

Given as an Example Exam

ES 3053

EXAM I
Open Books and Notes

September 30, 2019

A frictionless piston and cylinder arrangement initially contains $V_1=2500 \text{ cm}^3$ of pure, *saturated liquid* R-134a at $P_1=400 \text{ kPa}$. Use the R-134a tables in the back of your book for part I below.

I. 20 points total

A. 5 points

How many kg (kilograms) of R-134a does the piston and cylinder arrangement contain?

B. 5 points

What is the temperature in $^{\circ}\text{C}$?

B. 10 points

What are the total enthalpy (H_1) and internal energy (U_1) of the R-134a in kJ?

The piston and cylinder arrangement is then heated reversibly on a hot plate holding the temperature constant, until only saturated *vapor* exists. Use the R-134a tables for part II below.

II. 55 points total

A. 10 points

What is the total volume (V_2) of the R-134a in cm^3 ?

B. 10 points

What are the total enthalpy (H_2) and internal energy (U_2) of the R-134a in kJ?

C. 30 points

For the process I $\rightarrow$ II, what are ΔU , ΔH , Q , and W (all in kJ)?

D. 5 points

Why doesn't $\Delta H = \int C_p dT$ and $\Delta U = \int C_v dT$ for the process I $\rightarrow$ II?

The piston is then locked in place so that the volume is constant at $V=V_2$. The piston and cylinder arrangement is then returned to the hot plate and heating is continued until $T_2 = 80^{\circ}\text{C}$.

III. 25 points total

A. 10 points

Estimate the pressure using the ideal gas law for P-V-T behavior of the R-134a vapor.

B. 15 points

Find the pressure using the R-134a table.

$$R = 83.14 \text{ (cm}^3 \text{ - bar)/(gmole - K)} = 0.008314 \text{ (m}^3 \text{ - kPa)/(gmole - K)} = 0.08314 \text{ (L - bar)/(gmole - K)}$$

MW of R-134a is 102.03 g/gmole

Or you can use the value on a per kg basis in your book on pg 883.

Given as an Example Exam

Your Name: _____

Show your work. Your exam paper *must* include this work to get credit for any part.

Transfer the following answers from your pages of calculations and turn in with your calculations:

I. 20 points total

A. 5 points: mass of R-134a = _____ kg

B. 5 points: T_1 = _____ °C

B. 10 points: H_1 = _____ kJ

U_1 = _____ kJ

II. 55 points total

A. 10 points: V_2 = _____ m³

B. 10 points: H_2 = _____ kJ

U_2 = _____ kJ

C. 30 points: ΔU = _____ kJ

ΔH = _____ kJ

Q = _____ kJ

W = _____ kJ

D. 5 points: Why doesn't $\Delta H = \int C_p dT$ and $\Delta U = \int C_v dT$ for the process I→II?

Answer: _____

III. 25 points total

A. 10 points: P = _____ kPa (idea gas law)

B. 15 points: P = _____ kPa (R-134a table)