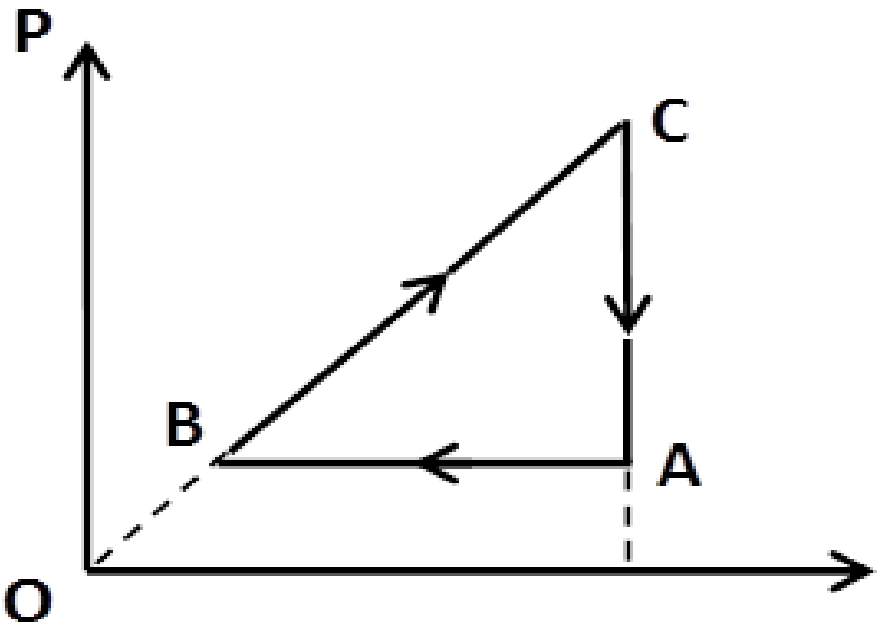
Bài tập Vật lý Đại cương I (bài thêm)
Buổi 7 (18/6/2021)

Bài tập thêm: 30,31,32,36,37,39

Bài 36.

Một khối khí lý tưởng có hệ số đoạn nhiệt là γ thực hiện một chu trình như hình vẽ, trong đó nhiệt độ tuyệt đối cao nhất gấp τ lần nhiệt độ tuyệt đối thấp nhất. Tìm hiệu suất của chu trình.

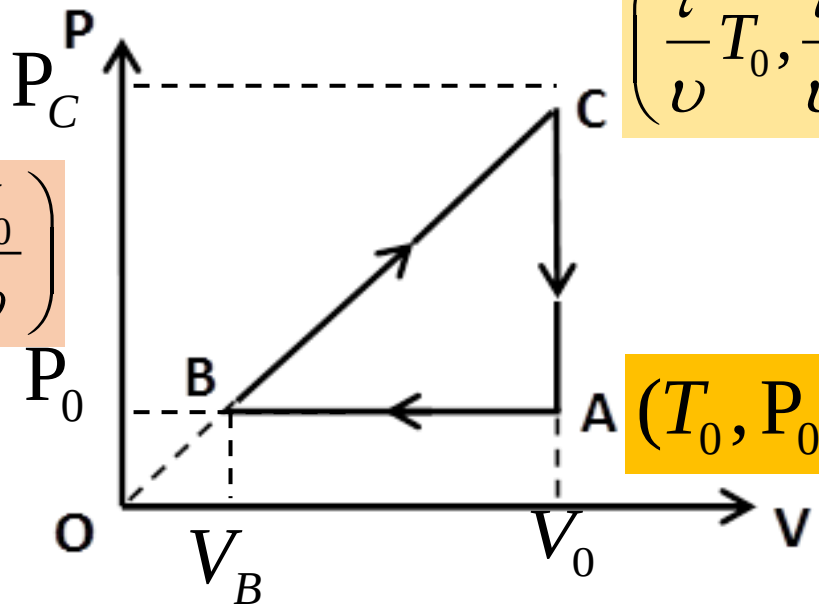


Bài 36.

