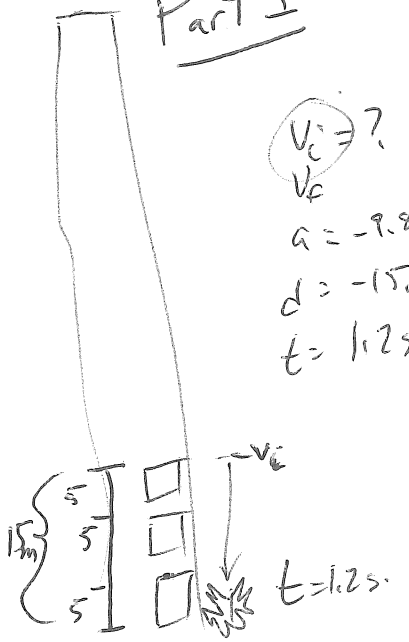
Kinematics Challenge #1

Part 1



$v_i = ?$

v_f

$a = -9.8 m/s^2$

$d = -15m$

$t = 1.2s$

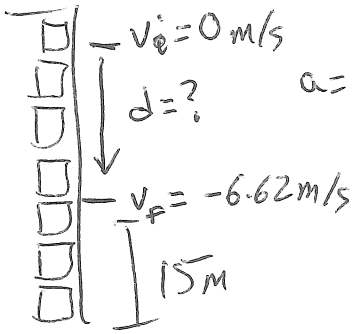
$$d = v_i t + \frac{1}{2} a t^2$$

$$v_i = \frac{d - \frac{1}{2} a t^2}{t}$$

$$v_i = \frac{-15 - \frac{1}{2}(-9.8)(1.2)^2}{1.2}$$

$$v_i = \frac{-15 + 7.056}{1.2} = -6.62 m/s$$

Part 2



$a = -9.8 m/s^2$

$v_i = 0 m/s$

$v_f = -6.62 m/s$

$a = -9.8 m/s^2$

$d = ?$

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

$$d = \frac{v_f^2 - v_i^2}{2a}$$

$$d = \frac{(-6.62)^2 - (0)^2}{2(-9.8)}$$

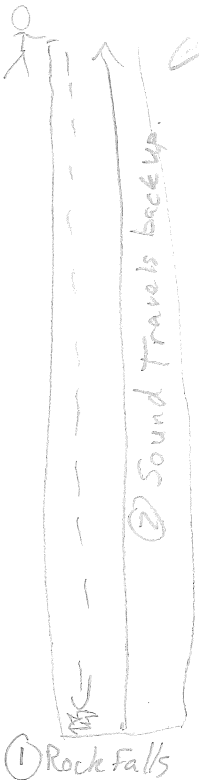
$$d = -2.236 m$$

Total distance fallen $= -15m + -2.236m = -17.236m$ ← middle of the 4th Floor.

The AC unit was dropped from the middle of the 4th Floor

Kinematics Challenge #2

a) For situation ① and ② the size of $\vec{d}$ is the same.



b) Total Time: $t_{drop} + t_{sound}$

$t_{drop} = Total - t_{sound}$

c) Dropped Rock

$v_i = 0$

$a = -9.8\ m/s^2$

$d = ?$

$t = 12.2 - t_{sound}$ (t_s)

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

d) Sound

$d = v_{sound} \cdot t_{sound}$ (v_s) (t_s)

$V_s = 331\ m/s$ at Standard Temperature and Pressure

Substitute

$-(V_s \cdot t_s) = v_i(12.2 - t_s) + \frac{1}{2}(-9.8)(12.2 - t_s)^2$

Because the rock is dropping

$-331 t_s = 0(12.2 - t_s) + (-4.9)(12.2 - t_s)^2$

$\frac{-331 t_s}{-4.9} = \frac{-4.9(12.2 - t_s)^2}{-4.9}$

$67.551 t_s = (12.2 - t_s)^2$ ← Use Distributive Property (or FOIL)

$67.551 t_s = 148.84 - 24.4 t_s + t_s^2$ ← Rearrange

$0 = t_s^2 - 91.951 t_s + 148.84$ ← Quad Eq^

$t_s = \frac{91.951 \pm \sqrt{(91.951)^2 - 4(1)(148.84)}}{2}$

→ 90.30 ← Reject because it is too long!

→ 1.648

$t_s = 1.648\ s$

$d = V_s \cdot t_s = 331 \cdot 1.648 = 545.5\ m$ 3 sig figs

The well is 546 m deep.