Pembahasan Soal No 1a

- Proses A

kitatahu bahwa berdasarkan Figurnya

- $P_1 = P_2 = P_0$ (Pers 1) ~~$T_3 = T_0 = T_1$~~
- $T_1 = T_0 = T_3$ (Pers 2)
- $T_2 = T_f$
- $V_1 = V_0$
- $V_2 = 2V_0$
- $V_3 = 6V_0$

maka dapat kita cari perubahan titik 1 ke 2

$$P_1 V_1 = nRT_1 \quad , \quad T_2 = T_f \ , \ P_1 = P_2$$

$$P_2 V_2 = nRT_2 \quad T_1 = T_0 \quad V_1 = V_0$$

$$P_1 = \frac{nRT_1}{V_1} = \frac{nRT_0}{V_0} \ , \ V_2 = 2V_0$$

$$P_2 = \frac{nRT_2}{V_2} = \frac{nRT_f}{2V_0}$$

dimana ~~maka~~ $P_1 = P_2$

$$\frac{\cancel{n}RT_0}{\cancel{V_0}} = \frac{\cancel{n}RT_f}{2\cancel{V_0}}$$

$$T_f = 2T_0$$

maka $T_f = 2T_0$

dari persamaan Gas ~~Ideal~~ Ideal

$$P_i V_i = nRT_i$$

nilai n (jumlah partikel) dan R (konstanta gas ideal) adalah tetap karena dalam ruangan tertutup

Perubahan Titik 2 ke 3

~~$P_2 = nR$~~ $T_f = 2T_0$

~~$V_2 = 2V_0$~~ $P_2 = \frac{nRT_f}{2V_0} = \frac{nR2T_0}{2V_0} = \frac{nRT_0}{V_0} = P_0$

$$P_3 V_3 = nRT_3 , \quad T_3 = T_0 \quad V_3 = 6V_0$$

$$P_3 = P_f$$

maka

$$P_f (6V_0) = nRT_0$$

$$P_f = \frac{nRT_0}{6V_0} = \frac{1}{6}\left(\frac{nRT_0}{V_0}\right), \quad P_0 = P_2 = \frac{nRT_0}{V_0}$$

$$P_f = \frac{1}{6}P_0$$

jadi nilai $T_f = 2T_0$; $P_f = \frac{1}{6}P_0$

- Proses B

Berdasarkan Figurnya dapat diketahui

- $V_1 = V_2 = V_0$
- $T_2 = T_3 = T_f$
- $P_1 = P_0 = P_3$
- $P_2 = P_f$
- $T_1 = T_0$
- $V_3 = 3V_0$

Dapat kita Cari perubahan titik 1 ke titik 2 berdasarkan Persamaan Gas Ideal

$$P_1 V_1 = nRT_1 \qquad P_3 V_3 = nRT_3$$

$$P_2 V_2 = nRT_2$$

$$V_1 = \frac{nRT_1}{P_1} = \frac{nRT_0}{P_0}$$

$$V_2 = \frac{nRT_2}{P_2} = \frac{nRT_f}{P_f}$$

maka

$$V_1 = V_2$$

$$\frac{\cancel{n}\cancel{R}T_0}{P_0} = \frac{\cancel{n}\cancel{R}T_f}{P_f}$$

$$\frac{T_0}{P_0} = \frac{T_f}{P_f} \quad \text{(Pers 3)}$$

berdasarkan

Perubahan titik 2 ke 3

kita tahu

$P_2 V_2 = nRT_2$ $\quad\quad$ $P_3 = P_1 = P_0$

$P_f V_0 = nRT_f$ $\quad\quad$ $T_3 = T_2 = T_f$

$P_3 V_3 = nRT_3$ $\quad\quad$ $V_3 = (3V_0)$

$$T_2 = \frac{P_f V_0}{nR}$$

$$T_3 = \frac{P_3 V_3}{nR} = \frac{P_0 (3V_0)}{nR}$$

$$T_2 = T_3$$

$$\frac{P_f \cancel{V_0}}{\cancel{nR}} = \frac{P_0 (3\cancel{V_0})}{\cancel{nR}}$$

