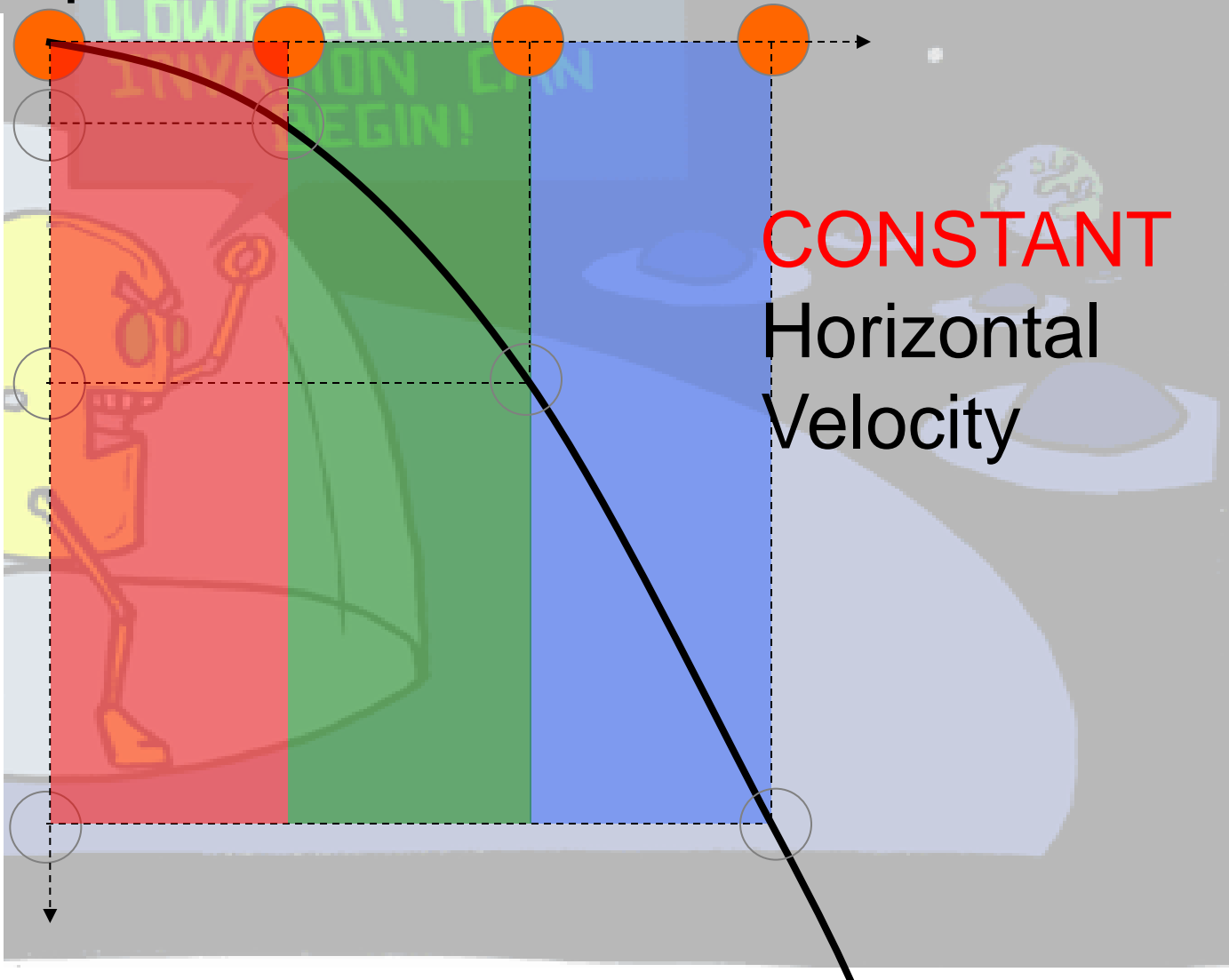
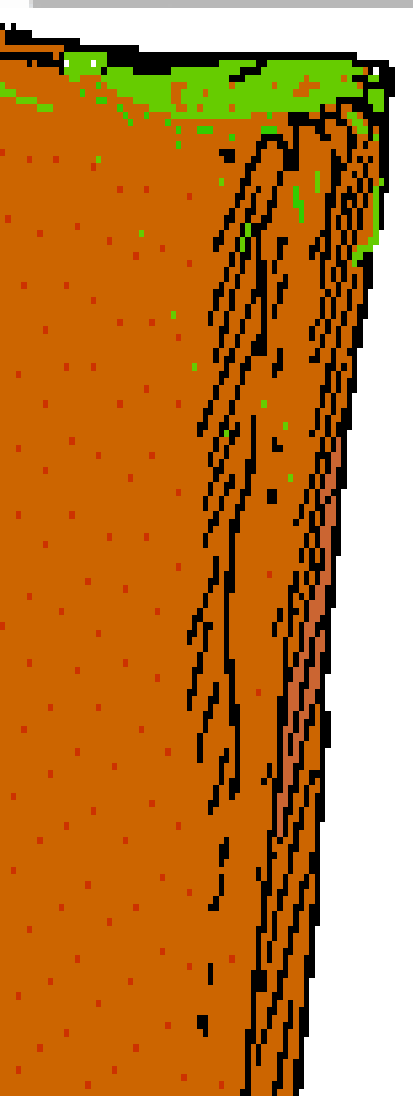
PROJECTILE MOTION

What does each vertical side of a colored region represent?



