

Pebble into Well problem

Annabelle drops a pebble from rest into a deep wishing well. It takes 8 seconds for the sound of the splash to get back to her. Assuming the speed of sound is 330 m/s, how deep is the well?

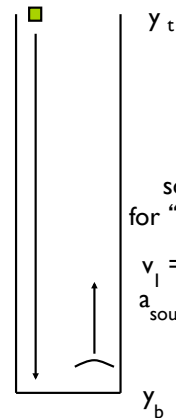
This problem has two parts. There is the motion of the pebble dropping to the water's surface and there is the sound of the splash returning to the top.

1.)

pebble falls
for "t" seconds.

$$v_{1p} = 0 \text{ m/s}$$

$$a_g = -9.8 \text{ m/s}^2$$



sound travels
for "8 - t" seconds.

$$v_{1s} = 330 \text{ m/s}$$

$$a_{\text{sound}} = 0$$

for the pebble:

$$y_{p,2} = y_{p,1} + v_{1p}t + \frac{1}{2}a_p t^2$$

$$\Rightarrow 0 = y_{\text{top}} + 0 + \frac{1}{2}(-9.8 \text{ m/s}^2)t^2$$

$$\Rightarrow y_{\text{top}} = 4.9t^2$$

for the motion in air:

$$y_{s,2} = y_{s,1} + v_{s,1}t + \frac{1}{2}a_s t^2$$

$$\Rightarrow y_{\text{top}} = 0 + (330 \text{ m/s})(8 - t) + 0$$

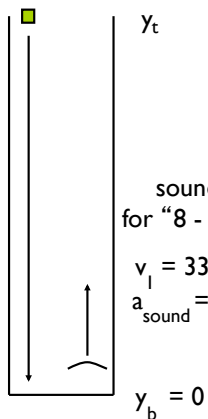
$$\Rightarrow y_{\text{top}} = 2640 - 330t$$

3.)

pebble falls
for "t" seconds.

$$v_{1p} = 0 \text{ m/s}$$

$$a_g = -9.8 \text{ m/s}^2$$



sound travels
for "8 - t" seconds.

$$v_{1s} = 330 \text{ m/s}$$

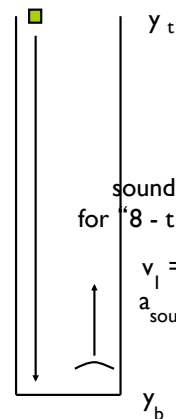
$$a_{\text{sound}} = 0$$

2.)

pebble falls
for "t" seconds.

$$v_{1p} = 0 \text{ m/s}$$

$$a_g = -9.8 \text{ m/s}^2$$



sound travels
for "8 - t" seconds.

$$v_{1s} = 330 \text{ m/s}$$

$$a_{\text{sound}} = 0$$

Combining yields:

$$4.9t^2 = 2640 - 330t$$

$$t^2 + 67.3t - 539 = 0$$

$$\Rightarrow t = 7.25 \text{ sec}$$

Solving, we get:

$$y_{\text{top}} = \frac{1}{2}(9.8 \text{ m/s}^2)t^2$$

$$= (4.9 \text{ m/s}^2)(7.25)^2$$

$$= 258 \text{ m}$$

OR

$$y_{\text{top}} = (330 \text{ m/s})(8 - t)$$

$$= (330 \text{ m/s})(.75 \text{ s})$$

$$= 247.5 \text{ m}$$

Close enough!

4.)