A bungee jumper jumps (with no initial speed) from a tall bridge attached to a light elastic cord (bungee cord) of unscratched length L. The cord first straightens and then extends as the jumper falls. This prevents her from hitting the water! Suppose that the bungee cord behaves like a spring with spring constant $k = 80\ N/m$. The bridge is $h = 110\ m$ high and the jumper's mass is $m = 40\ kg$. Use $g = 10\ m/s2$.

(a) What is the maximum allowed length L of the unstretched bungee cord (in m) to keep the jumper alive?

(b) Before jumping, our jumper verified the spring constant of the cord. She lowered herself very slowly from the bridge to the full extent of the cord and when she is at rest she measured the distance to the water surface. What was the measured distance (in m)?

a) The law of conservation of energy:

$$mgh = \frac{k(h-L)^2}{2}$$

mgh - potential energy of the jumper, $\frac{k(h-L)^2}{2}$ – energy of bungee cord deformation

Therefore:

$$L = h - \sqrt{\frac{2mgh}{k}} = \left(110 - \sqrt{\frac{2*40*110*10}{80}}\right)m = \left(110 - 10\sqrt{11}\right)m \approx 77\ m$$

Answer: 77 m

b) Newton’s first law of motion:

$$mg = k\Delta l$$

Δl - bungee cord deformation

Then, distance to the water surface equals:

$$l = h - L - \Delta l = h - L - \frac{mg}{k} = 110 - 77 - \frac{40*10}{80} = 28\ m$$

Answer: 28 m