13/20

MAE91 Summer 2004 – Quiz 5
Dr. H. Susan Zhou

Closed book and notes – 20 minutes

Name: Nasser Abbasi
ID: _____

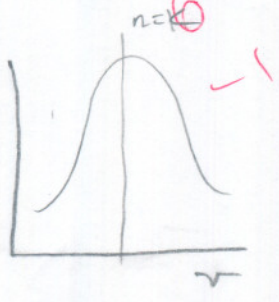
PV^n = constant

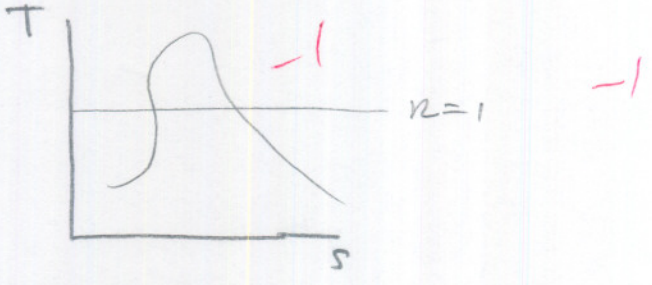
3/10

1. (10 points) Consider the reversible polytropic process for ideal gas. Plot the following four processes on both P-v and T-s diagram and give the n values for each process.
i) Isobaric process. ii) Isochoric process. iii) Isothermal process. iv) Isentropic process.

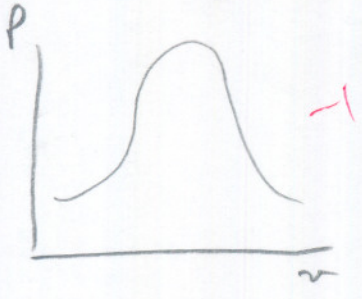
T=constant. reversible adiabatic

i)

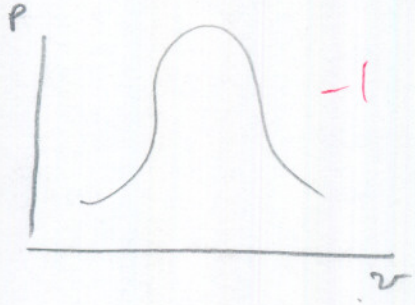


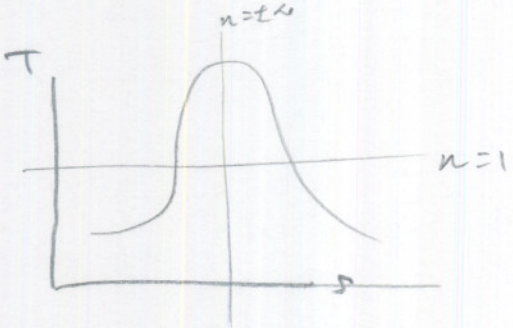


ii)

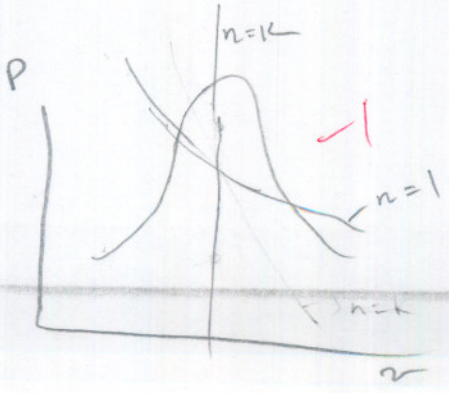


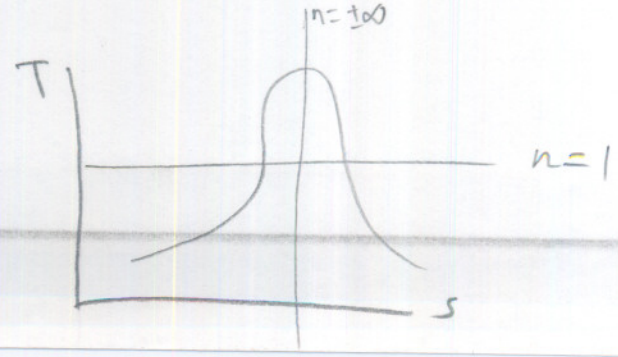
iii)





iv)

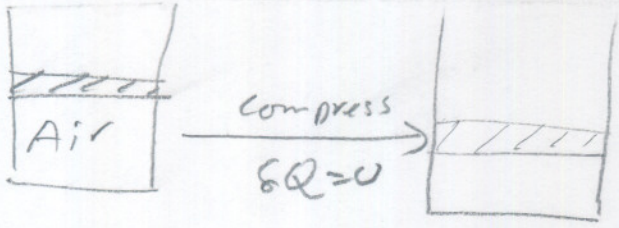




10/10

2. (10 points) Air in a piston-cylinder assembly (closed system) is adiabatically compressed. If the process is irreversible, does the entropy of the system increase, decrease, or remain the same? Why?

statement



Assumptions

- ideal gas.

