Answer #119

The answer is (b): 2.83 seconds, as can be seen by clicking your mouse on the photograph below.

The equation to determine how far an accelerated body moves as a function of time is:

\[ x = \frac{1}{2} a t^2. \]

where \( a \) is the acceleration.

The time for the accelerating body \( M \) to move the distance \( D \) between the two photocell gates due to the gravitational force on \( m \) is given by:

\[ t = \sqrt{\frac{2D}{(M+m)g}} \approx \sqrt{\frac{2DM}{mg}} = t_0, \]

where \( g \) is the acceleration of gravity. Substituting \( 2M \) for \( M \) yields approximately \( t = \sqrt{2}t_0 \) or 2.83 seconds. Because \( M \gg m \), we have dropped the \( m \) from the numerator in the final relation for \( t_0 \) in the equation above.

What error will this make in the final calculated value? The calculated time taken for mass \( m \) to accelerate mass \( M \) will be too short by the small fraction:

\[ \sqrt{1 + \frac{m}{M}}, \]

which is smaller than the experimental error in the apparatus.
For questions and comments regarding the *Question of the Week* contact [Dr. Richard E. Berg](mailto:Dr.Richard.E.Berg@UniversityOfMaryland.edu) by e-mail or using phone number or regular mail address given on the [Lecture-Demonstration Home Page](http://www.physics.umd.edu).