POOR SOLUTION EXAMPLE

Barely legible handwriting

A cannon is shot horizontally @ 40 m/s from a 100 ~~ft~~ m cliff. ~~When~~ 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

$t = 44.27$

No consideration of whether answer is reasonable in physical context

$x = vt$

$x = 40(44.72) = 788.8$

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

~~Ans:~~

Answer makes sense, I don't make mistakes.

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

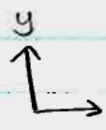
#YOLO

EXCELLENT SOLUTION EXAMPLE

Question: A cannon is shot horizontally at 40 m/s from a 100 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:

$\Delta y =$

$\Delta y = 100\ m$

$V_{oy} = 0\ m/s$

$a_y = 9.8\ m/s^2$

$a_x = 0\ m/s^2$

$V_{ox} = 40\ m/s^2$

Values from question tabulated for easy reference

Strategy: Separate problem into two separate but coupled problems.

① solve freefall in y direction to find flight time (Δt)

② use this Δt to find Δx

Clear strategy identified before work commences

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

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

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

Raw equations identified with explanation of why they are applicable here

① Solve for Δt in y direction:

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

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

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

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

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

Algebraic manipulations clearly presented

Arithmetic estimated by hand before using a calculator

② Solve for Δx using Δt

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

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

$$\Delta x = V_{0x} t + 0$$

$$\Delta x = (40\, m/s)(4.518\, s) \approx 180\, m$$

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

Clear line of logic

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