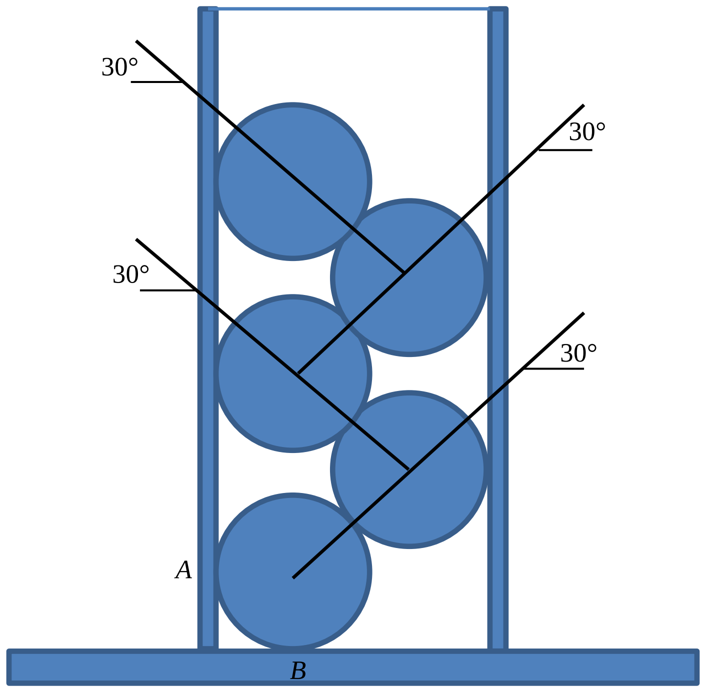
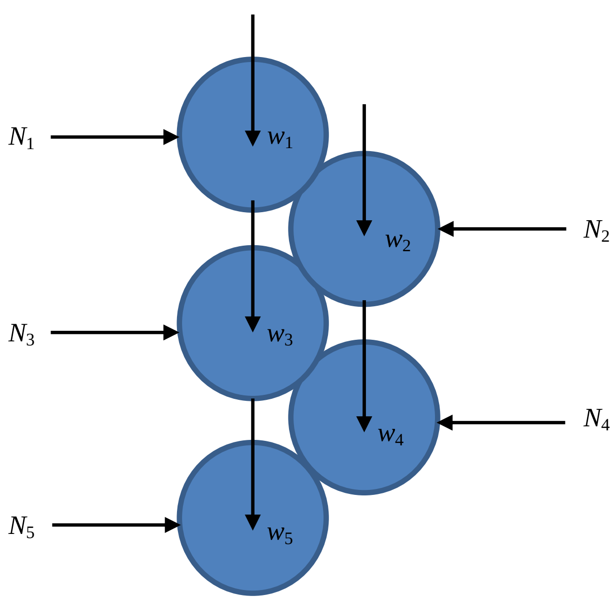
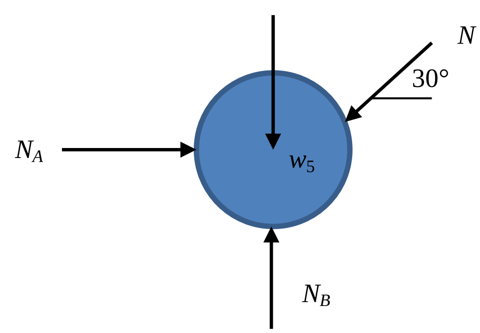
17. Five cylinders are placed between two smooth walls. The weights of the five cylinders are independently and normally distributed with $w_i \sim N(\mu_i, \sigma_i)$, i=1,2,…5, where w_i=20 lb (i=1,2…5), and σ_1=0.1, σ_2=0.2, σ_3=0.3, σ_4=0.4 and σ_5=0.5, respectively. Determine the normal reactions at points *A* and *B*.



Solution





All cylinders:

$$\sum F_y = 0; \quad N_B - \sum_{k=1}^{5} w_k = 0.$$

Since five cylinders follow their own normal distributions independently, we can obtain

$$\mu_{N_B} = 5\mu_w = 100\,\text{lb}$$ **Ans**.

$$\sigma_{N_B} = \sqrt{\sigma_1{}^2 + \sigma_2{}^2 + \sigma_3{}^2 + \sigma_4{}^2 + \sigma_5{}^2} = 0.74$$ **Ans**.

Bottom coin:

$$\sum F_y = 0; \quad N_B - w_5 - N \sin 30^\circ = 0$$

Then, we can have

$$\mu_N = 2(\mu_{N_B} - \mu_{w_5}) = 160\,\text{lb}$$

$$\sigma_N = 2\sqrt{\sigma_{N_B}{}^2 + \sigma_{w_5}{}^2} = 1.79$$

Also, we have

$$\sum F_x = 0; \quad N_A - N \cos 30^\circ = 0$$

Finally, we can obtain

$$\mu_A = \frac{\sqrt{3}}{2}\mu_N = 138.56\,\text{lb}$$ **Ans**.

$$\sigma_A = \frac{\sqrt{3}}{2}\sigma_N = 1.55$$ **Ans**.