$$P_f = 3P_0$$

Berdasarkan pers 3

dimana

$$\frac{T_0}{P_0} = \frac{T_f}{P_f} \quad \text{dimana } P_f = 3P_0$$

$$\frac{T_f}{P_f} = \frac{T_f}{3P_0} = \frac{T_0}{P_0}$$

$$T_f = 3T_0$$

jadi pada proses B

$T_f = 3T_0$ dan $P_f = 3P_0$

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16. Proses A

$Q_{12} = E_{Th} - W$ (isobaric)

$= nC_v\Delta t - (-nR\Delta T)$

$= n(C_v + R)\Delta T$

$= n(C_v + R)(2T_0 - T_0$

$= nT_0(C_v + R)$

$Q_{23} = 0$ (adiabatic

$Q = Q_{12} + Q_{23}$

$= nT_0(C_v + R) + 0$

$= nT_0(C_v + R)$

Proses B

$Q_{12} = E_{Th} - W$ (isokhorik $W = 0$)

$Q_{12} = n.C_v.\Delta t$

$= nC_v(T_f - T_0)$

$= nC_v(3T_0 - T_0)$

$= \cancel{2x}\ nC_v(2T_0$

$= nC_v 2T_0$

$Q_{23} = E_{th} - W$ (iso termal $\Delta E_{th} = 0$)

$Q_{23} = -W$

$Q_{23} = -[-nRT_f \ln\left(\frac{3V_0}{V_0}\right)]$

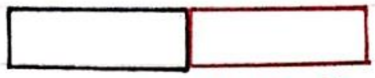
$$Q_{23} = nRT_f \ln(3)$$

$$= nR(3T_0)\ln(3)$$

$$= 3nRT_0 \ln(3)$$

$$Q_{tot} = 2nC_vT_0 + 3nRT_0\ln(3)$$

2.



M_A, C_A, T_A M_B, C_B, T_B

Balok A bermassa M_A dgn suhu T_A menyentuh balok B bermasa M_B dgn suhu T_B. Kalor jenis balok A $= C_A$ dan balok B $= C_B$.

a. Tentukan temperatur akhir T_f dari 2 balok logam!

Kita misalkan bahwa $T_A > T_B$.

Maka kita bisa menggunakan Asas black, dimana :

$$Q\ \text{lepas} = Q\ \text{terima}$$

$$M_A C_A (T_A - T_f) = M_B C_B (T_f - T_B)$$

$$M_A C_A T_A - M_A C_A T_f = M_B C_B T_f - M_B C_B T_B$$

$$M_A C_A T_f + M_B C_B T_f = M_A C_A T_A + M_B C_B T_B$$

$$\boxed{T_f = \frac{M_A C_A T_A + M_B C_B T_B}{M_A C_A + M_B C_B}}$$

b. Tentukan perubahan suhu :

$$\Delta T_A = T_f - T_A$$

Kita tinggal memasukkan persamaan T_f yg sudah didapat sebelumnya.

$$\Delta T_A = \frac{M_A C_A T_A + M_B C_B T_B}{M_A C_A + M_B C_B} - T_A$$

$$\Delta T_A = \frac{\cancel{M_A C_A T_A} + M_B C_B T_B}{M_A C_A + M_B C_B} - \left(\frac{\cancel{M_A C_A T_A} + M_B C_B T_A}{M_A C_A + M_B C_B}\right)$$

$$\Delta T_A = \frac{M_B C_B (T_B - T_A)}{M_A C_A + M_B C_B} \rightarrow \boxed{\Delta T_A = \frac{T_B - T_A}{\left(\frac{M_A C_A}{M_B C_B} + 1\right)}}$$

