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# Airspeed Definitions

**AE460 Aircraft Design**

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Lecturer

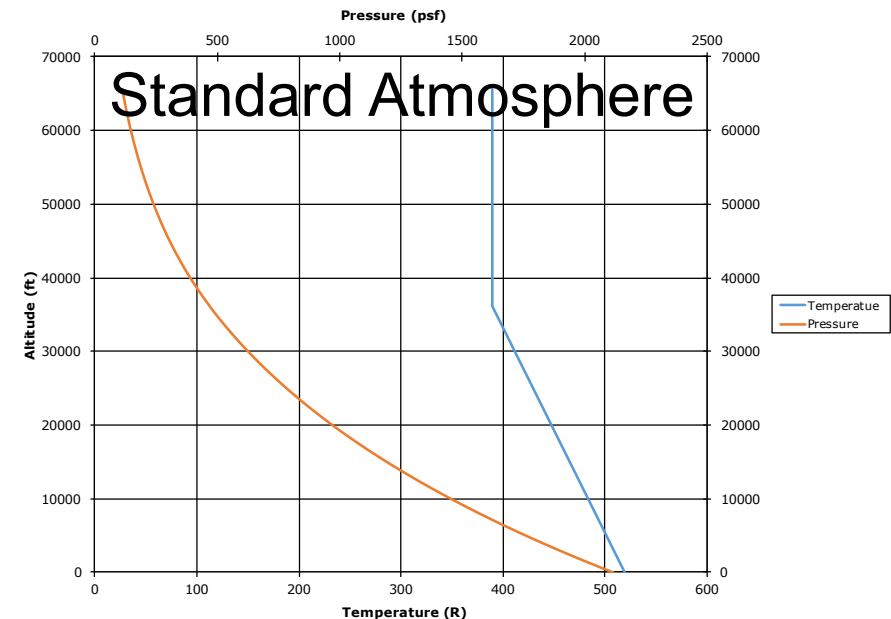
# Background



- Most aerospace classes use Mach ( $M$ ) and/or True Airspeed ( $V_\infty$ ) for calculations, but there are other airspeeds to consider for other purposes.
- This lecture describes the various airspeeds and how to calculate them.
- Example: (my airspeed calculator that I use in many of my spreadsheets)
  - Altitude and  $M$  are the inputs

Use this website to check your calculator:  
<http://www.hochwarth.com/misc/AviationCalculator.html>

|                            |          |                      |                     |
|----------------------------|----------|----------------------|---------------------|
| Altitude (h)               | 20000    | ft                   |                     |
| Mach ( $M$ )               | 0.8      |                      |                     |
| Temperature (T)            | 447.5    | R                    | Standard Atmosphere |
| Pressure (P)               | 971.7    | psf                  | Standard Atmosphere |
| Density ( $\rho$ )         | 0.001265 | slug/ft <sup>3</sup> | Standard Atmosphere |
| Speed of Sound (a)         | 1036.9   | ft/s                 |                     |
| Dynamic Pressure ( $q_c$ ) | 509.49   | psf                  | Raymer p781         |
| Airspeed ( $V_\infty$ )    | 491.5    | KTAS                 | Raymer p781         |
| Airspeed ( $V_\infty$ )    | 829.5    | ft/s                 |                     |
| Equivalent Air Speed       | 358.6    | KEAS                 | Raymer p781         |
| Corrected Airspeed         | 372.9    | KCAS                 | Raymer p781         |



# Airspeed Definitions (Raymer)



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- IAS – Indicated Airspeed. As read from the cockpit instruments
- CAS - Calibrated Air Speed. IAS corrected for airspeed and instrument error (every aircraft is different and is calibrated during flight test)
- EAS – Equivalent Airspeed. CAS corrected for compressibility effects.
- TAS – True Airspeed. EAS corrected for density (altitude)

# Airspeed Calculations (Raymer<sup>1</sup>)



Assume CAS=IAS in preliminary design

$$EAS = \frac{CAS}{\sqrt{\frac{P}{P_0}}} \left[ \frac{\left(\frac{q_c}{P} + 1\right)^{.286} - 1}{\left(\frac{q_c}{P_0} + 1\right)^{.286} - 1} \right]$$

$$TAS = \frac{EAS}{\sqrt{\frac{\rho}{\rho_0}}}$$

$$M = \frac{TAS}{a}$$

Where:

$$q_c = P([1 + .2M^2]^{3.5} - 1)$$

$a$  = speed of sound

$P_0$  = pressure at sea level

$\rho_0$  = density at sea level

<sup>1</sup>Raymer, Dan. Aircraft Design: A Conceptual Approach. Reston, Virginia: AIAA, 2006.



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