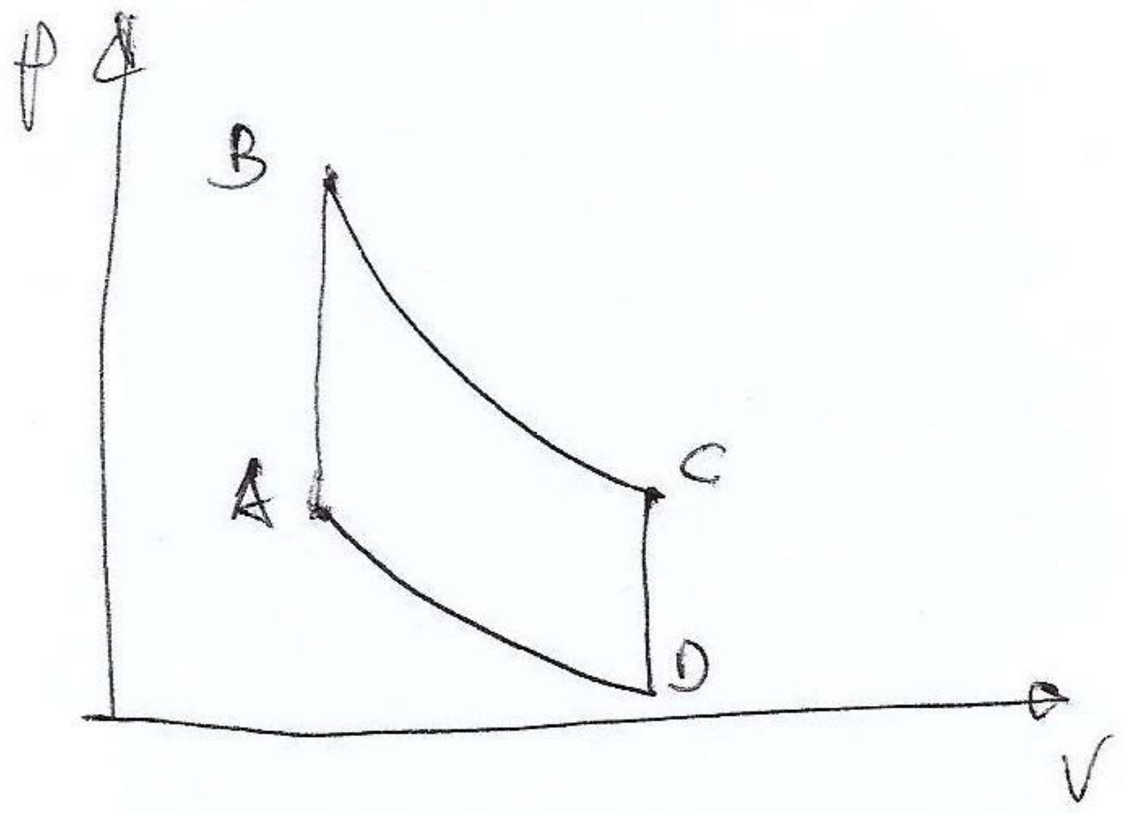
Problème 1



gaz monoatomique

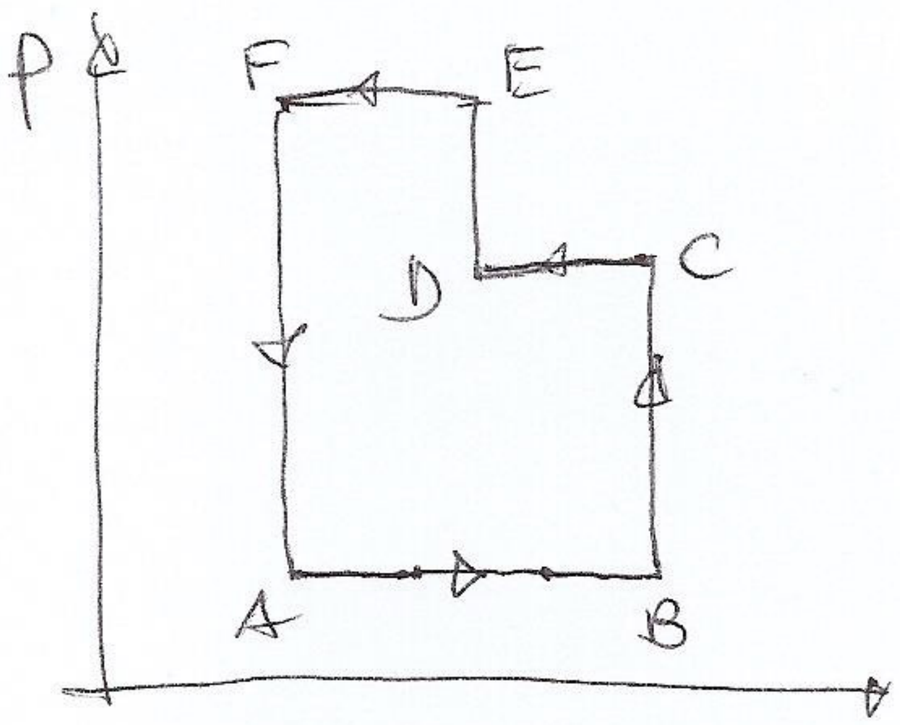
$n = 2$

	$p\ (\cdot 10^5\ Pa)$	$V\ (m^3)$	$T\ (K)$
A	2	0.010	122
B	8	0.010	488
C	2.285	0.035	488
D	0.571	0.035	122