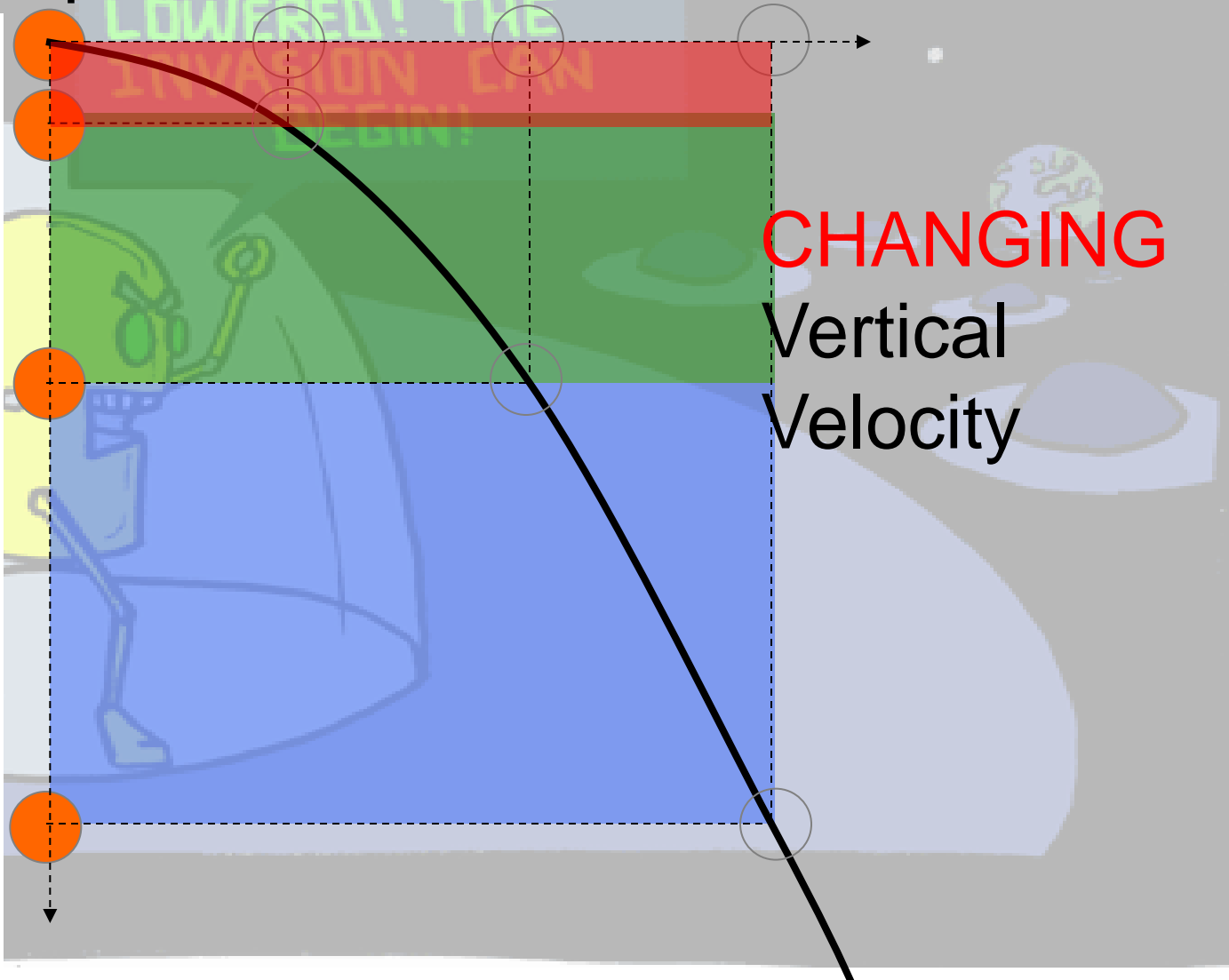
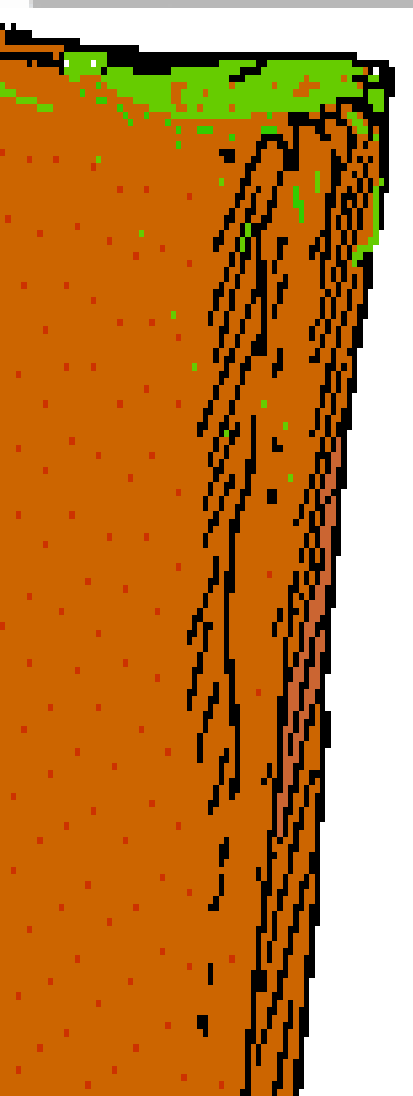
PROJECTILE MOTION

Describe the motion of the projectile at subsequent positions.



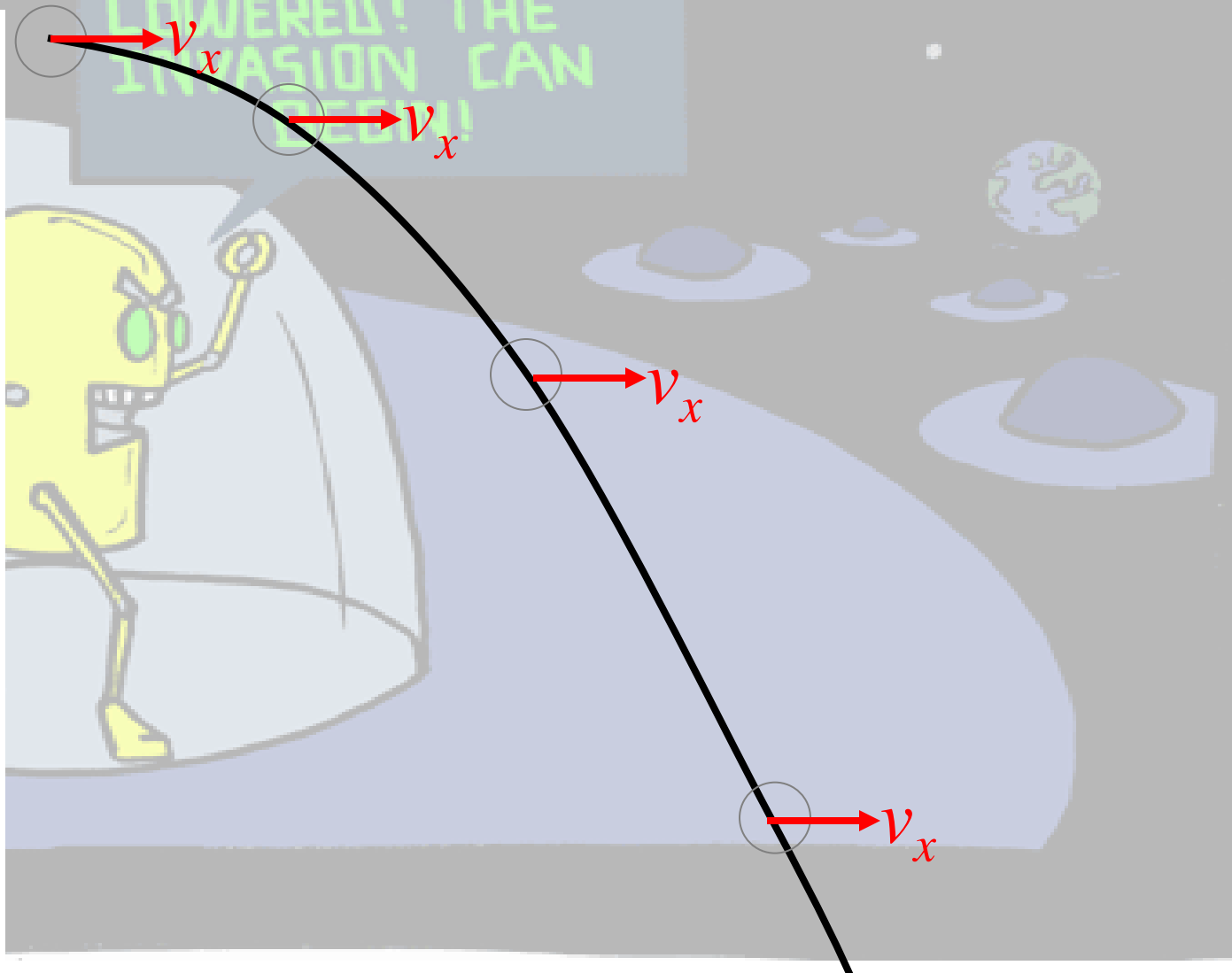
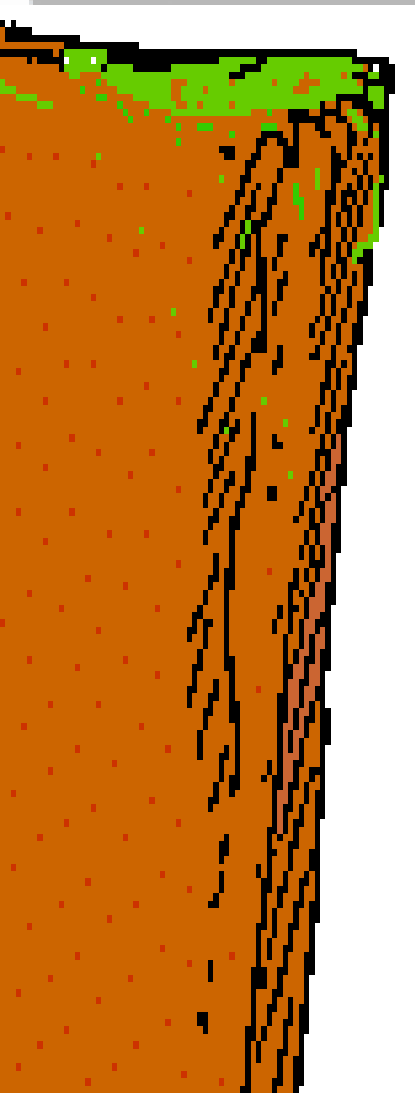
PROJECTILE MOTION

