St. Lawrence High School
A Jesuit Christian Minority Institution
Study Material – 2
Term : 1st

Class – X | Subject – Physical Science
Chapter – Thermal Phenomena | Date – 07.05.20
Topic – Thermal expansion of liquid

❖ Expansion of liquid:

Whenever we heat certain amount of liquid, we take that inside a container and then apply heat. Therefore, while the liquid expands, simultaneously the container containing that liquid, also expands. As a result the inner space of the container increases, so apparently the amount of liquid inside the container seems less than the actual amount. And what amount it seems at that condition, is known as the apparent volume of liquid inside the container. But actually it will be more than that.

Hence, the apparent expansion becomes less than real expansion.

Therefore, we get two types of volume expansion in case of liquid –

a) Apparent expansion of liquid

And

b) Real expansion of liquid

And the most important concept here to remember is then –

Real expansion of liquid is = Apparent expansion of liquid + Volume expansion of the container

Then,

Real expansion coefficient = Apparent expansion coefficient + Expansion coefficient of container

$\Rightarrow \gamma_r = \gamma_a + \gamma_c$

And hence, $\gamma_r > \gamma_a$ always for any liquid.

- S.I. Unit of γ_r , γ_a and γ_c are same which is $\Rightarrow /K$ or K^{-1}
- C.G.S Unit of γ_r , γ_a and γ_c are same which is $\Rightarrow$ /°C or $°C^{-1}$
- **Note –** the real expansion and the expansion of the container are constant for a particular liquid and a container. But the apparent expansion depends upon the relative values of expansion of liquid and the expansion of container. E.g, for a certain change in temperature, the apparent expansion of certain amount of water in a glass container and in a copper container will be different as the expansion rate of glass and copper are different.

  But, in both the cases, the real expansion of water will be same.

Therefore, γ_a depends on the relative values of γ_r and γ_c .

❖ Important Questions and Answers

➢ Very short answer questions (each of 1 mark)

1. Between apparent and real expansion coefficients of a liquid which one is its own characteristic ? – WBBSE, 2017
   Ans: Between apparent and real expansion coefficients of a liquid, real expansion coefficient is its own characteristic.

2. The real expansion of any liquid depends on the expansion of the vessel in which it is kept – write True or False. – WBBSE 2018
   Ans: False.

3. What is the SI unit of apparent expansion coefficient of any liquid?
   Ans: $/K$ or K^{-1}

4. For any liquid γ_r $can\ be\ less\ than\ \gamma_a$. – write True or false.
   Ans: False

5. Write down the relation connecting the real expansion coefficient and apparent expansion coefficient of liquid.
   Ans: Real expansion coefficient = Apparent expansion coefficient + Expansion coefficient of container

   $\Rightarrow \gamma_r = \gamma_a + \gamma_c$

➢ Short answer questions (each of 2 marks)

1. How many types of expansion coefficients do liquid posses?
   Ans: Two types – i) Apparent expansion coefficient and ii) Real expansion coefficient

2. Why do liquids have two types of volume expansion coefficients?
   Ans: Whenever we heat certain amount of liquid, we take that inside a container and then apply heat. Therefore, while the liquid expands, simultaneously the container containing that liquid, also expands. As a result the inner space of the container increases, so apparently the amount of liquid inside the container seems less than the actual amount. And what amount it seems at that condition, is known as the apparent volume of liquid inside the container. But actually it will be more than that.
   Hence, the apparent expansion becomes less than real expansion.
   Therefore, we get two types of volume expansion and hence two types of expansion coefficients in case of liquid –
   Apparent expansion of liquid And Real expansion of liquid

3. Define apparent expansion coefficient of a liquid.
   Ans: It is defined as the apparent expansion of the liquid over the unit initial volume, per degree rise in temperature.

4. Define real expansion coefficient of a liquid.
   Ans: It is defined as the real expansion of the liquid over the unit initial volume, per degree rise in temperature.

5. The real expansion coefficient of Ethyl Alcohol is $11 \times 10^{-4}/℃$. If it is heated in a silver container of volume expansion coefficient $36 \times 10^{-6}/℃$, then what will be the apparent expansion coefficient of Ethyl Alcohol in that container?
   Ans: we know, $\gamma_r = \gamma_a + \gamma_c$
   Then, $\gamma_a = \gamma_r - \gamma_c$
   $= (11 \times 10^{-4} - 36 \times 10^{-6})/℃ = 10.64 \times 10^{-4}/℃$

6. Write down the factors on which the real expansion coefficient of a liquid depends.
   Ans: It depends only on the nature of the material and it is independent of the initial volume, temperature difference, or the nature of the container.

7. Write down the factors on which the real expansion of a liquid depends.
   Ans: Real expansion of the liquid depends on – i) the initial volume ii) the temperature difference and iii) the nature of the liquid i.e. the real expansion coefficient of the liquid.

8. Write down the factors on which the apparent expansion coefficient of a liquid depends.
   Ans: It depends on i) the nature of the liquid i.e. on γ_r and ii) the nature of the container i.e. on γ_c

9. Write down the factors on which the apparent expansion of a liquid depends.
   Ans: it depends on – i) initial volume ii) temperature difference iii) the nature of the liquid i.e. on γ_r and iv) the nature of the container i.e. on γ_c

10. The three expansion coefficients in case a liquid are given as $36 \times 10^{-6}/℃$, $12 \times 10^{-4}/℃$ and $12.36 \times 10^{-4}/℃$. Identify γ_r , γ_a *and* γ_c.
    Ans: Among the three, $12.36 \times 10^{-4}/℃$. is the largest. As γ_r is the sum of other two, so it should be largest. Then , $\gamma_r = 12.36 \times 10^{-4}/℃$.

    Among remaining two, $12 \times 10^{-4}/℃$ is greater. Now, the expansion coefficient of a liquid is definitely greater than that of a solid container. So, $\gamma_a = 12 \times 10^{-4}/℃$
    Hence, $\gamma_c = 36 \times 10^{-6}/℃$.
    And obviously, $\gamma_r = \gamma_a + \gamma_c$ is satisfied.

_____End_____

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