	ΔU	L	Q
AB	+ 6083	0	+ 6083
BC	0	+ 10161	+ 10161
CD	− 6083	0	− 6083
DA	0	− 2540	− 2540
Tot	0	L_{TOT} 7621 J	L_{TOT} 7621 J

$Q_{ABC} =$ 16244 J

Problema 2



	$P(\cdot 10^5 Pa)$	$V_{(m^3)}$	T
A	2	3	
B	2	9	
C	6	9	
D	6	6	
E	8	6	
F	8	3	

$$L_{TOT} = -\text{area compresa nel ciclo}$$

$$= L_{AB} + L_{CD} + L_{EF} =$$

$$= p_A(V_B - V_A) + p_C(V_D - V_C) + p_E(V_F - V_E) =$$

$$= (12 - 18 - 24)\cdot 10^5 =$$

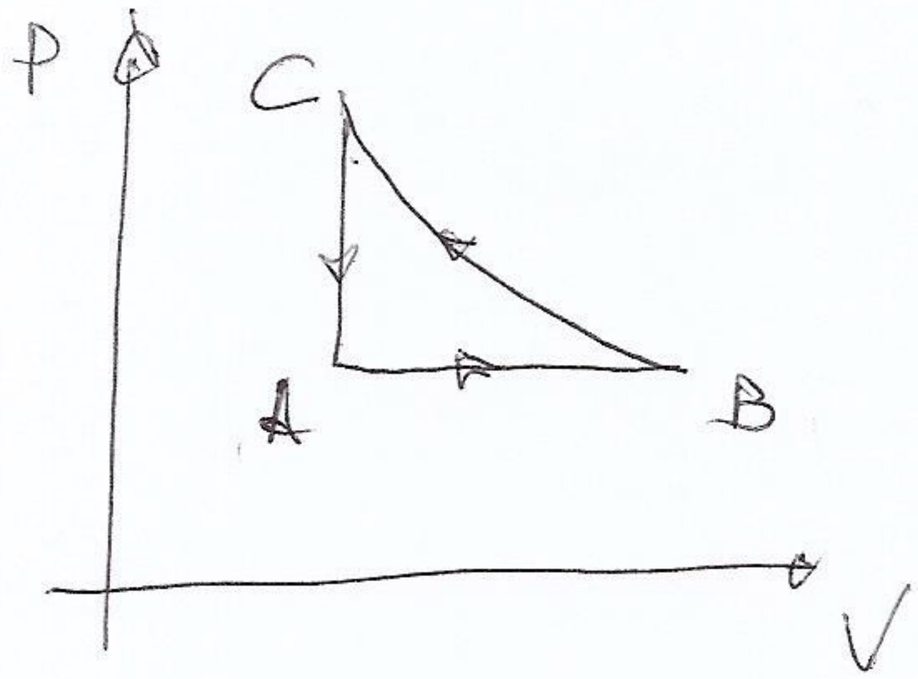
$$= -3 \cdot 10^6 \ J$$

Problema 2

	ΔU	L	Q
AB	+	+	+
BC	+	0	+
CD	−	−	−
DE	+	0	+
EF	−	−	−
FA	−	0	−
	0	L_{TOT}	L_{TOT}

$$Q_{TOT} = L_{TOT} = 3 \cdot 10^6 \text{ J}$$

complessivamente assorbito dal gas



Problema 3

$n = 180$ moli

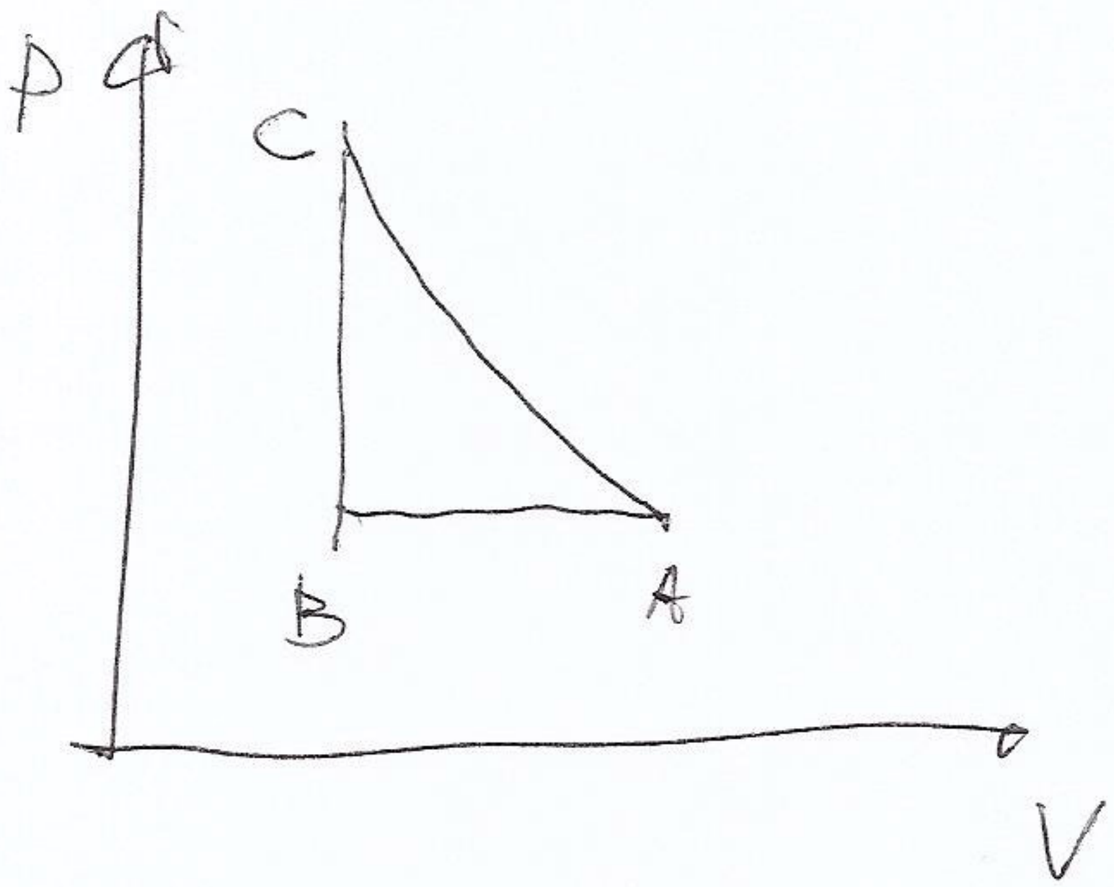
	$P_{(\cdot 10^5 Pa)}$	$V_{(m^3)}$	$T_{(K)}$
A	4	2	
B	4	4	1069
C		2	1069

