

Barely legible handwriting

A cannon is shot horizontally @ 40 m/s from a 100 m cliff. ~~What~~ what time does it hit the ground and where does it hit.

$$y = vt + \frac{1}{2}at^2$$

Raw equation presented but without any justification for why it is applicable here

$$100 = \frac{1}{2}at^2$$

Numerical values entered too soon

$$t = \sqrt{2a(100)}$$

At least enough work is included so that this algebra error can be identified!

$$t = \sqrt{2(9.8)100}$$

Units not included in calculation, which would have caught the error

$$t = 44.72$$

No consideration of whether answer is reasonable in physical context

$$x = vt$$

$$x = 40(44.72) = 1788.8$$

No estimation before using a calculator, which would have caught the numerical error

~~Answer~~

Answer makes sense,  
I don't make mistakes.

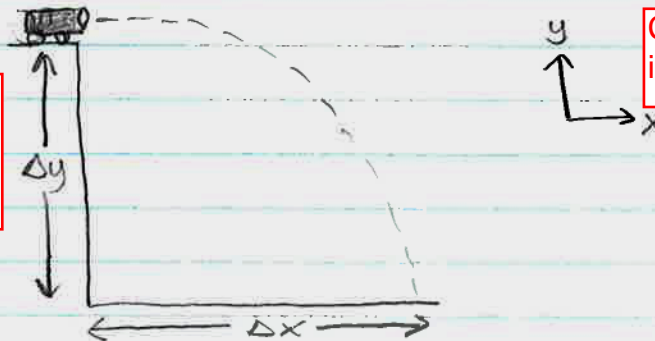
No comparison of the answer with any familiar physical situation to justify this claim

#VOLL

Question: A cannon is shot horizontally at  $40 \text{ m/s}$  from a  $100 \text{ m}$  cliff. Where does it hit the ground below and @ what time?

Figure:

Figure shows essential parts and identifies relevant variables



Coordinates identified

Known Values:

$$\Delta y =$$

$$\Delta y = 100 \text{ m}$$

$$V_{0y} = 0 \text{ m/s}$$

$$a_y = 9.8 \text{ m/s}^2$$

$$a_x = 0 \text{ m/s}^2$$

$$V_{0x} = 40 \text{ m/s}$$

Values from question tabulated for easy reference

Strategy: Separate problem into two separate but coupled problems.

Clear strategy identified before work commences

① Solve freefall in  $y$  direction to find flight time ( $\Delta t$ )

② use this  $\Delta t$  to find  $\Delta x$

Relevant equations: 1-D kinematics, applicable since accel. is constant

$$\Delta x = V_{0x} \Delta t + \frac{1}{2} a_x (\Delta t)^2$$

$$\Delta y = V_{0y} \Delta t + \frac{1}{2} a_y (\Delta t)^2$$

Raw equations identified with explanation of why they are applicable here

① solve for  $\Delta t$  in y direction:

- Find time it takes to fall 100 m given no initial velocity and a downward acceleration of  $g = 9.8 \text{ m/s}^2$

$$\Delta y = v_{oy}(\Delta t) + \frac{1}{2} a_y (\Delta t)^2$$

Algebraic manipulations clearly presented

$$\Delta y = 0 + \frac{1}{2} g (\Delta t)^2$$

$$\Delta t = \sqrt{\frac{2\Delta y}{a_g}} = \sqrt{\frac{2(100\text{m})}{9.8\text{m/s}^2}} \approx \sqrt{20\text{s}^2} \approx 4.5\text{s}$$

$$\boxed{\Delta t = 4.518 \text{ s}}$$

Arithmetic estimated by hand before using a calculator

② solve for  $\Delta x$  using  $\Delta t$

- Find how far the cannonball goes in the x direction in 4.518 s given  $v_{ox} = 40 \text{ m/s}$  and  $a_{ox} = 0 \text{ m/s}^2$

$$\Delta x = v_{ox}t + \frac{1}{2} a_{ox}(\Delta t)^2$$

$$\Delta x = v_{ox}t + 0$$

$$\Delta x = (40 \text{ m/s})(4.518 \text{ s}) \approx 180 \text{ m}$$

$$\boxed{\Delta x = 180.27 \text{ m}}$$

Units included and manipulated to verify algebra

conclusion: These answers seem reasonable because dropping something from a staircase takes a second or two to hit the ground, so 4.5 s for a 100 m height seems okay.

Answer compared to familiar physical situation

Clear line of logic