UNIFIED PROPULSION P4 SOLUTIONS WAITZ 2001

a) $V_{max\,range} = \left[4\left(\frac{W}{S}\right)^2 \frac{1}{\rho^2}\frac{1}{C_{Do}}\left(\frac{1}{\pi e AR}\right)\right]^{1/4}$

$\frac{W}{S} \approx \frac{4.8\,oz}{ft^2} = 14.4\frac{N}{m^2}$ $C_{D_0} \approx 0.3$ (per Coleman) $e \approx 0.96$ } ALL PER COLEMAN

$\rho = 1.2\,kg/m^3$ $AR \approx 5.12$ $W \approx 15\,oz = 4.2\,N$

$V_{max\,range} \approx 3.3\,m/s$

b) $V_{max\,endurance} = 3^{-1/4}\,(V_{max\,range}) = 2.5\,m/s$
(= min power)

c) ASSUME THE AIRPLANE IS BEING FLOWN AT MAX ENDURANCE CONDITIONS

$$\text{POWER REQUIRED} = D_{MIN\,POWER} \cdot V_{MIN\,POWER}$$

$D_{MIN\,POWER} = W\left[\frac{16}{3}\frac{C_{Do}}{\pi e AR}\right]^{1/2} = 1.34\,N$

$\text{POWER REQD} = D_{minpower}\,V_{minpower} = 3.4\,W = 3.4\,J/s$

FLIGHT TIME = 15 min = 900 s ∴ ~~ENERGY~~

$\therefore \text{ENERGY} = \text{TIME}\,(\text{POWER REQD}) * \frac{1}{\eta_o} = 30.6\,kJ$

NOTE: PROF. COLEMAN CALCULATED $E_{batt.} = 18.1\,kJ$ SO PERHAPS η_o IS BETTER THAN 0.1 !

(600 mA-hr = 2150 A-s 8.4 Volts = $\frac{W}{A}$
E = 8.4·2150 W·s = $J/s \cdot s$ = J = 18144)