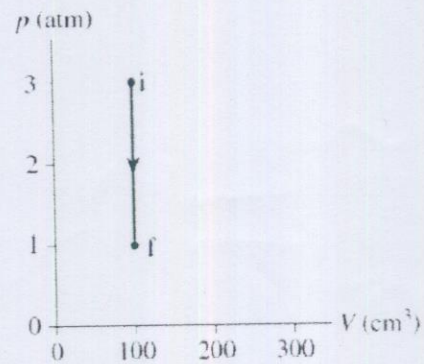
Gas Processes Group Problems

CQ 12. A gas is in a sealed container. By what factor does the temperature change if
   a. the volume is doubled and the pressure is tripled?
   b. the volume is halved and the pressure is tripled?

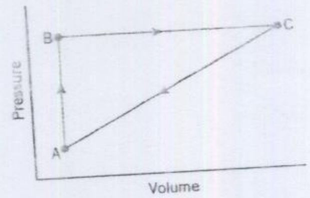
Prob 20. A cylinder contains 3.0 liters of oxygen at 300 K and 2.4 atm. The gas is heated, causing a piston in the cylinder to move outward. The heating causes the temperature to rise to 600 K and the volume of the cylinder to increase to 9.0 liters. What is the final gas ~~temperature~~?
Pressure

Prob 25. 0.0040 moles of gas undergoes the process shown.
   a. what type of process is this?
   b. what are the initial and final temperatures?



4. An ideal gas is taken through one complete cycle of a three-step process, as shown. The table shows some of the values of the change in thermal energy, heat, and work done by the gas during each step. Fill in the missing values.

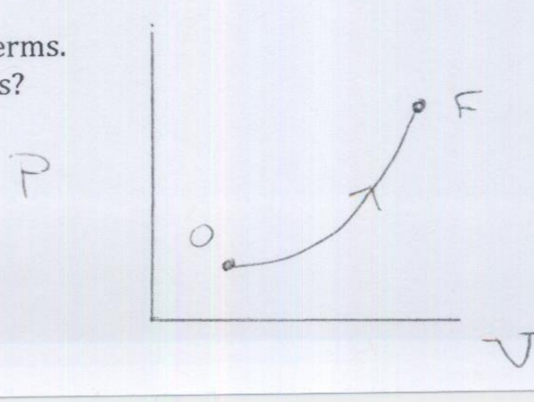
Process	ΔU	Q	W
A → B	(b)	+561 J	(a)
B → C	+4303 J	(c)	+3740 J
C → A	(d)	(e)	−2867 J



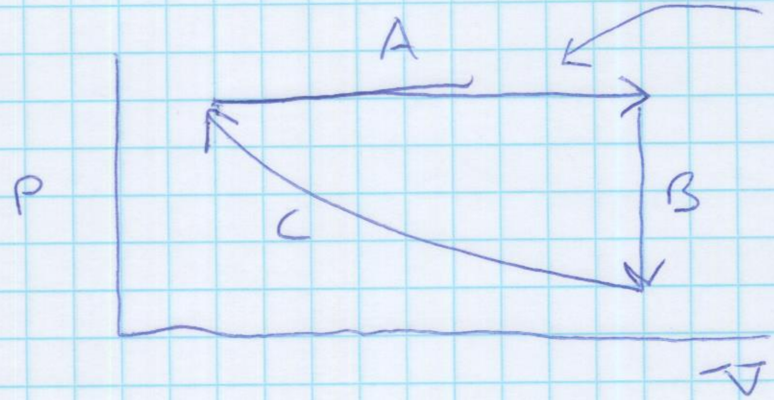
5. A gas goes through a three-step process as follows:
   A. an isobaric expansion.
   B. the temperature is lowered at constant volume.
   C. an isothermal compression which returns the gas to its initial state.

Sketch a P-V graph for this process. Explain whether the net work done by the gas is positive, negative, or zero.

6. Isotherms are always curves, but not all curves are isotherms.
Is it possible that this PV graph shows an isothermal process?
Explain your reasoning.



5.



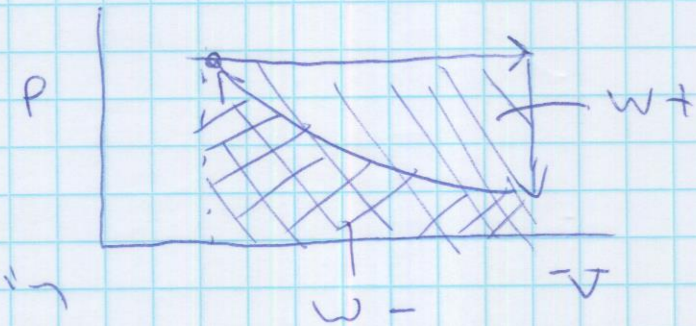
P constant, V ↑

V constant.

