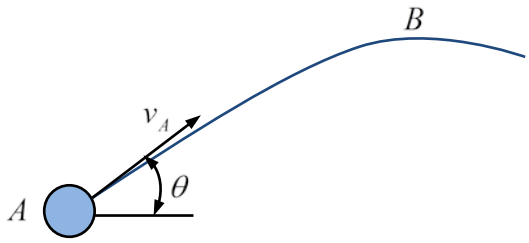
2-16. A $5\ \text{kg}$ ball is thrown with an initial speed of v_A at angle of $45°$, and $v_A \sim N(10, 1^2)\ \text{m/s}$. Determine the distributions of the time for the ball to reach its highest point B and its speed at B.



Solution:

Impulse and momentum

$$m(v_y)_A + \Sigma \int F_y \, dt = m(v_y)_B$$

$$mv_A \sin\theta - mgt_B = 0$$

$$t_B = \frac{v_A \sin\theta}{g}$$

$$m(v_x)_A + \Sigma \int F_x \, dt = m(v_x)_B$$

$$mv_A \cos\theta + 0 = mv_B$$

$$v_B = v_A \cos\theta$$

Thus,

$$\mu_{t_B} = \frac{\mu_{v_A} \sin\theta}{g} = 0.72\ \text{s}$$

$$\sigma_{t_B} = \frac{\sigma_{v_A} \sin\theta}{g} = 0.07\ \text{s}$$

and

$$\mu_{v_B} = \mu_{v_A} \cos\theta = 7.07\ \text{m/s}$$

$$\sigma_{v_B} = \sigma_{v_A} \cos\theta = 0.71\ \text{m/s}$$

Therefore, $t_B \sim N(0.72, 0.07^2)\ \text{s}$ and $v_B \sim N(7.07, 0.71^2)\ \text{m/s}$. **Ans.**