Intro to Orbital Mechanics

(1) \[ F_G = \frac{mgR_e^2}{r^2} \]

(2) \[ V_G = -\frac{mgR_e}{r} \]

During any "Free Flight" segment

(3) \[ \frac{V^2}{2} - 2g\frac{R_e^2}{r} = E_0 = \text{const.} \quad [\text{cons. of E}] \]

(4) \[ rV_0 = \frac{V_o}{r} = \text{const.} \quad [\text{cons. of 4th No.}] \]

These relations can be combined to establish that

(5) \[ V_r^2 = \frac{E_0 r^2 + (2gR_e^2)r - V_o^2}{r} \]

leading to the conclusion that:

(6) \[ E_0 r_m^2 + (2gR_e^2) r_m - V_o^2 = 0 \]

@ \[ r_m = r_{min} \text{ (and/or) } r_{max} \]