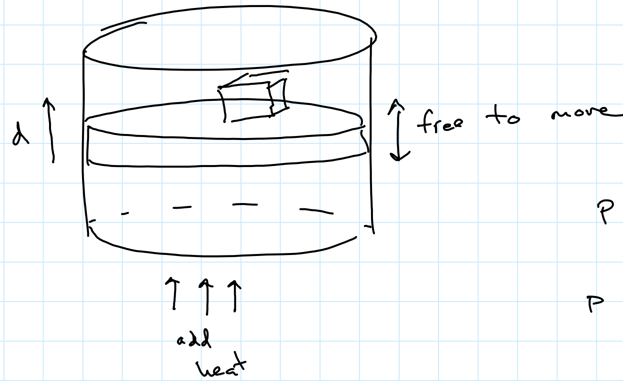
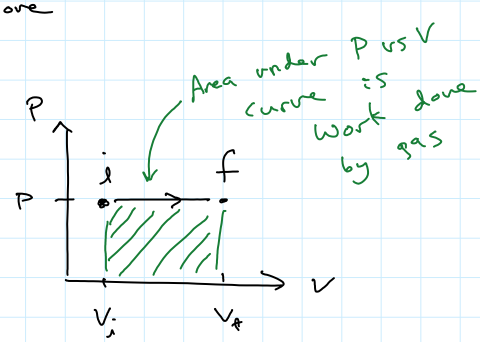
Phy 4C 1/25

Wednesday, January 25, 2017 11:49 AM

Common Processes:

Isobaric:





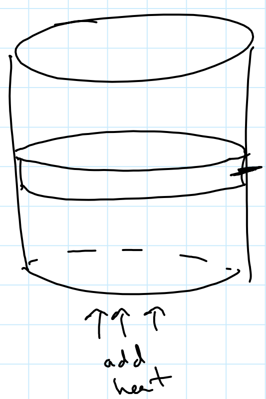
gas expands and pushes piston up

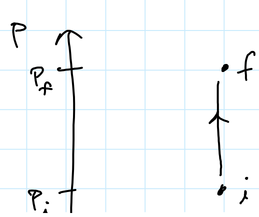
gas does positive work

$$W = F d$$
$$= (PA)\, d$$
$$= P\,(A d)$$
$$= P\,\Delta V$$

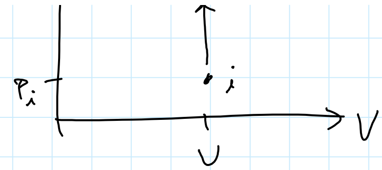
$$\boxed{\text{Isobaric:} \quad W_{By} = P\,\Delta V \qquad W_{on} = -P\,\Delta V}$$

Isochoric or isovolumetric (constant V)





heat



$$\boxed{\text{isochoric: } \quad W = 0}$$

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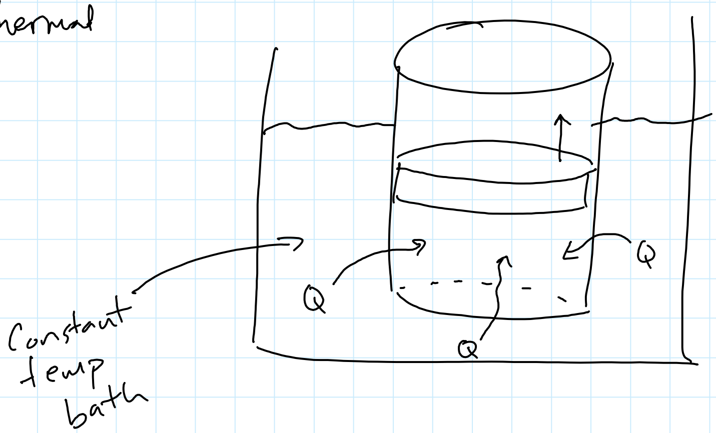
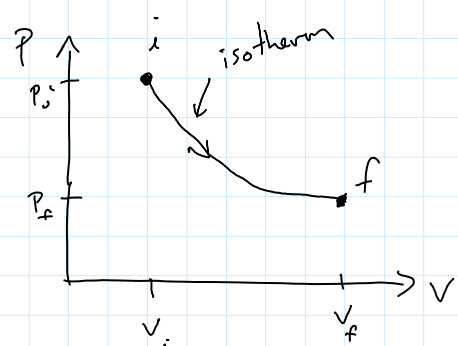
isothermal



