F20.
A small jet engine is to operate in a test facility which consists of a large air reservoir, exhausting through a duct of area \( A \) holding the engine. A throat of area \( A_t \) is behind the engine.

a) The engine is to be tested at \( M = 0.6 \). What must be the ratio \( A_t/A \) so that this test Mach number is achieved even if \( p_e \) is near vacuum? Will this test Mach number change as the tank gradually empties?

b) If \( p_r = 5 \times 10^5 \text{ Pa} \) and \( T_r = 300 \text{ K} \), what is the minimum \( p_e \) needed to ensure proper operation at \( M = 0.6 \) in a) above?

c) The throat is now set at \( A_t = 0.9A \), and we still have \( p_r = 5 \times 10^5 \text{ Pa} \) and \( T_r = 300 \text{ K} \). What must \( p_e \) be set to so that a normal shock appears in the straight section downstream of the throat? What is the static temperature just behind the shock?