	ΔU	L	Q
AB	+12	+8	+20
BC	0	−11	−11
CD	−12	0	−12
	0	L_{TOT}	L_{TOT}
		−3	−3

$\times 10^5 J$

Le 180 moli compiono un lavoro negativo: costituiscono un frigorifero che sottrae calore dalla sorgente A e lo cedono alla sorgente a temperatura più alta, $T_B = T_C$

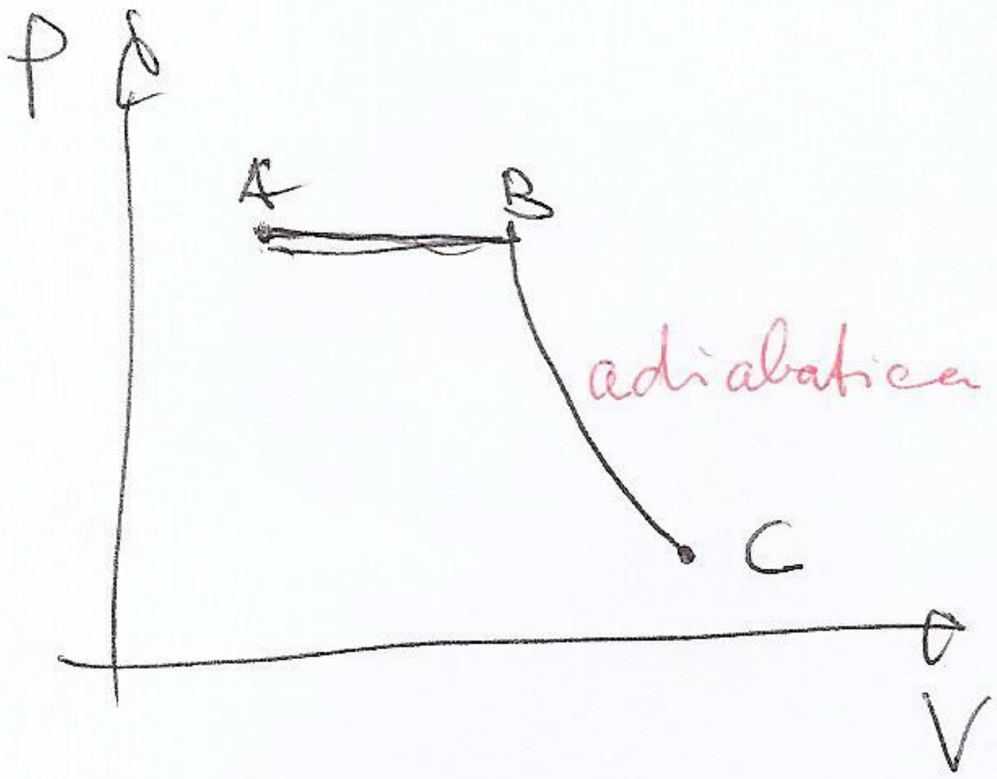
Problema 6



2 moli, gas monoat.

	$P_{(\cdot 10^5 Pa)}$	$V_{(m^3)}$	$T_{(K)}$
A	2	0.01	120
B	2	0.005	60
C	6.35	0.005	191

	ΔU	L	Q
AB	−	−	−249
BC	+	0	+3267
CA	−	+	0
	0	L_{TOT} +773	L_{TOT} +773



Problema 5

2 moli gas monoatomico

	$p\ (\cdot 10^5\ Pa)$	$V\ (m^3)$	$T\ (K)$
A	2	V_A 0.0242	291
B	2	$2V_A$ 0.0484	580
C	0.355	0.136	291

$$V_A = \frac{nRT_A}{p_A} = \frac{2 \cdot 8{,}31 \cdot 291}{2 \cdot 10^5} = 0.0242\ m^3$$

$$T_B = \frac{p_B V_B}{nR} = \frac{2 \cdot 10^5 \cdot 0{,}0484}{2 \cdot 8{,}31} = 580\ K$$

