THERMAL EXPANSION OF LIQUIDS

SYNOPSIS

INTRODUCTION:

- Liquids do not have a shape of their own. They assume the shape of the container.
- Linear and superficial expansions have no meaning for liquids.
- As liquids possess definite volume, they experience volume expansion only.

COEFFICIENT OF REAL EXPANSION(γ_r):

- The actual expansion of the liquid is called real or absolute expansion of liquid.
- The real expansion of liquid depends on
  a) Initial volume of liquid
  b) Rise in temperature
  c) Nature of liquid
- The real increase in volume per unit original volume per 1^0C rise in temperature is called coefficient of real expansion

$$\gamma_r = \gamma_{real} = \frac{V_2 - V_1}{V_1(t_2 - t_1)} \ /^0 C$$

$$\Rightarrow V_2 = V_1[1 + \gamma_r(\Delta t)]$$

- % Change in volume of liquid $= \gamma_r(t_2 - t_1) \times 100$.

COEFFICIENT OF APPARENT EXPANSION(γ_a):

- When a liquid is heated both liquid and its container expand. Though the expansion of the liquid is many times more than that of solid container, still the observed expansion of liquid is less than the actual expansion it had.
- The expansion of liquid relative to the container is called visible or apparent expansion.
- The apparent expansion of liquid depends on
  a) Initial volume of liquid.
  b) Rise in temperature.
  c) Nature of liquid.
  d) Nature of material of container.
- The apparent increase in volume per unit original volume per 1^0C rise in temperature is called coefficient of apparent expansion of liquid.

$$\gamma_a = \gamma_{app} = \frac{V_2 - V_1}{V_1(t_2 - t_1)} \ /^0 C$$

$$\Rightarrow V_2 = V_1[1 + \gamma_{app}(\Delta t)]$$

RELATION BETWEEN γ_r AND γ_a:

- The coefficient of real expansion of a liquid is equal to the sum of coefficient of apparent expansion of the liquid and coefficient of volume expansion of the vessel.

$$\gamma_r = \gamma_{app} + \gamma_{vessel} = \gamma_{app} + 3\alpha_{vessel}$$

- If $\gamma_r > \gamma_{vessel}$, the level of liquid in the vessel rises.
- If $\gamma_r = \gamma_{vessel}$, the level of liquid in the vessel remains stationary.
- If $\gamma_{real} < \gamma_{vessel}$, the level of liquid in the vessel will fall.
- If the same liquid is heated in two vessels X and Y then $\gamma_r = \gamma_{ax} + 3\alpha_x = \gamma_{ay} + 3\alpha_y$

$$\Rightarrow \gamma_{ax} - \gamma_{ay} = 3(\alpha_y - \alpha_x)$$

- Here γ_{ax}, γ_{ay} denote coefficients of apparent expansion in vessels X and Y.
- α_x and α_y are coefficients of linear expansion of vessels X and Y.

VARIATION OF DENSITY OF LIQUID WITH TEMPERATURE:

- The density of a liquid decreases with increase in temperature. For calculating the change in density the coefficient of real expansion of the liquid is to be considered.

  $d_0 = d_t(1+\gamma_r t)$ or $d_t = d_0(1-\gamma_r t)$

  where, d_0 = density of liquid at 0^0C

  d_t = density of liquid at t^0C

  γ_r = Coefficient of real expansion of liquid
- If d_1 and d_2 are the densities of liquid at temperatures t_1 and t_2

  $d_1 = d_2[1+\gamma(t_2 - t_1)]$
- If d_0 and d_t are densities of liquid at $0^0 C$ and $t^0 C$, then $\gamma_r = \frac{d_0 - d_t}{d_t \times t}$ (or) γ_r ; $\frac{d_0 - d_t}{d_0 \times t}$
- If d_1 and d_2 are densities of liquid at $t_1{}^0 C$ and $t_2{}^0 C$, then $\gamma_r = \frac{d_1 - d_2}{d_2 t_2 - d_1 t_1}$ (or) γ_r ; $\frac{d_1 - d_2}{d_1 t_2 - d_2 t_1}$

