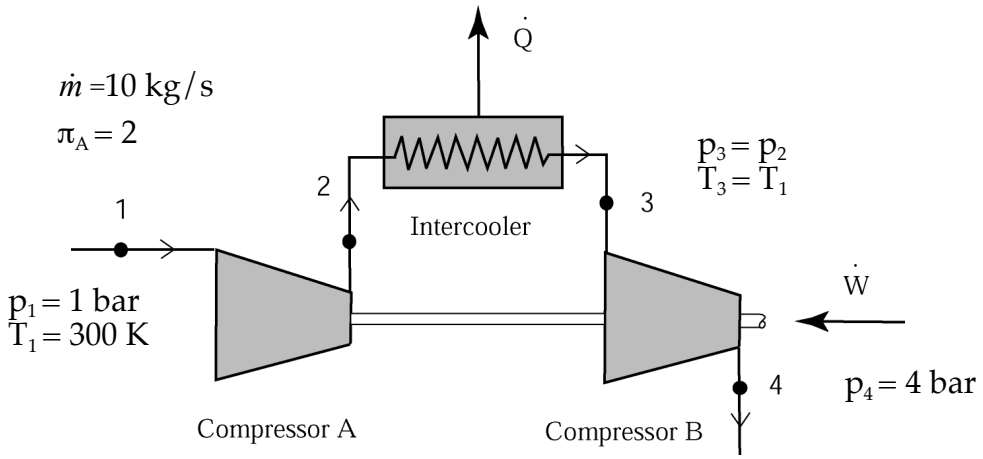
Unified Engineering **MIT ID# (last four digits):**
Thermo Quiz 4 (Score Weight 30/110) **Fall 2007**

Concepts assessed: application of 1st and 2nd laws of thermodynamics, h-s diagrams

An ideal two-stage air compressor has an intercooler between the two stages as shown below. The inlet state is at $p_1 = 1$ bar and $T_1 = 300$ K, and the final exit pressure is $p_4 = 4$ bar. The air mass flow is 10 kg/s and compressor A operates at a pressure ratio of 2. The constant pressure intercooler cools the air to the inlet temperature, $T_3 = T_1$. Both compressors are adiabatic and operate at steady state. Kinetic and potential energy effects can be neglected and air can be assumed a perfect gas with R = 287 J/kgK and $\gamma = 1.4$.



a) Sketch all the processes on the same h-s diagram. Draw the relevant isotherms and isobars. Mark the specific shaft work of compressors A and B and the heat transfer from the intercooler – how do they compare in magnitude?

b) What is the required shaft power $\dot{W}$ to drive the two-stage compressor?

c) The surroundings are at a constant temperature of 300 K. Find the specific total entropy change. Is the overall process reversible? Why or why not? Discuss your results and the underlying entropy changes.

(Extra page for solutions)