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A 531N, 1.62m stunt man is going to bungee jump from the Sidu River Bridge. At 496.00m above
the river bottom, it is the highest bridge in the world. You are tasked with the design of the bungee
cable. You want to make the stunt as spectacular as possible while keeping the stunt man safe.
So in your design, you want to keep the g-load under 3g, the stunt man to fall as fast and long as
possible, and you want to get his hair wet when he reaches the river below. Your bungee will snap
if its radius decreases by more than 50%. The rubber that makes up your bungee has an energy
storing capacity per square meter of cross-section of 167. \( \frac{J}{m^2} x^2 - 0.252 \frac{J}{m^3} x^3 \). What is the length and
radius of the bungee?
If you get done with enough time, find coefficients of energy capacity that will make the stunt even
more spectacular while keeping the radius of the cable reasonable. If you did it right, you won’t
have to reinvent the equations.

\[
H = h + \ell + x = 496m \\
\ell + x = 496m - 1.62m = 494.38m
\]
So I need to make all of the energy derived from falling and turn it in to energy stored in the bungee
cable.

\[
PE = mg(\ell + x) = W(\ell + x) = 262515.78J \\
PE = \pi R^2 (167. \frac{J}{m^4} x^2 - 0.252 \frac{J}{m^5} x^3)
\]
I also need to make sure that I don’t damage the stunt man by pulling on him with more than 3W. 
Since gravity pulls down with 1W I need the cable to not pull up with more than 2W. (I think I
led y’alls in the wrong direction at this point.)

\[
\vec{F} = -\nabla U \\
2W = 1061N = \pi R^2 (334. \frac{J}{m^4} x - 0.756 \frac{J}{m^5} x^2)
\]
I can now rearrange these equations so that I have have the cross-sections by themselves, which
must be equal to each other.

\[
\frac{\pi R^2}{PE} = 167. \frac{J}{m^4} x^2 - 0.252 \frac{J}{m^5} x^3 \\
\frac{\pi R^2}{2W} = \frac{334. \frac{J}{m^4} x - 0.756 \frac{J}{m^5} x^2}{2W}
\]

\[
262515.78J \frac{334.}{m^4} x - 0.756 \frac{J}{m^5} x^2 = 1061N (167. \frac{J}{m^4} x^2 - 0.252 \frac{J}{m^5} x^3) \\
262515.78m (334. - 0.756 \frac{1}{m} x) = 1061 (167. x - 0.252 \frac{1}{m} x^2) \\
87680270.52m - 198461.92968x = 177187x - 267.372 \frac{1}{m} x^2 \\
87680270.52m - 375648.92968x + 267.372 \frac{1}{m} x^2 = 0 \\
x = 1109.36m \text{ or } 295.61m \\
\ell = 494.38m - 295.61m = 198.77m
\]
Now that I know how long it the bungee cable needs to be, I can its radius. I can use either of the
above equations for cross-section area to find the radius.

\[
R = \sqrt{\frac{\frac{PE}{\pi (167. \frac{J}{m^4} x^2 - 0.252 \frac{J}{m^5} x^3)}}{262515.78J}} \\
R = \sqrt{\frac{\frac{PE}{\pi (167. \frac{J}{m^4} (295.61m)^2 - 0.252 \frac{J}{m^5} (295.61m)^3)}}{262515.78J}} \\
R = 0.102m = 10.2cm
\]
If you wanted to determine if the rope would break, you would use the fact that the volume of the
cable is conserved. Using that information, you would find that any cable would break when it
reacher 4 times it’s starting length. This cable can cover 800m before breaking so we safe to use it
If you wanted to make the stunt more exciting, you would want to use a cable that is as short as possible. Using the same conditions as before except that $\ell$ is a quarter of the fall distance. Then you would figure out that the proportionality constant between the two coefficients effects the length of the cable and the size of the coefficients would determine the radius of the cable. Then it would be up to you determine what reasonable might be.