- The temperature at which the density of liquid is x% less than that at 0^0C is $\left(\frac{x}{(100-x)\gamma_r}\right){}^0C$
- The temperature at which the density becomes x% of the density at 0^0C is $\left(\frac{100-x}{x\gamma_r}\right){}^0C$
- The temperature at which the density of liquid is $\frac{1}{x}$ times of its density at 0^0C is $\left(\frac{x-1}{\gamma_r}\right){}^0C$

DETERMINATION OF γ_{app} OF A LIQUID:

- From specific gravity bottle method, the coeffcient of apparent expansion of liquid is

$$\gamma_{app} = \frac{\text{mass of the expelled liquid}}{\text{Mass of the remaining liquid x temp diff}}$$

$$\Rightarrow \gamma_{app} = \frac{m_1 - m_2}{m_2(t_2 - t_1)} /{}^0C$$

where, m_1 = mass of liquid before heating

m_2 = mass of liquid after heating

t_1 = initial temperature of liquid

t_2 = final temperature of liquid

- $$\gamma_{app} = \frac{(w_2 - w_3)}{(w_3 - w_1)(t_2 - t_1)} /{}^0C$$

w_1 = Weight of the empty specific gravity bottle

w_2 = Weight of the specific gravity bottle filled with liquid at $t_1{}^0$ C.

w_3 = Weight of the Specific gravity bottle filled with liquid at $t_2{}^0$C.

- If mass of the liquid expelled is equal to 1/x th of the remaining mass, then

$$\gamma_a = \frac{1}{x(t_2 - t_1)}$$

- If mass of the liquid expelled is 1/x th of the initial mass, then $\gamma_a = \frac{1}{(x-1)(t_2 - t_1)}$

VOLUME OF UNOCCUPIED SPACE REMAINS SAME AT ALL TEMPERATURES:

- When a liquid is taken in a container and heated, the unoccupied volume over the liquid remains constant at all temperatures if

$$V_c\ \gamma_c = V_l\ \gamma_l$$

- where V_c and V_l are the volumes of the container and the liquid respectively.
- γ_c And γ_l are the coefficient of volume expansion of container and coefficient of real expansion of the liquid.
- The coefficient of real expansion of mercury is seven times that of glass approximately. Therefore for the unoccupied volume over liquid in a glass vessel to remain constant at all temperatures is

$$\frac{V_l}{V_c} = \frac{1}{7}$$

VOLUME OF LIQUID EXPELLED:

- A container of volume V_c at temperature $t_1{}^0C$ is completely filled with a liquid. If the container is heated to $t_2{}^0C$, then volume of liquid overflown is $\Delta V_l = (V_2)_l - (V_2)_c = (\gamma_l - \gamma_c)V_c(t_2 - t_1)$

APPARENT WEIGHT OF A SOLID IMMERSED IN LIQUID:

- When a body is immersed in a liquid its weight decreases.
- The apparent weight of the body, W=V(d-s) g.
  where d= density of solid
  s= density of liquid
  V= volume of solid .
- When temperature is increased, density of the liquid decreases more than that of solid. Hence apparent weight of solid immersed in liquid increases.

CONCEPTUAL QUESTIONS

1. Expansion of liquids on heating is different from that solids, since the expansion of liquids is
   1) much more than solids because molecular spacing in them is less
   2) much more than solids because molecular spacing in them is more
   3) much less than solids because molecular spacing in them is more.
   4) much less than solids because molecular spacing in them is less

2. If the temperature rise is measured in Fahrenheit scale instead of the centigrade scale, the numerical value of co-efficient of real expansion of liquid is
1. remains same 2. decreased
3. increased
4. depends upon the nature of the liquid

3. Real expansion of liquid is
1. Independent on expansion of the vessel.
2. Dependent on expansion of the vessel.
3. Independent on nature of the liquid.
4. Depends on both nature of the liquid and vessel.