- gas starts at temp of bath
- move piston up
- heat flows into system
- temp stays constant



Ideal gas

$$P = \frac{nRT}{V}$$

$$W = \int P \, dV$$

$$= \int \frac{nRT}{V} \, dV$$

$$= nRT \int \frac{dV}{V}$$

$$= nRT \int \frac{dV}{V}$$

$$= nRT \ln \frac{V_f}{V_i} \quad \text{by gas}$$

Isothermal

$$W_{By} = nRT \ln \frac{V_f}{V_i}$$

$$W_{ON} = nRT \ln \frac{V_i}{V_f}$$

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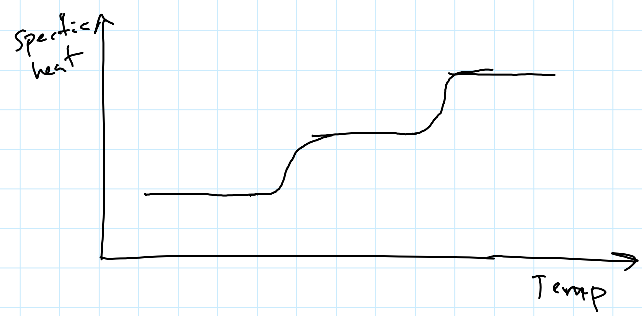
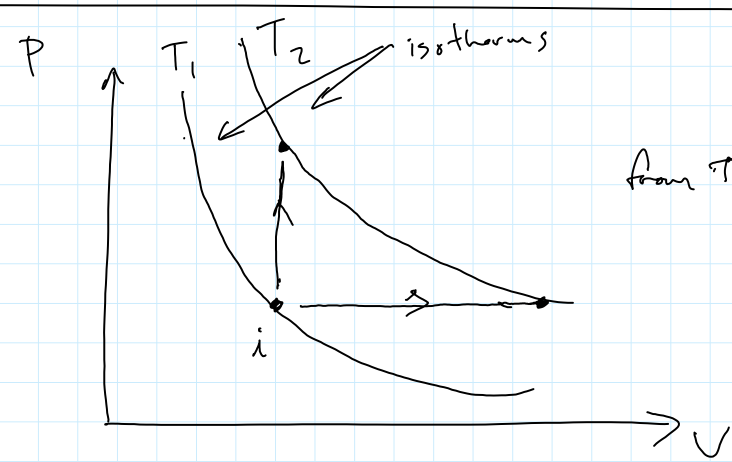
ch 21 $\quad E = \frac{1}{2} kT$ per degree of freedom

p 636





from T_1 to T_2

Specific heat for gases:

$$Q = n\, C_v\, \Delta T \quad (\text{constant } V)$$

$$Q = n\,C_p\,\Delta T \qquad (\text{constant } P)$$

$$C_p > C_v$$

$$C_p - C_v = R$$

Monatomic Ideal Gas: $C_v = \frac{3}{2}R$

$$\gamma = \frac{C_p}{C_v} = \frac{5}{3} \qquad \text{monatomic}$$

1st Law of Thermodynamics

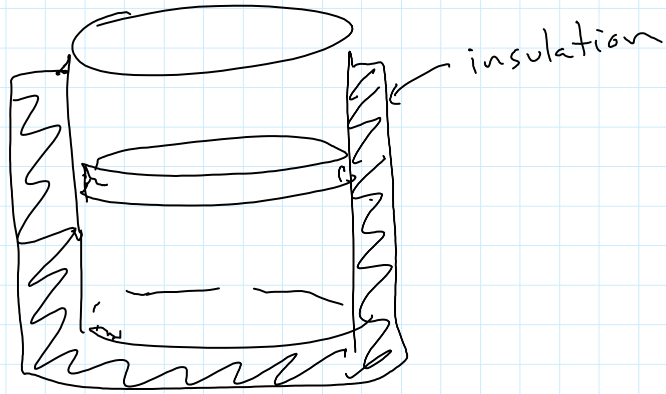
$$\Delta E_{int} = Q + W_{on}$$

or

$$\Delta E_{int} = Q - W_{BY}$$

$Q > 0$ when system gains heat (heat flows into system)

