Vertical Free-Fall Motion

The **height** s and vertical **velocity** v of an object in free fall are given by

$$s(t) = -\frac{1}{2}gt^2 + v_0 t + s_0 \quad \text{and} \quad v(t) = -gt + v_0,$$

where t is time (in seconds), $g \approx 32$ ft/sec^2 ≈ 9.8 m/sec^2 is the **acceleration due to gravity**, v_0 is the *initial vertical velocity* of the object, and s_0 is its *initial height*.

naught
is
0 initial

Velocity Equations

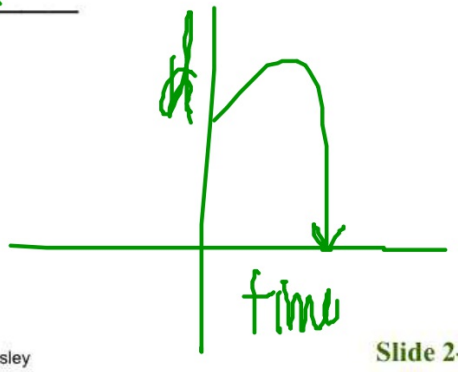
$$d = -16t^2 + 12t + 47$$

$-\frac{1}{2} \cdot g \, t^2$

-16

- Distance in ~~meters~~ feet, time in seconds
- Acceleration = -32 ft/sec^2
- Initial Velocity = 12 ft/sec
- Initial Height = 47 ft.

- What does this look like?



Velocity Equations

$$d = -13t^2 - 2t + 51$$

- Distance in meters, time in seconds
- Acceleration = $-26\ m/sec^2$
- Initial Velocity = $-2\ m/sec$
- Initial Height = $51\ m$

- What does this look like?

Velocity Equations

$$d = -16t^2 + 18t - 20$$

- Distance in meters, time in seconds
- Acceleration = -32 m/sec^2
- Initial Velocity = 18 m/sec
- Initial Height = -20 m

- What does this look like?

Velocity Equations

$$d = -16t^2 - 3t - 65$$

- Distance in meters, time in seconds
- Acceleration = $-32\ m/sec^2$
- Initial Velocity = $-3\ m/sec$
- Initial Height = $-65\ m$

- What does this look like?

AM: WP: Quadratic Equations

2. A rock is thrown ~~upward~~ from the top of a tall building. The distance, in feet, between the rock and the ground t seconds after the rock is thrown is given by $d = -16t^2 - 2t + 835$. How long after the rock is thrown is it 340 feet from the ground?

[A] $\frac{45}{8}$ s [B] $\frac{9}{2}$ s [C] $\frac{11}{2}$ s [D] none of these

$d = -16t^2 - 2t + 835$

$340 = -16t^2 - 2t + 835$

$-340 \quad -340$

$0 = -16t^2 - 2t + 495$

$a = -16 \quad b = -2 \quad c = 495$

$\frac{2 \pm \sqrt{(-2)^2 - 4(-16)(495)}}{2(-16)}$

$\frac{2 \pm 178}{-32}$

$\frac{-176}{-32} = \frac{11}{2}$

AM: WP: Quadratic Equations

1. The perimeter of a rectangular concrete slab is 110 feet, and its area is 624 square feet. What is the length of the longer side of the slab?

[A] 37 ft [B] 40 ft [C] 42 ft [D] none of these

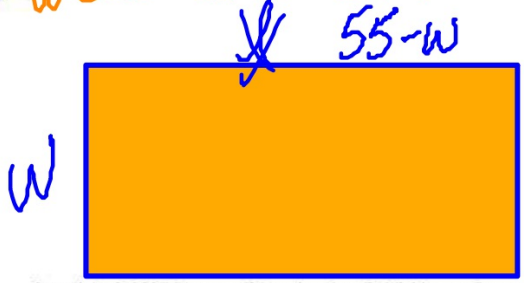
Variable and Equation Definitions (with units)

L= length

W= width

P= perimeter = $2l+2w = 110$

A= area = $l \times w = 624$



$l+w=55$

$l = 55-w$

$A = w(55-w) = 624$

$55w - w^2 = 624$

$-624 \quad -624$

$-w^2 + 55w - 624 = 0$

$a=-1 \quad b=55 \quad c=-624$

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