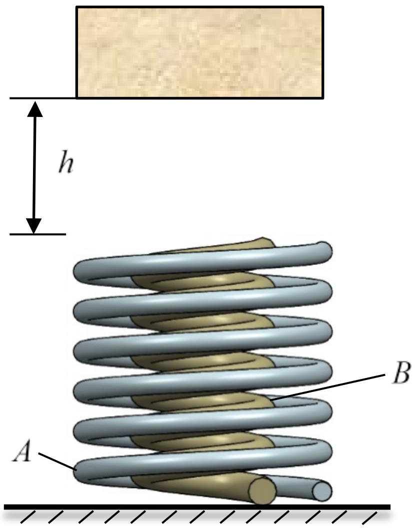
2-9. A shock absorber consists of two equal-length springs which are "nested" together. It is designed to arrest the motion of a 20 kg mass that is dropped h m above the top of the springs from an at-rest position, and the maximum compression of the springs is $s = 0.3$ m. If h follows a normal distribution $h \sim N(1, 0.1^2)$ m and the outer spring has a stiffness $k_A = 2000$ N/m, determine the distribution of required stiffness of the inner spring.



Solution

$$T_1 + V_1 = T_2 + V_2$$

$$0 + 0 = -mg(h+s) + \frac{1}{2}k_A s^2 + \frac{1}{2}k_B s^2$$

$$\Rightarrow k_B = \frac{2mg(h+s)}{s^2} - k_A$$

Thus

$$\mu_{k_B} = \frac{2mg(\mu_h + s)}{s^2} - k_A = 3668 \text{ N/m}$$ **Ans.**

$$\sigma_{k_B} = \frac{2mg}{s^2}\sigma_h = 436 \text{ N/m}$$ **Ans.**

Therefore, the required stiffness of the inner spring $k_B \sim N(3668, 436^2)$ N/m .