$$\Delta T_B = T_f - T_B$$

$$\hookrightarrow \Delta T_B = \frac{M_A C_A T_A + M_B C_B T_B}{M_A C_A + M_B C_B} - T_B$$

$$\Delta T_B = \frac{M_A C_A T_A + \cancel{M_B C_B T_B}}{M_A C_A + M_B C_B} - \left(\frac{M_A C_A T_B + \cancel{M_B C_B T_B}}{M_A C_A + M_B C_B}\right)$$

$$\Delta T_B = \frac{M_A C_A (T_A - T_B)}{M_A C_A + M_B C_B} \rightarrow \boxed{\Delta T_B = \frac{T_A - T_B}{\left(1 + \frac{M_B C_B}{M_A C_A}\right)}}$$

c. Misal $M_A = M_B$ dan $|\Delta T_A| > |\Delta T_B|$

Balok logam mana yg punya C lebih tinggi ?

Diketahui bahwa $\Delta T_A > \Delta T_B$

$$\frac{\Delta T_A}{\Delta T_B} > 1$$

Lalu kita gunakan asas Black lagi

$$Q_A = Q_B$$

$$\cancel{M_A} C_A \Delta T_A = \cancel{M_B} C_B \Delta T_B$$

$$\frac{\Delta T_A}{\Delta T_B} = \frac{C_B}{C_A} \longrightarrow \frac{C_B}{C_A} > 1$$

$$\boxed{C_B > C_A}$$

3. Diketahui :

$N_v(v) = 4\pi N_0 \, (m/2\pi K_B T)^{3/2} \, v^2 e^{-mv^2/2K_BT}$

$dN = N_v(v) \; dv$

$N = \int_{v_1}^{v_2} N_v(v) \, dv$

hint : $\int_0^\infty x^3 e^{-ax^2} = 1/2a^2$; $\int_0^\infty x^4 e^{-ax^2} = 3/8 \sqrt{\pi/a^5}$

Buktikan :

a) $V_{rms} = \sqrt{3K_BT/m}$

$V_{rms} = \sqrt{\dfrac{\int_0^\infty v^2 N_v(v) \, dv}{N_0}}$ (1) ; hitung integral terlebih dahulu

$= \int_0^\infty v^2 \, 4\pi N_0 \left(\dfrac{m}{2\pi K_BT}\right)^{3/2} v^2 e^{-mv^2/2K_BT}$

$4\pi N_0 \left(\dfrac{m}{2\pi K_BT}\right)^{3/2} \int_0^\infty v^4 e^{-mv^2/2K_BT}$

$\int_0^\infty x^4 e^{-ax^2} = 3/8 \sqrt{\pi/a^5} \Rightarrow x = V \; ; \; a = m/2K_BT$

$\Leftrightarrow 4\pi N_0 \left(\dfrac{m}{2\pi K_BT}\right)^{3/2} \cdot \sqrt{\dfrac{\pi}{(m/2K_BT)^5}} \cdot \dfrac{3}{8}$

$\dfrac{3}{8}\left(\left(\dfrac{2\pi K_BT}{m}\right)^5 \cdot \dfrac{1}{\pi^4}\right)^{1/2} \cdot 4\pi N_0 \left(\dfrac{m}{2\pi K_BT}\right)^{3/2}$

$= \dfrac{3}{2\cancel{8}} \sqrt{\left(\dfrac{2\pi K_BT}{m}\right)^{5}}^{2} \cdot \dfrac{1}{\pi^{2}} \cdot \cancel{4}\pi N_0 \left(\sqrt{\left(\dfrac{m}{2\pi K_BT}\right)^{3}}\right)$

$\dfrac{3}{\cancel{2}} \cdot \dfrac{\cancel{2\pi} K_BT}{m} \cdot \dfrac{1}{\cancel{\pi}} \cdot N_0 = \dfrac{3K_BT}{m} N_0$

input ke dalam persamaan (1)

