Nama : Muchammad Daniyal Kautsar
NIM : 21/479067/TK/52800

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UAS Fisika Fluida Kalor Gelombang

Pakta Integritas:

"Saya yang bertanda tangan dibawah ini, secara sadar dan sungguh-sungguh akan mengerjakan soal Ujian Akhir Semester Fisika Fluida Kalor dan Gelombang dengan jujur, tidak bertanya, berdiskusi, dan bekerja sama dengan teman/orang lain, tidak mencari pertolongan dengan cara, media, dan bentuk apapun, dan tidak akan saling membagi jawaban selama masa ujian berlangsung. Bila saya melanggar, saya siap menerima konsekuensi berupa UAS saya tidak akan dinilai sama sekali dan dianggap bernilai Nol."

Sleman, 20 Desember 2021

Muchammad Daniyal Kautsar.

0. Initializing Variables

NIU = 479067
NIF = 52800

$\beta_i = 1 + (NIU_{(i+1)} \times NIF_{(6-i)}) \bmod 10$

$\beta_1 = 1 + (7 \times 0) \bmod 10 = 1$
$\beta_2 = 1 + (9 \times 0) \bmod 10 = 1$
$\beta_3 = 1 + (0 \times 8) \bmod 10 = 1$
$\beta_4 = 1 + (6 \times 2) \bmod 10 = 1 + 2 = 3$
$\beta_5 = 1 + (7 \times 5) \bmod 10 = 1 + 5 = 6$

1. Tea break

$M_w : 100g = 0,1\ kg$
$C_w = 4200\ J/kg°C$
$T_w = 96°C$

$M_c = 300g = 0,3\ kg$
$C_c = 700\ J/kg°C$
$T_c = 18°C$

a. Determine the temperature of tea in equilibrium condition.

* Since the system is on the equilibrium condition, we can calculate by

$M_w \cdot C_w \cdot \Delta T_w = M_c \cdot C_c \cdot \Delta T_c$

$M_w \cdot C_w (T_w - T_{eq}) = M_c \cdot C_c \cdot (T_{eq} - T_c)$

$0,1 \cdot 4200 \cdot (96 - T_{eq}) = 0,3 \cdot 700 \cdot (T_{eq} - 18°C)$

$\frac{6}{3}(96 - T_{eq}) = (T_{eq} - 18)$

$192 - 2T_{eq} = T_{eq} - 18$

$3T_{eq} = 192 + 18$

$3T_{eq} = 210$

$T_{eq} = 70°C$

So, the tea temperature in equilibrium condition will be equal to 70°C.

b. Determine the temperature of the tea in equilibrium condition.

She add sugar with $M_s = 50g = 0,05\ kg$ ($C_s = 1400\ J/kg°C$, $T_s = 18°C$)

* We can calculate the equilibrium condition (with sugar added) by.

$M_w \cdot C_w \cdot \Delta T_w = M_c \cdot C_c \cdot \Delta T_c + M_s \cdot C_s \cdot \Delta T_s$

$M_w \cdot C_w \cdot (T_w - T_{eq}) = M_c \cdot C_c \cdot (T_{eq} - T_c) + M_s \cdot C_s (T_{eq} - T_s)$

$0,1 \cdot 4200 (96 - T_{eq}) = 0,3 \cdot 700 \cdot (T_{eq} - 18°C) + 0,05 \cdot 1400 \cdot (T_{eq} - 18°C)$

$12 (96 - T_{eq}) = 6 (T_{eq} - 18°C) + 2 (T_{eq} - 18°C)$

$6 (96 - T_{eq}) = 4 (T_{eq} - 18°C)$

$288 - 3T_{eq} = 2T_{eq} - 36$

$5T_{eq} = 324$

$T_{eq} = 64,8°C$

So, the temperature of the tea in the equilibrium condition equal to 64,8°C

c. Can she successfully cool down the tea? By how much the tea temperature is decreased after she put the sugar into the teacup?

→ Yes, she can successfully cool down the tea temperature from 96°C to 64,8°C (with sugar added). The temperature decreased by 31,2°C (calculated by subtracting 96°C or initial condition with 64,8°C or equilibrium condition).

d. Prove the temperature difference by the formula.

$$\Delta T_w = \left(\frac{M_s \cdot C_s}{M_w C_w + M_c C_c + M_s C_s}\right)\left(\frac{M_w C_w (T_w - T_s) + M_c C_c (T_c - T_s)}{M_w C_w + M_c C_c}\right)$$

