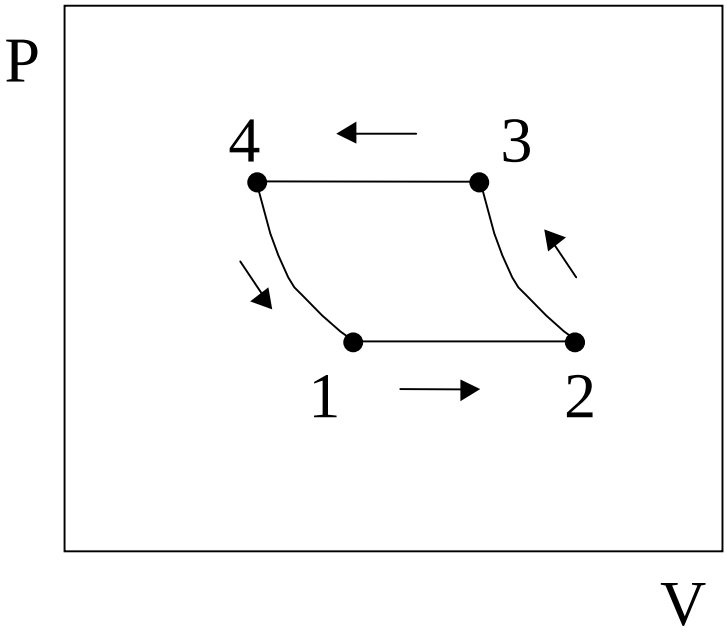
AREN 2110: Thermodynamics
Practice Problems, Chapters 1 - 4

1. Use the P-V diagram below to answer the following questions

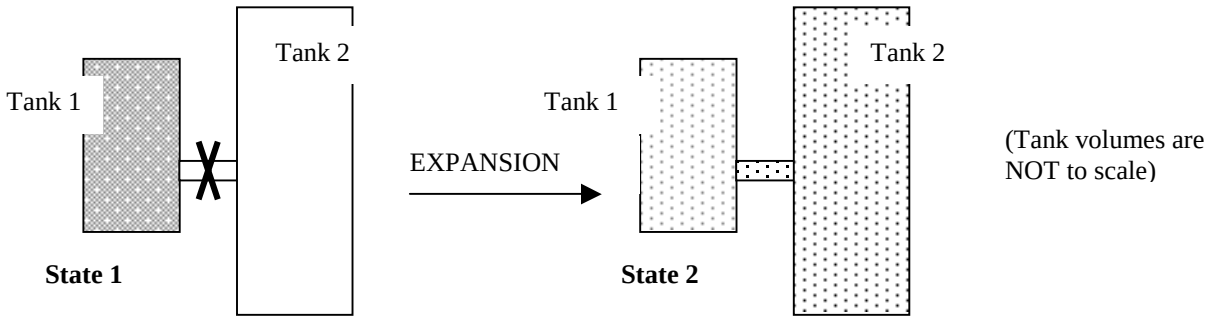



1a) The Net Work for the cyclic process is:
a) Zero
b) Positive
c) Negative
d) Cannot tell from the diagram

1b) The processes from states 1 to 2 and 3 to 4 are:
a) Isothermal
b) Isobaric
c) Isochoric
d) Isometric

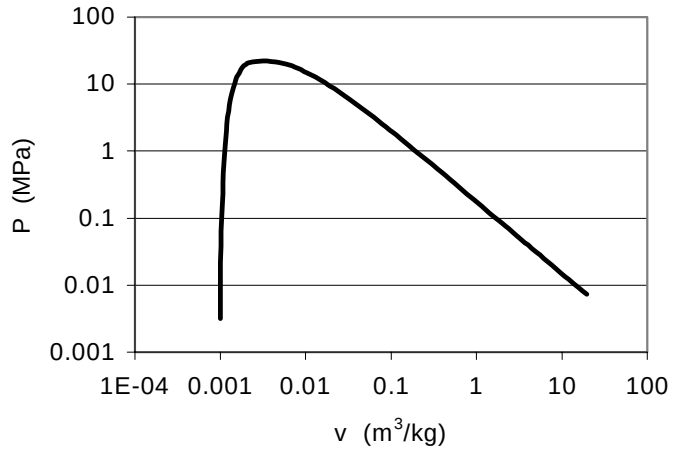
1c) The Net Heat Transfer for the cyclic process is:
a) Zero
b) Positive
c) Negative
d) Cannot tell from the diagram

2. State 1: Ten (10) kg of saturated liquid water at 100 $^{o}$C and 0.10133 MPa with a specific volume of 0.001044 m$^3$/kg is contained in a tank connected to a second empty tank through a pipe with a closed valve. The valve is opened and the water expands isothermally into the second tank until equilibrium is reached. State 2: 10 kg water at 100 $^{o}$C and 0.01 MPa.




2a) Draw the process on the P-v diagram below, showing process directions:

**a)** P-v diagram for water




2b) The total volume of the two tanks is (justify your answer):