$$\frac{T_C}{T_B}=\tau \qquad \eta=?$$

Gọi T, P, V tại A là (T_0, P_0, V_0)

Giả sử $\frac{V_A}{V_B}=\upsilon$ $\rightarrow V_B=\frac{V_0}{\upsilon}$



$\left(\frac{\tau}{\upsilon}T_0, \frac{\tau}{\upsilon}P_0, V_0\right)$

$B:\left(\frac{T_0}{\upsilon}, P_0, \frac{V_0}{\upsilon}\right)$

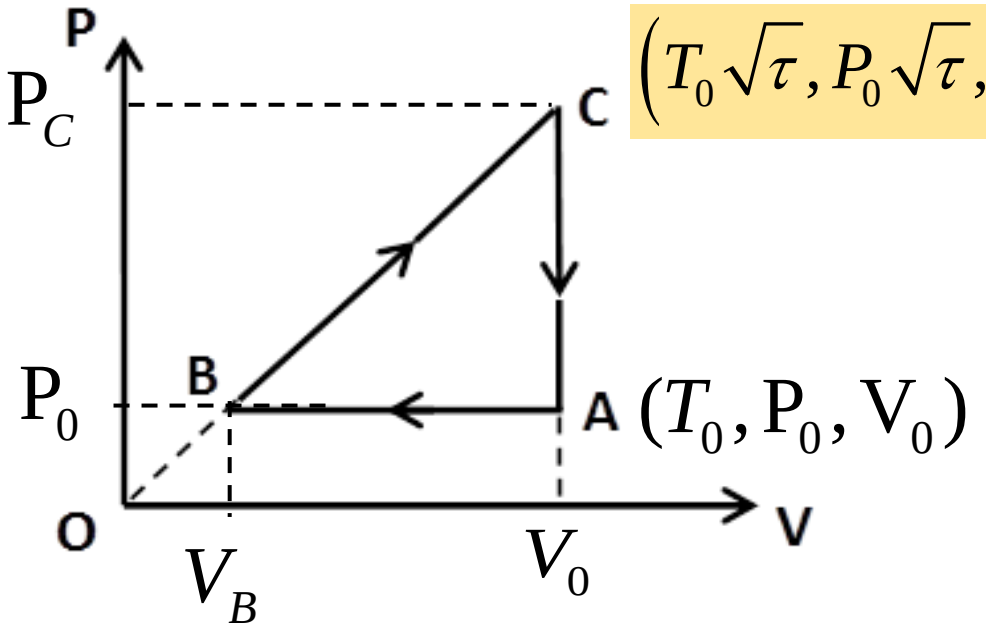
(T_0, P_0, V_0)

$\frac{T_C}{T_B}=\tau \rightarrow T_C=\tau T_B=\tau\frac{T_0}{\upsilon}$

- $A \rightarrow B \quad \frac{V_A}{T_A}=\frac{V_B}{T_B} \rightarrow T_B=\frac{T_0}{\upsilon}$
- $C \rightarrow A \quad \frac{P_C}{T_C}=\frac{P_A}{T_A} \rightarrow \frac{P_C}{\tau\frac{T_0}{\upsilon}}=\frac{P_0}{T_0} \rightarrow P_C=\frac{\tau}{\upsilon}P_0$

Bài 36.

$$P_B = P_0, \quad T_B = \frac{T_0}{\upsilon} \quad V_B = \frac{V_0}{\upsilon}$$



$$P_C = \frac{\tau}{\upsilon} P_0 \quad T_C = \frac{\tau}{\upsilon} T_0 \quad V_C = V_0$$

ΔOCV_A Đồng dạng ΔOBV_B

$$\frac{OV_A}{OV_B} = \frac{OC}{OB} = \frac{OP_C}{OP_0} \rightarrow \frac{V_A}{V_B} = \frac{P_C}{P_0} \rightarrow \frac{V_0}{V_0/\upsilon} = \frac{\frac{\tau}{\upsilon}P_0}{P_0} = \frac{\tau}{\upsilon} \rightarrow \upsilon = \sqrt{\tau}$$

