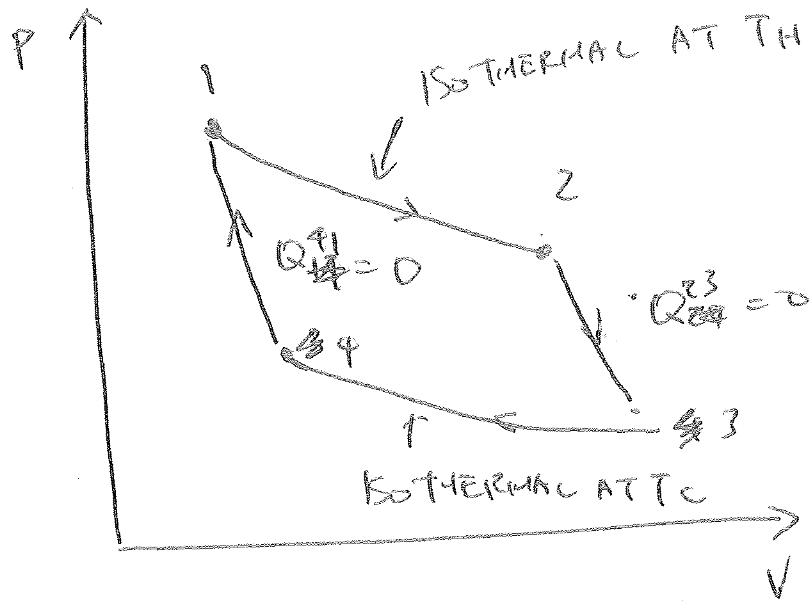
REVIEW SESSION

#1 CONSIDER A CARNOT CYCLE



1.) CALCULATE EFFICIENCY INTERMS OF T_C, T_H

2) DOES ENERGY CHANGE BETWEEN 1 AND 2?

~~3) CALCULATE EFFICIENCY INTERMS OF T_C, T_H, V_1, V_2, V_3, V_4~~

~~4) PROVE THAT $V_4 V_2 = V_3 V_1$~~

3) CALCULATE RELATION SHIP BEWEEN Q_R AND W_{12}

4) CALCULATE EFFICIENCY INTERMS OF T_C, T_H, V_1, V_2, V_3, V_4

5)

FIND A RELATION SHIP BETWEEN V_1, V_2, V_3, V_4

SOLUTION

#1

1) EFFICIENCY $= 1 - \frac{T_c}{T_H}$

2) $U_1 = U_2$ BECAUSE $U = \frac{3}{2} N k T$

3) $dU = Q + W$

$$U_2 - U_1 = Q_{12} + W_{12} \rightarrow Q_{12} = -W_{12}$$

4) EFFICIENCY $= 1 - \frac{T_c}{T_H} = \frac{Q_H - Q_C}{Q_H}$

$$= 1 - \frac{Q_C}{Q_H}$$

WE NOTE

$Q_C = -Q_{34}$

$Q_H = Q_{12}$

$$Q_{12} = -W_{12} = +\int_{V_1}^{V_2} p\,dV = +\int_{V_1}^{V_2} p\,dV$$

$$= +\int_{V_1}^{V_2} \frac{Nk T_H}{V} dV$$

$$= NkT \ln \frac{V_2}{V_1}$$

SIMILARLY

$$Q_{34} = Nk T_c \ln \frac{V_4}{V_3}$$

$$\text{EFFICIENCY} = 1 - \frac{Q_C}{Q_H}$$

$$= 1 - \frac{\cancel{nR}\, T_C \ln \frac{V_3}{V_4}}{\cancel{nR}\, T_H \ln \frac{V_2}{V_1}}$$

$$= 1 - \frac{T_C \ln \frac{V_3}{V_4}}{T_H \ln \frac{V_2}{V_1}}$$

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5)

$$\frac{T_C}{T_H} = \frac{T_C \ln \frac{V_3}{V_4}}{T_H \ln \frac{V_2}{V_1}}$$

$$1 = \frac{\ln \frac{V_3}{V_4}}{\ln \frac{V_2}{V_1}}$$

OR

$$\frac{V_3}{V_4} = \frac{V_2}{V_1}$$

$$V_1 V_3 = V_2 V_4$$

#2

GIVEN $dF = -SdT - pdV + \mu dN$

A METAL MATERIAL HAS $F = 100\ kJ$ AT $20°C$ AND $S = 10\ kJ/K$

WHAT IS ITS F AT $30°C$ IF VOLUME STAYS CONSTANT

SOLUTION #2

$$F = 100\ kJ - 10\ kJ/K \times 10\ K = \boxed{0}$$

#3 GIVEN A TWO-STATE PARAMAGNET

	MAGNETIC MOMENT	ENERGY
———	$-\mu$	μB
———	$+\mu$	$-\mu B$

1) WHAT IS THE PARTITION FUNCTION?

2) CALCULATE MAGNETIZATION OF THE SYSTEM.

$$\bar{M} = N\bar{\mu}$$

3) CALCULATE AVERAGE ENERGY OF THE SYSTEM

$$\bar{E} = N\bar{\varepsilon}$$

4) WHAT HAPPENS TO M AS $B \to \infty$?

SOLUTION #3

1) $Z = e^{-\mu B \beta} + e^{\mu B \beta}$

2) $M = N\left[\frac{1}{Z}\left(-\mu e^{-\mu B\beta} + \mu e^{+\mu B \beta}\right)\right]$

3) $E = N\left[\frac{1}{Z}\left(\mu B e^{-\mu B \beta} - \mu B e^{+\mu B\beta}\right)\right]$

4) AS $B \to \infty$ $\quad Z \simeq e^{\mu B \beta}$

SO $M \sim N \dfrac{\mu e^{\mu B \beta}}{e^{\mu B \beta}} = \boxed{N\mu}$