$PV = nRT$
down constant down

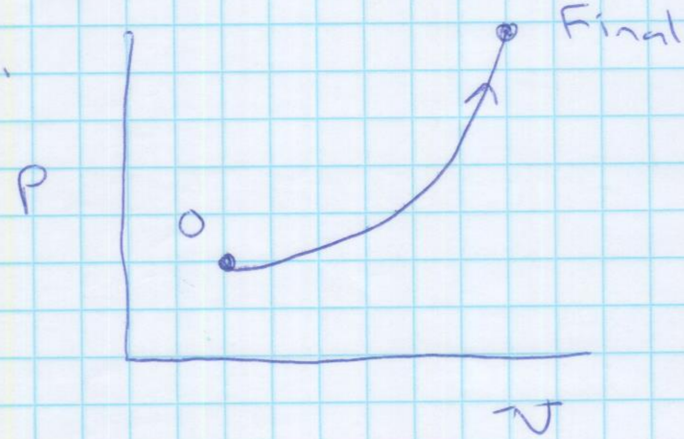
C: hyperbolic curve.
Ends at state it started at.

Step A: Work +
B: Work 0
C: Work −



net Work +:
magnitude greater during
A than C.

6.



$PV = nRT$

(Starts with
low P, low V.

Ends with high P,
high V.

T_F must be > T_0.

	ΔE_{TH}	Q	W
$A \to B$		$+561$ J	
$B \to C$	$+4303$ J		$+3740$ J
$C \to A$			-2867 J

$A \to B$: $\Delta V = 0$ so $\underline{W = 0}$

$\Delta E_{TH} = Q - W_{GAS}$

$\Delta E_{TH} = \underline{+561 \text{ J}}$

$B \to C$: $\Delta E_{TH} = Q - W_{GAS}$

$Q = \Delta E_{TH} + W_{GAS}$

$Q = 4303 + +3740$ J

$Q = +\underline{8043}$ J

$C \to A$: Over whole cycle $A \to B \to C \to A$, total $\Delta E_{TH} = 0$

$\Delta E_{TH,\,A\to B} + \Delta E_{TH,\,B\to C} + \Delta E_{TH,\,C\to A} = 0$

$561 + 4303 + \Delta E_{TH,\,C\to A} = 0$

$\Delta E_{TH,\,C\to A} = -\underline{4864 \text{ J}}$

$C \to A$: $Q = \Delta E_{TH} + W$

$= -4864 + -2867$ J

$=$ ~~-8601~~ J

-7731 J

CQ 12 a. $P_0 V_0 = nRT_0$

$P_F V_F = nRT_F$

$V_F = 2V_0$

$P_F = 3P_0$

so

$(3P_0)(2V_0) = nRT_F$

$6(P_0 V_0) = nRT_F$

$6(nRT_0) = nRT_F$

$T_F = 6T_0$

b. $P_0 V_0 = nRT_0$

$V_F = \frac{1}{2} V_0$

$P_F = 3P_0$

$P_F V_F = nRT_F$

$(3P_0)(\frac{1}{2}V_0) = nRT_F$

$1.5(nRT_0) = nRT_F$

$T_F = 1.5T_0$

12 - 20 $P_0 V_0 = nRT_0$

$P_F V_F = nRT_F$

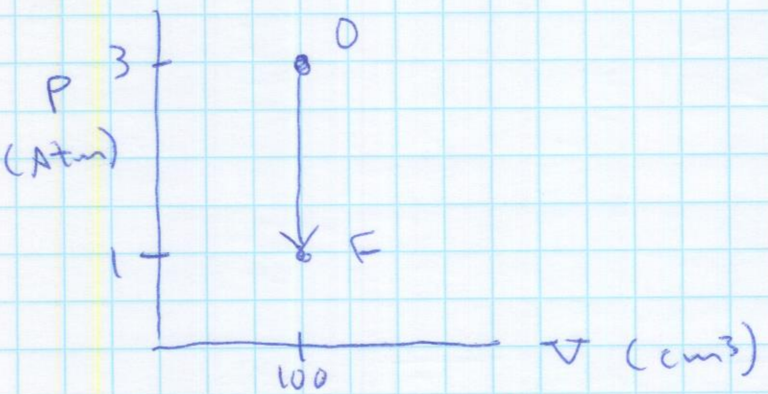
so $nR = \frac{P_0 V_0}{T_0} = \frac{P_F V_F}{T_F}$

$$\frac{(2.4\ \text{Atm})(3.0\ \ell)}{300\text{K}} = \frac{P_F(9.0\ \ell)}{600\text{K}}$$

$P_F = 1.6$ Atm

Does this make sense? Yes: Note that T doubles while V triples. V changes more than it should from ΔT alone. You must have decreased P.

12 - 25 $\quad n = 0.0040$ mole



V = constant, so Isochoric

$1 \text{ Atm} = 1.013 \times 10^5 \ \frac{N}{m^2}$

$1 \text{ cm}^3 = 10^{-6} \text{ m}^3$

$$P_0 V_0 = nRT_0$$

$$T_0 = \frac{(3.03 \times 10^5 \ N/m^2)(100 \times 10^{-6} \ m^3)}{(0.0040 \text{ mole})(8.31 \ J/\text{mole} \cdot K)}$$

$T_0 =$ ~~902~~ K 910

$$T_F = \frac{P_F V_F}{nR}$$

$$T_F = \frac{(1 \times 10^5 \ N/m^2)(100 \times 10^{-6} \ m^3)}{(0.0040 \text{ mole})(8.31 \ J/\text{mole} \cdot K)}$$

$T_F = 300$ K