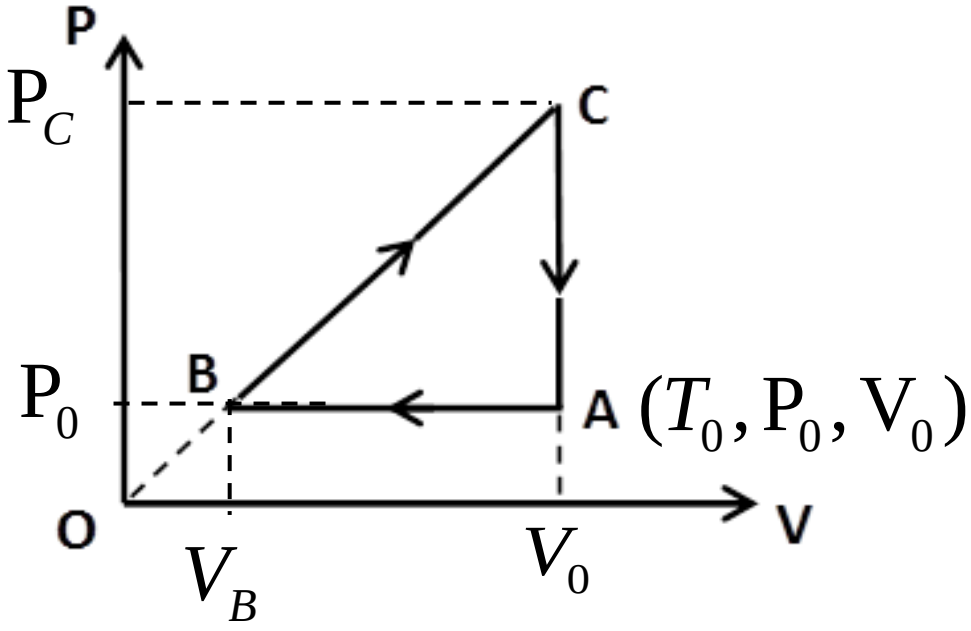
$$P_B = P_0, \quad T_B = \frac{T_0}{\sqrt{\tau}} \quad V_B = \frac{V_0}{\sqrt{\tau}}$$

$$P_C = \frac{\tau}{\upsilon} P_0 = \sqrt{\tau} P_0 \qquad T_C = \frac{\tau}{\upsilon} T_0 = \sqrt{\tau} T_0 \quad V_C = V_0$$

Bài 36.

$$P_B = P_0, \quad T_B = \frac{T_0}{\sqrt{\tau}} \quad V_B = \frac{V_0}{\sqrt{\tau}}$$

$$P_C = \sqrt{\tau} P_0 \qquad T_C = \sqrt{\tau} T_0 \quad V_C = V_0$$



$$\eta = 1 - \frac{Q'_2}{Q_1}$$

$$C_V = \frac{iR}{2} = \frac{R}{\gamma - 1}$$

$$C_P = \gamma C_V = \frac{\gamma R}{\gamma - 1}$$

$$Q'_2 = Q'_{CA} + Q'_{AB} = \frac{M}{\mu} C_V (T_C - T_A) + \frac{M}{\mu} C_P (T_A - T_B) =$$

$$= \frac{M}{\mu} C_V \left(\sqrt{\tau} T_0 - T_0\right) + \frac{M}{\mu} C_P \left(T_0 - \frac{T_0}{\sqrt{\tau}}\right) =$$

$$= \frac{M}{\mu} R T_0 \frac{\sqrt{\tau} - 1}{\gamma - 1} \left(1 + \frac{\gamma}{\sqrt{\tau}}\right)$$

Bài 36.

$$P_B = P_0$$

$$T_B = \frac{T_0}{\sqrt{\tau}}$$

$$V_B = \frac{V_0}{\sqrt{\tau}}$$

$$P_C = \sqrt{\tau} P_0$$

$$T_C = \sqrt{\tau} T_0$$

$$V_C = V_0$$

$$Q_1 = Q_{BC} = \Delta U + A' = \frac{M}{\mu} C_V \left(T_C - T_B\right) + \frac{P_B + P_C}{2}\left(V_A - V_B\right)$$

$$= \frac{M}{\mu} C_V \left(\sqrt{\tau} T_0 - \frac{T_0}{\sqrt{\tau}}\right) + \frac{P_0 + P_0\sqrt{\tau}}{2}\left(V_0 - \frac{V_0}{\sqrt{\tau}}\right) =$$

