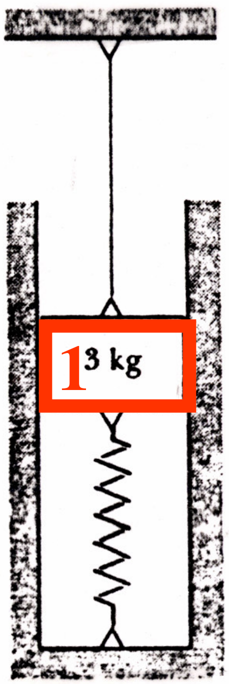
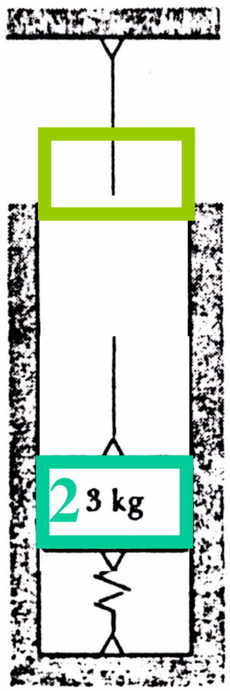
Example: A 3-kg block is attached to a cable and to a spring as shown. The constant of the spring is k = 1400 N/m and the tension in the cable is 15 N. If the cable is cut, determine (a) the maximum displacement of the block, (b) the maximum velocity of the block.





