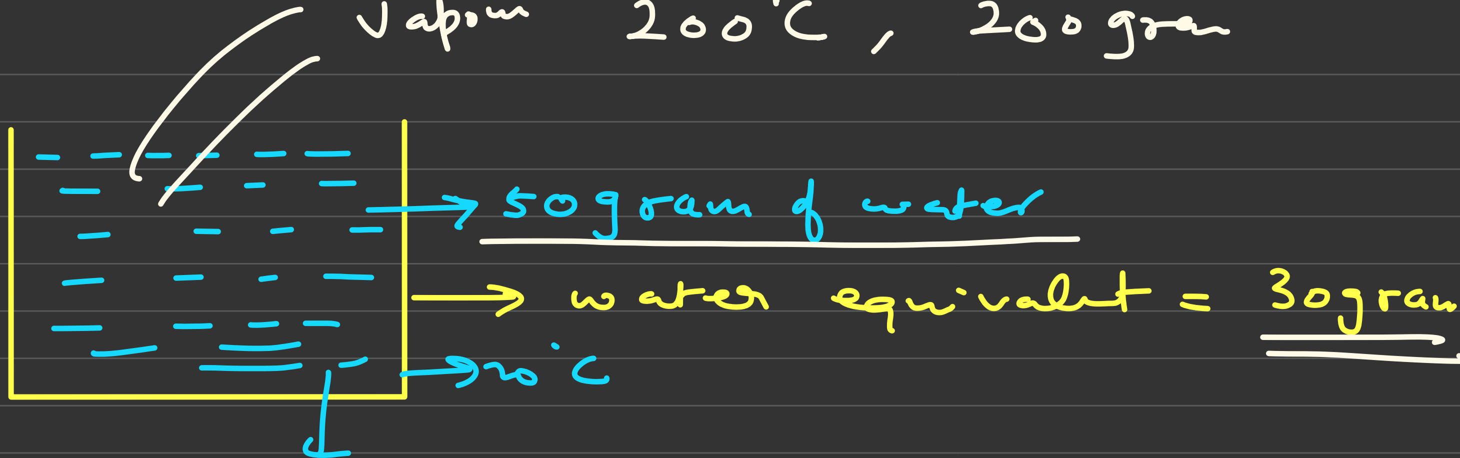
POM-2

VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Q)

Vapour 200°C, 200 gram



(iii) amount of vapor for which final temp of system 100°C with all water becomes vapor.

loss (Vapor)	gain (Cal + water)
$m \times 0.5 \times (200-100) =$	$80 \times 1 \times (80) + 50 \times 540$

$m \times 0.5 \times 100 = 6400 + 50 \times 540$

$50m = 6400 + 27000$

$\boxed{m = 668}$ Ans $\rightarrow 200^\circ C$

(iv) amount of vapor for which final temp of system is $100^\circ C$ and all vapor gets condense

$m \times 0.5 \times 100 + m \times 540 = 80 \times 1 \times (80)$

$m\,590 = 6400$

$\boxed{m = 10.8 \text{ gram}}$ Ans $\rightarrow 200^\circ C$

Q)

50 gram of vapor at 100°C

initially System is at 0°C

if pour 50 gram of vapor at 100°C then find temp and composition?

final temp

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$$20 \times 80 + 250 \times 1 \times 100$$

