

**Problem T10 (Unified Thermodynamics)**

An aircraft is flying at  $M=2.0$  at 11km ( $T_{\text{atm}} = 217\text{K}$ ,  $p_{\text{atm}} = 22.6\text{kPa}$ ,  $\gamma = 1.4$ ). (LO# 4)

- In the reference frame of the airplane, what are the static and stagnation (or total) temperatures, and static and stagnation (or total) pressures?
- In the inlet of the engine, the flow is decelerated (adiabatically and quasi-statically) to about  $M=0.7$  before passing into the compressor. Again in the reference frame of the airplane, what are the stagnation and static pressures and temperatures at the entrance to the compressor?
- The fan tip speed is Mach 1.7 relative to the engine. In the reference frame of the fan tip, what are the stagnation and static pressures and temperatures at the entrance to the compressor?
- A wind-tunnel is being designed to test the engine of this aircraft. The tunnel will be a blowdown facility like that shown below. High pressure air will be metered through a valve so that it flows through the wind-tunnel test section at Mach = 2 relative to the stationary lab frame. If the high pressure air were to start at room temperature and be accelerated adiabatically with no external work enroute to the test section, what would the static temperature of the flow in the wind-tunnel be? What temperature would it be necessary to set the pressure vessels to so that the static temperature in the test section matched those experienced in flight?

