AP PHYSICS - CH 12

Q4: THE SMALLER ONES TEND TO BE MORE "MOBILE" AND MOVE MORE QUICKLY. THEY WIND UP SETTLING INTO GAPS CREATED WHEN THE BIG ONES BOUNCE UPWARD. AS FAR AS THE SECOND LAW GOES ... THIS CREATES A MORE ORDERED SYSTEM WHICH REPRESENTS A REDUCTION IN ENTROPY! HOWEVER, SOMEONE IS SHAKING THE JAR - PUTTING ENERGY INTO THE SYSTEM AND THIS PERSON HAS A LARGER INCREASE IN ENTROPY THAT OFFSETS THE DECREASE WITHIN THE JAR.

Q6: TEMPERATURE - A MEASURE OF THE AVERAGE SPEED OF THE MOLECULES

INTERNAL ENERGY - THE SUM OF ALL OF THE ICE OF THE MOLECULES

HEAT - THERMAL ENERGY THAT FLOWS FROM ONE BODY TO ANOTHER THROUGH CONDUCTION, CONVECTION OR RADIATION

Q7: TEMPERATURE IS ONLY ONE INDICATION OF HEAT. THE AMOUNT OF MATTER (MASS) AND COMPOSITION (SPECIFIC HEAT) OF AN OBJECT ALSO DETERMINE THE HEAT/TEMP RELATIONSHIP

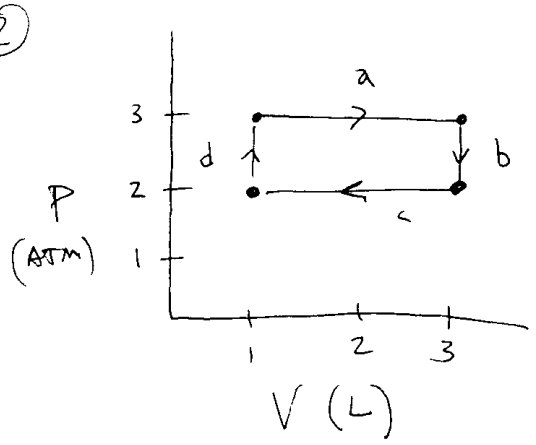
(1) FOR AN IDEAL GAS ... $PV = NkT$ AND FROM CH 10 ... $\overline{KE} = \frac{3}{2}kT$

INTERNAL ENERGY $\rightarrow U = N \cdot \overline{KE}$ $\leftarrow$ AVG ICE OF ONE MOLECULE

$\uparrow$ # OF MOLECULES

$$U = \frac{3}{2}NkT = \frac{3}{2}PV = U \quad \text{QED}$$

(2)



a) 1L → 3L @ 3 atm

b) 3 atm → 2 atm @ 3L

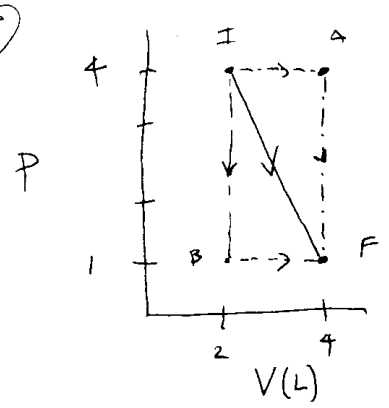
c) 3L → 1L @ 2 atm

d) ~~2~~ 2 atm → 3 atm @ 1L

WORK
$-(3\times10^5)(2\times10^{-3}) = -600\,J$
$0\,J$
$-(2\times10^5)(-2\times10^{-3}) = 400\,J$
$0\,J$
NET IS $-200\,J$

SO THE GAS DOES 200 J OF WORK FOR US

(5)



