Math Rocks: A Lesson in Asteroid Dynamics

1. What is the straight-line distance the meteor traveled through Earth's atmosphere?

Using d=rt, d=(18 km/s)(32.5 s) = **585 km**

2. Compute the volume of the asteroid, assuming it was nearly spherical.

Using $V = \frac{4}{3}\pi r^3$, $V = \frac{4}{3}(\pi)(8.5\ m)^3 \approx 2572\ m^3 \approx \mathbf{2600\ m^3}$

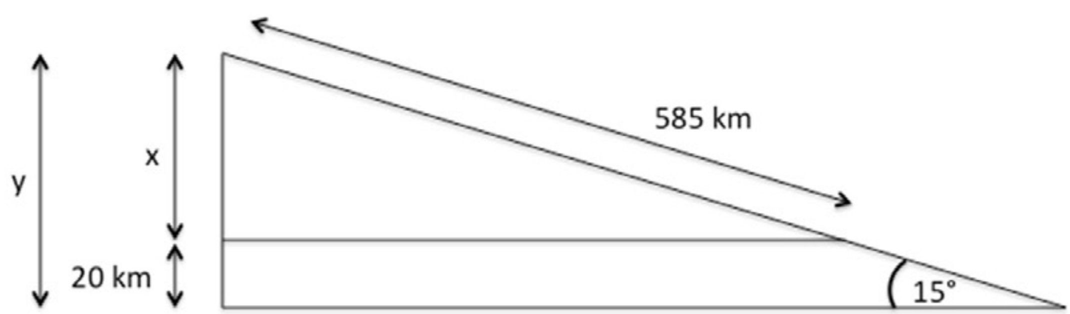
3. Compute the density of the asteroid. What does this tell you about the physical composition of the asteroid? Is it primarily ice? Rock? Iron?

Using $D = \frac{m}{V}$, $D \approx \frac{11{,}000{,}000\ kg}{2572\ m^3} \approx \mathbf{4200\ kg/m^3}$ Because most rock has density varying between 2000 and 3000 kg/m^3 and iron has density of about 8000 kg/m^3, we can conclude this was likely a mostly stony asteroid. Additionally, meteorites recovered on the ground are most likely stony.

4. How much energy was released by the event? Give answer in Joules and kilotons.

Using $E_k = \frac{1}{2}mv^2$, $E_k = \frac{1}{2}(11{,}000{,}000\ kg)(18{,}000\ ^m/_s)^2 \approx \mathbf{1.8 \times 10^{15}}$ **Joules**
1 Joule = 2.39×10^{-13}kT, so $E_k \approx (1.8 \times 10^{15})\,(2.39 \times 10^{-13}) \approx$
$\mathbf{4.3 \times 10^2\ kT\ or\ 430\ kT}$

5. At what altitude did atmospheric entry occur? What layer of the atmosphere is this?



The altitude, y, is equal to $x + 20$.

$$\sin 15° = \frac{x}{585} \rightarrow x \approx 151\ km$$
$$y = x + 20 \approx 151 + 20 \approx \mathbf{171\ km}$$

This is the thermosphere.

This lesson was developed for JPL Education by JPL educator Dr. Ota Lutz with input from JPL scientist Paul Chodas
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