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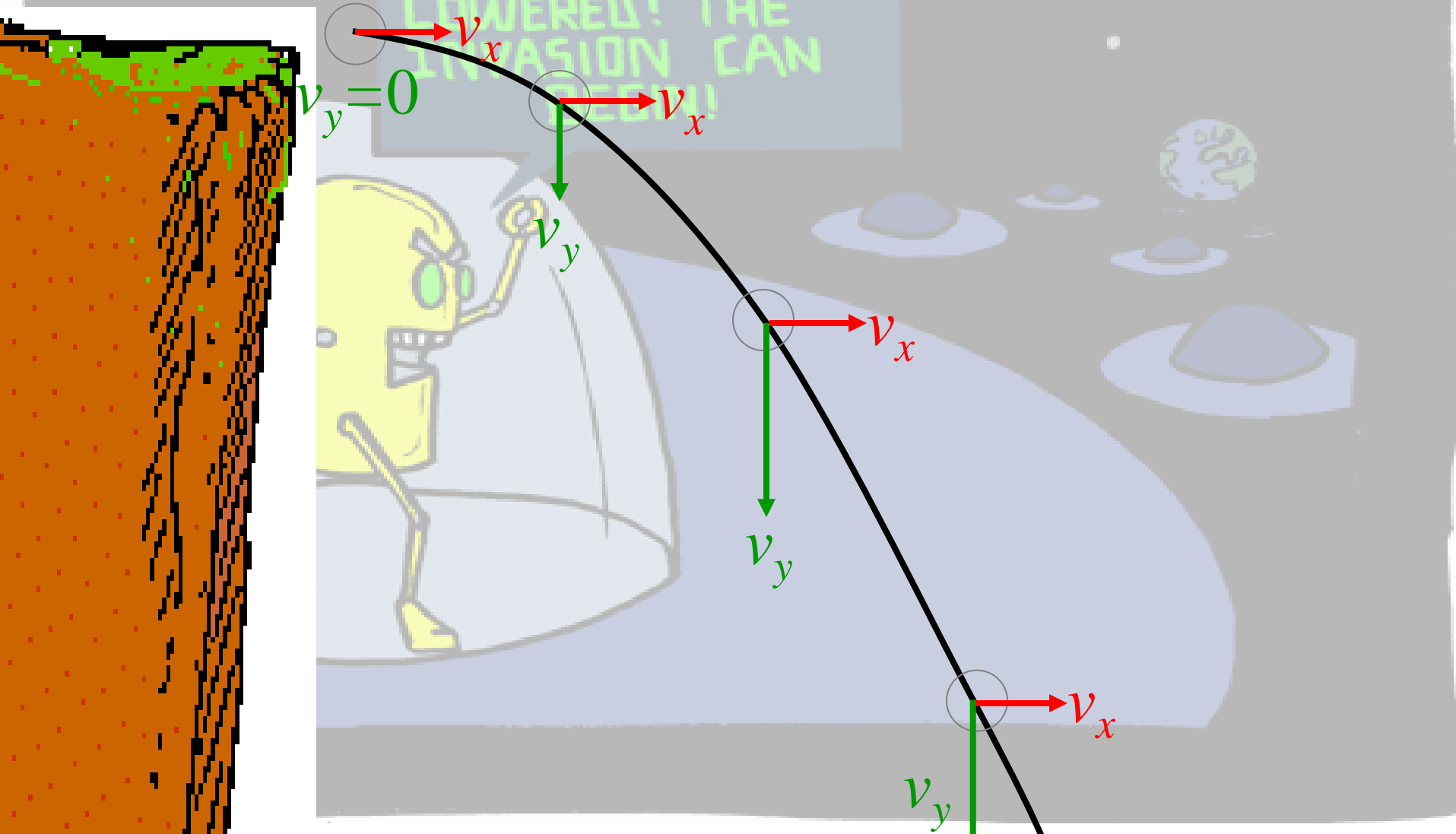
PROJECTILE MOTION

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



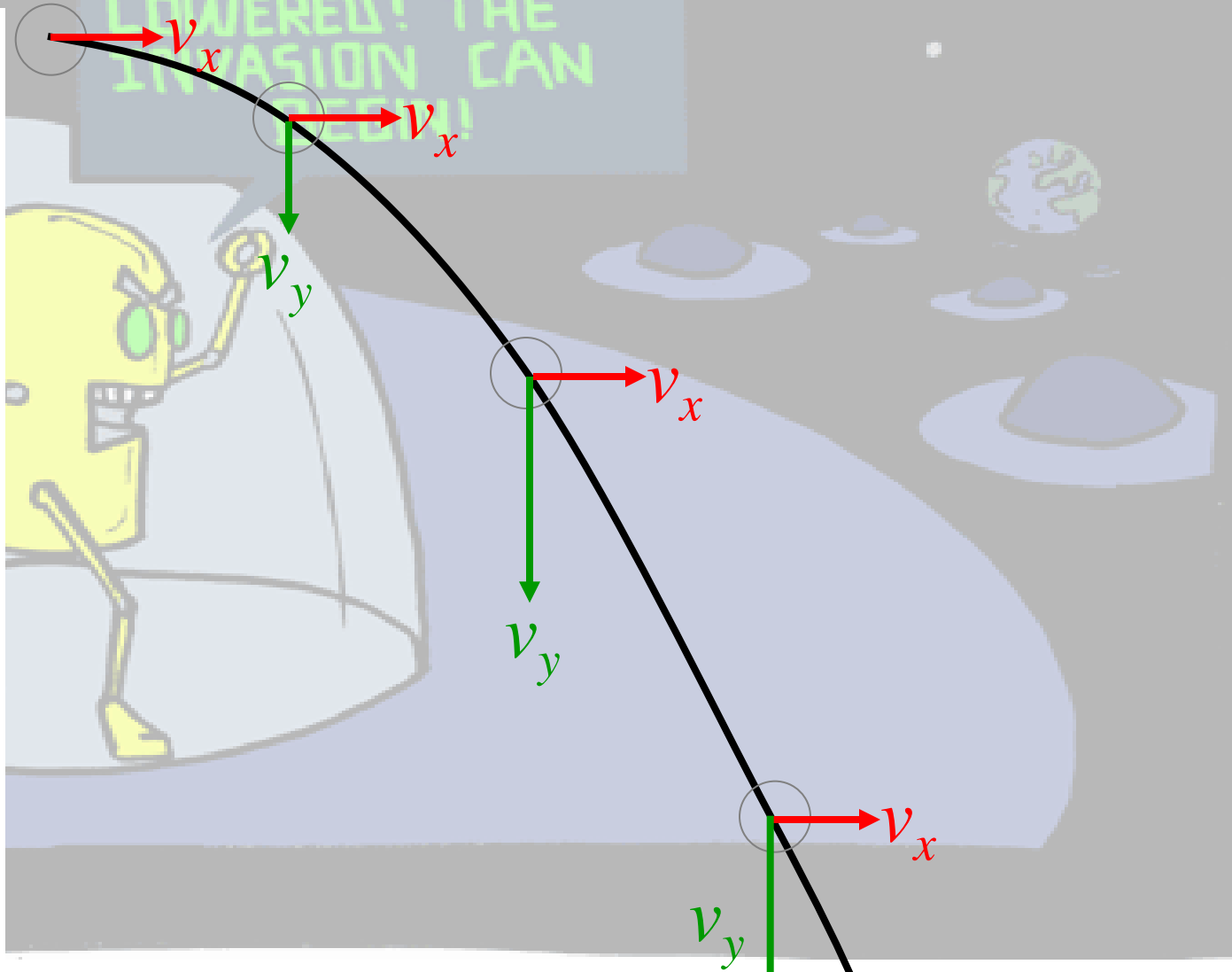
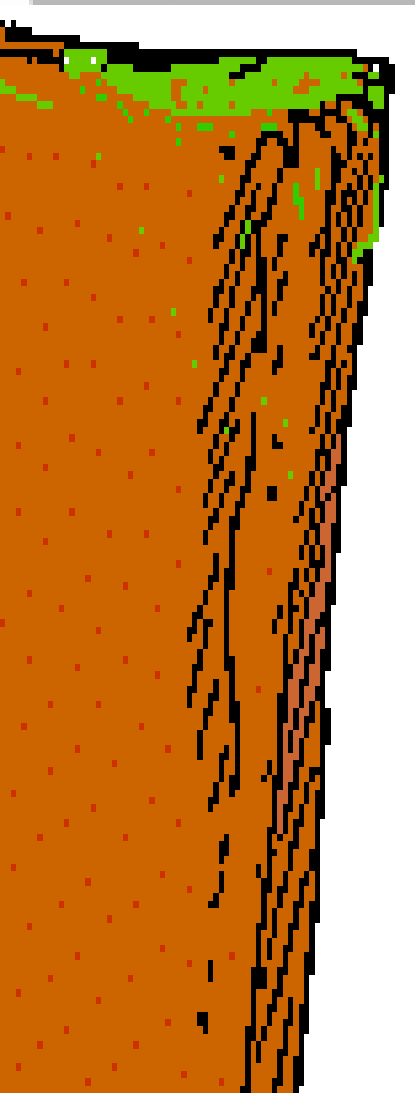
PROJECTILE MOTION

