Trevor Swan **ECHE225: EXAM #1 // 10.04.24**

1. Constant P

2. Water $T = 275°C$, $s = 6\ \frac{kJ}{kgK}$

$s_f = 3.0221$

$s_g = 5.8944$

$s_f < s_g < s$

$\boxed{\text{Superheated Vapor}}$

3. Heat, Work, Mass

4. Heat flows spontaneously from higher to lower energy matter.

5. Energy is conserved

6. Heat Pump for car heater

Car temp: 68°F (293K) = T_H

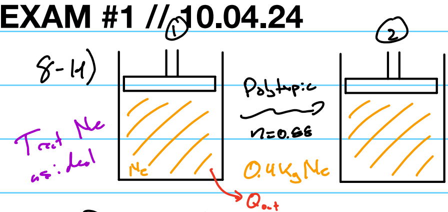
Outdoor temp: 10°F (261K) = T_L

$$CoP_{HP,carnot} = \frac{1}{1 - \frac{T_L}{T_H}}$$

$$\boxed{CoP_{HP} = 9.15625}$$

7. Not possible, $CoP_{HP,carnot} = 9.15$, and this is for ideal/max

8-14)



$R = 0.4119\ \frac{kJ}{kgK}$

$C_v = 0.6179\ \frac{kJ}{kgK}$

$C_p = 1.0299\ \frac{kJ}{kgK}$

$P_1 = 100\,kPa$ $\quad$ $P_2 = 400\,kPa$

$T_1 = 20°C = 293.15K$ $\quad$ $V_2 = 0.1\,m^3$

8) $P_1V_1^n = P_2V_2^n$

$$V_1^n = \frac{P_2V_2^n}{P_1}$$

actually ill use EoS!!

$$P_1V_1 = mRT_1 \rightarrow V_1 = \frac{mRT}{P_1}$$

$$V_1 = \frac{(0.4kg)(0.4119\frac{kJ}{kgK})(293.15K)}{100kPa} = \boxed{0.483\,m^3}$$

9) $$W_{piston} = \frac{P_2V_2 - P_1V_1}{n} = \frac{400(.1) - 100(.483)}{0.88}$$

$$\boxed{W_{piston} = -9.43}$$

12) $$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow T_2 = \frac{P_2V_2T_1}{P_1V_1}$$

$$T_2 = \frac{400(0.1)(293.15K)}{100(0.483)} = \boxed{242.77K}$$

13) 1st Law

$$(\cancel{Q_{in}}^{0} - Q_{out}) + (\cancel{W_{in}} - W_{out}) = m(u_2 - u_1)$$

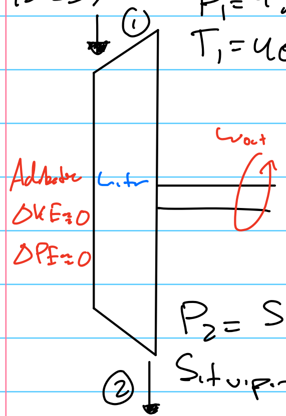
$$\boxed{-Q_{out} - W_{out} = m\,\Delta u}$$

14) $$\Delta u = C_v(T_2 - T_1)$$
$$= 0.6179\ \frac{kJ}{kgK}(242.77 - 293.15)$$
$$= -31.1298\ \frac{kJ}{kg}$$

$$-Q_{out} - (-9.43) = 0.4(-31.1298)$$

$$\boxed{Q_{out} = 21.88\ kJ}$$

15-25)



$P_1 = 4\ MPa$

$T_1 = 400°C = 673.15K$

$P_2 = 50kPa$

Sat vapor $(x=1)$

15) adiabatic; ΔKE, ΔPE ≈ 0

$$(\cancel{Q_{in}} - \cancel{Q_{out}}) + (W_{in} - W_{out}) = \dot m\left[(h_2-h_1) + \cancel{\tfrac{1}{2}(V_2^2-V_1^2)} + \cancel{g\Delta z}\right]$$

$$\cancel{W_{in}}^{\,0} - W_{out} = \dot m(h_2-h_1)$$

$$\boxed{W_{out} = \dot m(h_2-h_1)}$$

16-17) $P_1 = 4MPa$, $T_1 = 400°C$ $\xrightarrow{SH}$ $h_1 = 3214.5\ \frac{kJ}{kg}$, $s_1 = 6.7714\ \frac{kJ}{kgK}$

16 $\boxed{h_1 = 3214.5\ \frac{kJ}{kg}}$

17 $\boxed{s_1 = 6.7714\ \frac{kJ}{kgK}}$

18-19) $P_2 = 50kPa$, $x=1$ $\xrightarrow{\text{sat mix}}$ $\boxed{h_g = h_{2A} = 2645.2\ \frac{kJ}{kg} \quad s_g = s_{2A} = 7.5931\ \frac{kJ}{kgK}}$

20) Reversible → ideal → isentropic

Phase change fluid: $s_2 = s_1$ ∴ $\boxed{s_{2s} = 6.7714\ \frac{kJ}{kgK}}$

21) Ideal: $x = 0.874$

$50kPa$, $x=0.874$ → $h_f = 340.54$, $h_g = 2645.2$

$$h = h_f + x(h_g - h_f)$$

$$\boxed{h_{2s} = 2354.81\ \frac{kJ}{kg}}$$

22) $$\eta_t = \frac{h_1 - h_{2A}}{h_1 - h_{2s}} = \frac{3214.5 - 2645.2}{3214.5 - 2354.81} = 0.662$$

23) $\Delta s_{sys} = s_{2A} - s_{1A} = 7.5931 - 6.7714 = 0.8217$

24) Adiabatic → no heat exchanged so $\Delta s_{surr} = 0$ $\quad \frac{Q}{T}$

25) $\Delta s_{tot} = \Delta s_{sys} + \Delta s_{surr} = 0.8217$