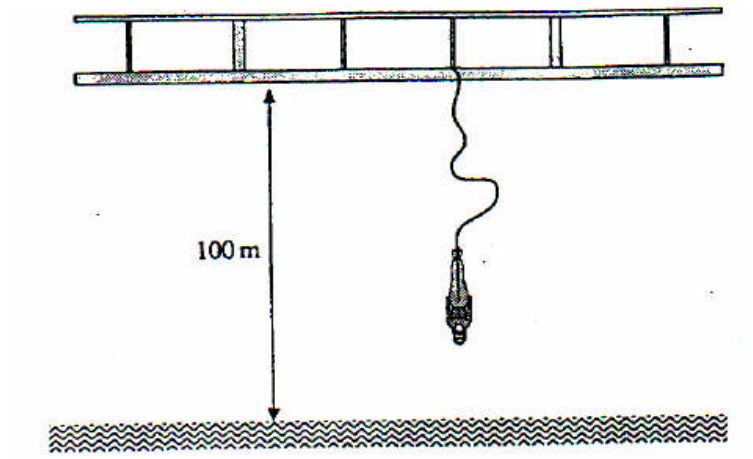
Chapter 9
Short answer question

This question is about the sport of bungee jumping.



A girl of mass 50 kg jumps from a bridge 100 m above a river. Attached to her ankles is an elastic rope of natural length 50 m. The rope extends as she falls and brings her to a momentary halt 10 m above the water surface.

(a) Describe the energy transfers which occur from the time the girl jumps until she first comes to rest.

Gravitational potential energy (GPE) to KE; KE to elastic strain energy in rope; some GPE at end when at rest.

(b) At what point during the jump does the elastic rope exert the greatest force on the girl? Explain your answer.

When elastic rope has extended to greatest distance; $F \propto \chi$ for rope,

i.e. 100-10-50 = 40 m extension

(c) A relative of the girl, observing the jump, thought this activity was far too dangerous, since the decelerating force on the girl was so large.

(i) Estimate the energy stored in the rope when the girl first comes to rest 10 m above the water.
(g = 9.8 Nkg^{-1})

$\Delta GPE = mg\Delta h = 50 \times 10 \times 90$

$= 44\ kJ$

(ii) Hence estimate the mean force exerted by the rope on the girl whilst bringing her to rest. Assume the rope obeys Hooke's Law.

$$\text{Energy} = (\frac{1}{2}\text{F})x = \text{mean force x } x$$

$$\text{Mean force} = \frac{44000}{40} = 1.1\text{kN}$$

(d) The organisers of the event have ropes with different values of force constant (k) where k is defined by Hooke's Law:

force = k x *extension*

They match the rope to the weight of the person.

Discuss what would happen if the force constant of the rope were:

(i) too large,

High 'k' value means small extensions and large forces on muscles.

(ii) too small.

Low 'k' value means large extensions and smaller forces; but girl would hit the water.