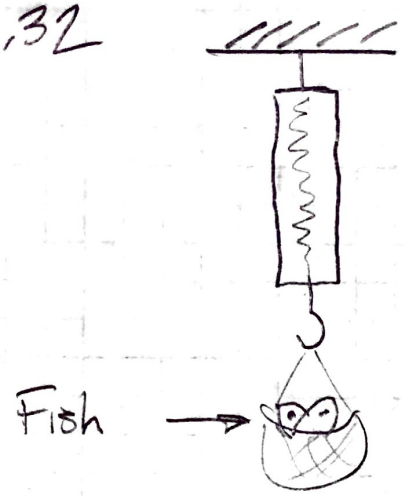
15.32



a) Find k, spring constant, if $m = 10.0\,kg$ causes 8.00 cm stretch.

$F = -kx$, so

$k = \frac{-F_{spring}}{-x}$

$F_{spring} = -F_g$ → $= \frac{-(10\,kg)(9.8\,N)}{-0.08\,m}$

$= \boxed{1225\,N/m}$

b) If the spring stretches 5.5 cm, what is the mass?

$F = -kx$

$= (1225\,N/m)(0.055\,m)$

$= 67.375\,N \times \frac{1\,kg}{9.8\,N} = \boxed{6.875\,kg}$

c) How far apart are half-kilogram marks on the scale?

In other words, what's the displacement for a mass of 0.5 kg?

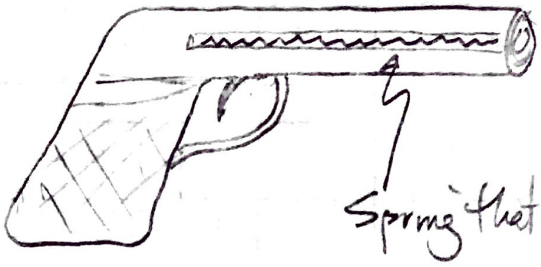
$F = -kx$, so $x = \frac{F}{k} = \frac{mg}{k}$

$x = \frac{(0.5\,kg)(9.8)}{1225\,N/m}$

$= 0.004\,m$

$= \boxed{0.4\,cm}$

15.34



a) Find force constant k for spring if depressing it distance $x = 0.150\ m$ endows a speed of $20.0\ m/s$ for the $0.0500\ kg$ plunger.

So, $v_{max} = 20.0\ m/s$ for the $0.0500\ kg$ mass.

E at $x=0$ is $\frac{1}{2}mv^2$

$= \frac{1}{2}(0.0500\ kg)(20\ m/s)^2$

$= 10.0\ J$

So $U = \frac{1}{2}kx^2$, which $= 10.0\ J$ when depressed

$10\ J = \frac{1}{2}k(0.150\ m)^2$

$k = \boxed{889\ N/m}$

Could also solve in one step:

$U_i = K_f$

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

$k = \frac{mv^2}{x^2} = \frac{(0.05)(20)^2}{(0.150)^2} = \boxed{889\ N/m}$

b) What force is required to depress the spring?

The force is 0 at the beginning, because the spring isn't depressed yet. The more we depress the spring, the more force it takes to keep pushing.

At $x = 0.150\ m$, we'll be using

$F = kx = (889\ N/m)(0.150\ m) = \boxed{133\ N}$

of force.

15.37

$k = 1.40e4\ N/m$

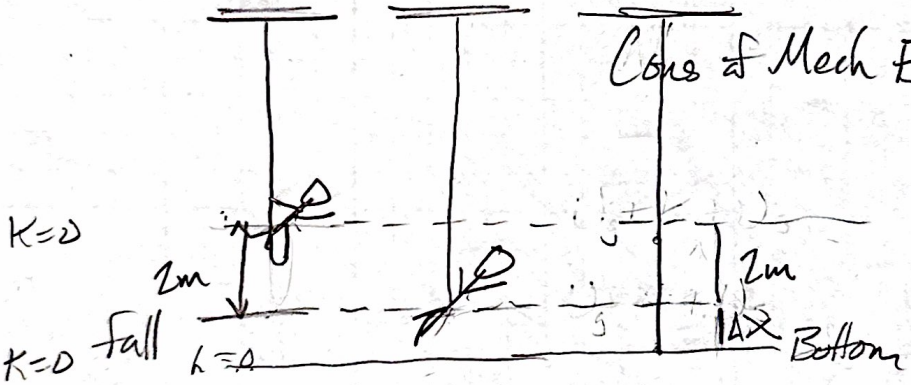
$m = 90.0\ kg$.

a) Frequency of bouncing for the climber?

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{1.4e4\ N/m}{90\ kg}} = \boxed{1.99\ Hz}$$

b) How much will rope stretch if climber has 2.00m of slack?



$$U_g = U_s$$

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

$$(90)(9.8)(2+x) = \frac{1}{2}(1.4e4)(x^2) + U_g$$

$$180g + 90gx = 0.7e4\,x^2$$

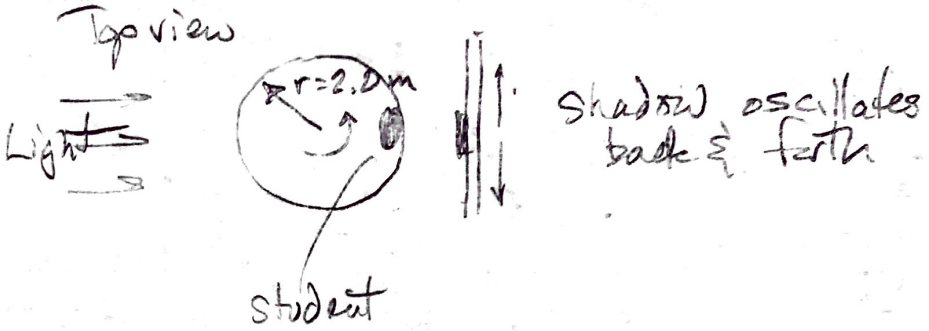
$$0.7e4\,x^2 - 90gx - 180g = 0$$

Quadratic: $x = \boxed{0.569\ m}$

What does $x = -0.44\ m$ solution represent? Nothing that is physically relevant in this problem.

c) A spring twice as long has twice as much material to stretch, so $k' = \frac{1}{2}k$.

15.41



$$\text{Rotation} = \frac{5 \text{ rev}}{\text{min}} \times \frac{\text{min}}{60 \text{ s}} \times \frac{2\pi \text{ rads}}{1 \text{ rev}} = 0.524 \text{ rad/s} = \omega$$

a) $x = A\cos(\omega t + \phi)$ ← Value of ϕ depends upon where shadow is at time $t = 0$.

$$x = 2.0\cos(0.524t)$$

b)

$$v = -\omega A \sin(\omega t + \phi)$$

$$= -(0.524)(2.0)\sin(0.524t)$$

$$= -1.05\sin(0.524t)$$