Laws

$$(m\,\Delta s) = \frac{\delta Q}{T} + S_{gen.}$$

↘ system entropy.

steps

since irreversible, then $S_{gen} > 0$. (i.e. friction, etc..)

$\delta Q = 0$. (since adiabatic).

hence $\boxed{m(s_2 - s_1) = S_{gen.}}$

So entropy of system increases since $S_{gen} > 0$ here since irreversible.

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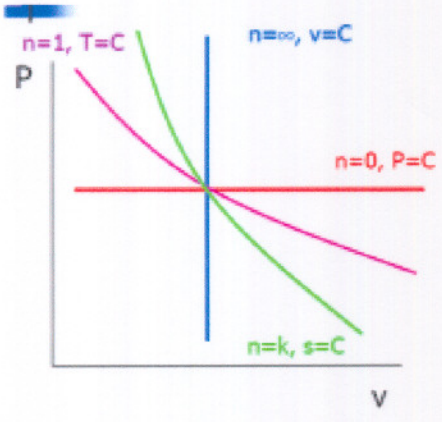
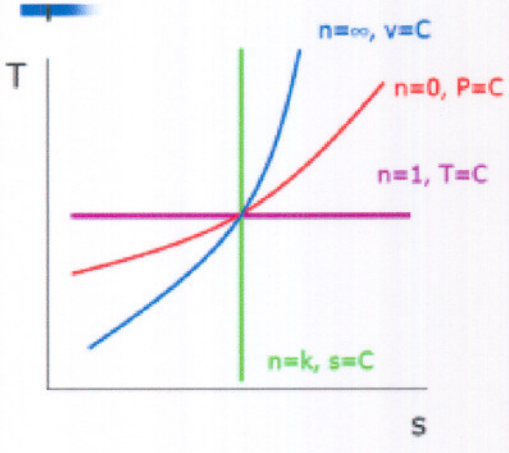


$Pv^n=C$

1. Isobaric process: n=0, P=C
2. Isochoric process: n=∞, v=C
3. Isothermal process: n=1, T=C
4. Isentropic process: n=k, s=C



$Pv^n=C$

1. Isothermal process: n=1, T=C
2. Isentropic process: n=k, s=C
3. Isobaric process: n=0, P=C
4. Isochoric process: n=∞, v=C

$$Tds = du + Pdv \quad (1)$$
$$Tds = dh - vdP \quad (2)$$
$$(1)\ v = C: Tds = du = C_{v0}dT \quad (3)$$
$$(2)\ P = C: Tds = dh = C_{p0}dT \quad (4)$$
$$(3)\ \left.\frac{dT}{ds}\right|_{v=C} = \frac{T}{C_{v0}} \quad v = C \quad (5)$$
$$(4)\ \left.\frac{dT}{ds}\right|_{P=C} = \frac{T}{C_{p0}} \quad P = C \quad (6)$$

2. (10 points) Air in a piston-cylinder assembly (closed system) is adiabatically compressed. If the process is irreversible, does the entropy of the system increase, decrease, or remain the same? Why?

To solve this problem we start with the entropy equation:

$$m(s_2 - s_1) = \int \frac{dQ}{T} + {}_1S_{2,gen} \Rightarrow$$

$$m(s_2 - s_1) - \int \frac{dQ}{T} = {}_1S_{2,gen} \Rightarrow$$

$$\Delta S_{system} + \Delta S_{surr} = \Delta S_{net}$$

Knowing that this process is adiabatic means that:

$$m(s_2 - s_1) = {}_1S_{2,gen}$$

$$\Delta S_{system} = \Delta S_{net}$$

Now in an irreversible process we know that:

$${}_1S_{2,gen} > 0$$

Therefore we can conclude that:

$$m(s_2 - s_1) = {}_1S_{2,gen} > 0 \Rightarrow$$

$$\Delta S_{system} = \Delta S_{net} > 0$$

$$\therefore \Delta S_{system} > 0$$

Therefore there is an entropy **increase.**