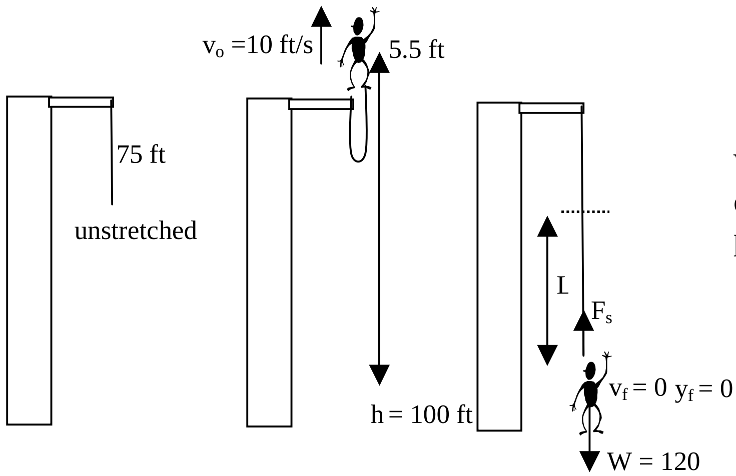
1. Group Problem



What is the elastic force constant of the cord so that the person does not hit the ground?

100 ft =75 ft +L+5.5 ft
19.5 ft =L

Use conservation of energy to relate jumper's speed off the diving board to the stretch of the cord.

System: jumper + Earth + cord
Initial time: jumper just leaves the board.
Final time: jumper stops before hitting ground.

Neglect the air resistance and any horizontal component of jump.
Conservation of Energy: $E_f - E_i = E_{input} - E_{output}$

$E_i = GPE_i = \frac{1}{2}mv_o^2 + mgh$. Choose the zero of the vertical position at the center of the person hanging at the end of the cord. h is the vertical position of the person just leaving the diving board.

$E_f = SPE_f = \frac{1}{2}kL^2$. L is the distance the cord stretches.

There are no external forces on the parts of the system that are moving.
Thus $E_{input} = 0$ and $E_{output} = 0$.

Conservation of energy: $\frac{1}{2}kL^2 - \left(\frac{1}{2}mv_o^2 + mgh\right) = 0$ since W=mg

$$\frac{1}{2}kL^2 - \left(\frac{1}{2}\frac{W}{g}v_o^2 + Wh\right) = 0$$

Only one unknown. Check units before solving.

$$\left[\frac{N}{m}\right][m]^2 - \left(\left[\frac{N}{\frac{m}{s^2}}\right]\left[\frac{m}{s}\right]^2 + [N][m]\right) = 0$$

$[Nm] - ([Nm] + [Nm]) = 0$ Units are correct since all terms have the same units.

$$\frac{1}{2}kL^2 - \left(\frac{1}{2}\frac{W}{g}v_o^2 + Wh\right) = 0$$

$$k = \frac{\left(\frac{W}{g} v_o^2 + 2Wh\right)}{L^2}$$

$$k = \frac{\left(\frac{120\text{lb}}{32\frac{\text{ft}}{\text{s}^2}}\left(10\frac{\text{ft}}{\text{s}}\right)^2 + 2(120\text{lb})(100\text{ft})\right)}{(19.5\text{ft})^2} = 64\frac{\text{lb}}{\text{ft}}$$

The spring constant is in the correct units of force/distance.

If the length that the cord stretches (L) is decreases, k increases. That is reasonable because a stiffer spring would stretch less under the same conditions.

If the speed that the person jumps off the diving board (v_o) increases, k increases for the same L. That is reasonable because a stiffer spring would be required to stop the person in the same distance.

If the person jumps from a greater height (h), k increases. That is reasonable because a stiffer spring would be required to stop the person in the same distance.

If the person just hung on the cord, it would stretch an amount determined by F=ky. In that case, the force exerted on the person by the cord would be equal to the weight of the person, W=ky. This gives the amount of stretch as 120 lb/(64lb/ft) = 1.9 ft. Seems small but not unreasonable.