$TV^{\gamma-1} = cost$ $\quad \gamma = 5/3 \quad \gamma - 1 = 2/3$

Problema 5

$$V_C = V_B \left(\frac{T_B}{T_C}\right)^{\frac{1}{\gamma-1}} =$$

$$= 0.0484 \cdot (1.99)^{3/2} = 0.1362 \ m^3$$

$$p_C = \frac{nRT_C}{V_C} =$$

$$= \frac{2 \cdot 8.31 \cdot 291}{0.136} = 0.355 \cdot 10^5$$

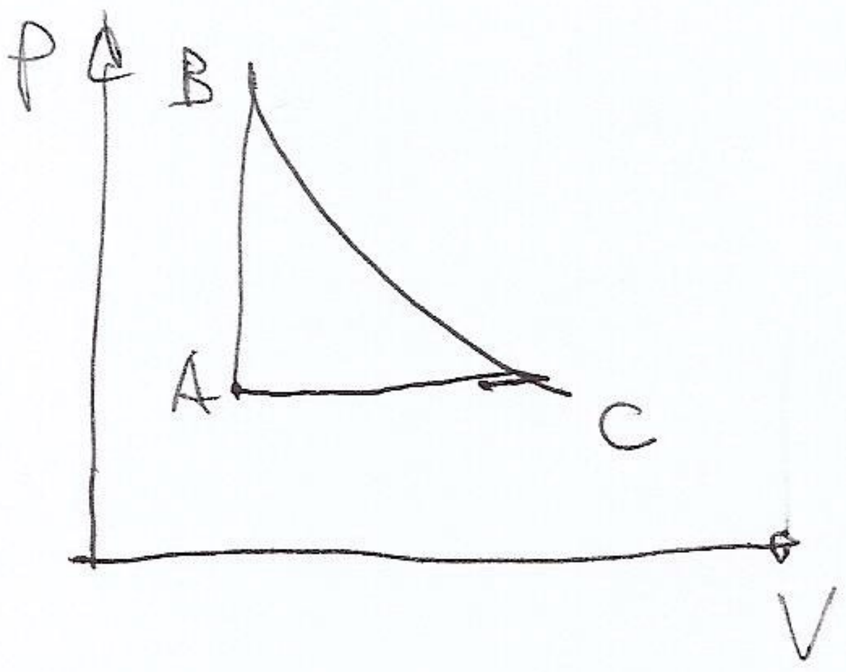
	ΔU	L	Q
AB	+	+	+
BC	−	+	0

$$Q_{TOT} = Q_{AB} =$$

$$= n C_p (T_B - T_A) =$$

$$= 2 \cdot \frac{5}{2} \cdot 8.31 \ (580 - 291)$$

$$= 1.20 \cdot 10^4 \ J$$



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Problema 6

Gaz monoatomic

	$p\ (\cdot 10^5\ Pa)$	$V\ (m^3)$	$T\ (K)$
A	1	0.005	300
B	3	0,005	$T_B = 900$
C	1	0.015	$T_B = 900$

$$n = \frac{p_A V_A}{R T_A} = \frac{10^5 \cdot 5 \cdot 10^{-3}}{8,31 \cdot 300} \approx 0,201 \text{ moli}$$

$$T_B = \frac{p_B V_B}{n R} = \frac{3 \cdot 10^5 \cdot 5 \cdot 10^{-3}}{0,201 \cdot 8,31} = 900\ K$$

$$V_C = \frac{n R T_C}{p_C} = \frac{0.201 \cdot 8,31 \cdot 900}{1 \cdot 10^5} = 0.015\ m^3$$

