

05

Monday, February 29, 2016 1:13 PM

## More Stuffs Launched off of Different Stuffs

The key with all projectile questions is that their entire journey can be calculated the moment of launch.

(note to athletes: how important is your follow through...?)

A projectile launches with an initial velocity in the x direction, and that value does not change.

Since  $a_x = 0$

$$v_{fx}^2 = v_{ix}^2 + 2ad$$

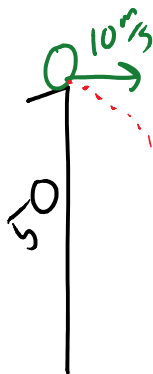
The value in the y direction (up and down) does change as gravity is the only force acting on the projectile after launch.

∴ The only work that we really need to do is find  $v_{fy}$ . Every question will have to give you either time (t) or height (h,d,y) where you need to find the velocity.

$$v_{fy} - v_{0y} = a_y t$$

$$v_{fy}^2 = v_{0y}^2 + 2ad$$

Find the velocity of a watermelon 3.0s after being launched horizontally at 10m/s from a 50m cliff.



$$v_{fy} - 0 = -9.8(3)$$

$$v_{fy} = -29.4 \text{ m/s}$$



$$v_f = \sqrt{10^2 + 29.4^2}$$

$$= 31 \text{ m/s} @ \theta = \tan^{-1}\left[\frac{29.4}{10}\right] = 71^\circ$$

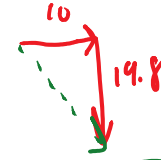
... from

Find the velocity of a watermelon 20m below the top of a 50m high cliff after being launched horizontally at 10m/s.



$$v_{fy}^2 = 0 + 2(-9.8)(-20)$$

$$v_{fy} = -19.8 \text{ m/s}$$



$$v_f = \sqrt{10^2 + 19.8^2}$$

$$= 22.2 \text{ m/s} @ \theta = \tan^{-1}\left[\frac{19.8}{10}\right]$$

= 62°

$= 71^\circ$   
down from horizontal

$@ \theta = \tan^{-1} \left[ \frac{10}{7} \right]$   
 $= 63^\circ$   
down from horizontal

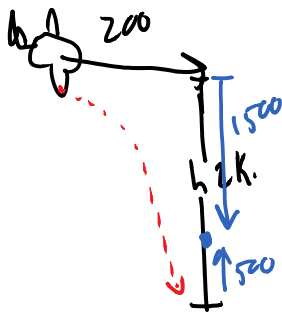
**An airplane example:**

You need to remember angle of inclination and declination.

A bomb is dropped from a plane flying horizontally at 200m/s from a height of 2.0km. Find the bomb's velocity after

A. 10s

B. after falling to a height of 500m.



$$v_{fy} - v_{iy} = at$$

$$v_{fy} - 0 = -9.8(10)$$

$$v_{fy} = -98 \text{ m/s}$$

$$v_f = \sqrt{200^2 + 98^2}$$

$$= 223 \text{ m/s}$$

@  $\theta = 26^\circ$  down from horizontal

$$v_f^2 = v_i^2 + 2ad$$

$$v_{fy}^2 = 0 + 2(-9.8)(1500)$$

$$v_{fy} = 171 \text{ m/s}$$



$$v_f = 263 \text{ m/s} @ \theta = \tan^{-1} \left[ \frac{171}{200} \right]$$

$$= 41^\circ$$

Lui Passaglia kicks a football at 22m/s at  $30^\circ$  from the horizontal.