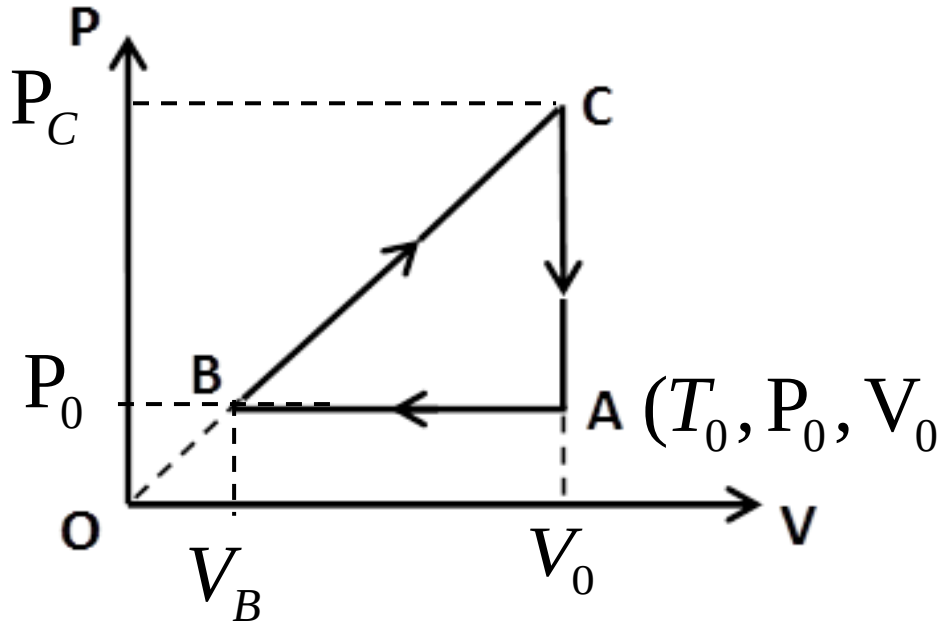
$$= \frac{M}{\mu} T_0 \frac{R}{\gamma - 1}\left(\sqrt{\tau} - \frac{1}{\sqrt{\tau}}\right) + \underbrace{\frac{P_0 V_0}{2}}_{\frac{1}{2}\frac{M}{\mu}RT_0} \underbrace{\left(1 + \sqrt{\tau}\right)\left(1 - \frac{1}{\sqrt{\tau}}\right)}_{\left(\sqrt{\tau} - \frac{1}{\sqrt{\tau}}\right)}$$

$$= \frac{M}{\mu} RT_0 \left(\sqrt{\tau} - \frac{1}{\sqrt{\tau}}\right)\left(\frac{1}{\gamma - 1} + \frac{1}{2}\right) = \frac{M}{\mu} RT_0 \frac{\gamma + 1}{2(\gamma - 1)} \frac{\tau - 1}{\sqrt{\tau}}$$

Bài 36.

$$P_B = P_0, \quad T_B = \frac{T_0}{\sqrt{\tau}} \quad V_B = \frac{V_0}{\sqrt{\tau}}$$

