Problem 1  Consider a shock tube with driver pressure $p_4$ and driven pressure $p_1$. Consider the following:

(a) As the ratio $p_4/p_1 \to \infty$, what is the limiting value of $M_s$, the shock Mach number?

(b) If you want to increase the shock Mach number $M_s$ for a given value of $p_4/p_1$, how should you select the driver and driven gases?

(c) What is the ideal driver gas?

Problem 2  A simple shock tube consists of a constant-area tube with a diaphragm mounted at the end. The outside pressure is $p_a$. The tube is initially pressurized with a perfect gas of sound speed $c_1$ and pressure $p_1 > p_a$. The diaphragm is ruptured (instantaneously disappears at $t = 0$). Find the minimum value of $p_1/p_a$ such that the initial outflow from the tube into the ambient fluid is choked.

Problem 3  Consider an air-air shock tube with initial temperatures $T_1 = T_4 = 300$ K. Find the pressure ratio $p_4/p_1$ required such that the tail of the expansion fan is stationary, e.g., $u_3 - c_3 = 0$.

Problem 4  Consider an air-air shock tube with initial temperatures $T_1 = T_4 = 300$ K with a rigid wall located at the end of driven section. Find the pressure ratio $p_4/p_1$ required to heat up the gas after the reflected shock from the driven section wall to 2000 K. What is the maximum amount of time this temperature is available?

*This HW is optional and, if turned in, will be used to replace your lowest HW score.