This is a 1-D problem involving Free-Fall acceleration.

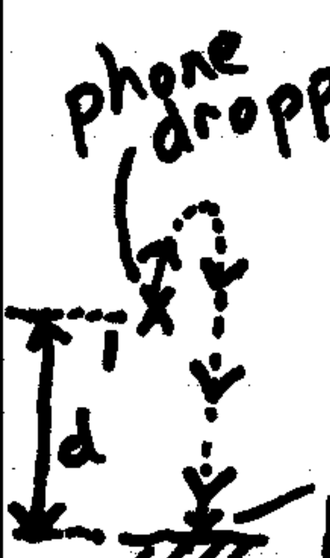
A drop tower at an amusement park rises at 5 m/s and is 45 m above the ground when one of the riders drops her phone.

(a) How long does it take for the phone to fall to the ground?

(b) At what speed does the phone hit the ground?

Solution:

Assumptions: - Phone motion is purely vertical
- Air resistance is negligible



(a) Use the kinematic equation:

$$d = v_i t + \frac{1}{2} g t^2$$

$d = -45\,m$ (negative displacement)

$v_i = +5\,m/s$ (initial vertical speed)

$g = -9.8\,m/s^2$

$t = ?$ (airborne time)

↑ + (sign convention)

Substitute:

$$-45 = 5t - \frac{1}{2}(9.8)t^2$$

$$\Rightarrow -45 = 5t - 4.9t^2$$

$$\Rightarrow -4.9t^2 + 5t + 45 = 0$$

This is a quadratic equation.

Solve for $t = 3.58s$ or $t = -2.56s$ (invalid)

It takes the phone 3.6 s to fall to the ground (answer).

(b) Use the kinematic equation: $v_2 = v_1 + gt$

$v_2 = ?$ (the speed at which phone hits ground)

substitute:

$v_2 = 5 - (9.8)(3.58)$

$v_2 = -30.1\ m/s$ (downward speed)

The phone hits the ground at 30.1 m/s (answer).