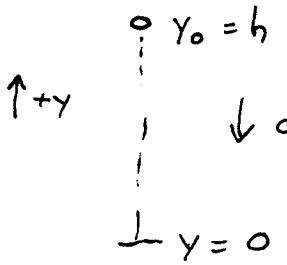
Problem 7-24



Let t_f = time for stone to fall

$$y = y_0 + v_0 t_f + \frac{1}{2} a t_f^2$$

($v_0 = 0$)

$$\therefore 0 = h - \frac{1}{2} g t_f^2$$

$$\therefore t_f = \sqrt{\frac{2h}{g}}$$

Let t_s = time for sound to travel to boy.

$$t_s = \frac{h}{v_s} \quad (\text{where } v_s = \text{speed of sound})$$

$$t_f + t_s = 9.00\ s$$

$$\therefore \sqrt{\frac{2h}{g}} + \frac{h}{v_s} = 9$$

Treat $\sqrt{h}$ as the unknown. Write $\sqrt{h} = z$.

$$\therefore \frac{z^2}{v_s} + \sqrt{\frac{2}{g}}\, z - 9 = 0$$

$$\therefore z = \frac{-\sqrt{\frac{2}{g}} \pm \sqrt{\frac{2}{g} - 4\left(\frac{1}{v_s}\right)(9)}}{\frac{2}{v_s}}$$

Subst. $g = 9.80\ m/s^2$ and $v_s = 350\ m/s$

$$\therefore z = \frac{-0.4518 \pm \sqrt{0.2041 + 0.1029}}{0.005714}$$

$$= \frac{-0.4518 \pm 0.5540}{0.005714}$$

Need $z > 0 \Rightarrow \therefore z = 17.90\ m^{1/2}$

Then, $h = z^2 = 3.20 \times 10^2\ m$