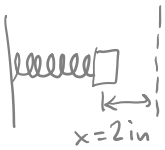
1. A force of 4 lb is required to hold a spring compressed 2 in. beyond its natural length. How much work is done in stretching the spring from its natural length to 5 in. beyond its natural length?

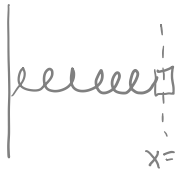


$F = kx$

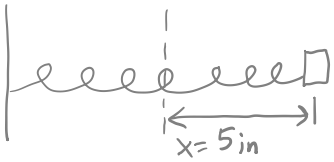
$4\text{ lb} = k(2\text{ in})$

$k = 2\ \text{lb/in}$ ← Spring constant for this spring

From



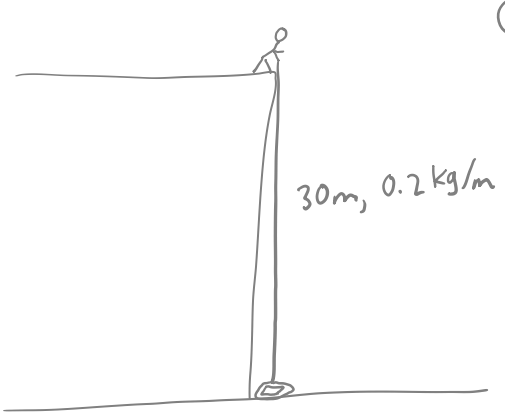
to



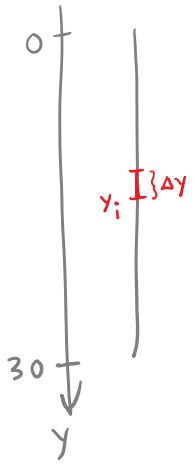
$$W = \int_0^5 F\,dx$$
$$= \int_0^5 2x\,dx$$
$$= x^2\Big]_0^5$$
$$= 5^2 - 0$$
$$= 25\text{ in-lb}$$

$$25\text{ in-lb} \times \frac{1\text{ ft}}{12\text{ in}} \approx \boxed{2.083\text{ ft-lb}}$$

2. A rope with density 0.2 kg/m is hanging over the edge of building 61 so the end touches the ground. At the end of the rope, you attach a 5-kg tray and put in a 10-kg Calculus book. Assuming that building 61 is 30 m high, find the work done in pulling the rope, tray, and book up to the top of the building.



③ Rope:



mass: 0.2 kg × $\Delta y\text{ m}$; acceleration: $9.8\ \text{m/s}^2$

$$F_i = \frac{0.2\text{ kg}}{1\text{ m}} \times \frac{\Delta y\text{ m}}{1} \times 9.8\ \text{m/s}^2$$
$$= 1.96\,\Delta y\text{ N}$$

$$W_i = (1.96\,\Delta y\text{ N})(y_i\text{ m})$$
$$= 1.96\,y_i\,\Delta y\text{ N-m}$$

↖ Work to lift this part of rope to top

$$W = \lim_{n\to\infty} \sum_{i=1}^{n} 1.96\,y_i\,\Delta y$$ ← Riemann Sum
$$= \int_0^{30} 1.96\,y\,dy$$
$$= 0.98y^2\Big]_0^{30}$$
$$= 0.98(30)^2 - 0$$
$$= 882\text{ J}$$

① Tray: $W = Fd = (5\text{ kg})(9.8\ \text{m/s}^2)(30\text{ m})$
$= 1470\text{ J}$

② Book: $W = Fd = (10\text{ kg})(9.8\ \text{m/s}^2)(30\text{ m})$
$= 2940\text{ J}$

④ Total work $= 1470 + 2940 + 882$
$= \boxed{5292\text{ J}}$

Q: What five-letter word becomes shorter when you add two letters to it?