Problema 6

	ΔU	L	Q	
AB	+ 1503	0	+ 1503	J
BC	0	+ 1651	+ 1651	
CA	− −1503	− −1002	− −2505	
	0	L_{TOT} 649	Q_{TOT} 649	

$$Q_{AB} = n C_V (T_B - T_A) =$$

$$= 0{,}201 \cdot \frac{3}{2} \cdot 8{,}31 \,(900 - 300) = 1503 \text{ J}$$

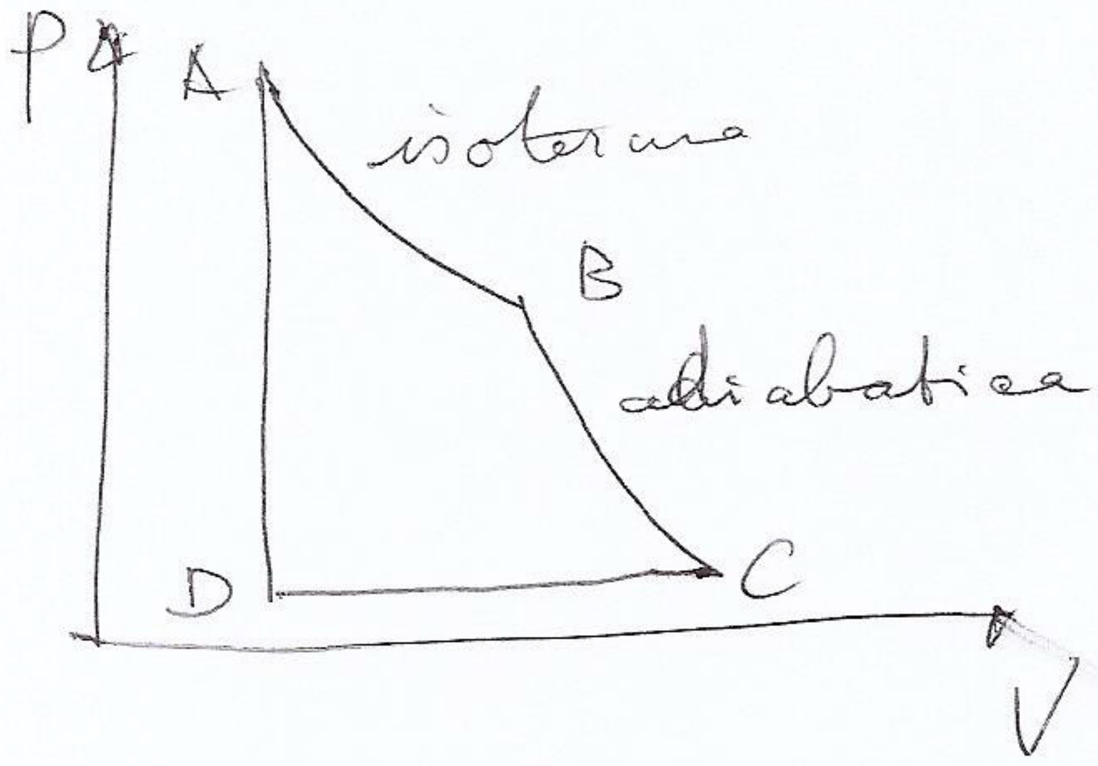
$$Q_{BC} = n R T_B \ln \frac{V_C}{V_B} =$$

$$= 0{,}201 \cdot 8{,}31 \cdot 900 \cdot \ln \frac{15}{5} = 1651 \text{ J}$$

$$Q_{CA} = n C_P (T_A - T_C) =$$

$$= 0{,}201 \cdot \frac{5}{2} \cdot 8{,}31 \,(300 - 900) = -2505 \text{ J}$$

$$Q_{TOT} = 649 \text{ J}$$



Problema 7

2 moli gas monoatomico

$\gamma = 5/3$

	$P (\cdot 10^5 Pa)$	$V (m^3)$	$T (K)$
A	2	0.001	$T_A = 12.0$
B	0.997	0.002	$T_B = 12.0$
C	0.5	0.003	9.1e
D	0.5	0.001	3.03