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



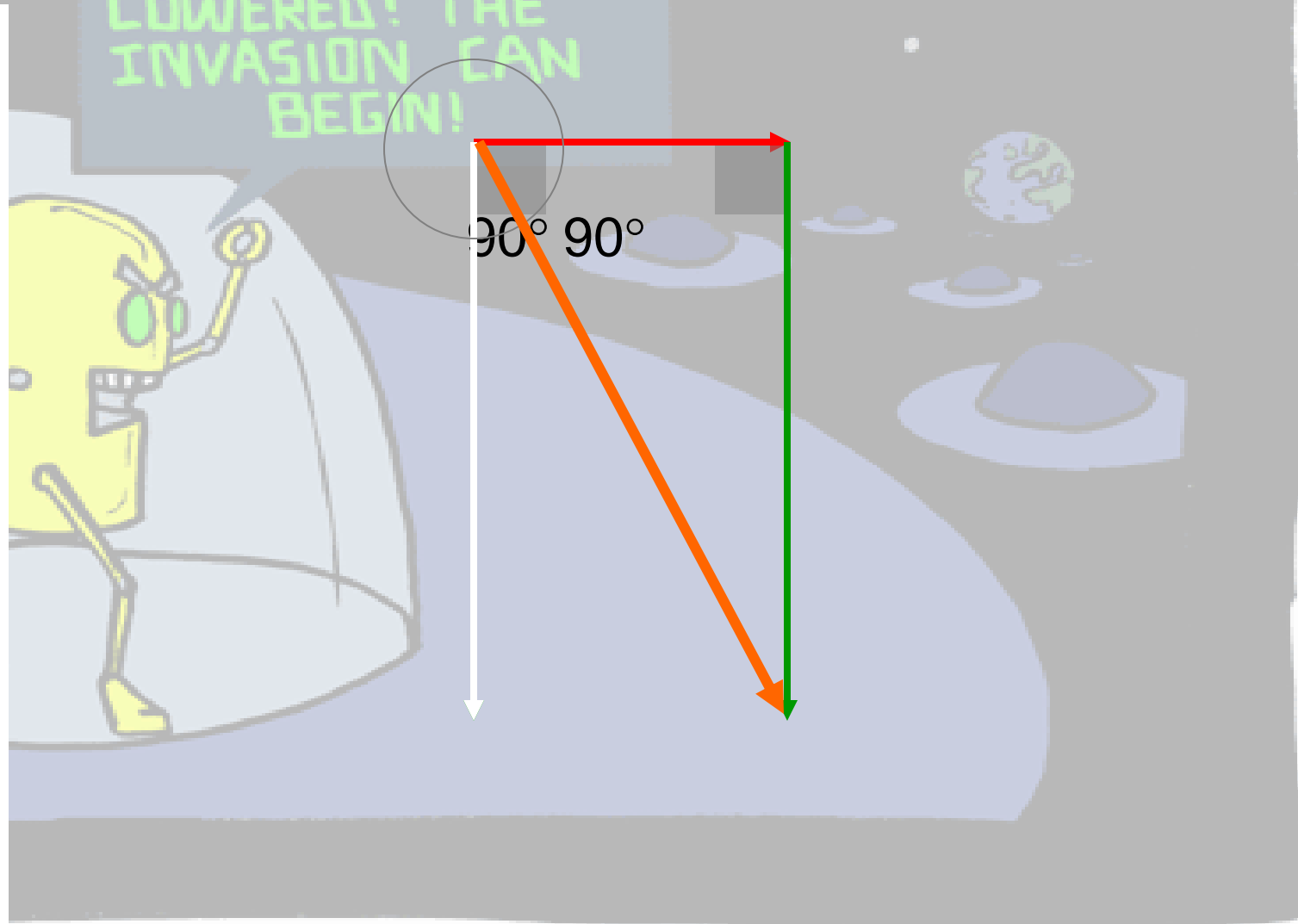
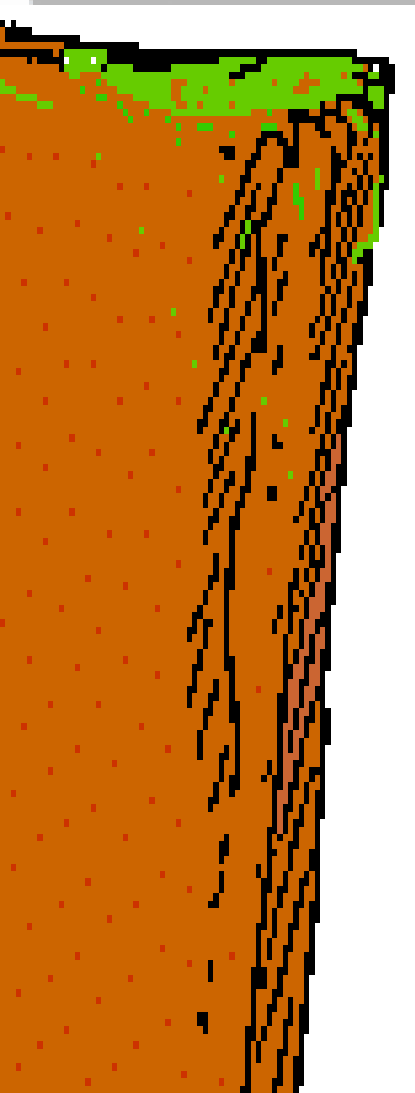
PROJECTILE MOTION

Draw an arrow representing the speed at each position.