• We can substitute the information from the problem

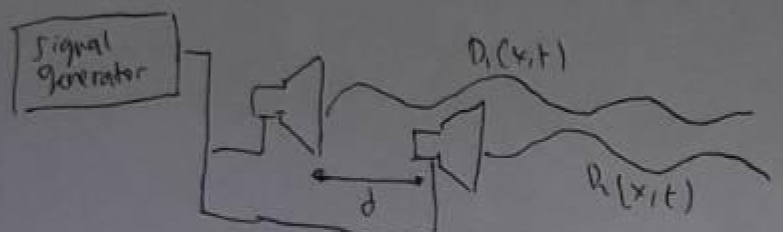
$$\Delta T_w = \left(\frac{0{,}05 \cdot 1900}{0{,}1 \cdot 4200 + 0{,}3 \cdot 700 + 0{,}05 \cdot 1400}\right)\left(\frac{0{,}1 \cdot 4200 (96-18) + 0{,}3 \cdot 700 (18-18)}{0{,}1 \cdot 4200 + 0{,}3 \cdot 700}\right)$$

$$= \left(\frac{70}{420 + 210 + 70}\right)\left(\frac{32760}{420 + 210}\right) = \left(\frac{\cancel{70}}{\underset{10}{\cancel{700}}}\right)\left(\frac{3276\cancel{0}}{63\cancel{0}}\right)$$

$$= \frac{3276}{630} = 5{,}2\,°C$$

The formula isn't produce the $\Delta T_w = 31{,}2°C$. Therefore the formula is wrong.

2. Measuring speed of sound.



a. Determine the value of d_{min} and d_{max}, wich produce destructive and constructive interference. Express in f and V_s!

→ Since both speaker produce same sound wave. We know that

$D_1(x,t) = A\sin(k(x-d/2)-wt)$, $D_2(x,t) = A\sin(K(x+d/2)-wt)$.

Therfore,

$$D(x,t) = D_1(x,t) + D_2(x,t)$$
$$= A\sin(k(x-d/2)-wt) + A\sin(k(x+d/2)-wt)$$
$$= A(\sin(kx-kd/2-wt) + \sin(kx + kd/2 - wt))$$

we can use the trigonometri identity $\sin A + \sin B = 2\cos\left(\frac{A-B}{2}\right)\sin\left(\frac{A+B}{2}\right)$.

Thus,

$$D(x,t) = A(\sin(kx-kd/2-wt) + \sin(kx+kd/2-wt))$$
$$= A\left(2\cos\left(\frac{kx-kd/2-wt-kx-kd/2+wt}{2}\right)\sin\left(\frac{kx-kd/2-wt+kx+kd/2-wt}{2}\right)\right)$$
$$= A\left(2\cos\left(\frac{-kd}{2}\right)\sin(kx-wt)\right)$$
$$= 2A\cos\left(-\frac{kd}{2}\right)\sin(kx-wt).$$

We can let $A(d) = 2A\cos\left(\frac{-kd}{2}\right)$. Thus, we get

$$D(x,t) = A(d)\sin(kx-wt).$$

Now, we need to find the maximum intensity by calculating

$I = CA^2$, where A from the $D(x,t)$ is equal to $A = A(d) = 2A\cos\left(\frac{-kd}{2}\right)$

Therefore, $I = CA^2$

$$I = C\left(2A\cos\left(\frac{-kd}{2}\right)\right)$$
$$I = C.4A^2\cos^2\left(\frac{-kd}{2}\right)$$

Maximum intensity happen when $\cos^2\theta = 1$, Thus

$\cos^2\left(\frac{-kd}{2}\right) = 1$, since $\cos^2\left(\frac{-kd}{2}\right) = \cos^2\left(\frac{kd}{2}\right)$. we can use the $\cos^2\left(\frac{kd}{2}\right)$ instead.

$\frac{kd}{2} = m.\pi \rightarrow \frac{2\pi}{\lambda}.\frac{d}{2} = m\pi \rightarrow d_{max} = \lambda.m$

~~Maximum intensity is also occurs when $\cos^2\theta = 0$~~

When $\cos^2\theta = 0$, we can calculate the d_{min}.
thus,

$$\cos^2\left(\frac{kd}{2}\right) = 0$$

$$\frac{kd}{2} = m\pi + \frac{\pi}{2}$$

$$\frac{2\pi}{\lambda} \cdot \frac{d}{2} = \pi\left(m + \frac{1}{2}\right)$$

$$d_{min} = \lambda\left(m + \frac{1}{2}\right)$$

$\Rightarrow$ since we need to use the term f and V_s, we know that $\lambda = \frac{V}{f}$.

Therefore, $d_{max} = \lambda \cdot m \rightarrow d_{max} = \frac{V_s}{f} \cdot m$

$$d_{min} = \lambda\left(m + \frac{1}{2}\right) \rightarrow d_{min} = \frac{V_s}{f}\left(m + \frac{1}{2}\right).$$

where $m = \ldots, -2, -1, 0, 1, 2, \ldots$

b.

3. Why a ~~bi~~ bicycle pump getting hot?

a. Determine the value of n_0 and n_t.

* From the condition I, we know that each pump and tire condition ~~is~~ are shown on the condition I picture. Therefore.

$$P_0 V_0 = n_0 . R T_0.$$
$$n_0 = \frac{P_0 . V_0}{R . T_0}.$$

$$P_t . V_t = n_t . R . T_0$$
$$n_t = \frac{P_t . V_t}{R . T_0}$$

b. Determine the value of P_1 and V_1 at the end of process I (condition II).

