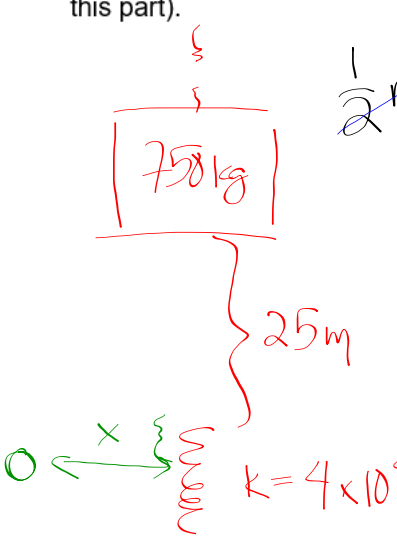


23. An elevator cable breaks when a 750-kg elevator is 25 m above a huge spring ($k=4.0 \times 10^4$ N/m) at the bottom of the shaft. Calculate

- the work done by gravity on the elevator before it hits the spring.
- the speed of the elevator just before striking the spring.
- the amount the spring compresses (Hint: remember that work is done by both the spring and gravity in this part).



A diagram shows a red box labeled "750 kg" representing the elevator. A red bracket to its right indicates a distance of "25 m" from the elevator to a red coiled spring at the bottom. To the left of the spring, a green arrow points right towards it, with a red "x" above it representing the compression distance. Next to the spring, the spring constant is given as $k = 4 \times 10^4 \text{ N/m}$.

$$\frac{1}{2}mv_0^2 + mgh_0 + \frac{1}{2}kx_0^2 + W_{NL} = \frac{1}{2}mv^2 + mgh + \frac{1}{2}kx^2$$

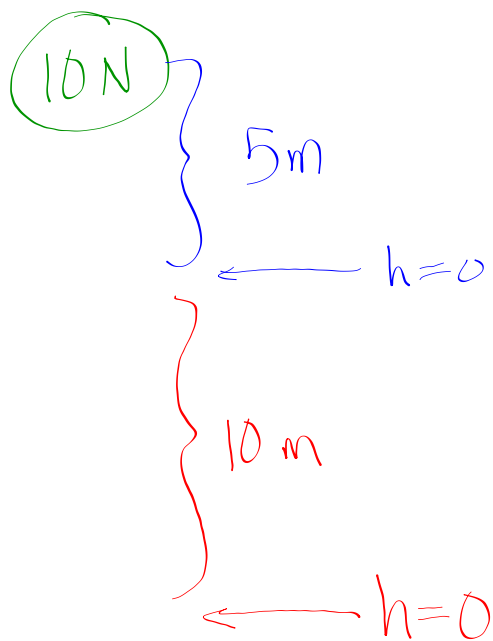
$$mgh_0 = \frac{1}{2}kx^2$$

$$(750)(9.8)(25+x) = \frac{1}{2}(40,000)x^2$$

$$20,000x^2 - 7350x - 183750 = 0$$

$$3.22, -2.85$$

3.22m



$$mgh = 10 \cdot 5 = 50 \text{ J}$$

$$mgh = 10 \cdot 15 = 150 \text{ J}$$

22. A 130-kg load is lifted 30 m vertically by a single cable with an acceleration $a = 0.15 g$ (one "g" is 9.8 m/s^2). Determine

- the tension in the cable
- the net work done on the load
- the work done by the cable on the load.
- the work done by gravity on the load.
- the final speed of the load assuming it started from rest.

$$\begin{array}{c}
 \uparrow T \\
 \boxed{130 \text{ kg}} \\
 \downarrow -mg
 \end{array}
 \quad
 \begin{array}{l}
 \Sigma F = ma \\
 T + -mg = ma \\
 T + -130(9.8) = 130 \cdot (0.15)(9.8) \\
 T = 1465.1 \text{ N} \quad \textcircled{a}
 \end{array}$$

$$W_{\text{Net}} = F_{\text{Net}} \cdot d$$

$$= (1465.1 - 130 \cdot 9.8)(30) = 5733 \text{ J} \quad \textcircled{b}$$

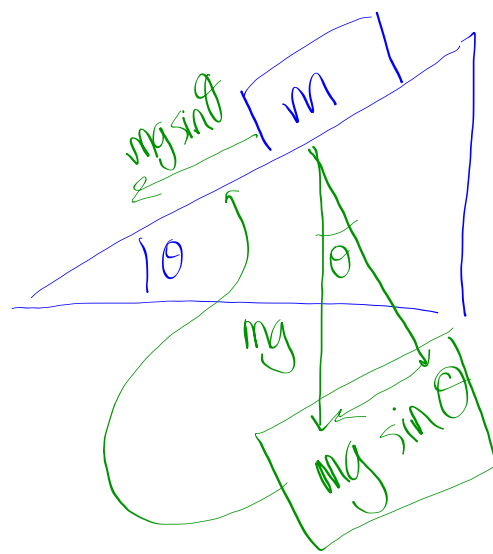
$$W_T = T \cdot d = 1465.1 \cdot 30 = 43,953 \text{ J} \quad \textcircled{c}$$

$$W_g = F_g \cdot d = (130 \cdot 9.8)30 = 38,220 \text{ J} \quad \textcircled{d}$$

$$\begin{array}{l}
 \cancel{\frac{1}{2}mv_0^2} + \cancel{mgh_0} + \cancel{\frac{1}{2}kx_0^2} + W_{\text{nc}} = \frac{1}{2}mv^2 + mgh + \frac{1}{2}kx^2 \\
 W_{\text{nc}} = \frac{1}{2}mv^2 + mgh
 \end{array}$$

$$43,953 \text{ J} = \frac{1}{2}(130)v^2 + (130)(9.8)(30)$$

$$v = 9.4 \frac{\text{m}}{\text{s}}$$



Force of gravity
down the ramp:

$$mg \sin \theta$$