4. A liquid with co-efficient of real volume expansion (γ) is filled in container of material having co-efficient of linear expansion (α). If liquid over flows on heating.
1. $\gamma = 3\alpha$ 2. $\gamma>3\alpha$
3. $\gamma<3\alpha$ 4. $\gamma=\alpha$

5. On heating a liquid of co-efficient of real expansion α in a container having coefficient of linear expansion $\frac{\alpha}{3}$. The level of liquid in the container will
1. rise 2. fall
3. remain 4. over flows

6. A long cylindrical vessel of volume V and co-efficient of linear expansion α contains a liquid. The level of liquid has not changed on heating. The co-efficient of real expansion of the liquid is.
1. $\frac{V-\alpha}{V}$ 2. $\frac{V+\alpha}{V}$ 3. . $\frac{V}{V-\alpha}$ 4. 3α

7. The liquid whose co-efficient of real expansion is equal to 1.5 times the co-efficient of areal and heated then the level of the liquid taken in the container
1. Rises 2. Falls
3. Remains same 4. First rises and then falls

8. By increasing the temperature of a liquid its
1. Volume and density decreases
2. volume and density increases
3. volume increases and density decreases
4. volume decreases and density increases

9. Density of liquid at any temperature 't' is given by $d_t = d_0\,[1-\gamma t]$. This equation applies to
1. all liquids 2) only water
3) no liquid
4) all liquids except mercury

10. Co-efficient of apparent expansion of a liquid can be experimentally determined by using
1) Pyknometer 2) Specific gravity bottle
2) Weight thermometer 4) all the above

11. A metal ball suspended from the hook of a spring balance is kept immersed in a liquid other than water. On increasing the temperature of this liquid, the reading in the spring balance.
1) increases 2) decreases
3) remains same
4) may increases or decreases.

12. A metal ball immersed in alcohol weights W_1 at 0^0C and W_2 at 50^0 C Assuring that the density of the metal is large compared to that of alcohol then.
1. $W_1 = W_2$ 2. $W_1>W_2$
3. $W_1< W_2$ 4. $W_1 \geq W_2$

13. A block of wood is floating on water at 20^0C with certain volume x above the water level. The temperature of water is slowly increased the volume x.
1. increases. 2. decreases
3. remains same
4. first decreases and then increases.

14. A small stone is inside a ice block which floats in water. When the ice fully melts the level water
1. increases 2. decreases
3. dose not change
4. first decreases and then increases

15. Water in closed rectangular tube with left arm vertically placed above the arc lamp is heated
1. Water will begin to circulate in anticlockwise direction.
2. Water will begin to circulate in clockwise direction.
3. Water will not circulate but heats up
4. Water will oscillate in clockwise and anticlock wise directions.

16. The apparent coefficient of expansion of a liquid depends upon
1. The nature of the liquid
2. The nature of the vessel in which it is heated
3. Both (1) and (2) 4. None of the above

KEY

01. 2	02. 2.	03. 1	04. 2	05. 3
06. 4	07. 3	08. 3	09. 1	10. 4
11.1	12.3	13.2	14.2	15. 2
16.3				

LEVEL - I

1. The liquid with co-efficient of real expansion of $27 \times 10^{-6}\ /^0$ C is heated in a vessel with the co-efficient of linear expansion $9 \times 10^{-6}/^0$C. The level of the liquid
1. Rises 2. Falls
3. Remains same 4. First falls then rises

2. The co- efficient of real expansion γ_R of a liquid is 5 times the co-efficient of linear expansion of the material of the container in which the liquid is present. The ratio of the co-efficient of apparent expansion and real expansion of the liquid is
1. 5:2 2. 1:5 3. 2:5 4. 5:1

3. The co-efficient of real expansion of liquid is γ_r and the co-efficient of apparent expansions of the liquid is γ_a. The co-efficient of cubical expansion of the vessel is γ. If $\gamma_r : \gamma_a$ =4:1 then $\gamma_a : \gamma$ is
1. 3;1 2. 1:3 3. 4:1 4. 1:4

4. The co-efficient of real expansion of a liquid is $7x10^{-4}/^0$ C. The co efficient of linear expansion of the vessel is $1x10^{-4}/^0C$. The co-efficient of apparent expansion of the liquid is
1. $7x10^{-4}/^0C$. 2. $6x10^{-5}/^0C$.
3. $67x10^{-5}/^0C$. 4. $73x10^{-5}/^0C$.