* From the condition II picture, we can get some information. ~~that~~
There fore, $P_1 V_1 = P_0 V_0$. That happen because the temperature is constant.

* From the Process I statement, the final condition will be end up when the pressure inside the pump is equal to the pressure inside the tyre.
There fore, $P_1 = P_t$.

Thus for V_1, we can expressed by

$$P_1 V_1 = P_0 V_0$$
$$V_1 = \frac{P_0 V_0}{P_1} \Rightarrow V_1 = \frac{P_0 . V_0}{P_t}$$

c. Determine the Q_1 during Process I.

* The process is isothermal because the temperature remains the same.
Therefore, for Q_1, we can expressed by.

$$Q_1 = P_0 . V_0 \ln \frac{V_1}{V_0}$$
$$= P_0 V_0 \ln \left(\frac{P_0 . V_0}{P_t . V_0} \right) = P_0 V_0 \ln \left(\frac{P_0}{P_t . \cancel{V_0}} \right)$$
$$Q_1 = P_0 V_0 \ln \left(\frac{P_0}{P_t} \right)$$

d). Determine the P_2, air pressure inside the tire at the end of process II (condition III).

* From the Process II statement, we know that all of the air are pumped into the tyre. Therefore.

$$P_2 . V_t = (n_0 + n_t) . R T_0$$, since the volume is constant, we use the V_t.

$$P_2 = \frac{(n_0 + n_t) R T_0}{V_t}$$

$$P_2 = \frac{(n_0 R T_0) + (n_t . R . T_0)}{V_t}$$

Since we know that $n_0 . R T_0 = P_0 . V_0$ and $n_t . R . T_0 = P_t . V_t$. We can simplyfy the P_2.

Therefore. $$P_2 = \frac{(n_0 . R . T_0) + (n_t . R . T_0)}{V_t}$$

$$P_2 = \frac{P_0 . V_0 + P_t . V_t}{V_t}$$

e). Determine the Q_2 during Process II.

* Since Process II happen in isochoric process, ~~...~~ Therefore Q_2 will be.

$Q_2 = n C_v \, \Delta T$.

we can define the ΔT by using Temperature T_0, when $P_2 . V_t = (n_0 + n_t) R T_0$ as final condition, and T_0 when $P_t . V_t = n_t . R T_0$ as initial condition.

Therefore.

$$\cancel{P_2 . V_t = (n_0 + n_t) R T_0}$$

$$\cancel{T_0 = \frac{P_2 . V_t}{(n_0 + n_t) R}}$$

$$\frac{P_2}{T_F} = \frac{P_t}{T_0}$$

$$\frac{P_2}{P_t} = \frac{T_F}{T_0}$$

$$\frac{T_F}{T_0} = \frac{P_0 V_0 + P_t . V_t}{P_t} \rightarrow T_F = T_0 \left(\frac{P_0 V_0 + P_t . V_t}{P_t} \right)$$

We add them to the Q_2 equation

$$Q_2 = n C_v \, \Delta T$$

$$Q_2 = n C_v \left(T_0 \left(\frac{P_0 V_0 + P_t . V_t}{P_t} \right) - T_0 \right)$$

$$= n C_v \left(T_0 \left(\frac{P_0 V_0 + P_t . V_t}{P_t} - 1 \right) \right)$$

* to define the Cv we assume that the gas is monoatomic. Therefore

$Cv = \frac{3}{2} P V_t / \Delta T . n$

* we can add them to Q_2.

$Q_2 = n . Cv . \Delta T$

$= \cancel{n} . \frac{\frac{3}{2} P_t V_t}{\cancel{n} . \cancel{\Delta T}} . \cancel{\Delta T}$

$Q_2 = \frac{3}{2} P_t . V_t .$

f. Determine the Q_3.

* On the process III, the pressure is constant, and the volume is change. Therefore, the process is isobaric process.
Thus,

$Q_3 = n_o C_p . \Delta T .$

* We can define C_p by assuming that the gas is mono atomic. Therefore

$C_p = \frac{5}{2} R$

* we add them to Q_3

$Q_3 = n_o \frac{5}{2} R . \Delta T$

g. Determine the Q.

* We can sum the calculate by

$Q = Q_1 + Q_2 + Q_3$

$= P_o V_o \ln\left(\frac{P_o}{P_t}\right) + \frac{3}{2} P_t V_t + n_o \frac{5}{2} R . \Delta T$

4. ~~B~~ Interference in Thin Glass

a. Determine the value of α!

- The laser is refracted ~~th~~, thus we can calculate the α by snell law. Therefore,

$$n_0 . \sin\theta = n . \sin\alpha$$

$$\sin\alpha = \frac{n_0}{n} \sin\theta$$

$$\alpha = \sin^{-1}\left(\frac{n_0}{n} . \sin\theta\right)$$