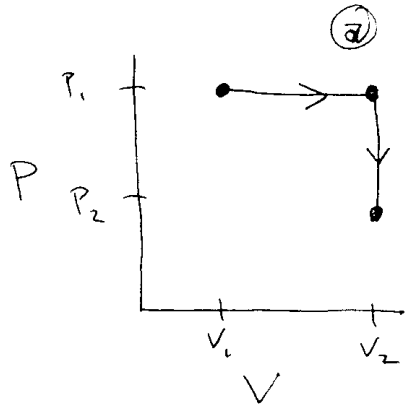
a) IAF $\Rightarrow W = -(4\times10^5)(2\times10^{-3}) = -800\,J$

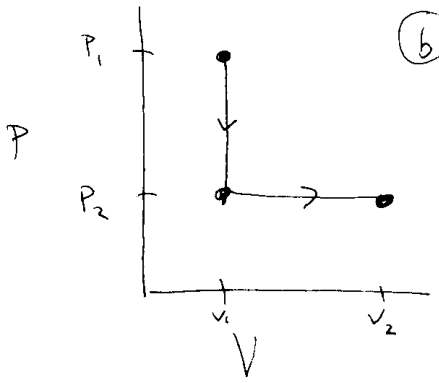
b) IF $\Rightarrow W = -(1\times10^5)(2\times10^{-3}) + -\frac{1}{2}(3\times10^5)(2\times10^{-3})$

$-200\,J - 300\,J = -500\,J$

c) IBF $\Rightarrow W = -(1\times10^5)(2\times10^{-3}) = -200\,J$

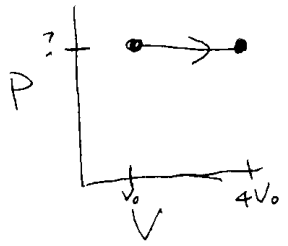
(6)





MORE WORK IS DONE BY THE GAS IN (a) BECAUSE THERE IS MORE AREA UNDER a's CURVE.

(9)



$PV = NkT$ N, k, P KEPT CONSTANT

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{V_0}{273} = \frac{4V_0}{T_2} \rightarrow T_2 = 4 \cdot 273$$

$T_2 = 1092\ K$ or $819^\circ C$

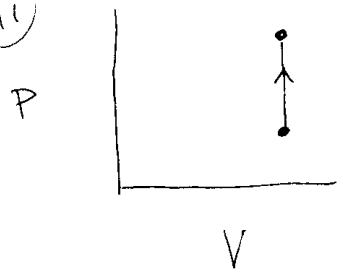
$$W = -P(\Delta V_0) = -(10^5 Pa)(4V_0 - V_0) = -3 \times 10^5 V_0$$

BUT WHAT IS V_0?

$$PV = NkT \rightarrow V = \frac{NkT}{P} = \frac{6.02 \times 10^{23}\,(1.38 \times 10^{-23})(273)}{1.01 \times 10^5} = .022\ m^3$$

$$W = -3 \times 10^5 (.022) = -6700\ J$$

(11)



ISOVOL

SO $W = 0$.

SO $\Delta U = Q$

SINCE THE WATER GETS WARMER HEAT MUST FLOW OUT SO Q = NEGATIVE

THUS ΔU = NEGATIVE

SO

ΔU	−
Q	−
W	0

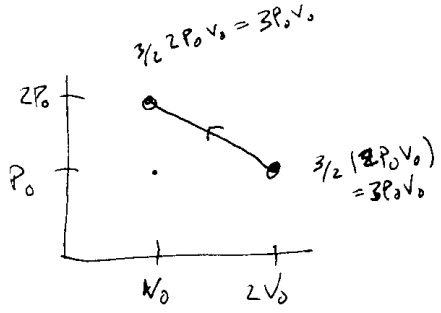
} FOR THE SYSTEM

AND

ΔU	+
Q	+
W	0

} FOR THE WATER BATH

(14)

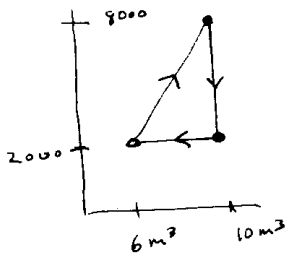


$\Delta U = 0$

$W = +$

$Q = -$

(16)



