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 $p_r = 5 \times 10^5$ Pa and $T_r = 300$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 $p_r = 5 \times 10^5$ Pa and $T_r = 300$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?