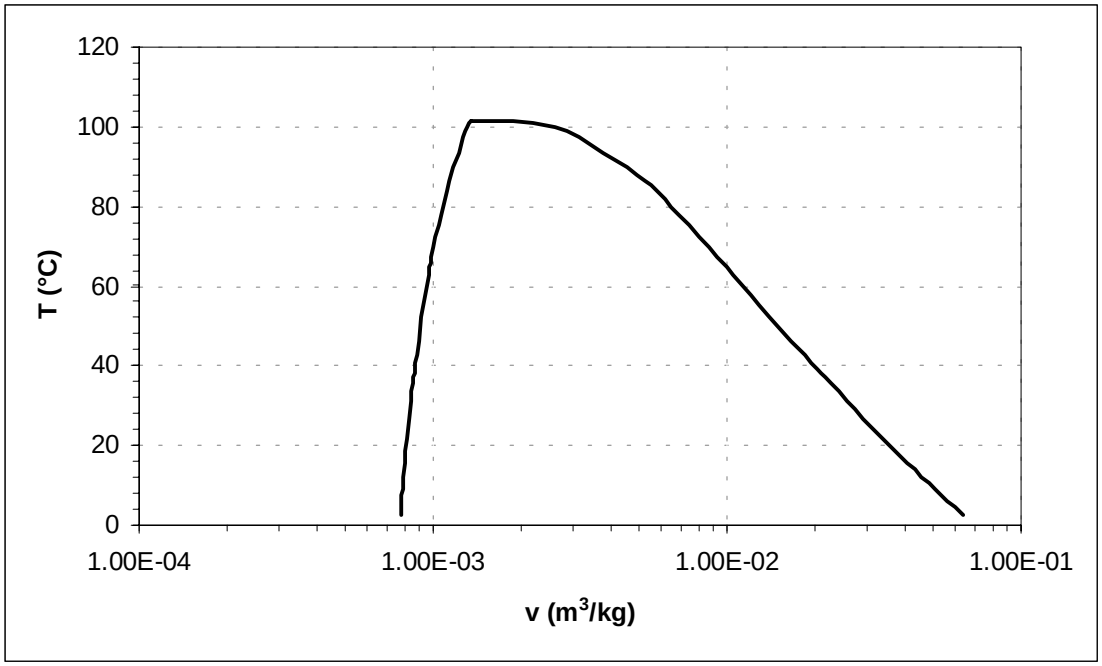
a. 172 m$^3$
b. 16.7 m$^3$
c. 146.7 m$^3$
d. Cannot be determined from the information given

3. A one-liter volume of liquid water at 25 $^{o}$C and 1 atmosphere pressure is cooled to 0 $^{o}$C and eventually frozen completely at constant pressure. The final temperature of the ice is 0 $^{o}$C. Calculate the total change in enthalpy of the water.

4. A pistion/cylinder system has 2 kg of R-134a refrigerant at $T$=40°C and $P$=800 kPa. The refrigerant is cooled to $T$=20°C at constant pressure. (The R-134a tables are A-8 to A-10, pp 857-860)


4a) What is the saturation temperature for R-134a in this system?

4b) Draw the process on the T-v diagram below.

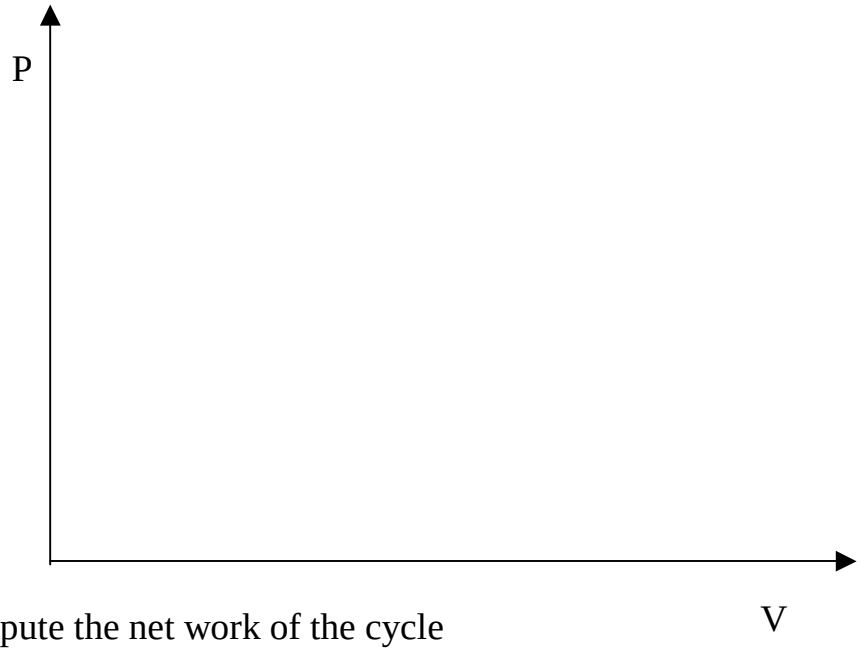


5. A piston/cyclinder starts at pressure $P_1$ and volume $V_1$ and undergoes the following cycle:
   - 1→2 Isobaric expansion to triple the original volume
   - 2→3 Compression to twice the original volume according to the *P*-*V* relation

$$P = 4P_1 - \frac{P_1}{V_1}V$$

   - 3→4 Isobaric compression to the original volume
   - 4→1 Isochoric heat removal returning the system to its original pressure

a) Draw a *P*-*V* diagram for the cycle labeling all points and indicating direction




b) Compute the net work of the cycle

6. Twenty-five (25) kg of helium gas at a temperature of 300 K and pressure of 20 kPa is compressed until the pressure doubles. During the compression the gas properties follow the expression:

$$\mathbf{PV^2 = constant}$$

a. What is the final temperature of the helium?

b. What is the work done during the compression?

7. The temperature of two kilograms of water contained in an 0.20-$m^3$ rigid tank is 200 $^oC$. Determine:

a. the pressure in the system

b. the specific enthalpy of the system

c. the mass of the vapor phase

d. the volume of the vapor phase

8. Fill in the property table below for water in the specified equilibrium states:

| | T($^oC$) | P (kPa) | h (kJ/kg) | v ($m^3$/kg) | x | phase |
|---|---|---|---|---|---|---|
| a) | | 300 | | | 0.5 | |
| b) | | | 762.81 | | | saturated liquid |
| c) | 80 | 125 | | | | |
| d) | | 600 | 3270.3 | | | |