$$= 25000 + 1600$$

$$= 26600 \text{ cal} \nearrow 100$$

$$= 540 \times 50$$

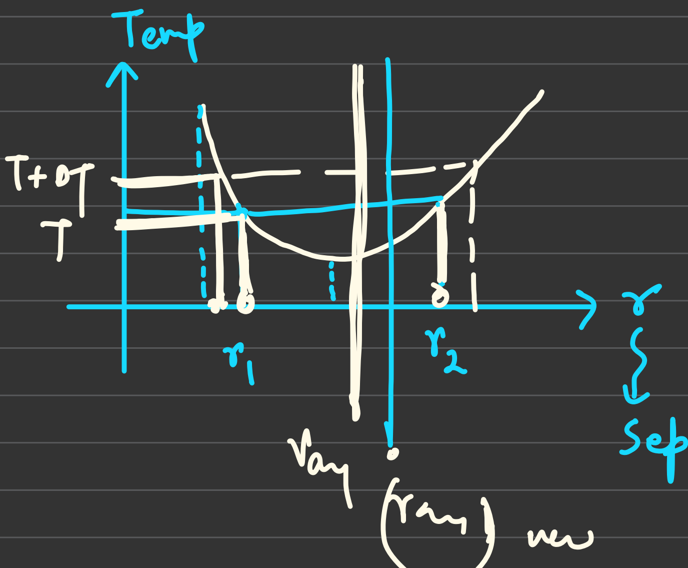
$$= 27000 \text{ cal}$$

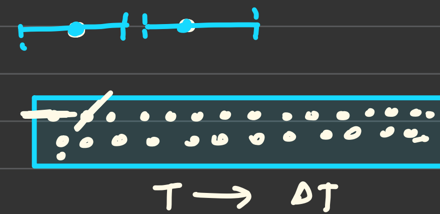
100°C

Thus . all

$$\frac{400}{540} = 0.8 \text{ gram}$$

Thermal Expansion





$$r_{avg} = \frac{r_1 + r_2}{2}$$

$(r_{avg})_{new}$ ↑

①

l_0

$T_1 \uparrow \quad \Delta\theta \uparrow$

$$\frac{dl}{d\theta} \propto l_0$$

$$\boxed{dl = \alpha\, l_0\, d\theta}$$

$$\Delta l \propto l_0$$
$$\Delta l \propto \Delta\theta$$

$$\Rightarrow \boxed{\Delta l = l_0\, \alpha\, \Delta\theta}$$

"Approximation"

$$l_2 - l_0 = l_0\, \alpha\, \Delta\theta$$

$$l_2 = l_0(1 + \alpha\Delta\theta)$$

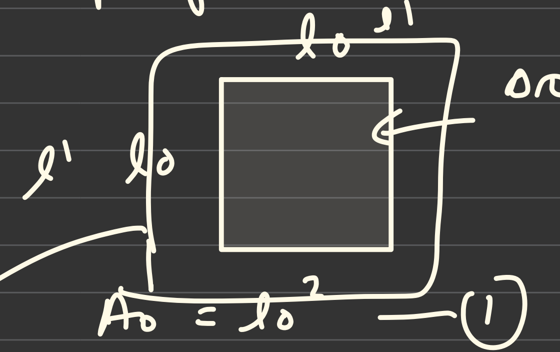
$$l_{final} = l_0(1 + \alpha\Delta\theta)$$

"Coefficient of linear expansion"

(ii) $A = A_0(1+\beta\Delta\theta)$

Coefficient
Superficial exp

$\beta = 2\alpha$



$(1+x)^n = 1+nx$

$\alpha\Delta\theta << 1$

$\alpha = 10^{-5}, {}^{-6}, {}^{-7}$

order

$A' = l'^2 = l_0(1+\alpha\Delta\theta)\, l_0(1+\alpha\Delta\theta)$

$A' = l_0^2(1+\alpha\Delta\theta)^2$

$A' = A_0(1+2\alpha\Delta\theta)$

$\beta = 2\alpha$

(iii) $V = V_0 (1 + \gamma \Delta\theta)$

"coefficient of volumetric Expansion"

$\gamma = 3\alpha$

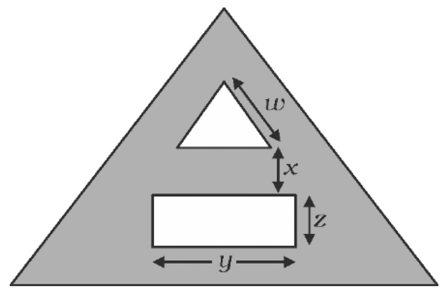
16. A triangular plate has two cavities, one triangle and other rectangle. The plate is heated :

(A) x increases, wzy decreases

~~(B)~~ $xwzy$ all increase

(C) w, z, y increase, x decreases

(D) information is not sufficient

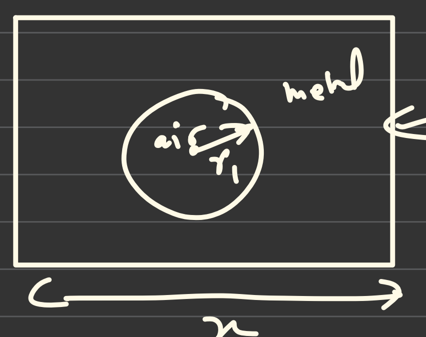


Thermal Expansion:

Photographic enlargement

"Thermal expansion follows photographic enlargement"

Q)