5. The co-efficient of apparent expansion of a liquid is $30x10^{-6}/^0C$. It is kept in a vessel whose co-efficient of superficial expansion is $1.8x10^{-5}/^0C$. The co-efficient of real expansion of the liquid is
1. $22x10^{-6}/^0C$. 2. $5.7x10^{-6}/^0C$.
4. $1x10^{-4}/^0C$. 4. $2.2x10^{-5}/^0C$.

6. The co-efficient of linear expansion of glass is $8x10^{-6}/^0C$ and the co-efficient of real expansion of mercury is $180x10^{-6}/^0C$. The co-efficient of apparent expansion of mercury in glass vessel is
1. $204x10^{-6}/^0C$. 2. $7.5x10^{-6}/^0C$.
3. $18x10^{-5}/^0C$. 4. $156x10^{-6}/^0C$.

7. For a liquid, when heated in a vessel it is found that $\gamma_a = \frac{6}{7}\gamma_r$. The co-efficient of linear expansion of the vessel is
1. $\frac{\gamma_r}{21}$ 2. $\frac{\gamma_r}{11}$ 3. $\frac{\gamma_r}{12}$ 4. $\frac{\gamma_r}{14}$

8. The density of a liquid at 100^0C is 8.0 gm/cm^3 and at 0^0C is 8.4 gm/cm^3, the coefficient of cubical expansion of the liquid is
1. 10^{-4} / $^0C^{-1}$ 2. $5x10^{-4}$/ $^0C^{-1}$
2. $8x10^{-4}$/ $^0C^{-1}$ 4. $4x10^{-4}$/ $^0C^{-1}$

9. The coefficient of real expansion of a liquid is $0.2x10^{-3}/^0C$ if its density at 0^0C is 10 gm/c.c. Then its density at 100^0C is
1. 9.8gm/c.c. 2. 980 gm /c.c.
3. 0.98 gm/c.c. 4. 10.2 gm/c.c.

10. A specific gravity bottle can hold 101 gm of a liquid at 0^0C and 100 gm at 100^0C. The co-efficient of apparent expansion of the liquid is
1. $1x10^{-3}/^0C$ 2. $1x10^{-6}/^0C$
3. $1x10^{-5}/^0C$ 4. $1x10^{-4}/^0C$

11. A specific gravity bottle contains 51 gm at 20^0C. When it is heated to 100^0C one gram of the liquid over flows. The co-efficient of apparent expansion of the liquid is
1. $4x10^{-5}$ $/^0C$ 2. $25x10^{-4}/^0C$
3. $25x10^{-5}/^0C$ 4. $8x10^{-5}$ $/^0C$

12. A weight thermometer contains 52 gms of a liquid at 10^0C. When it is heated to 110^0C, 2 gm of the liquid is expelled. The co-efficient of real expansion of the liquid is [α of glass is $9x10^{-6}/^0C$]
1.$27x10^{-6}/^0C$ 2. $427x10^{-6}/^0C$
3. $373x10^{-6}/^0C$ 4. 0

13. A specific gravity bottle contains liquid of masses 21 gms and 20 gms at 50^0C and 100^0C respectively. The coefficient of apparent expansion of liquid is
1. $10x10^{-4}/^0C$ 2. $10^{-4}/^0C$
3. $10^{-5}/^0C$ 4. $10^{-6}/^0C$

14. A weight thermometer contains 51 gms of mercury at 20^0C and 50 gms of mercury at 100^0C. The coefficient of apparent expansion of mercury in glass vessel is
1. $25x10^{-5}/^0C$ 2. $2.5x10^{-3}/^0C$
3. $2x10^{-5}/ ^0C$ 4. $4x10^{-4}/^0C$

15. A specific gravity bottle contains 510 gms of liquid at 0^0 C. When heated to 100^0C it is found that 10 gms of liquid overflows. The coefficient of apparent expansion of liquid is
1. $20x10^{-5}$ $/^0C$ 2. $0.2x10^{-5}$ $/^0C$
3. $20x10^{-4}/^0C$ 4. $200x10^{-4}/^0C$

