2.2

Flowerpot falls a distance \( 0.85 \times 2.2 = 1.87 \text{ m} \) at 30 frames/s, 6 frames take 0.20 s.

\[
\text{\textit{v}}_{\text{avg}} = \frac{1.87 \text{ m}}{0.20 \text{ s}} = 9.35 \text{ m/s} = \text{\textit{v}} \text{ at center of window}
\]

Suppose pot was dropped from rest. How long had it been falling?

\[
\text{\textit{v}}_{t} = \text{\textit{v}}_{i} - g(\Delta \text{t}) \Rightarrow \Delta \text{t} = \frac{-9.35 \text{ m/s}}{9.80 \text{ m/s}^2} = 0.954 \text{ s}
\]

What is original height above center of window?

\[
\text{\textit{y}}_{t} = \text{\textit{y}}_{i} + \text{\textit{b}} \text{\textit{y}} \Delta \text{t} + \frac{1}{2}(-g)(\Delta \text{t})^2
\]

\[
(\text{\textit{y}}_{t} - \text{\textit{y}}_{i}) = \frac{1}{2}(-9.8 \text{ m/s}^2)(0.954 \text{ s})^2 = -4.46 \text{ m}
\]

So 4.46 m above center of window.

Assume each floor in the building is 10' = 3.0 m high. So the pot could have dropped from rest from the floor of a balcony on the 6th floor, or else perhaps was thrown down by someone on the 5th floor.

33

As the ball is brought to rest from 50 m/s,

\[
\Delta \text{p} = \text{m} \Delta \text{v} = (0.0057 \text{ kg})(50 \text{ m/s}) = 2.85 \text{ kg.m/s}
\]

Assume it slows down at a uniform rate from 50 m/s to 0, so \( \text{\textit{v}}_{\text{avg}} = 25 \text{ m/s} \).

\[
\text{\textit{v}}_{\text{avg}} = \frac{\Delta \text{r}}{\Delta \text{t}} \Rightarrow \Delta \text{t} = \frac{\Delta \text{r}}{\text{\textit{v}}_{\text{avg}}} = \frac{0.02 \text{ m}}{25 \text{ m/s}} = 0.0008 \text{ s}
\]

\[
\text{\textit{F}}_{\text{avg}} = \frac{\Delta \text{p}}{\Delta \text{t}} = \frac{2.85 \text{ kg.m/s}}{0.0008 \text{ s}} = 3600 \text{ N}
\]
\[ \Delta \rho = F \Delta t = \left( 6 \times 10^3 \text{ kg}, 0, 0 \right) \left( 3.45 \right) = \left( 20.4 \times 10^3 \text{ kg}, 0, 0 \right) \text{ kg/m}^3 \]

\[ \Delta v = \frac{\Delta \rho}{\rho} = \frac{\left( 20.4 \times 10^3 \text{ kg}, 0, 0 \right)}{1.5 \times 10^5 \text{ kg}} = \left( 1.36, 0, 0 \right) \text{ m/s} \]

\[ v_f = v_i + \Delta v = \left( 0, 20000, 0 \right) \text{ m/s} + \left( 1.36, 0, 0 \right) \text{ m/s} = \left( 1.36, 20000, 0 \right) \text{ m/s} \]

During burn, \[ \bar{v}_{\text{avg}} = \frac{1}{t} (v_i + v_f) = \left( 0.68, 20000, 0 \right) \text{ m/s} \]

\[ \Delta r = \bar{v}_{\text{avg}} \Delta t = \left( 0.68, 20000, 0 \right) \left( 3.45 \right) = \left( 2.68 \times 10^3, 0 \right) \text{ m} \]

\[ r_f = r_i + \Delta r = \left( 12000, 15000, 0 \right) \text{ m} + \left( 2.68 \times 10^3, 0 \right) \text{ m} = \left( 12268, 15000, 0 \right) \text{ m} \]

Now it coast at \( v_f \) for 3600 s.

\[ \Delta r = \left( 1.36, 20000, 0 \right) \text{ m/s} \left( 3600 \right) = \left( 4896, 72000, 0 \right) \text{ m} \]

\[ r_f = \left( 12268, 73000, 0 \right) \text{ m} + \left( 4896, 72000, 0 \right) \text{ m} = \left( 16964, 72080, 0 \right) \text{ m} = \left( 16.96, 72080, 0 \right) \text{ km} \]