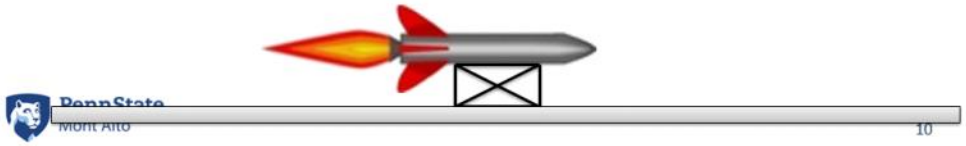
Problem 3

## Force Method in One Dimension (Worked Example)

- A rocket test sled is being used test a solid rocket booster (m=1000kg). It's known that generally a solid rocket booster's force will fit the equation a F= A + Bt – $Ct^2$. If the rocket has an initial thrust of 10 kN, and achieves a speed of 150 m/s and travels 700m during a 10 second test run, determine the constants A, B and C for the rocket.




$$F(t) = A + Bt - Ct^2$$

$$F(0) = 10{,}000\ N = A \rightarrow \boxed{A = 10{,}000}$$

$$a = \frac{F}{m} = \frac{A}{m} + \frac{B}{m}t - \frac{C}{m}t^2$$

$$a(t) = 10 + \frac{B}{1000}t - \frac{C}{1000}t^2$$

$$V(t) = 10t + \frac{B}{2000}t^2 - \frac{C}{3000}t^3 + V_0$$

$$V(10) = 150 = 10(10) + \frac{B}{2000}(10)^2 - \frac{C}{3000}(10)^3$$

$$50 = \frac{1}{20}B - \frac{1}{3}C$$

$$B = 1000 + \frac{20}{3}C$$

$$S(t) = 5t^2 + \frac{B}{6000}t^3 - \frac{C}{12{,}000}t^4 + \cancel{C_0}$$

$$S(10) = 500 + \frac{B}{6000}(10)^3 - \frac{C}{12{,}000}(10)^4 = 700$$

$$\frac{1}{6}B - \frac{5}{6}C = 200$$

$$\frac{1}{6}\left(1000 + \frac{20}{3}C\right) - \frac{5}{6}C = 200$$

$$.2778\,C = 33.33$$

$$\boxed{C = 120}$$

$$B = 1000 + \frac{20}{3}(120)$$

$$\boxed{B = 1800}$$

$$\boxed{F = 10{,}000 + 1800t - 120t^2}$$