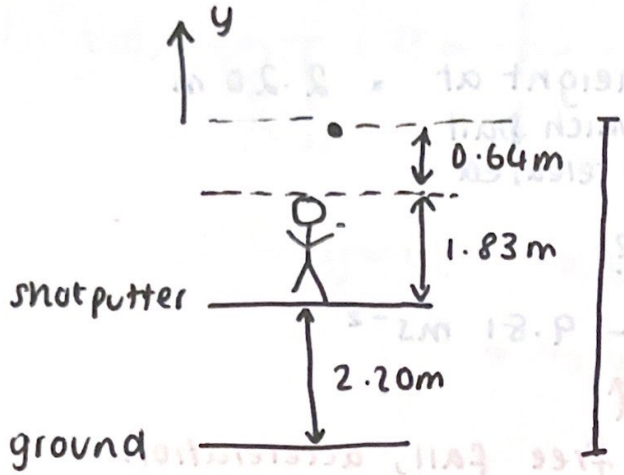
1. we have a constant acceleration problem.



4.67m = max height achieved by ball above ground level.

- identify variables:

$v_{0,y}$ = initial velocity (vertical) = 0 ms^{-1}

v_y = ?

a_y = const. upward acceleration = 35.0 ms^{-2}

$y - y_0$ = distance between shotputter & ball = 0.64 m.

- identify equation:

$$v_y^2 = v_{0,y}^2 + 2a_y(y - y_0)$$

$$\Rightarrow v_y = \sqrt{v_{0,y}^2 + 2a_y(y - y_0)}$$

$$= \sqrt{2 \times 35.0 \times 0.640}$$

$$= 6.69\ ms^{-1} \quad (3\ s.f.)$$

b. height above ground is at a maximum when $v_y = 0$ (the turning point)

variables: y_0 = height at which ball is released = 2.20 m

y = ?

$a_y = g = -9.81\ ms^{-2}$

↑ free fall, acceleration due to gravity is downwards, in our axis choice (↑y)

$v_{0,y}$ = initial speed at release = 6.69 ms^{-1} (from a)

v_y = velocity at max. height = 0 ms^{-1}

$$\Rightarrow \quad y - y_0 = \frac{v_y^2 - v_{0,y}^2}{2a_y} = \frac{v_y^2 - v_{0,y}^2}{-2g}$$

$$= \frac{0 - (6.69)^2}{2(-9.81)}$$

$$= 2.28\ m$$

but we are 2.20 m above the ground so the maximum height from the ground is

$$s_{max} = 2.20 + 2.28 = 4.48\ m \quad (3\ s.f.)$$

c. time from release to fall to the release position; call this time $t=0 \to t=T$.

$2.20\text{ m} = "y_0"$

$1.83\text{ m} = "y"$

$\left.\begin{matrix}\\\\\end{matrix}\right\} y - y_0 = "\Delta s"$

$0 \leftarrow$ take the ground to be zero.

$$y - y_0 = V_{0,y}\,t + \tfrac{1}{2} a_y t^2$$

$$= V_{0,y}\,t + \tfrac{1}{2} g t^2$$

$$\Rightarrow \quad 1.83 - 2.20 = 6.69t + \tfrac{1}{2}(-9.81)t^2$$

$$\Rightarrow \quad -0.37 = 6.69t - 4.905t^2$$

$$\Rightarrow \quad -4.905t^2 + 6.69t + 0.37 = 0$$

$$\Rightarrow \quad t = \frac{-6.69 \pm \sqrt{6.69^2 - 4(\cdots\cdots)}}{2(-4.905)}$$

is a quadratic in t, giving...

$t = -0.053\cdots$ OR $t \doteq 1.41714\ldots$

↑ reject negative time

↑ correct solution

$$\Rightarrow \quad t = 1.42\text{ s} \quad (3\text{ s.f.})$$