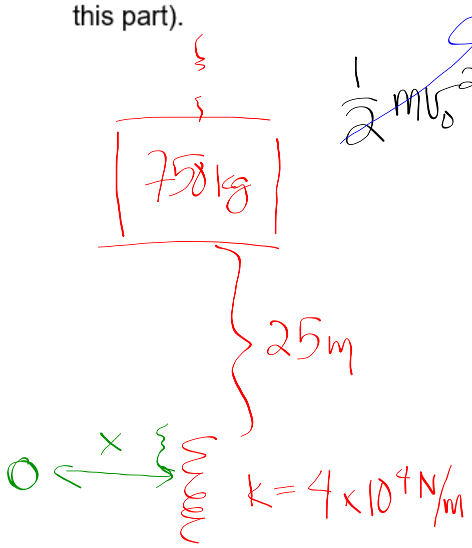
23. An elevator cable breaks when a 750-kg elevator is 25 m above a huge spring ($k=4.0\times10^4$ N/m) at the bottom of the shaft. Calculate

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




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

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

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

$$20{,}000x^2 - 7350x - 183{,}750 = 0$$

$$\boxed{3.22},\ -2.85$$

3.22m

10N

5m

$mgh = 10 \cdot 5 = 50J$

$h = 0$

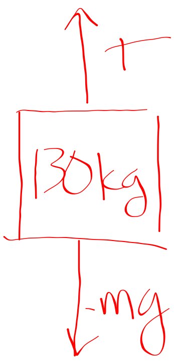
10 m

$mgh = 10 \cdot 15 = 150J$

$h = 0$

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

a) the tension in the cable
b) the net work done on the load
c) the work done by the cable on the load.
d) the work done by gravity on the load.
e) the final speed of the load assuming it started from rest.




$$\Sigma F = ma$$

$$T_T - mg = ma$$

$$T_T - 130(9.8) = 130\cdot(0.15)(9.8)$$

$$T = 1465.1\text{ N} \quad (a)$$

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

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

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

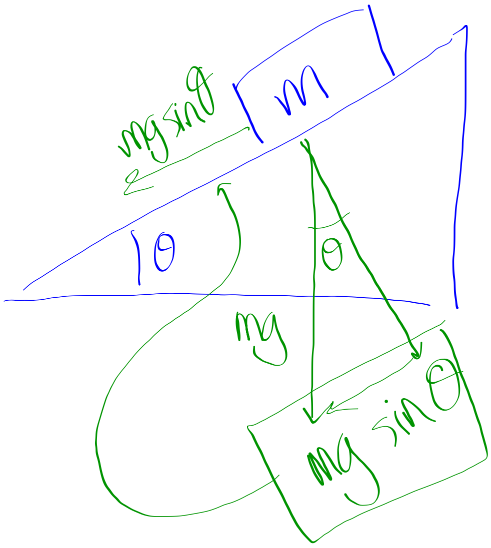
$$W_g = F_g\cdot d = (130\cdot 9.8)30 = 38{,}220\text{ J} \quad (d)$$

$$\cancel{\tfrac{1}{2}mv_0^2} + \cancel{mgh_0} + \cancel{\tfrac{1}{2}kx_0^2} + W_{NC} = \tfrac{1}{2}mv^2 + mgh + \cancel{\tfrac{1}{2}kx^2}$$

$$W_{NC} = \tfrac{1}{2}mv^2 + mgh$$

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

$$v = 9.4\ \tfrac{m}{s}$$




Force of gravity down the ramp:

$\boxed{mg \sin \theta}$