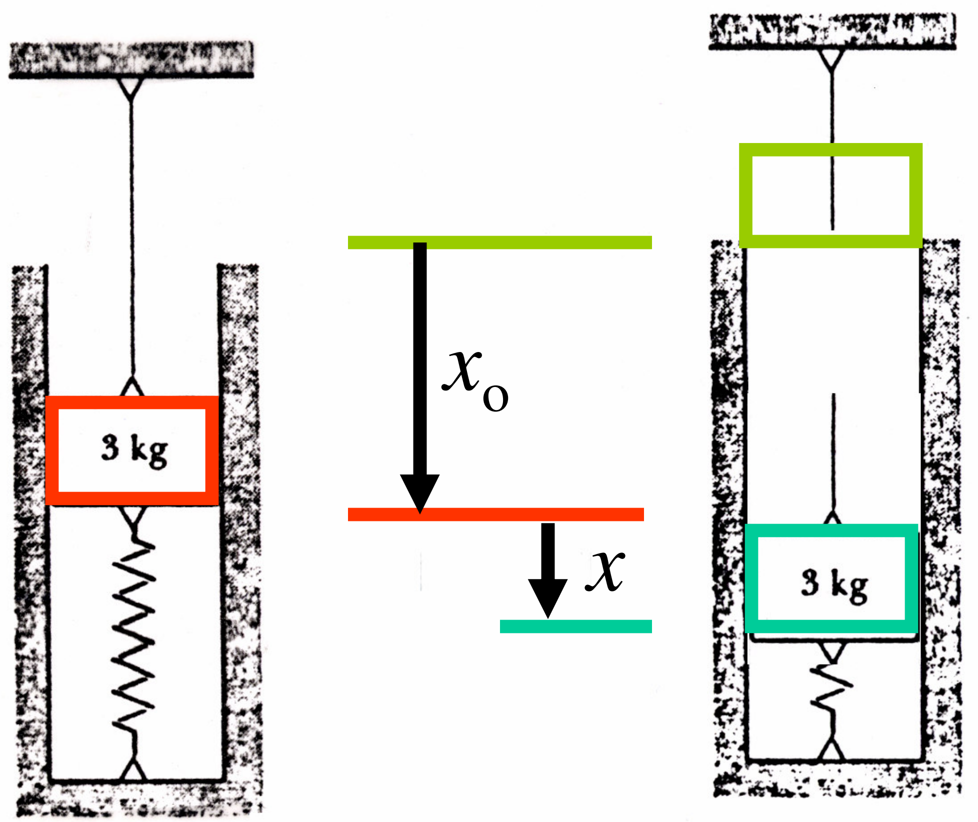
1: Initial position

2: Maximum displacement

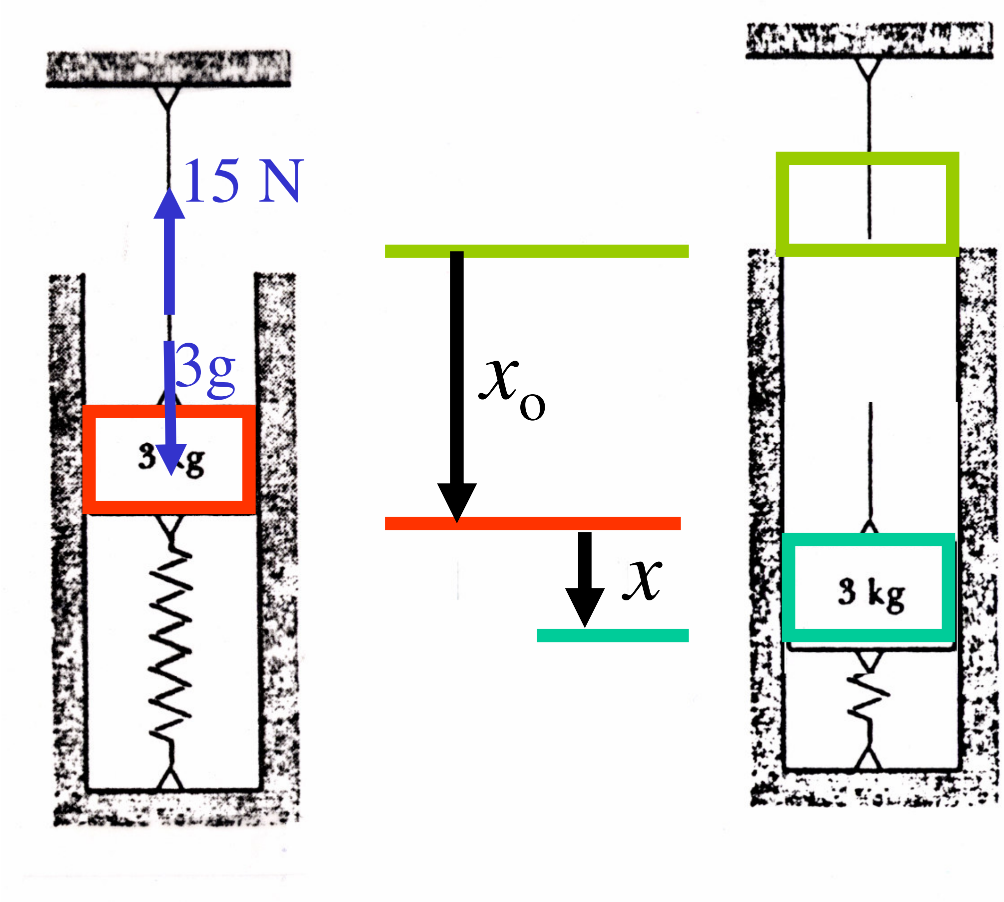
0: Uncompressed position

The spring is compressed in both positions 1 and 2

Example: A 3-kg block is attached to a cable and to a spring as shown. The constant of the spring is k = 1400 N/m and the tension in the cable is 15 N. If the cable is cut, determine (a) the maximum displacement of the block, (b) the maximum velocity of the block.



Example: A 3-kg block is attached to a cable and to a spring as shown. The constant of the spring is k = 1400 N/m and the tension in the cable is 15 N. If the cable is cut, determine (a) the maximum displacement of the block, (b) the maximum velocity of the block.