16. A one liter flask contains some mercury. It is found that at different temperatures the volume of air inside the flask remain same. The volume of mercury taken in the flask is (Co-efficient of linear expansion of glass is $9x10^{-6}/^0C$ and coefficient of volume expansion of Hg is $1.8x10^{-4}/^0C$).
1. 150ml 2. 750 ml 3. 1000 ml. 4. 700 ml

KEY

01. 3	02. 3	03. 2	04. 3	05. 3
06. 4	07. 1	08. 2	09. 1	10. 4
11. 3	12. 2	13. 1	14. 1	15. 1
16. 1				

LEVEL-II

1. A vessel is half filled with a liquid at 0^0C. When then vessel is heated to 100^0C the liquid occupies 3/4 volume of the vessel. Coefficient of apparent expansion of the liquid is
1. $0.5/^0C$ 2. $0.05/^0C$
3. $0.005/^0C$ 4. $0.0005/^0C$

2. The ratio of co-efficients of apparent expansions of the same liquid in two different vessels is 1:2. If α_1 and α_2 are the coefficient of linear expansions then coeffcient of real expansion of the liquid is
1. $2\alpha_1 - \alpha_2$ 2. $3\alpha_1 - 4\alpha_2$
3. $\alpha_2 - 2\alpha_2$ 4. $6\alpha_1 - 3\alpha_2$

3. The ratio of coefficient of apparent expansions of a liquid in the containers A and B is 1:2. If $18x10^{-6}/^0C$ and $12x10^{-6}/^0C$ are the co-efficients of linear expansions of the containers A and B respectively, then the coefficient of real expansion of the liquid is

1. $24x10^{-6}/^0C$ 2. $6x10^{-6}/^0C$
3. $72x10^{-6}/^0C$ 4. $30x10^{-6}/^0C$

4. The co-efficient of apparent expansion of a liquid in a vessel A is $18x10^{-4}/^0C$. The difference in the coefficients of linear expansions of A and B is

1. $1x10^{-3}/^0C$ 2. $1x10^{-6}/^0C$
3. $1x10^{-5}/^0C$ 4. $1x10^{-4}/^0C$

5. The sum and difference of the coefficient of real and apparent expansion of a liquid are in the ratio 2:1. The ratio of the coefficient of real expansion and apparent expansion must be

1. 1:1 2. 2:3 3. 3:1 4. 6:5

6. If coefficient of real expansion of a liquid is $\frac{1}{5500}/^0C$. The temperature at which its density is 1% less than density at 0^0C is

1. 55.5^0C 2. 100^0C 3. 99^0C 4. 1^0C

7. A boat is floating in water at 0^0 C such that 97% of the volume of the boat is submerged in water. The temperature at which the boat will just completely sink in water is

1. 10^0C 2. 100^0C 3. 60^0C 4. 50^0C

8. A solid floats in a liquid at 20^0C with 75% of it immersed in a liquid. When the liquid is heated to 100^0C the same body floats with 80% of it immersed in the liquid. The coefficient of real expansion of the liquid is

1. $8x10^{-4}/^0C$ 2. $8.33x10^{-4}/^0C$
3. $8.33x10^{-5}/^0C$ 4. $8x10^{-5}/^0C$

9. A body is floating in water at 4^0C such that 0.98 of its total volume is immersed in water. If the coefficient of real expansion of water is $3.3x10^{-4}/^0C$. The temperature at which the body gets immersed completely is

1. 32.8^0C 2. 28.4^0C
3. 65.8^0C 4. 72.4^0C

10. A specific gravity bottle contains m grams of liquid of apparent expansion γ_a at 0^0C. When it is heated to t^0 C the mass of liquid expelled is

1. $\frac{1+\gamma_a t}{\gamma_a mt}$ 2. $\frac{\gamma_a m}{1+\gamma_a t}$ 3. $\frac{\gamma_a mt}{1+\gamma_a t}$ 4. $\frac{\gamma_a mt}{1-\gamma_a t}$

11. The coefficient of apparent expansion of mercury in glass is $\frac{1}{6400}/^0C$. A glass bulb at 0^0C is completely filled with mercury. The mass of mercury is 260 g. The glass bulb is heated to 100^0C. mass of the mercury over flown will be.