Adiabatic Process:



$$Q = 0$$

$$\Delta E_{int} = W_{on}$$

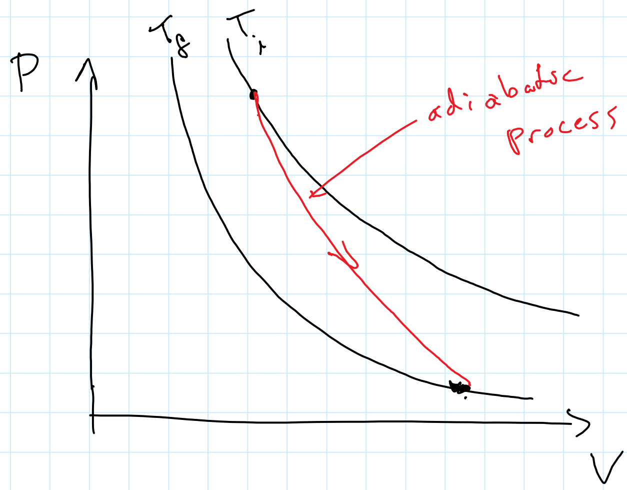
$$E_f - E_i = W_{on}$$

if monatomic ideal gas: $E_{int} = \frac{3}{2} nRT$

$$\frac{3}{2} nRT_f - \frac{3}{2} nRT_i = W_{on}$$

$$\boxed{W_{on} = \frac{3}{2} nR(T_f - T_i)}$$

monatomic ideal gas



For Adiabatic Processes:

$$PV^{\gamma} = \text{constant}$$

$$P_i V_i^{\gamma} = P_f V_f^{\gamma}$$

$$\gamma = \frac{c_p}{c_v}$$

For monatomic ideal gas

$$C_p = \frac{5}{2} R$$
$$C_v = \frac{3}{2} R$$
$$\gamma = \frac{5}{3}$$

$$C_p - C_v = R$$

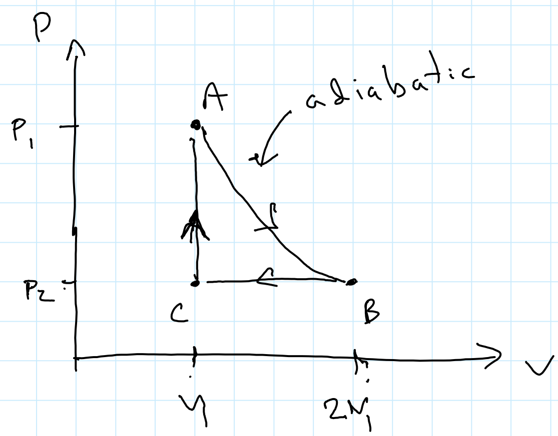
Problem: 2 moles of an ideal monatomic gas go through the following cycle:

given

$P_1 = 8 \times 10^5$ Pa

$T_A = 400$ K

$T_B = 300$ K



Find W_{Net} in one cycle

ON the gas

States

	P	V	T	E_{int}
A	8×10^5 Pa	8.3×10^{-3} m^3	400 K	9972 J
B	3×10^5 Pa	1.6×10^{-2} m^3	300 K	7479 J
C	3×10^5 Pa	8.3×10^{-3} m^3	150 K	3740 J

1) Find V_A

2) $V_C = V_A$

$V_B = 2V_A$

3) Find P_B

4) $P_C = P_B$

5) Find T_C

6) $E_{int} = \frac{3}{2} nRT$

Path

	Q	W_{on}	ΔE_{int}
A → B			

	Q	W_{on}	ΔE_{int}
$A \to B$	0		-2493 J
$B \to C$		Area	-3740 J
$C \to A$		0	$+6232$ J
Net			0

Useful conversions:

$$1 \text{ atm} = 101{,}325 \text{ Pa}$$

$$1 \text{ m}^3 = 1000 \text{ L}$$

$$1 \text{ Pa} = \frac{\text{N}}{\text{m}^2}$$

$$(\text{Pa})(\text{m}^3) = \text{J}$$

or

$$(\text{k Pa})(\text{Liters}) = \text{J}$$

$$R = \begin{cases} 0.0821 & \dfrac{\text{L atm}}{\text{mol K}} \\ \text{OR} & \\ 8.31 & \dfrac{\text{J}}{\text{mol K}} \end{cases}$$

6) $E_{int} = \frac{3}{2} nRT$

7) $\Delta E = E_f - E_i$

8) $W_{C \to A} = 0$

9) $Q_{A \to B} = 0$

10) $W_{B \to C} = \text{area}$

11) use 1st law

$\Delta E = Q + W_{on}$

To get

$W_{A \to B}$

$Q_{B \to C}$

$Q_{C \to A}$