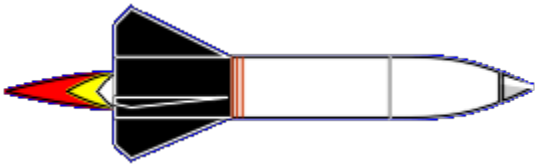
Rocket Equations Quick Reference



Equations for finding your rocket's peak altitude and motor delay.

$$k = \frac{1}{2}\rho C_d A$$

$$q = \sqrt{\frac{T - mg}{k}}$$

$$x = \frac{2kq}{m} = 2\frac{\sqrt{(T - mg)\cdot k}}{m}$$

$$t = \frac{I}{T}$$

$$v = q\frac{1 - e^{-xt}}{1 + e^{-xt}}$$

$$y_1 = \frac{-m}{2k}\ln\left(\frac{T - mg - kv^2}{T - mg}\right)$$

Definition of Terms

- m = rocket mass in kg (see below)
- g = acceleration of gravity = 9.81 m/s^2
- A = rocket cross-sectional area in m^2
- C_d = drag coefficient = 0.75 for average rocket
- r (rho) = air density = 1.22 kg/m^3
- t = motor burn time in seconds (NOTE: little t)
- T = motor thrust in Newtons (NOTE: big T)
- I = motor impulse in Newton-seconds
- v = burnout velocity in m/s
- y_1 = altitude at burnout
- y_c = coasting distance
- Note that the peak altitude is $y_1 + y_c$
- t_a = coasting time => delay time for motor

$$y_c = \frac{m}{2k}\ln\left(\frac{mg + kv^2}{mg}\right)$$

$$q_a = \sqrt{\frac{mg}{k}}$$

$$q_b = \sqrt{\frac{gk}{m}}$$

$$t_a = \frac{\tan^{-1}\left(v/q_a\right)}{q_b}$$

Note on the rocket mass: you usually know the empty (no motor) mass of your rocket m_r. You can usually find the loaded mass of your motor, m_e, and the mass of the propellant, m_p. Both Estes and Aerotech provide these numbers in their spec sheets and with the motors. Then

- average mass during boost is $m_r + m_e - m_p/2$
  use this value for all but the y_c, q_a, and q_b calculations.
- mass during coast is $m_r + m_e - m_p$
  use this value for the y_c, q_a, and q_b calculations.

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Questions

Your questions and comments regarding this page are welcome. You can e-mail Randy Culp (Tripoli #6926) for inquiries, suggestions, new ideas or just to chat.
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