$$T_A = \frac{p_A V_A}{nR} =$$

$$= \frac{2 \cdot 10^5 \cdot 0.001}{2 \cdot 8.31} = 12.0\ K$$

$$p_B = \frac{nRT_B}{V_B}$$

$$= \frac{2 \cdot 8.31 \cdot 12}{0.002} = 0.997 \cdot 10^5\ Pa$$

Problema 7

$pV^{\gamma} = cost$

$$V_C = V_B \left(\frac{P_B}{P_C}\right)^{1/\gamma} =$$

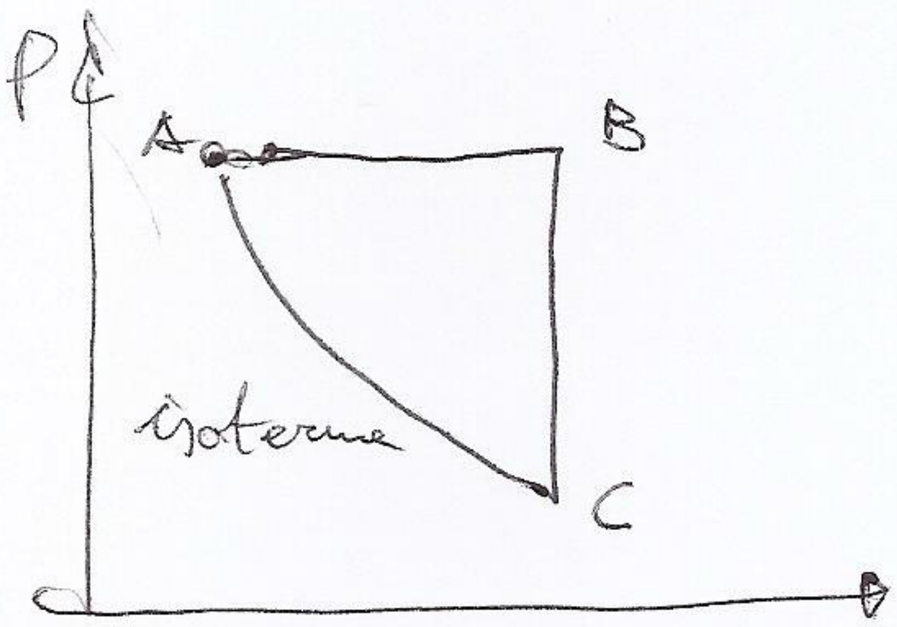
$$= 0,002 \cdot \left(\frac{0,997}{0.5}\right)^{3/5} = 0.003 \cdot m^3$$

$$T_C = \frac{P_C V_C}{nR} =$$

$$= \frac{0,5 \cdot 10^5 \cdot 0,003}{2 \cdot 8,31} = 9.10 \ K$$

$$T_D = \frac{P_D V_D}{nR}$$

$$= \frac{0,5 \cdot 10^5 \cdot 0,001}{2 \cdot 8,31} = 3,03 \ K$$



Problema 8

1 mole gas monoatomic

	P ($\cdot 10^5$ Pa)	V (m^3)	T (K)
A	1.013	0.001	$T_A = 12.2$
B	1.013	0.002	24.4
C	0,507	0.002	$T_A = 12.2$

$$T_A = \frac{P_A V_A}{n R} =$$

$$= \frac{1.013 \cdot 10^5 \cdot 0,001}{1 \cdot 8,31} = 12.2 \text{ K}$$

$$T_B = \frac{P_B V_B}{nR} = \frac{1.013 \cdot 0,002 \cdot 10^5}{1 \cdot 8,31} = 24,4 \text{ K}$$

$$P_C = \frac{nRT_C}{V_C} = \frac{1 \cdot 8,31 \cdot 12.2}{0,002} = 0,507 \cdot 10^5 \text{ Pa}$$