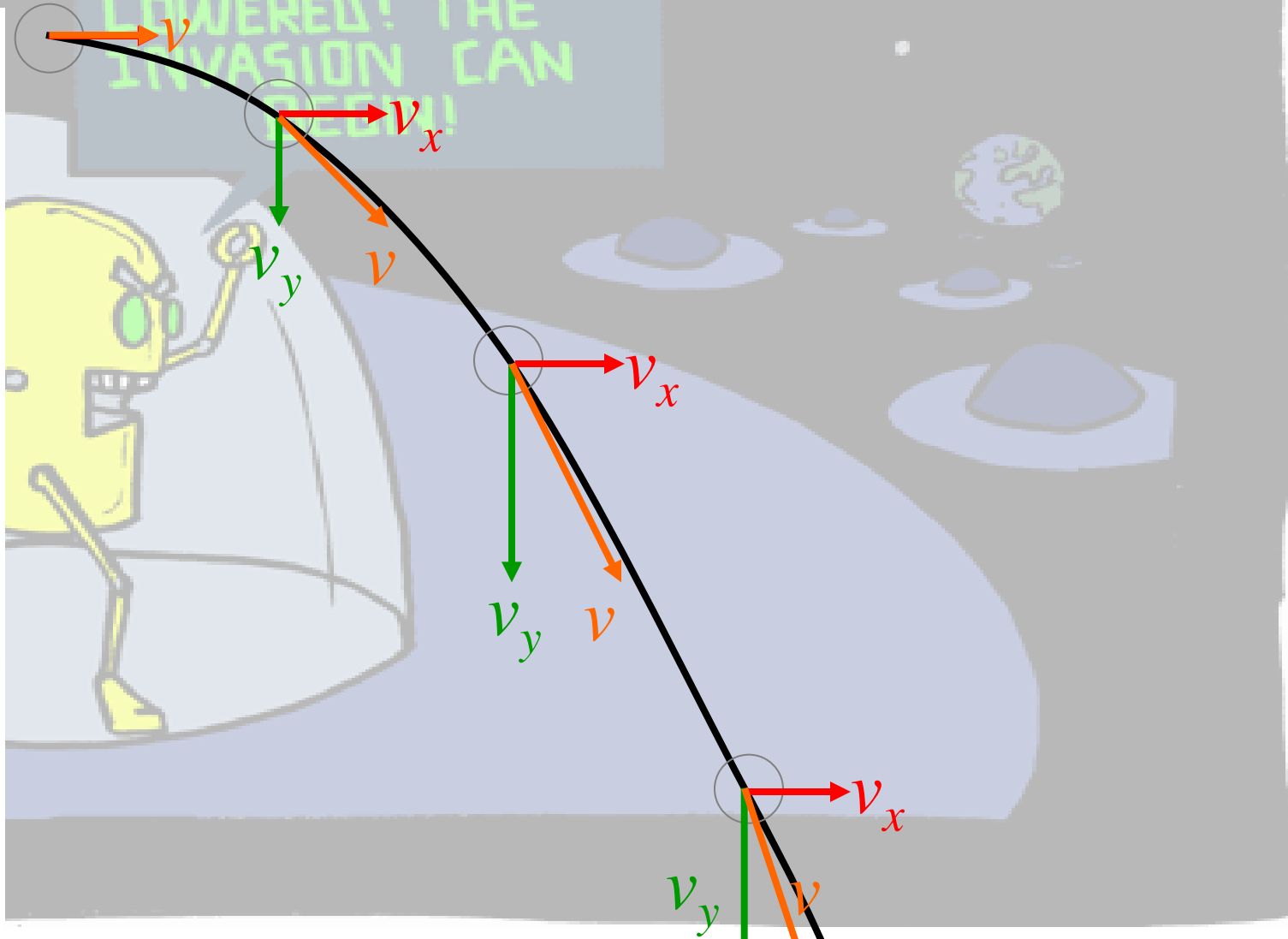
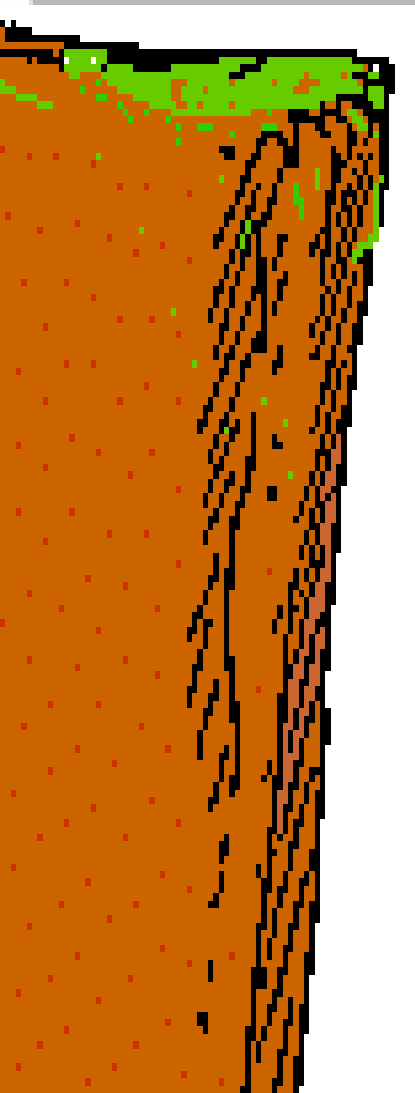
PROJECTILE MOTION

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



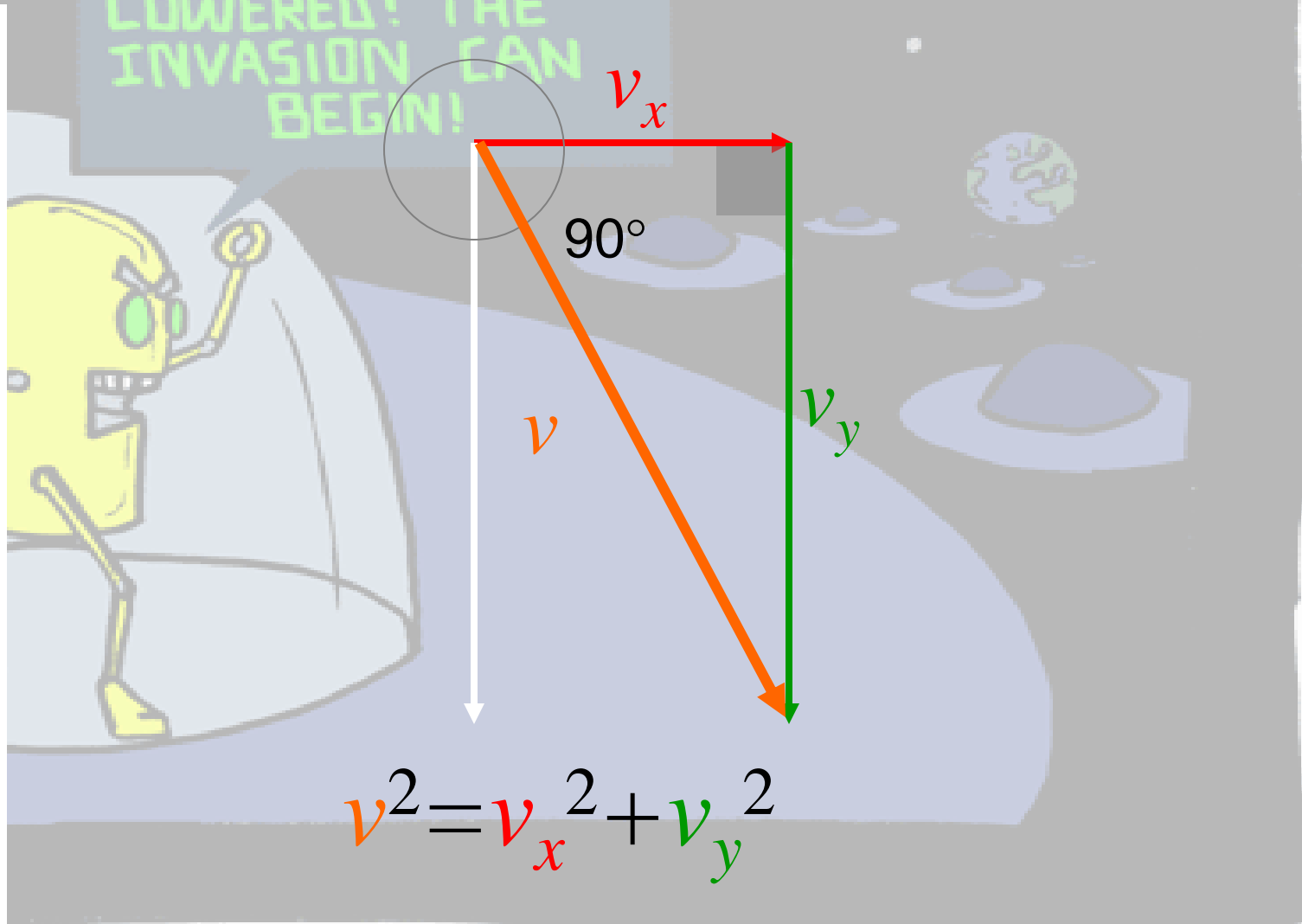
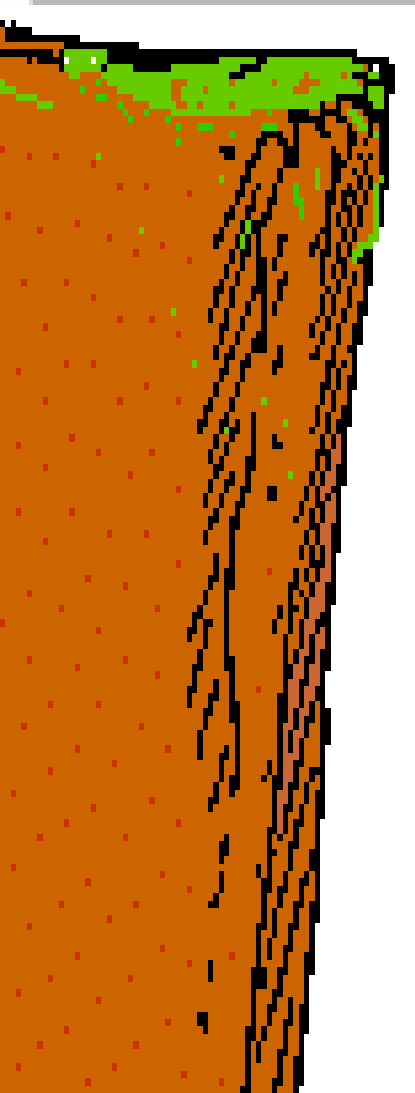
PROJECTILE MOTION