$r_1 \uparrow$ $x \uparrow$ upon Heating

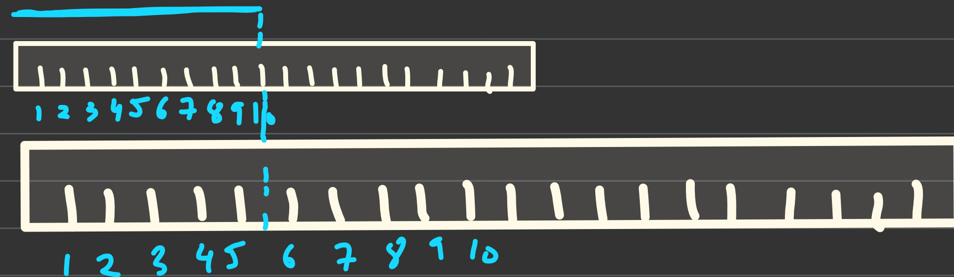
upon cooling down $r_1 \downarrow$ $x \downarrow$

mettalic scale :

10 cm

To

T+ΔT



measured length < Actual length

Actual length = measured length $(1 + \alpha\Delta\theta)$

Illustration - 10 *A surveyor's 30 m steel tape is correct at a temperature of 20°C. The distance between two points, as measured by this tape on a day when the temperature is 35°C, is 26 m. What is the true distance between the points ?* $(\alpha_{steel} = 1.2 \times 10^{-5}/°C)$

SOLUTION :

Let temperature rise above the correct temperature be θ.

$\Rightarrow \quad \theta = 35 - 20 = 15°C.$

Using the relation :

Correct length = measured length $(1 + \alpha\theta)$

True distance between the points

$$= 26\,(1 + 1.2 \times 10^{-5} \times 15)$$

$\Rightarrow \quad$ true distance $= 26.00468\ m.$

True distance = measured length $(1 + \alpha \Delta\theta)$

True distance = $26 (1 + 1.2 \times 10^{-5} \times 15)$

$= 26.00468$ m

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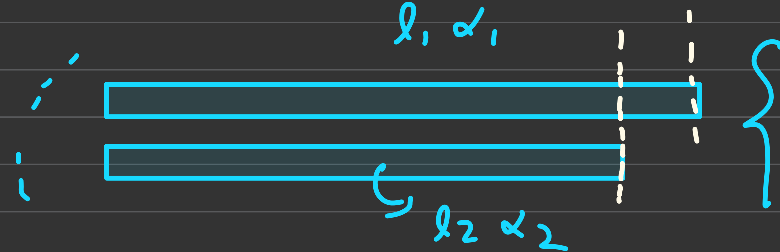


initial diff of length = $(l_1 - l_2)$ — (1)

if both rod heated by $(\Delta\theta)$

$$l_1' = l_1 (1 + \alpha_1 \Delta\theta)$$
$$l_2' = l_2 (1 + \alpha_2 \Delta\theta)$$ — (2)

"find condition for which change in difference in rod is $= 0$"

final diff $= l_1' - l_2' = l_1(1 + \alpha_1 \Delta\theta) - l_2(1+\alpha_2\Delta\theta)$

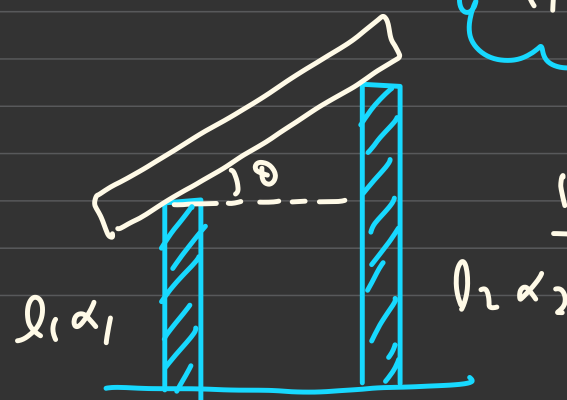
$$\underline{\cancel{l_1}(1+ \alpha_1 \Delta\theta) - \cancel{l_2}(1+\alpha_2 \Delta\theta)} = \underline{l_1 - \cancel{l_2}}$$

$$\alpha_1 l_1 \cancel{\Delta\theta} - l_2 \alpha_2 \cancel{\Delta\theta} = 0$$

$$\alpha_1 l_1 = \alpha_2 l_2$$

Remember this

Ex:



$1^\circ C \longrightarrow 50^\circ$

$$l_1 \alpha_1 = l_2 \alpha_2$$

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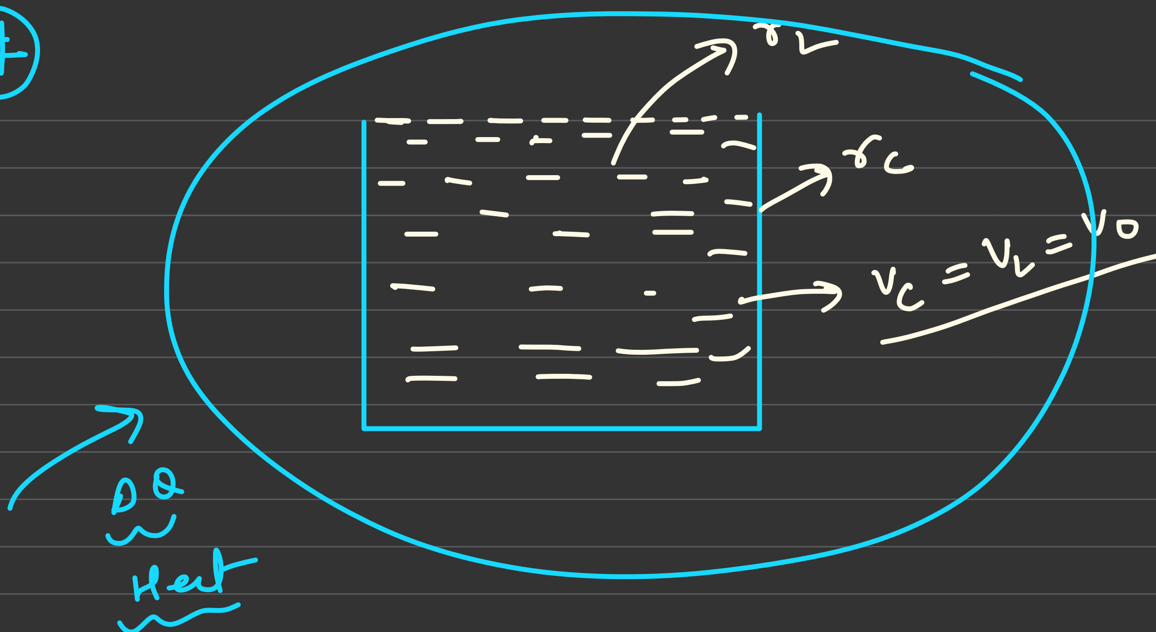


Case I:

$V_C = V_L = V_0$

initial

initial diff in Volume = 0

$$\begin{cases} (V_f)_C = V_0(1 + \gamma_C \Delta\theta) \\ (V_f)_L = V_0(1 + \gamma_L \Delta\theta) \end{cases}$$

$(V_f)_L > (V_f)_C$

overflow

$$(V_f)_C = (V_f)_L$$

$$(r_C \, \Delta\theta \, V_0 = r_L \, V_0 \, \Delta\theta)$$

$$r_C = r_L$$

$(V_f)_L < (V_f)_C$

underflow

Case II: a) if $(V_L)_0 \neq (V_C)_0$

$(V_C)_0 > (V_L)_0$

change in diff in volume →

$$\boxed{r_C (V_C)_0 = r_L (V_L)_0}$$

b) $(\Delta V_L) >$ {initial diff. in volume

(This means overflow)}

Illustration - 14 *A glass flask whose volume is exactly 1000 cm^3 at 0°C is filled level full of mercury at this temperature. When the flask and mercury are heated to 100°C, 15.2 cm^3 of mercury overflow. If the coefficient of cubical expansion of Hg is $1.82 \times 10^{-4}/°C$, compute the coefficient of linear expansion of glass.*

SOLUTION :

As 15.2 cm^3 of Hg overflow at 100 °C,

final volume of Hg – final volume of glass flask

$= 15.2\ cm^3$

$$\Rightarrow \quad 1000(1+\gamma_\ell\theta) - 1000(1+\gamma_g\theta) = 15.2$$

where θ = rise in temperature = 100 – 0 = 100°C

$$\Rightarrow \quad \gamma_g = \gamma_\ell - \frac{15.2}{1000\ \theta} = 0.000182 - 0.000152$$

$$\Rightarrow \quad \gamma_g = 0.00003/°C = 3\times 10^{-5}\ (°C)^{-1}$$

$$\Rightarrow \quad \alpha_g = \frac{\gamma_g}{3} = 1\times 10^{-5}\ (°C)^{-1}$$

$$(V_L)_f - (V_f)_c = 15.2$$

$$1000(1+1.82\times 100) - 1000(1+\gamma_g\, 100) = 15.2$$

$$\gamma_g = 0.00003/°C$$

$$\alpha_g = 0.00001\ C^{-1}$$

Illustration - 15 *A 250 cm^3 glass bottle is completely filled with water at 50°C. The bottle and water are heated to 60°C. How much water runs over if :*

~~(a)~~ *the expansion of the bottle is neglected ?*

(b) *the expansion of the bottle is included ? Given the coefficient of cubical expansion of glass*

$$\gamma_g = 1.2 \times 10^{-5} / °C \text{ and } \gamma_{water} = 60 \times 10^{-5} / °C.$$

SOLUTION :

Water overflow = (final volume of water)

– (final volume of bottle)

(a) If the expansion of bottle is neglected :

Water overflow $= 250\,(1 + \gamma_\ell \theta) - 250$

$= 250 \times 60 \times 10^{-5} \times 10$

$\Rightarrow$ water overflow $= 1.5\ cm^3$.