$W_{ON} = -\frac{1}{2}(4)(6000) = -12{,}000\ J$

$\Delta U = 0$ FOR A CYCLE; SO

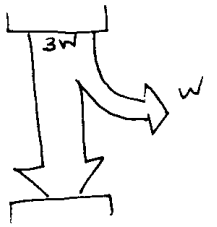
~~$Q = 12{,}000\ J$~~

$Q = \Delta U - W = 12{,}000\ J$

IF REVERSED; $W_{ON} = 12{,}000\ J$ SO $Q = -12{,}000\ J$

(23) $\varepsilon_{MAX} = \varepsilon_{CARNOT} = 1 - \frac{T_C}{T_H} = 1 - \frac{293}{573} = .489 = 48.9\%$

(25)



SO $\varepsilon = \frac{W}{3W} = .33 = 33\%$

$Q_C = 2W$

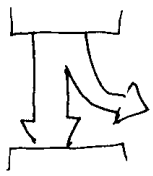
(27) $\varepsilon_{MAX} = 1 - \frac{703}{2143} = .67 = 67\%$

$\varepsilon_{REAL} = .42 = \frac{W}{Q_H} = \frac{W}{1.4 \times 10^5\ J}$ $\quad W = \varepsilon Q_H = 5.88 \times 10^4\ J$

(30) $\varepsilon_{MAX} = 1 - \frac{T_C}{T_H} = 1 - \frac{278}{293} = 5\%$

$\Rightarrow Q_H = 75\text{MW} \div .05 = 1500\text{MW}$ OR 1.5×10^9 J/s $= 5.4\times10^{12}$ J/hr

(33)



33% EFFICIENCY $\Rightarrow Q_H = 3\times10^9$ J/s

$Q_C = 2\times10^9$ J/s

SO 2×10^9 J GOES INTO 1.0×10^6 kg OF WATER EVERY SECOND

$Q = mC\Delta T$

$2\times10^9 = 1\times10^6 (4186)\Delta T$ $\quad \Delta T = .48\ ^\circ C$

(35) 1.0 L OF WATER IS $1/1000$ m^3 SO IT IS 1.0 kg

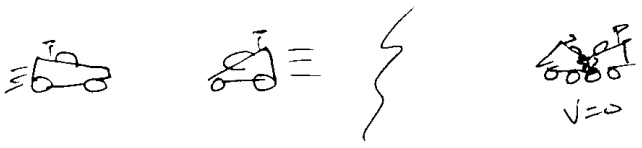
SO $Q = mH_f = (1.0\text{kg})\left(3.34\times10^5 \frac{J}{kg}\right) = 3.34\times10^5$ J ← HEAT MUST BE REMOVED

a) $\frac{Q_{ICE}}{T_{ICE}} = \frac{-3.34\times10^5}{273} = -1223$ J/K

b) $\frac{Q_{FREEZER}}{T_{FREEZER}} = \frac{3.34\times10^5}{273} = 1223$ J/K

} WHICH MEANS THIS WON'T WORK. $T_{FREEZER}$ NEEDS TO BE LOWER THAN 273K!

(38)



SO ENERGY $= 2(KE) = mV^2 = 2000(20)^2 = 8\times10^5$ J ← CARS LOSE THIS BUT THE UNIVERSE GAINS IT

$\Delta S = \frac{+8\times10^5 \text{ J}}{296 \text{ K}} = +2702$ J/K

(41)

RESULT		# OF WAYS
ALL H	HHHH	1
3H 1T	HHHT, HHTH, HTHH, THHH	4
2H 2T	HHTT, HTHT, THHT, THTH, TTHH	5
1H 3T	HTTT, THTT, TTHT, TTTH	4
4T	TTTT	1

MOST PROBABLE = 2H 2T

MOST ORDERED = 4H or 4T

MOST DISORDERED = 2H 2T