1. $\frac{1}{2}gm$ 2. $\frac{1}{4}gm$ 3. $\frac{1}{3}gm$ 4. 4gm

12. When 52 gm of a liquid in a vessel is heated from 0^0C to 100^0C, 2gm of liquid is expelled. If 104 gm of liquid is taken in a vessel made of same material, the mass of the liquid expelled on heating from 0^0C to 100^0C is

1. 4gms 2. 3 gms 3. 8 gms 4. 1 gms

13. The loss in weight of a solid when immersed in a liquid at 0^0C is w_0 and at t^0 C is 'W'. If cubical coefficient of expansion of the solid and the liquid are γ_s and γ_l then W=

1. $W_0\left[1+(\gamma_s-\gamma_l)t\right]$ 2. $W_0\left[1-(\gamma_s-\gamma_l)t\right]$
3. $W_0\left[(\gamma_s-\gamma_l)t\right]$ 4. $\frac{W_0 t}{\gamma_s-\gamma_l}$

14. A vessel of volume 1 liter is filled with a liquid whose coefficient of volume expansion is 20 times as that of the vessel. At all temperatures if volume of air above the liquid is constant the volume of that empty space is

1. 950 c.c 2. 50 c.c.
3. 1000 c.c. 4. 500 c.c.

15. A vessel contains a liquid filled upto $\frac{1}{10}$ th of its volume. Another vessel contains same liquid upto $\frac{1}{8}$ th of its volume. In both cases volume of empty space remains constant at all temperatures. Then the ratio of the coefficients of the cubical expansion of the two vessels is

1. 2:5 2. 5:2 3. 4:5 4. 5:4

HINTS

1. $\gamma_{app}=\frac{\Delta V}{V_1(t_2-t_1)}$

$\Delta V=\frac{3}{4}V-\frac{V}{2}$ $V=\frac{V}{2}$

2. $\gamma_r=x+3\alpha_1$

$\gamma_r=2x+3\alpha_2$

Solve γ_r

4. $\gamma_r = \gamma_{app1} + 3\alpha_1 \qquad \gamma_r = \gamma_{app2} + 3\alpha_2$

find $(\alpha_1 \sim \alpha_2)$

5. use compodendo and dividendo method

6. $\frac{d_0}{d_t} = 1 + \gamma_r t$

7. weight of body $= \frac{97}{100} V d_{Liquidsat^0C}\, g$

$= V d_{Liquidsat^0t}\, g$

$\frac{97}{100} = \frac{d_1}{d_0} = 1 - \gamma_r t$

9. Weight of the body = $0.98 V d_{L4} g = V d_{Lt} g$

$\frac{d_4}{d_t} = [1 + \gamma_r (t-4)]$

10. $\gamma_{app} = \frac{x}{(m-x)t}$

KEY

01. 3	02. 4	03. 3	04. 4	05. 3
06. 1	07. 2	08. 2	09. 3	10. 3
11. 4	12. 1	13. 1	14. 1	15. 3

LEVEL - 3

1. If γ (apparent) of a liquid in a vessel is 76% of γ (real) of that liquid, the coefficient of linear expansion of the vessel is

1. 8% of γ (real) 2. 16% of γ (real)
3. 24% of γ (real) 4. 25.3% of γ (real)

2. If d_1 and d_2 are the densities of a liquid at t_1^0 C and t_2^0 C, then $\frac{d_1}{d_2}$ is (γ = coefficient of real expansion)

1. $\frac{1+\gamma t_1}{1+\gamma t_2}$ 2. $\frac{1-\gamma t_1}{1-\gamma t_2}$ 3. $\frac{1+\gamma t_2}{1+\gamma t_1}$ 4. $\frac{1-\gamma t_2}{1-\gamma t_1}$