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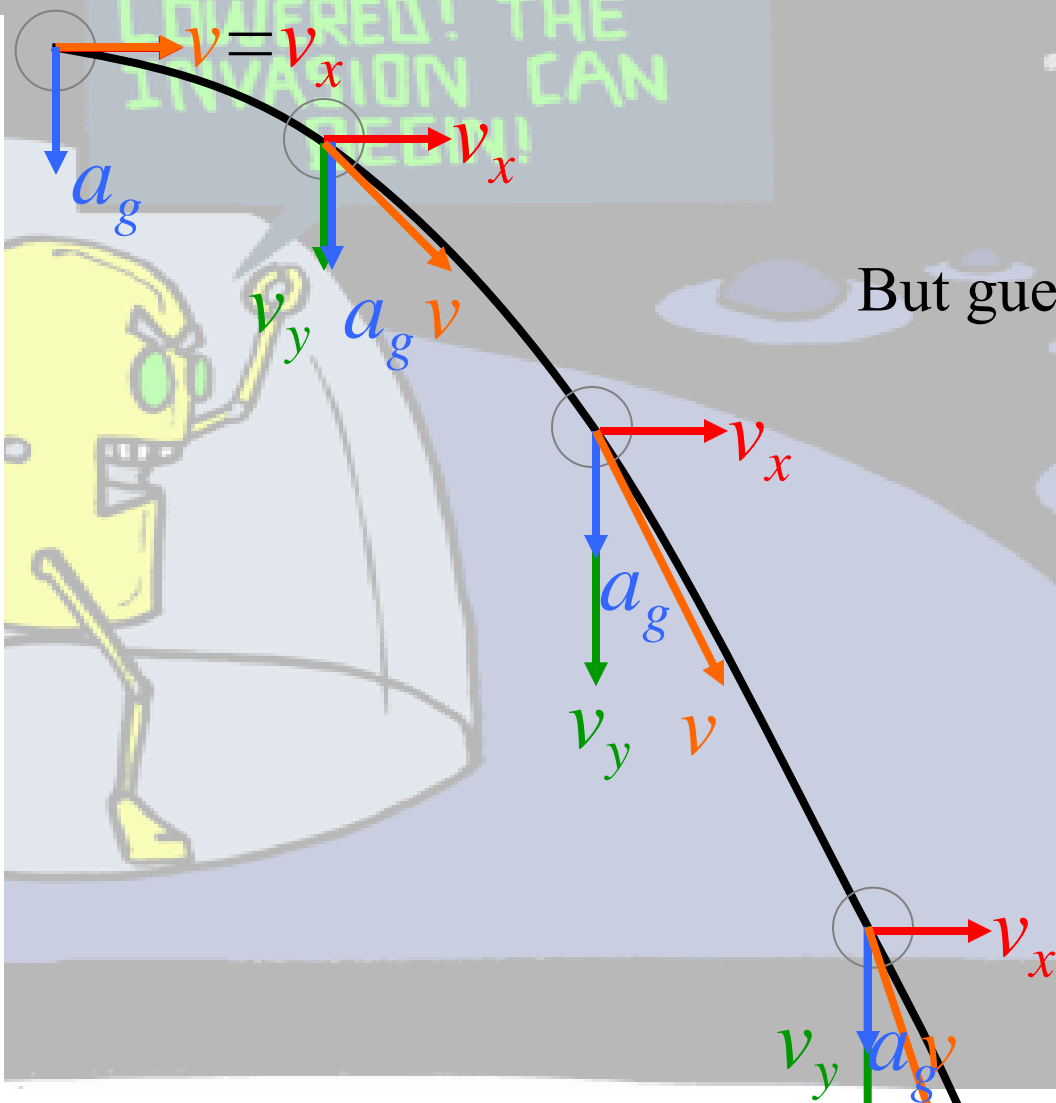
PROJECTILE MOTION

Use your knowledge of the Pythagorean theorem to calculate the speed.

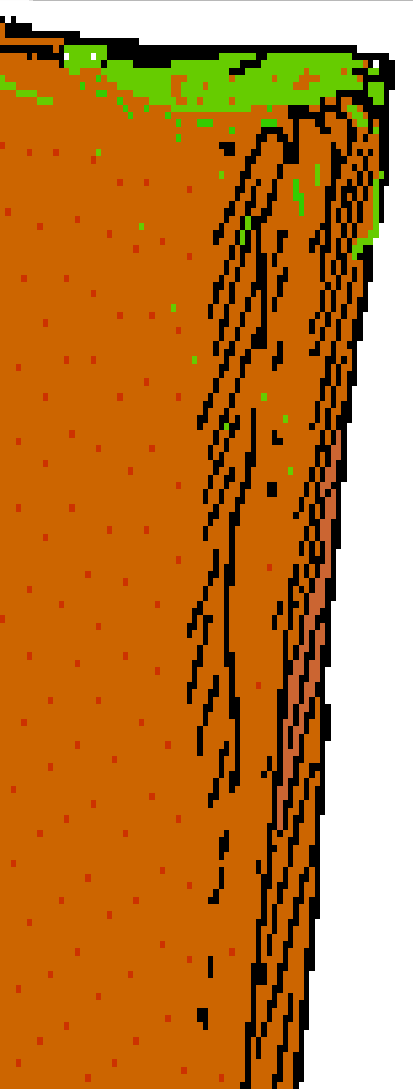


PROJECTILE MOTION

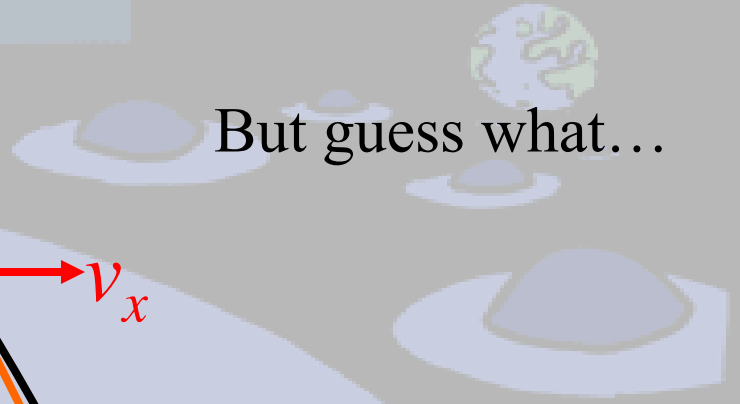
Draw an arrow representing the acceleration at each position.