$V_{rms} = \sqrt{\dfrac{3K_BT}{m} \cdot \cancel{N_0} \cdot \dfrac{1}{\cancel{N_0}}} = \sqrt{\dfrac{3K_BT}{m}}$ //

b) $V_{avg} = \sqrt{8 K_B T / \pi m}$

$$V_{avg} = \frac{\int_0^\infty v \, N_v(v) \, dv}{\int_0^\infty N_v(v) dv}$$

$$\int_0^\infty v \, N_v(v) \, dv = \int_0^\infty v \cdot 4\pi N_0 \left(\frac{m}{2\pi K_B T}\right)^{3/2} v^2 e^{-mv^2/2K_BT}$$

$$\Leftrightarrow 4\pi N_0 \left(\frac{m}{2\pi K_B T}\right)^{3/2} \cdot \int_0^\infty v^3 e^{-mv^2/2K_BT}$$; sesuaikan dengan hint

$$\int_0^\infty x^3 e^{-ax^2} \approx \int_0^\infty v^3 e^{-mv^2/2K_BT} \Rightarrow x = v \; ; \; a = m/2K_BT$$

$\rightarrow 1/2a^2$

$$\Leftrightarrow 4\pi N_0 \left(\frac{m}{2\pi K_B T}\right)^{3/2} \cdot \frac{1}{2(m/2K_BT)^2} = 4\pi N_0 \left(\frac{m}{2\pi K_B T}\right)^{3/2} \left(\frac{2\pi K_B T}{m}\right)^2 \cdot \frac{1}{2\pi^2}$$

$$\Leftrightarrow 4\pi N_0 \left(\frac{\cancel{m^{3/2}} \, m^{-1/2}}{\cancel{(2\pi K_B T)^{3/2}}}\right) \left(\frac{(2\pi K_B T)^{\cancel{2}\,1/2}}{\cancel{m^2}}\right) \cdot \frac{1}{2\pi^2}$$ agar tidak merubah nilai

$$\Leftrightarrow \frac{\cancel{4}^{2}\pi N_0}{\cancel{2}\pi^2} \sqrt{\frac{2\pi K_B T}{m}} \Rightarrow N_0 \sqrt{\frac{8\cancel{\pi} K_B T}{\pi^{\cancel{2}} m}} = N_0 \sqrt{\frac{8 K_B T}{\pi m}}$$

diketahui bahwa :

$$N = \int_{V_1}^{V_2} N_v(v) \, dv \Rightarrow \int_0^\infty N_v(v) dv \approx N_0$$

$$\Leftrightarrow V_{avg} = \frac{\cancel{N_0} \sqrt{\frac{8 K_B T}{\pi m}}}{\cancel{N_0}} = \sqrt{\frac{8 K_B T}{\pi m}}$$

c) $V_{mp} = \sqrt{\frac{2K_BT}{m}} \Rightarrow \frac{dN_V(V)}{dV} = 0 \Rightarrow \frac{d}{dV} N_V(V) = 0$

$$\frac{d}{dV} 4\pi N_0 \left(\frac{m}{2\pi K_B T}\right)^{3/2} V^2 e^{-mV^2/2K_BT} \Rightarrow \frac{d}{dV} V^2 e^{-mV^2/2K_BT} = 0$$

$$\Leftrightarrow \quad 2Ve^{-mV^2/2K_BT} - \left(\frac{mV^3}{K_BT}\right) e^{-mV^2/2K_BT} = 0$$

$$2\cancel{V}\cancel{e^{-2mV^2/2K_BT}} = \frac{mV^{\cancel{3}2}}{K_BT} \cancel{e^{-mV^2/2K_BT}}$$

$$V^2 = \frac{2K_BT}{m} \Rightarrow V_{mp} = V = \sqrt{\frac{2K_BT}{m}} \quad //$$