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STUDENT VERSION

Falling Meteorite

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STATEMENT

We have considered the situation of an object falling with air resistance or drag. We found the ordinary differential equation (ODE) for the motion to be

$$v' = g - \frac{\rho}{m} v^2 \tag{1}$$

where v is the velocity as a function of time, g is the acceleration due to gravity, ρ is the drag coefficient, and m is the mass of the object. We assume the initial velocity is zero and call the constant solution the *terminal velocity* v_∞, which is given by

$$v_\infty^2 = \frac{mg}{\rho}.$$

After separating variables and using a partial fraction decomposition, the solution to (1) is found to be

$$v(t) = v_\infty \tanh\left(\frac{\rho}{m} v_\infty t\right).$$

In arriving at this solution, we have made a variety of assumptions, i.e. we have ignored factors that affect the motion of the object to a smaller extent. Now consider a falling meteorite. We will simplify the situation mathematically by assuming that the meteorite falls straight downward and consider only the vertical motion, i.e. we will look at equations in only one position variable. However, consider all of the other factors that affect the flight of the object.

PROBLEM

1. Make a list of every factor that affects the motion of a meteorite as it falls from above the atmosphere to the ground. Be creative. List everything you can think of, even if you are unsure. Watch this amazing video of meteorites caught on camera . There are three parameters listed in the original ODE (1). How could each of them change? Consider researching "drag coefficient."
2. Rank these factors from largest to smallest effect. It is fine to have a tie.
3. Modify (1) to incorporate the top one or two of the factors in your ranking. Record your model here.
4. Choose one member of your group to present your model to the class.