But guess what...

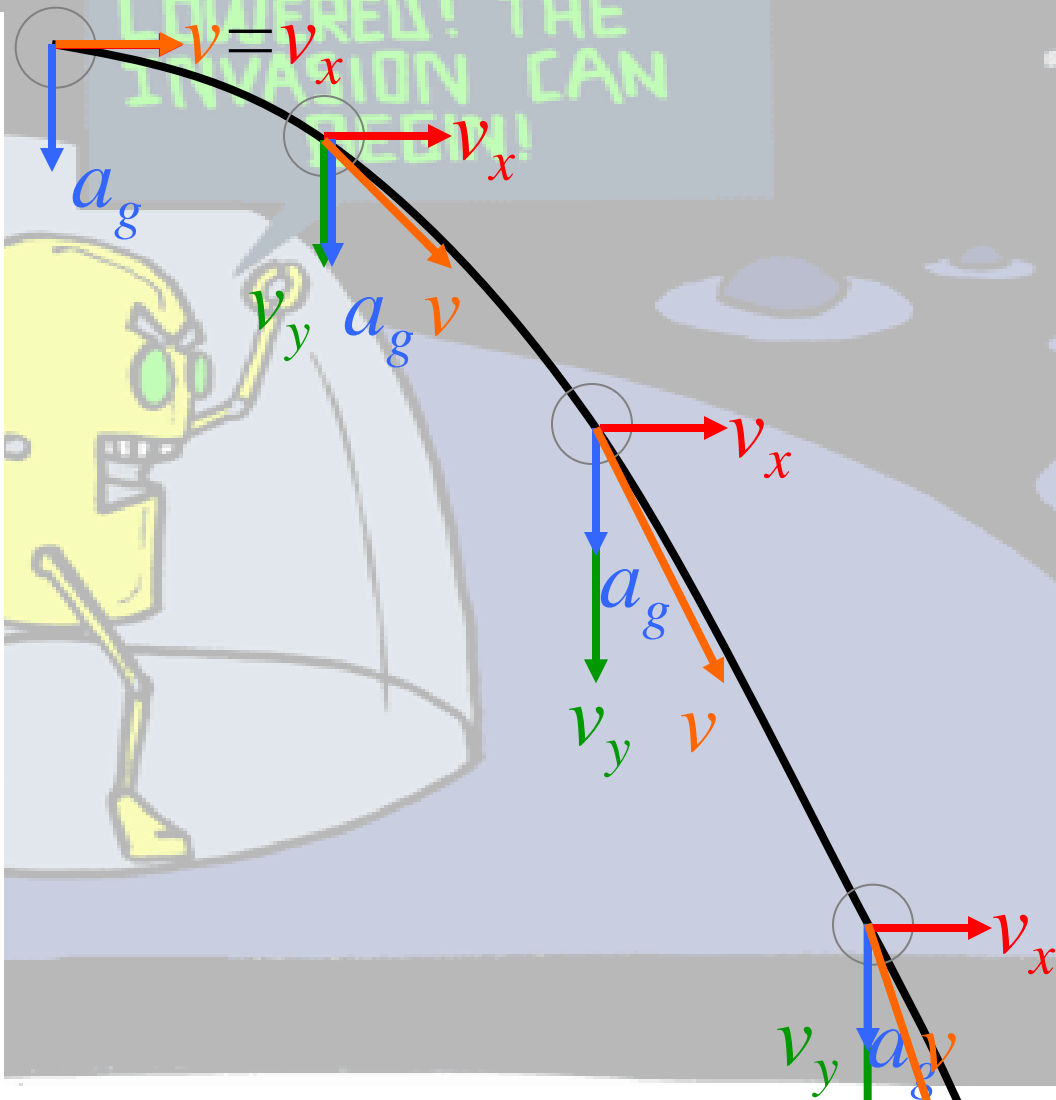


GLOBAL WARMING
GREENHOUSE GAS
LEVELS HAVE
LOWERED! THE
INVASION CAN
BEGIN!



PROJECTILE MOTION

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

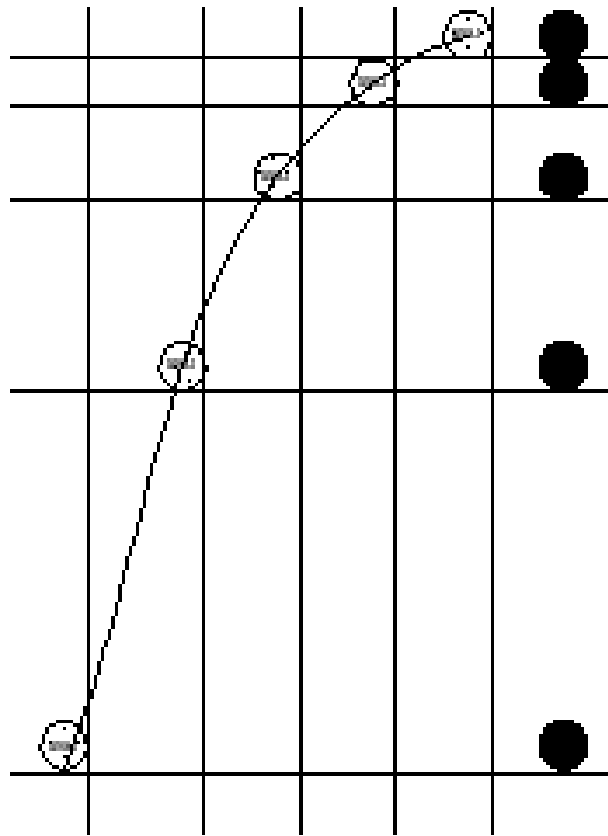
$$a_y = -g = -9.81 \text{ m/s}^2$$

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

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

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

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

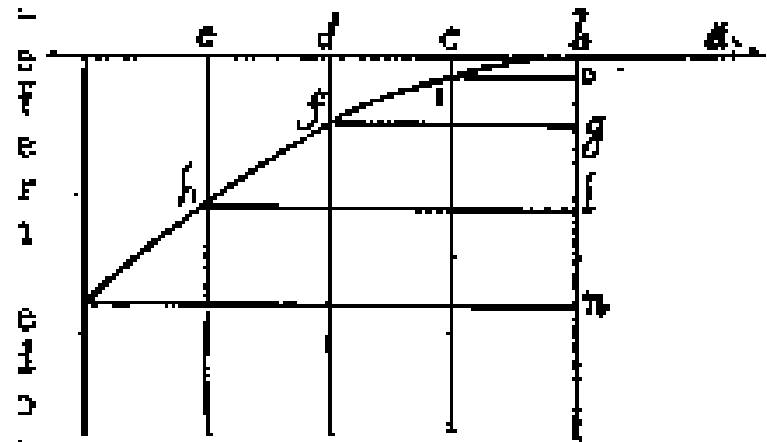
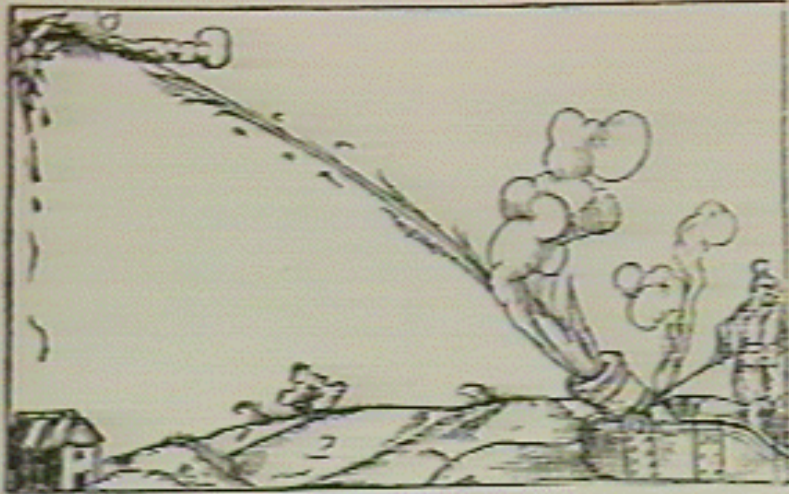


