St. Lawrence High School

A Jesuit Christian Minority Institution

Work Sheet - Solution

Date – 09.04.20 Class – X

Subject – Physical Science Topic – Thermal Phenomena

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1. MCQ.

i) The increase in length in case of thermal expansion does not depend on

a) Initial length b) increase in temperature

c) nature of material d) measuring unit of temperature

Ans: d) measuring unit of temperature

ii) The value of α of a metal is given as $1.6 \times 10^{-6}\ K^{-1}$ in SI unit. In C.G.S system, α will be –

a) More b) less c) equal d) $\frac{1}{273}$ times

Ans: c) equal.

iii) The C.G.S unit of β is –

a) $/K$ b) K^{-1} c) °C d) $°C^{-1}$

Ans: d) $°C^{-1}$

iv) Value of coefficient of volume expansion i.e. γ, depends on –

a)The initial volume b) change in temperature

c)nature of the material d) all of these

Ans: c) nature of the material

v) If $\alpha : \beta : \gamma = 1 : 2 : 3$ then which relation is correct?

a) $\frac{\alpha}{3} = \frac{\beta}{2} = \gamma$ b) $\alpha : \beta : \gamma = 1 : \frac{1}{2} : \frac{1}{3}$ c) $3\alpha = 2\beta$ d) $3\beta = 2\gamma$

Ans: d) $\boldsymbol{3\beta = 2\gamma}$

2. Answer the following questions in short.

i) In the equation $(l_2 - l_1) = \alpha l_1 (t_2 - t_1)$, which parameter depends only on the nature of the material?

Ans: α depends only on the nature of the materuial.

ii) The C.G.S units of all three expansion coefficients are same and that is $/°C$ *or* $°C^{-1}$ - write true or false.

Ans: True. All three expansion coefficients, i.e. α, β *and* γ have same units as $/°C$ *or* $°C^{-1}$.

iii) The coefficient of superficial expansion of a metal is $10^{-6}/K$. Its α will be _____ /°C.

Ans: We know, If $\alpha : \beta : \gamma = 1 : 2 : 3$

Then we can write $\alpha = \frac{\beta}{2} = \frac{\gamma}{3}$

So, $\alpha = \frac{\beta}{2}$

Here , coefficient of superficial expansion of the metal is given as $\beta = 10^{-6}/K$.

Hence $\alpha = \frac{\beta}{2} = \frac{10^{-6}}{2}\ /K$

Or, $\alpha = 0.5 \times 10^{-6}/K = 5 \times 10^{-7}/K$

So, $\alpha = 5 \times 10^{-7}/K$

Now, according to the question we need to find out it in C.G.S unit. But one degree change in 'Celsius scale' is equal to one Kelvin change in 'kelvin scale'. So, in C.G.S unit also the value of α remains same. Hence the answer will be $\alpha = 5 \times 10^{-7}/℃$.

iv) β of iron is $24 \times 10^{-6}/℃$. The coefficient of volume expansion of iron will be _____.

Ans: Given $\beta = 24 \times 10^{-6}/℃$

Now, from $\alpha = \frac{\beta}{2} = \frac{\gamma}{3}$, we can write $\frac{\beta}{2} = \frac{\gamma}{3}$

Or, $\gamma = \frac{3}{2}\beta = \frac{3}{2} \times 24 \times \frac{10^{-6}}{℃} = 36 \times 10^{-6}/℃$

v) Define "coefficient of superficial expansion".

Ans: It is defined as the change (or increase) in surface area over unit initial surface area per degree change (or increase) in temperature.

Alternatively, **coefficient of superficial expansion** can also be defined as the relative change (or increase) in surface area per degree change (or increase) in temperature.

3. Answer the following questions.

i) **If the temperature of two iron rods of length 1cm and 1m respectively, changed by same amount, then which one will increase more and why?**

Ans: The longer one i.e. 1m long rod will increase more.

As we know, more is the initial amount, the increment will be more, and length of 1m rod is more than 1cm rod. So, 1m rod will increase more.

ii) **γ of a material is $36 \times 10^{-6}/℃$. What do you mean by this?**

Ans: It means, if $1cm^3$ volume of that material is heated and the temperature is increased by 1℃, then the volume of the material will increase by $36 \times 10^{-6}\ cm^3$.

iii) **α of iron is $12 \times 10^{-6}/K$ and α of silver is $18 \times 10^{-6}/K$. If two identical rods of iron and silver are heated through same temperature difference, then in which case the increase in length will be more? And why?**

Ans: The increase in length will be more for silver.

As coefficient of linear expansion of silver is more than that of iron, so for per degree rise in temperature, silver rod of same length (as of iron rod) will increase more.

iv) **Why do the numerical values of coefficient of linear expansions remain same in both the systems (i.e. in SI and C.G.S) ?**

Ans: The expression of α is, $\alpha = \frac{(l_2 - l_1)}{l_1(t_2 - t_1)}$.

Hence numerical value of α only depends on the change in temperature.

Now, the change in temperature in Celsius scale and Kelvin scale are same. For example let the temperature is changed from $27℃\ to\ 57℃$, then the change in temperature $= (57 - 27)℃ = 30℃$.

Now, in Kelvin scale the corresponding temperatures are $(273 + 27)K = 300\ K$ and $(273 + 57)K = 330\ K$. So, the change in temperature here also $= 330K - 300\ K = 30\ K$.
As, numerical value of α only depends on the change in temperature, which is same in both the scale, so the numerical values also becomes same.

vi) **For which condition, the increase in length of two strings (one made up of iron and another made up of silver) be always same when heated through same temperature difference? Given α of iron is $12 \times 10^{-6}/K$ and α of silver is $18 \times 10^{-6}/K$.**

Ans: According to the problem, $(l_2 - l_1)\ and\ (t_2 - t_1)$ are same for both.
Let, $x = initial\ length\ of\ iron\ string$ and $y = initial\ length\ of\ silver\ string$
Now, for iron string we have
$(l_2 - l_1) = 12 \times 10^{-6} \times x \times (t_2 - t_1)$ ……(1) .

And for silver string we have
$(l_2 - l_1) = 18 \times 10^{-6} \times y \times (t_2 - t_1)$ ……(2) .

Dividing equation (1) by equation (2) we get,
. $\frac{12x}{18y} = 1$
Or, $x = \frac{18}{12}y$
Or, $x = 1.5\ y$
Hence, in order to get same increase in length for two cases, the initial length of iron string should be 1.5 times the initial length of silver string always.

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