SPC 407
Sheet 2
Compressible Flow - Governing Equations

1. Is it possible to accelerate a gas to a supersonic velocity in a converging nozzle? Explain.
2. Consider a converging nozzle with sonic speed at the exit plane. Now the nozzle exit area is reduced while the nozzle inlet conditions are maintained constant. What will happen to (a) the exit velocity and (b) the mass flow rate through the nozzle?
3. In March 2004, NASA successfully launched an experimental supersonic-combustion ramjet engine (called a scramjet) that reached a record-setting Mach number of 7. Taking the air temperature to be -20 C, determine the speed of this engine.
4. Is it possible to accelerate a fluid to supersonic velocities with a velocity other than the sonic velocity at the throat? Explain
5. Air enters a converging–diverging nozzle at 1.2 MPa with a negligible velocity. Approximating the flow as isentropic, determine the back pressure that would result in an exit Mach number of 1.8.
6. Air enters a converging–diverging nozzle of a supersonic wind tunnel at 150 psia and 1008 F with a low velocity. The flow area of the test section is equal to the exit area of the nozzle, which is 5 ft^2. Calculate the pressure, temperature, velocity, and mass flow rate in the test section for a Mach number Ma 5 2. Explain why the air must be very dry for this application.
7. Air enters a nozzle at 0.5 MPa, 420 K, and a velocity of 110 m/s. Approximating the flow as isentropic, determine the pressure and temperature of air at a location where the air velocity equals the speed of sound. What is the ratio of the area at this location to the entrance area?
8. Repeat Prob. 7 assuming the entrance velocity is negligible.