A. Find the velocity of the ball at the high point.

B. Find the velocity of the ball after 2.2s.



A)  $v_{ox} = 22 \cos(30)$   
 $= 19.1 \text{ m/s}$

$\rightarrow v_{high} = 19.1 \text{ m/s}$  forward

$$v_{oy} = 22 \sin(30)$$

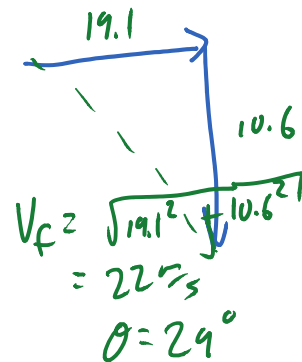
$$= 11 \text{ m/s}$$

B)  $v_{fy} - v_{iy} = at$

$$v_f - 11 = -9.8(2.2)$$

$$v_f = -9.8(2.2) + 11$$

$$= -10.6 \text{ m/s}$$

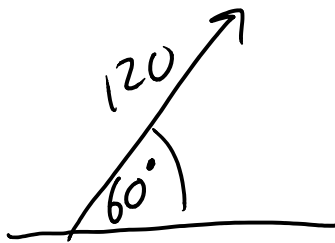


$$\theta = 29^\circ$$

When I tell Nolan that we have a test on Vectors and Projectiles on Monday, he threatens to rip off my head and throw it at a velocity of 120m/s at an angle 60° above horizontal.

--it was a very specific threat

What would the velocity be at h=20m?

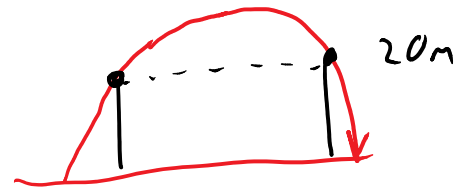


$$V_{0x} = 120 \cos(60)$$

$$= 60$$

$$V_{0y} = 120 \sin(60)$$

$$= 104$$

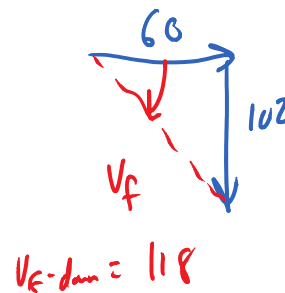
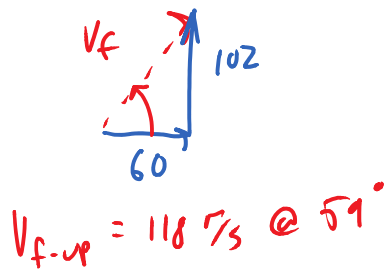


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$$V_f^2 = V_i^2 + 2ad$$

$$V_f^2 = 104^2 + 2(-9.8)(20)$$

$$= \pm 102 \text{ m/s}$$



## Projectile Practice w answers.

- 1) Nolan, a cliff diver is on a 30.0 m high cliff. With what velocity should he leave the cliff, (assume he jumps out horizontally) in order to miss 8.0 m of rock coming from the cliff's base?
- 2) A mountain goat butts you off a 50.0 m high cliff with a horizontal velocity of 3.0 m/s. How far from the base will you strike the ground?
- 3) ~~Tom~~ <sup>Kyle</sup> strikes a golf ball giving it a velocity of 35m/s at 35 o . If the course is completely flat how far will the ball travel before bouncing? typeII
- 4) Use the information in #3 to find the maximum height to which the ball will rise.
- 5) A flying squirrel leaps off a building of height 30.0 m. If it left the building with a horizontal velocity of 1.0 m/s will it land safely on some garbage bags 5.0 m from the base of the building?
- 6) Mathew hits a baseball at 30.0m/s on an angle of 40 o , what is its maximum height?
- 7) What is the velocity of the baseball in #6 3.0 s after leaving the bat?
- 8) What is the velocity of the baseball in #7 when it reaches a height of 10 m?
- 9) Lauren, a stunt person, jumps at 5.0 m/s horizontally, if she just lands on an airbag 24.2 m from the base of a building how high was the building?

### Answers:

- 1)  $V_{ox} = 3.23 \text{ m/s}$
- 2)  $dx = 9.58 \text{ m}$
- 3)  $dx = 117 \text{ m}$
- 4)  $dy = 20.4 \text{ m}$
- 5) no,  $dx = 2.47 \text{ m}$
- 6) 19.0 m
- 7) 25.1 m/s at 23.7 o down from horizontal
- 8)  $V_f = 26.6 \text{ m/s}$  at 30 o up and down from horizontal
- 9) 115 m