Fig. 108

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

A History of Projectile Motion

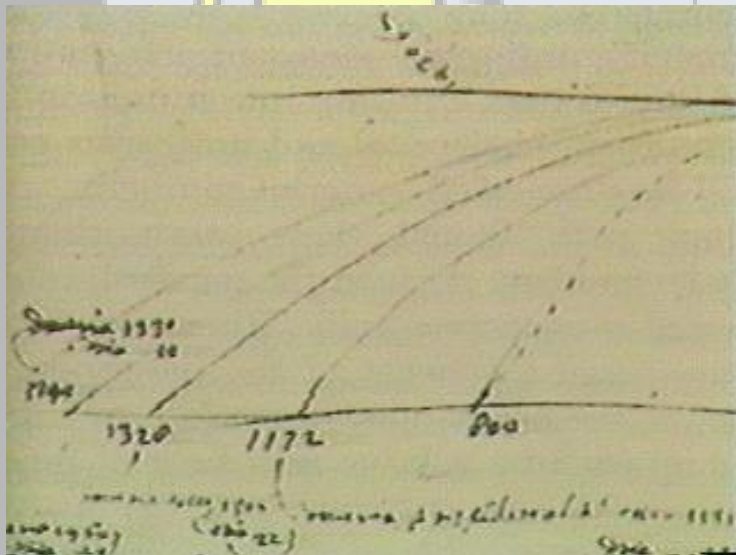


Aristotle:

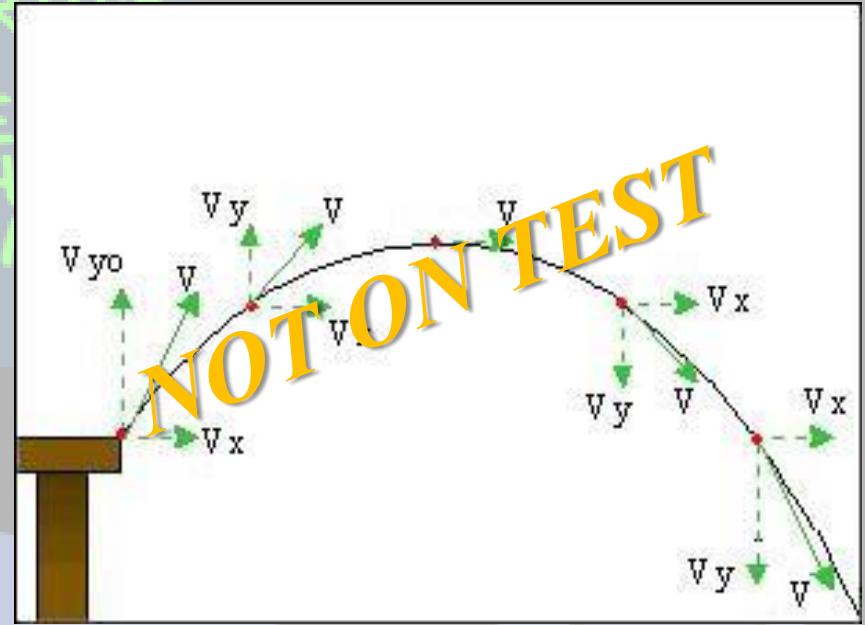
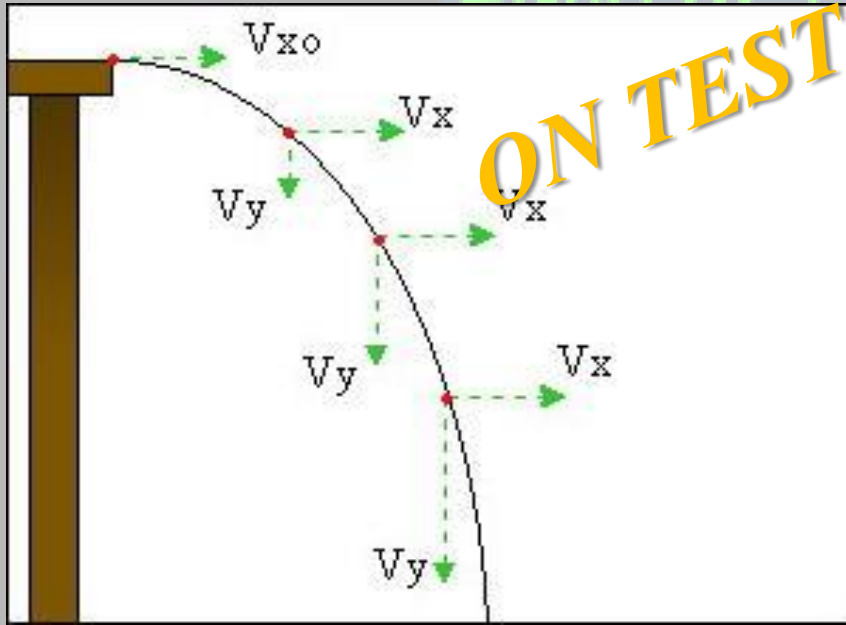
The canon ball travels in a straight line until it loses its 'impetus'.

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.

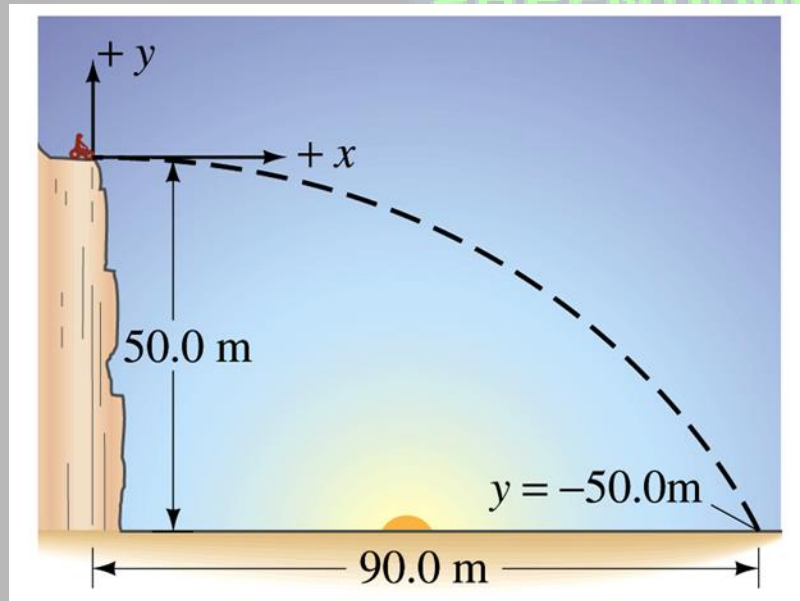
$$V_x = V_{xi} \quad x = v_{xi}t$$

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.

Sample Prob 1



Find v_H & t

Tablet PC SOL

WS PRACTICE...

REMAINED ON THE
GREENHOUSE GAS
LEVELS HAVE
LOWERED! THE
INVASION CAN
BEGIN!

Stop Here...



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

