

AREN 2110 THERMODYNAMICS

Midterm Examination II

9 November 2006

Name, Nom, Nombre _____
PRINT

Examination Time is 75 minutes. This examination is open book and open notes

Point value for each problem is written next to the problem label in parentheses (e.g. (3)).

SCORE

1. _____(25)

2. _____(25)

3. _____(25)

4. _____(25)

Σ . _____(100)

I have read, understand, and agree to abide by the University of Colorado honor code in this test context:
I have neither given nor received unauthorized assistance during this examination.

Signed: _____

1. (25 points.) Answer the following by circling the BEST answer.

1) (5) The boundary work associated with a constant volume process is always

- (a) negative
- (b) zero
- (d) positive
- (d) equal to the heat transfer
- (e) equal to the change in internal energy
- (f) equal to the change in enthalpy

2) (5) For an open system, “steady-state” is associated with which unique condition?

- (a) Mass is conserved
- (b) Energy is conserved
- (c) Energy of the control volume does not change with time
- (d) The process is adiabatic
- (e) Inlet velocity = outlet velocity
- (f) Inlet temperature = outlet temperature

3) (5) Boundary work can be done by an ideal gas in a closed system in an isothermal process if, and only if

- (a) the process is not adiabatic
- (b) the process is isobaric
- (c) the process is polytropic
- (d) the process is adiabatic
- (e) the process is isochoric
- (f) isothermal process cannot have boundary work

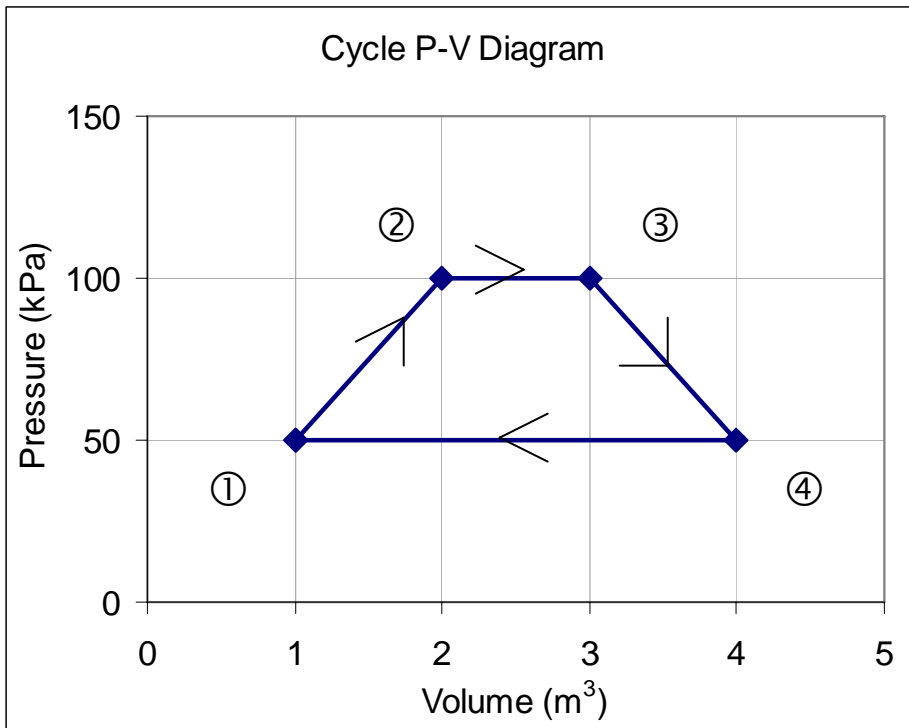
4) (5) The purpose of an adiabatic turbine is to

- (a) produce work from heat transfer to fluid
- (b) produce work from evaporation of fluid
- (c) reduce the pressure and temperature of fluid
- (d) increase pressure from enthalpy decrease of fluid
- (e) produce work from enthalpy decrease of fluid
- (f) produce work from enthalpy increase of fluid

5) (5) An ideal gas flows through a steady-state adiabatic diffuser. The temperature of the gas **MUST**