(b) If the bottle (glass) expands :

Water overflow = (final volume of water)

– (final volume of glass)

$= 250\,(1 + \gamma_\ell \theta) - 250\,(1 + \gamma_g \theta) = 250\,(\gamma_\ell - \gamma_g)\theta$

$= 250\,(58.8 \times 10^{-5}) \times (60 - 50)$

$\Rightarrow$ water overflow $= 1.47\ cm^3$.

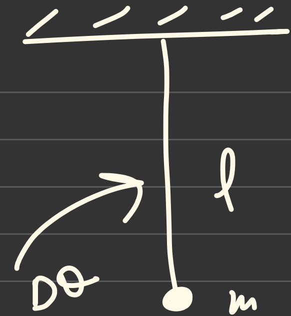
a) over flow = $V_f = V_0 (1 + \alpha \Delta\theta)$

$(V_f - V_i) = (V_0 \gamma_L \Delta\theta) = 250 \times 60 \times 10^{-5} \times 10$

$= 1.5\ cm^3$

b) overflow = "final volume water – final volume glass"

Pendulum:



$$T_0 = 2\pi\sqrt{l_0/g} \quad \text{— (1)}$$

Time period

$\theta_0 \downarrow$

$\theta_f \uparrow$

$\theta_f - \theta_0 = \Delta\theta$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T = 2\pi\sqrt{\frac{l_0(1+\alpha\Delta\theta)}{g}}$$

$$T = 2\pi\sqrt{\frac{l_0}{g}}\,(1+\alpha\Delta\theta)^{1/2}$$

$$T = 2\pi\sqrt{l_0/g}\,\left(1+\frac{1}{2}\alpha\Delta\theta\right)$$

$$T = T_0\left(1+\frac{1}{2}\alpha\Delta\theta\right.$$

$$T = T_0 + \frac{T_0 \alpha \Delta\theta}{2}$$

if T_0 is true period

After Heating it with $\Delta\theta$

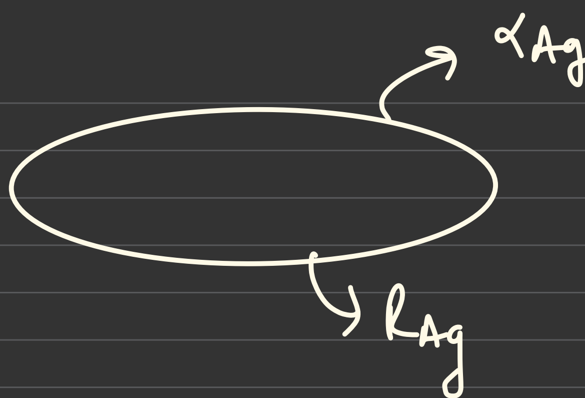
increase in time period is going to be $\left(\frac{T_0}{2} \alpha \Delta\theta\right)$

if $T_0 = 1$ sec

Per sec loss $= \left(\frac{1}{2} \alpha \Delta\theta\right)$

Per day loss $= 86400 \times \frac{1}{2} \alpha \Delta\theta$

Ring:



$R_{cu} < R_{Ag}$

$\Delta\theta \uparrow$

$$\cancel{2\pi} R'_{Ag} = \cancel{2\pi} R_{Ag}(1 + \alpha_{Ag}\Delta\theta) \Rightarrow$$

$$\cancel{2\pi} R'_{cu} = \cancel{2\pi} R_{cu}(1 + \alpha_{cu}\Delta\theta)$$

$$R'_{Ag} = (1 + \alpha_{Ag}\Delta\theta) R_{Ag}$$

$$R'_{cu} = (1 + \alpha_{cu}\Delta\theta) R_{cu}$$

$$(1 + \alpha_{Ag} \Delta\theta) R_{Ag} = (1 + \alpha_{Cu} \Delta\theta) R_{Cu}$$

$$\boxed{\frac{R_{Ag} - R_{Cu}}{\alpha_{Cu} R_{Cu} - \alpha_{Ag} R_{Ag}} = \Delta\theta}$$

"module complete",

" { DTS # 1, 2, → Level 1 / Level 2 } both