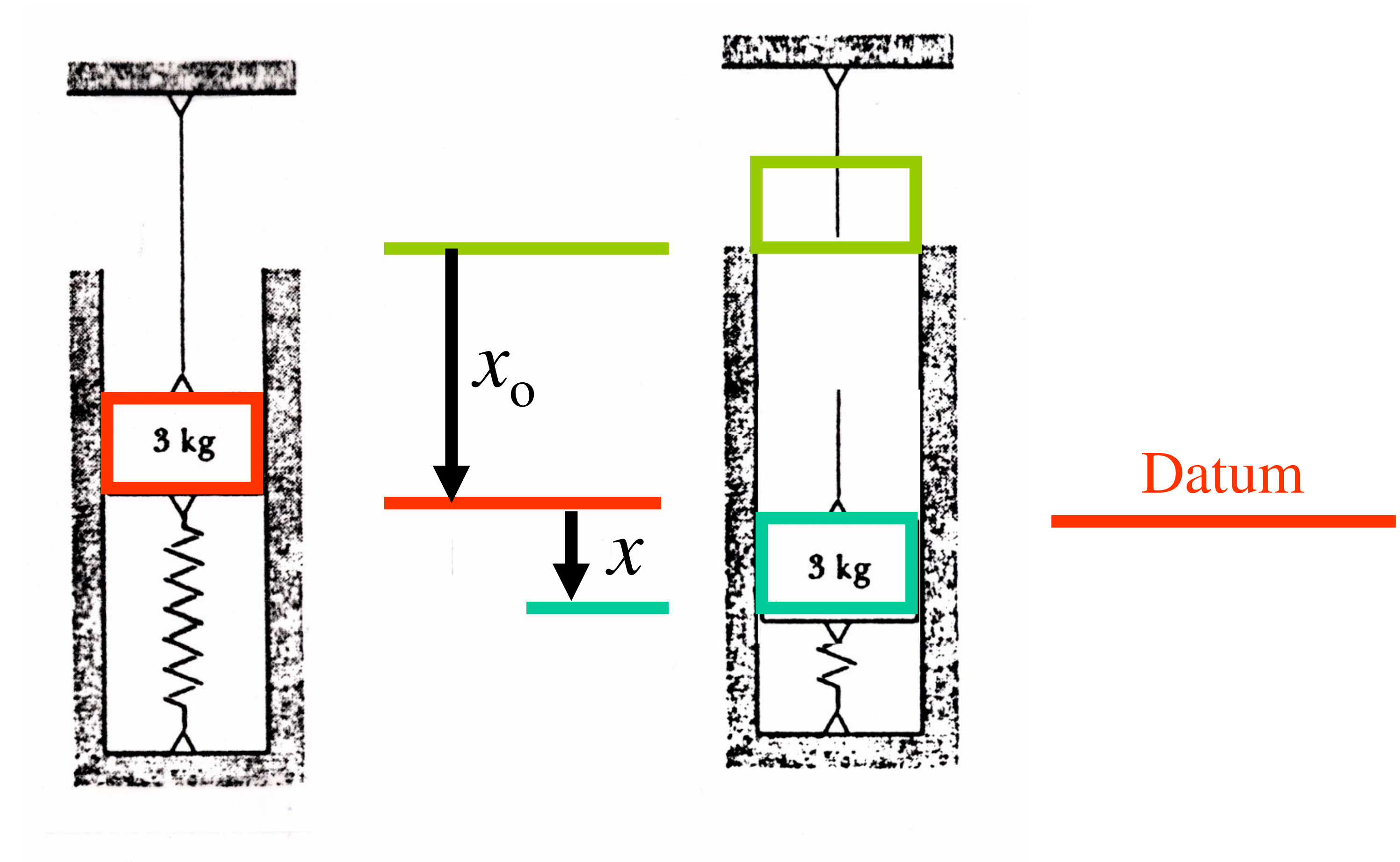
Static before cutting the cable

Spring compression force

= 3g–15 = 29.43–15 = 14.43 N

Initial compression of the spring

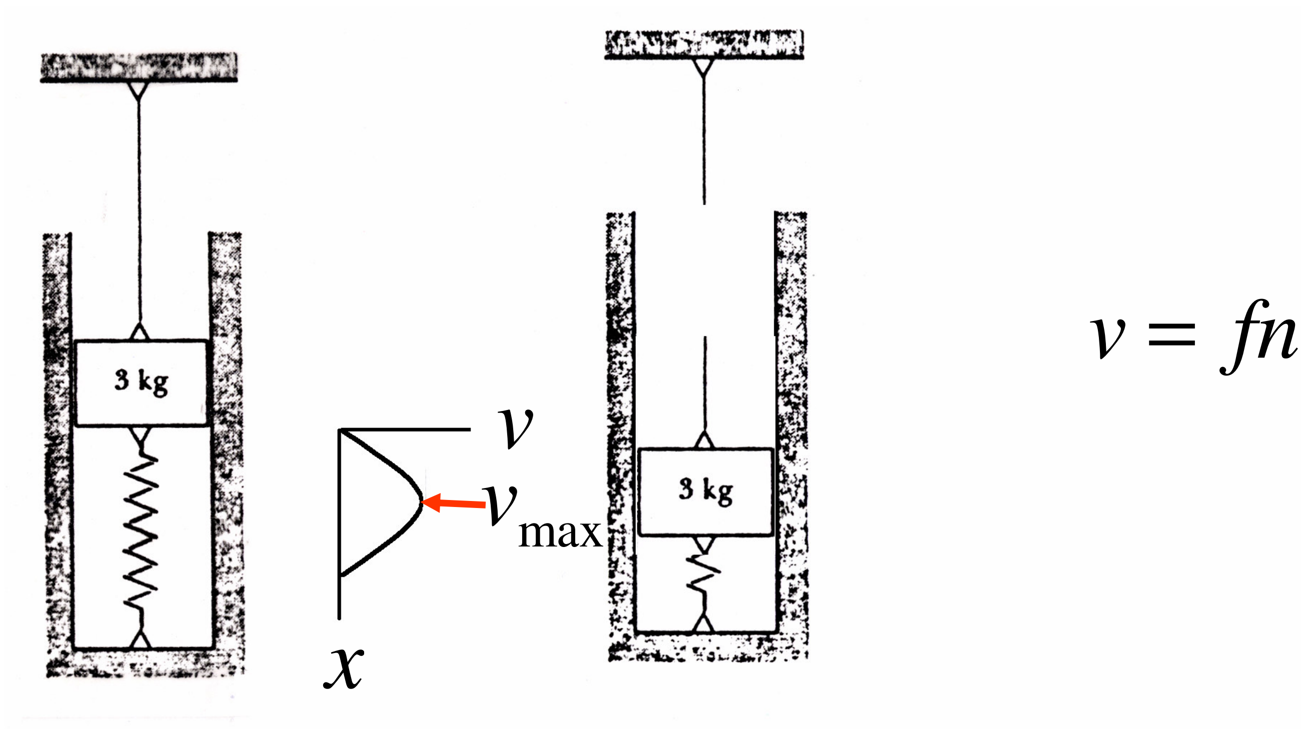
x_o = 14.43/1400 = 0.01031 m



$$\frac{1}{2}k(x+x_o)^2 - mgx + \frac{1}{2}mv^2 = \frac{1}{2}kx_o^{\;2} + 0 + 0$$

$$\frac{1}{2}k(x+x_o)^2 - mgx + \frac{1}{2}mv^2 = \frac{1}{2}kx_o^{\ 2} + 0 + 0$$

