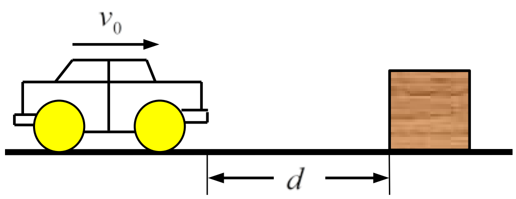
1-8. A car is traveling on a straight street at a velocity $v_0 = 25$ m/s. After the driver observed a block $d = 150$ m ahead of the car, it takes the driver t_0 seconds to react and decelerate at $a = 3$ m/s^2.

1) For a normal driver, assume t_0 is normally distributed $t_0 \sim N(1, 0.1^2)$ s
2) For a drunk driver, assume $t_0 \sim N(3, 0.5^2)$ s

Determine the possibility that the car would hit the block.



Solution: the distance before a driver reacts and decelerates

$$d_0 = v_0 t_0$$

$$v^2 = v_0^2 - 2a(s - s_0)$$

$$0 = v_0^2 - 2a(s - v_0 t_0)$$

$$s = v_0 t_0 + \frac{v_0^2}{2a}$$

1) For a normal driver

$$\mu_s = v_0 \mu_{t_0} + \frac{v_0^2}{2a} = 25(1) + \frac{(25)^2}{2(3)} = 129.17 \text{ m}$$

$$\sigma_s = v_0 \sigma_{t_0} = 25(0.1) = 2.5 \text{ m}$$

$$\Pr\{s > d\} = 1 - \Phi\left(\frac{d - \mu_s}{\sigma_s}\right) = 1 - \Phi\left(\frac{150 - 129.17}{2.5}\right) = 0$$

2) For a drunk driver

$$\mu_s = v_0 \mu_{t_0} + \frac{v_0^2}{2a} = 25(3) + \frac{(25)^2}{2(3)} = 179.17 \text{ m}$$

$$\sigma_s = v_0 \sigma_{t_0} = 25(0.5) = 12.5 \text{ m}$$

$$\Pr\{s > d\} = 1 - \Phi\left(\frac{d - \mu_s}{\sigma_s}\right) = 1 - \Phi\left(\frac{150 - 179.17}{12.5}\right) = 0.99$$