- (a) remain constant
- (b) decrease
- (c) depend on work done by the system
- (d) increase
- (e) depend on heat loss from the system
- (f) cannot tell from information given

2. (25 points) Please refer to P-V diagram for a cycle with an ideal gas in a closed system to answer a) – e)



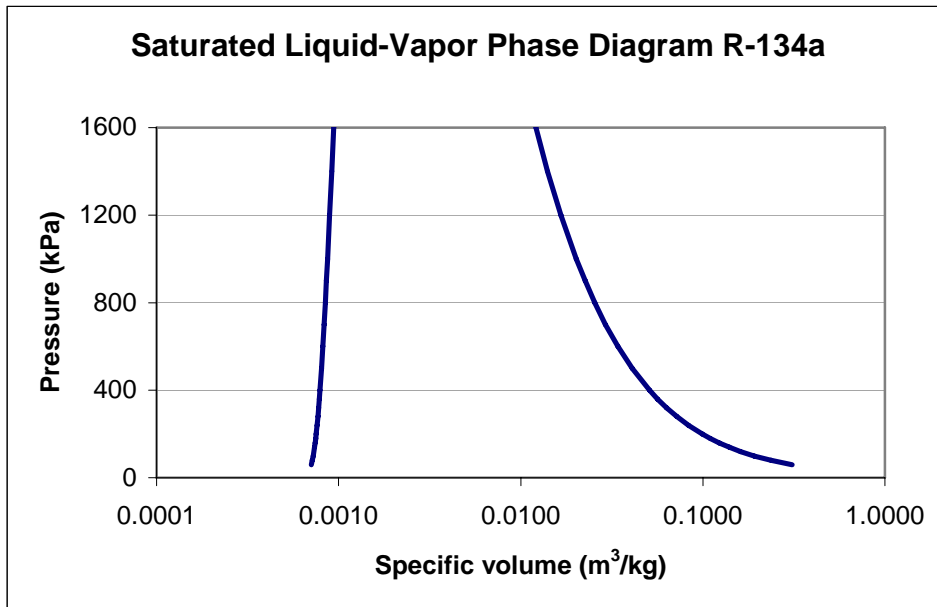
- Process 1 → 2: linear expansion
- Process 2 → 3: isobaric expansion
- Process 3 → 4: linear expansion
- Process 4 → 1: isobaric compression

Be sure to use the correct sign convention. You will lose significant credit for the wrong sign.

- a) (5) The work for 1 → 2 is _____ kJ.
- b) (5) The work for 4 → 1 is _____ kJ
- c) (5) The work for 2 → 3 is _____ kJ.
- d) (5) The net work for the cycle is _____ kJ
- e) (5) The net heat transfer for the cycle is _____ kJ

3. (25 points) Heat is removed from 0.5 m^3 of saturated refrigerant vapor at 1.4 MPa in a constant pressure process until half the R-134a vapor has condensed.

a. Draw the process on the P-v diagram below.



b) (7) What is the boundary work of the process in kJ?

c) (5) How much heat must be removed in kJ?

3. (continued)

d) (3) What is the mass of liquid at the end of the process in kg?

e) (5) If this process were carried out at constant volume, how much heat (kJ) would have to be removed to condense half the R-134a?

4. (25 points) The pressure of air is increased from 150 kPa to 600 kPa in an adiabatic compressor operating at steady state with 25 kw power from the motor. The inlet air flow rate is 6 m³/min and inlet air temperature is 40 °C.

a) (10) What is the temperature of the air at the compressor outlet? Neglect kinetic energy change.

b) (5) What is the volumetric flowrate at the compressor outlet?

4. (continued) **The compressed air now flows into an adiabatic nozzle where the velocity is increased from 4 m/s at the inlet to 100 m/s at the outlet and the pressure decreases from 600 kPa to 250 kPa.**

c) (5) What is the temperature of the air as it exits the nozzle?

d) (5) What is the ratio of the inlet area to the outlet area for the nozzle (A_1/A_2)?