$$P_C = \sqrt{\tau} P_0 \qquad T_C = \sqrt{\tau} T_0 \quad V_C = V_0$$



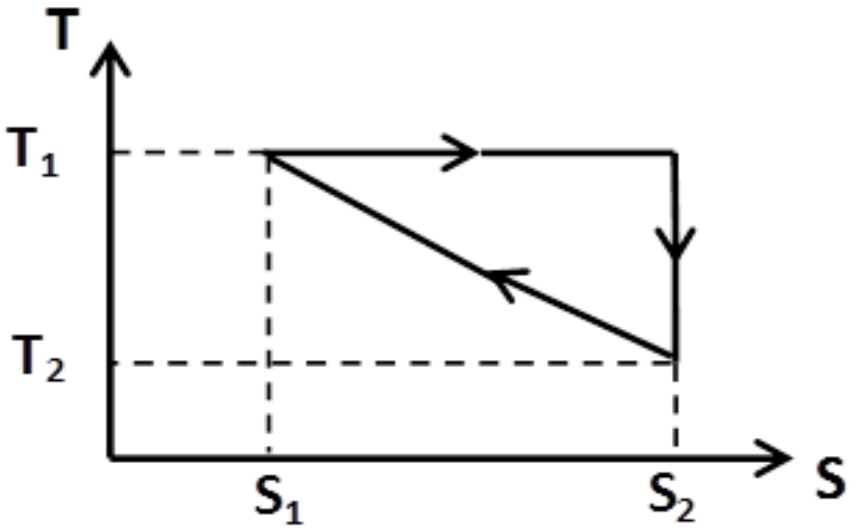
$$Q'_2 = Q'_{CA} + Q'_{AB} = \frac{M}{\mu} R T_0 \frac{\sqrt{\tau} - 1}{\gamma - 1}\left(1 + \frac{\gamma}{\sqrt{\tau}}\right)$$

$$Q_1 = Q_{BC} = \frac{M}{\mu} R T_0 \frac{\gamma + 1}{2(\gamma - 1)} \frac{\tau - 1}{\sqrt{\tau}}$$

$$\eta = 1 - \frac{Q'_2}{Q_1} = \frac{(\gamma - 1)\left(\sqrt{\tau} - 1\right)}{(\gamma + 1)\left(\sqrt{\tau} + 1\right)}$$

Bài 39.

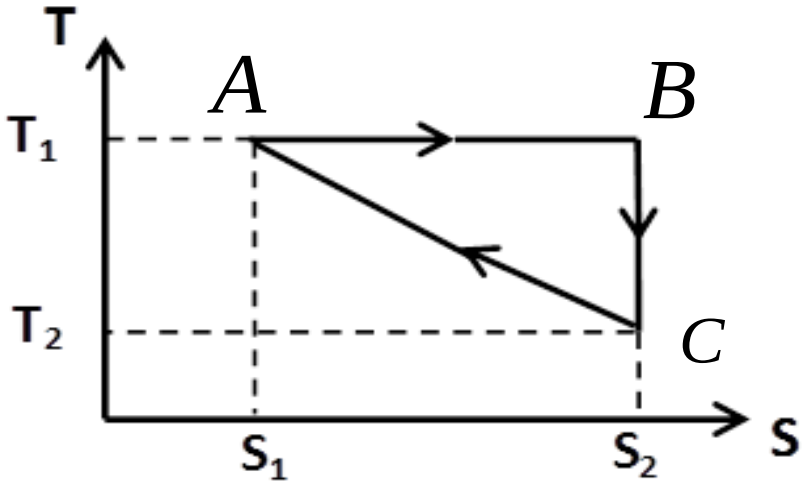
Một khối khí thực hiện một chu trình biểu diễn trên hình. Trong chu trình nhiệt độ tuyệt đối cực đại gấp 2 lần nhiệt độ cực tiểu. Tìm hiệu suất của chu trình.



Bài 39.

$$\frac{T_1}{T_2} = 2 \qquad \eta = ?$$

$$dS = \frac{\delta Q}{T}$$



B $\rightarrow$ C: *S=const* $\rightarrow$ *BC là quá trinh đoạn nhiệt, Q=0*

$$Q_1 = Q_{AB} = \int_A^B T\mathrm{d}S = T_1(S_2 - S_1)$$

$$Q'_2 = S_{\mathrm{ACS_2S_1}} = \frac{1}{2}(T_1 + T_2)(S_2 - S_1)$$

$$\eta = \frac{Q_1 - Q'_2}{Q_1} = \frac{T_1(S_2 - S_1) - \frac{1}{2}(T_1 + T_2)(S_2 - S_1)}{T_1(S_2 - S_1)} = \frac{T_1 - T_2}{2T_1} = 25\%$$