Problema 8

	ΔU	L	Q	
$A \to B$	$+$ $+152$	$+$ $+101$	$+$ 253	J
$B \to C$	$-$ -152	0	$-$ -152	
$C \to A$	0	$-$ -70.3	$-$ $-70,3$	
	0	L_{TOT} 30.7	Q_{TOT} 30.7	

$$Q_{AB} = n C_p (T_B - T_A)$$

$$= 1 \cdot \frac{5}{2} 8.31 (24.4 - 12.2) = 253 \text{ J}$$

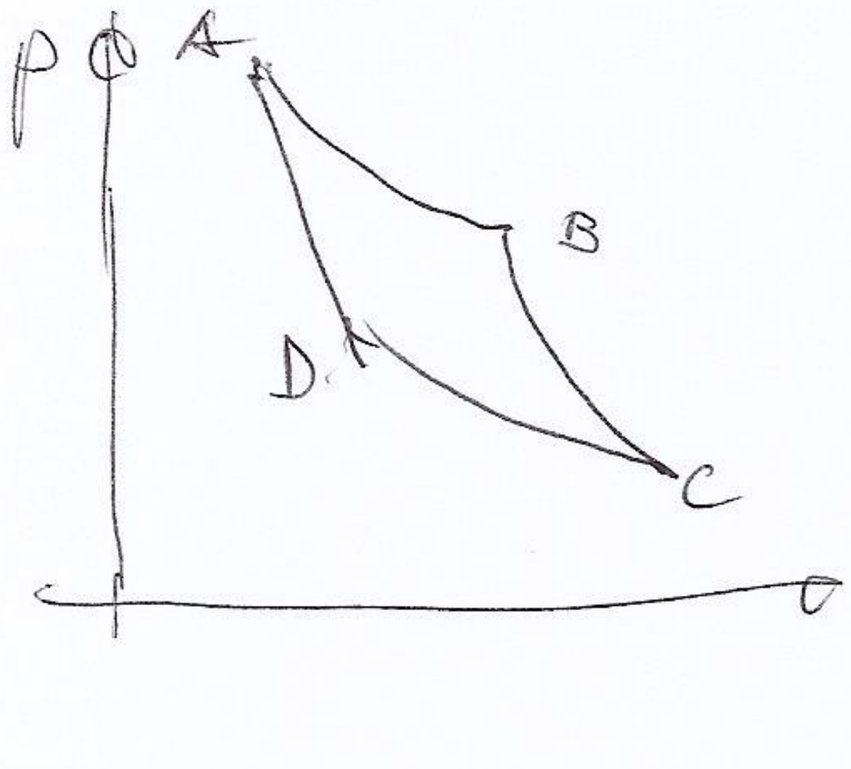
$$Q_{BC} = n C_v (T_C - T_A)$$

$$= 1 \cdot \frac{3}{2} \cdot 8.31 (12.2 - 24.4) = -152 \text{ J}$$

$$Q_{CA} = n R T_C \ln\left(\frac{V_A}{V_C}\right)$$

$$= 1 \cdot 8.31 \cdot 12.2 \ln \frac{1}{2} = -70.3 \text{ J}$$

$$Q_{TOT} = 30.7$$



Problema 9

2 moli

$T_a = 500\ K$

$T_b = 400\ K$

	ΔU	L	Q
AB	0	13000	13000 J
BC	−	+	0
CD	0	−	−
DA	+	−	0

$$\eta_{Carnot} = 1 - \frac{T_b}{T_a}$$

$$= 1 - \frac{400}{500} = 0.200$$

$$L_{TOT} = \eta \cdot Q_{ass} = 0.2 \cdot 17000$$

$$= 3400\ J$$

$$L_{AB} = Q_{AB} = nRT_A \ln \frac{V_B}{V_A}$$

$$\ln \frac{V_B}{V_A} = \frac{Q_{AB}}{nRT_A} = 1.5644$$

$$\frac{V_B}{V_A} = e^{1.5644} = 4.78$$