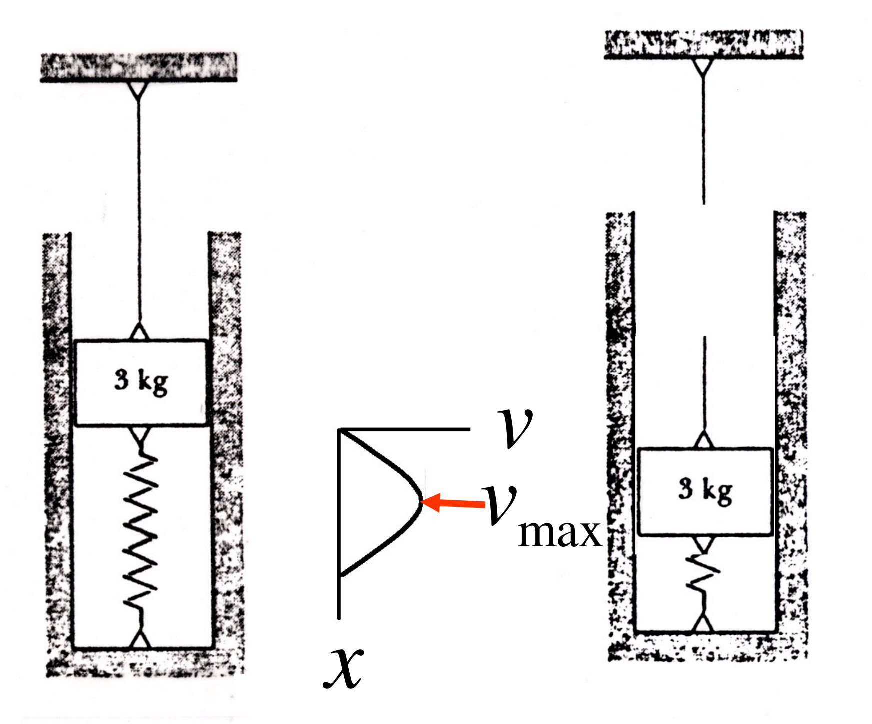
Velocity v is a function of position x. Maximum velocity occurs when $dv/dx = 0$



$$v = fn(x)$$

$$\frac{1}{2}k(x+x_o)^2 - mgx + \frac{1}{2}mv^2 = \frac{1}{2}kx_o^{\,2} + 0 + 0$$

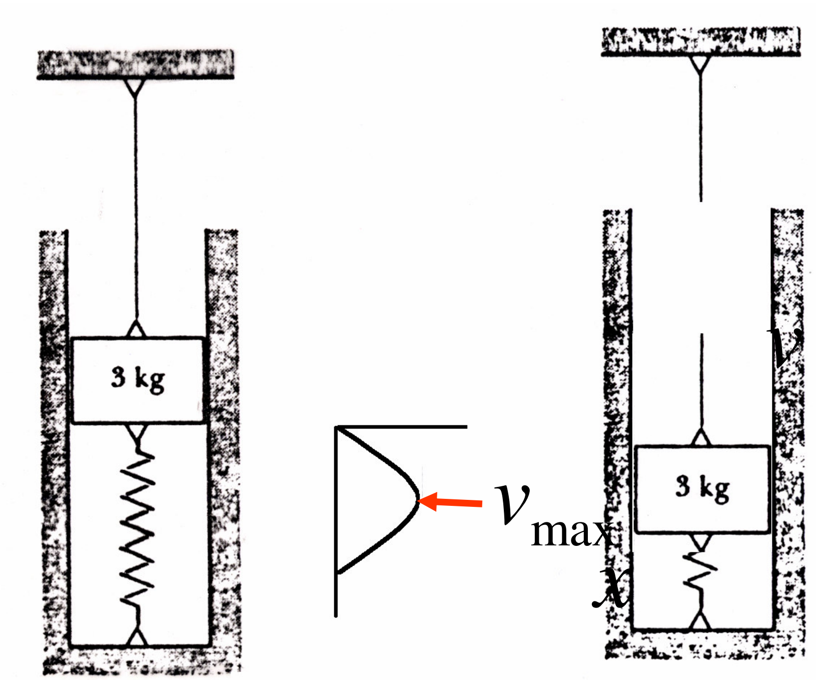
$$\frac{1}{2}k(x^2 + 2xx_o + x_o^2) - mgx + \frac{1}{2}mv^2 = \frac{1}{2}kx_o^2$$



$$v = fn(x)$$

$$\frac{1}{2}k(x^2 + 2xx_o + x_o^2) - mgx + \frac{1}{2}mv^2 = \frac{1}{2}kx_o^2$$

$$v^2 = -\frac{k}{m}(x^2 + 2xx_o) + 2gx$$



For maximum velocity,

$$\frac{dv^2}{dx} = -\frac{k}{m}(2x + 2x_o) + 2g = 0$$

$$x_{\text{max vel}} = \frac{gm}{k} - x_o = 0.0107 \text{ m}$$