3. A solid whose volume does not change with temperature floats in liquid at two different temperatures t_1^0C and t_2^0 C of the liquid. Fractions of the volume of the solid remain submerged are f_1 and f_2 respectively. The coefficient of absolute expansion of the liquid is equal to

1. $\frac{f_1 - f_2}{f_2 t_2 - f_1 t_2}$ 2. $\frac{f_1 - f_2}{f_1 t_1 - f_2 t_2}$
3. $\frac{f_1 + f_2}{f_2 t_1 + f_1 t_2}$ 4. $\frac{f_1 \times f_2}{f_2 t_1 + f_1 t_2}$

4. When a block of iron floats in mercury at 0^0 C, a fraction k_1 of its volume is submerged, while at the temperature 60^0C, a fraction k_2 is seen to be submerged. If the coefficient of volume expansion of iron is γ_{Fe} and that of mercury is $\gamma_{Hg,}$ then the ratio k_1/k_2 can be expressed as

1. $\frac{1+60\gamma_{Fe}}{1+60\gamma_{Hg}}$ 2. $\frac{1-60\gamma_{Fe}}{1+60\gamma_{Hg}}$
3. $\frac{1+60\gamma_{Fe}}{1-60\gamma_{Hg}}$ 4. $\frac{1+60\gamma_{Hg}}{1+60\gamma_{Fe}}$

5. A sphere of mass 266.5g and diameter 7 cm floats on the surface of a liquid. When the liquid is heated to 35^0 C, the sphere sinks in the liquid. If the density of liquid at 0^0 C is 1.527 gcm^{-3}. The coefficient of real expansion of liquid is

1. $8.48 \times 10^{-4} ({}^0C)^{-1}$ 2. $7.88 \times 10^{-4} ({}^0C)^{-1}$
3. $6.48 \times 10^{-4} ({}^0C)^{-1}$ 4. $5.48 \times 10^{-4} ({}^0C)^{-1}$

6. A piece of metal floats on mercury. The coefficients of volume expansion of the metal and mercury are γ_1 and γ_2 respectively. If the temperature of both mercury and metal are increased by an amount Δt, the fraction of the volume of the metal submerged in mercury changes by the factor.

1. $\frac{1}{(\gamma_2 - \gamma_1)\Delta t}$ 2. $\frac{1}{(\gamma_1 - \gamma_2)\Delta t}$
3. $(\gamma_1 - \gamma_2)\Delta t$ 4. $(\gamma_2 - \gamma_1)\Delta t$

7. If γ of a solid container is x% of γ (real) of a liquid, the volume fraction of the container which should be filled with that liquid to keep that unoccupied volume above the liquid in it constant at all temperatures is

1. x^2% 2. (x-1)% 3.(x+1)% 4.x%

8. The coefficient of cubical expansion of liquid and glass are in the ratio of 8:1. The volume of the liquid to be taken into 800 cc container so that the unoccupied portion remains constant is

1.10cc 2. 100cc 3. 80cc 4. 8cc

9. A uniform pressure P is exerted on all sides of a solid cube at temperature t^0 C. By what amount should the temperature of the cube be raised in order to bring its volume back to the original value before the pressure was applied, if the bulk modulus is B and volume coefficients is γ?

1) $\frac{\gamma P}{B}$ 2) $\frac{P}{\gamma B}$ 3) $\frac{B}{\gamma P}$ 4) $\frac{1}{\gamma BP}$

10. Mercury is poured into a glass vessel of height 10 cm. At 10^0 C the level of mercury is 1 mm below the upper edge of the vessel. The coefficient of volume expansion of mercury is 1.82×10^{-4}/K . Neglecting the expansion of the vessel , the mercury can be heated to temperature t^0C without mercury overflowing then t is equal to
1. 56^0C 2. 65^0C 3. 36^0C 4. 82^0C

11. The co-efficient of linear expansion of iron is $\frac{11}{180}$ of volume coefficient of expansion of mercury which is $18\times10^{-5}/^0$C. An iron rod is 10m long at 27^0 C. The length of the rod will be decreased by 1.1 mm when the temperature of the rod changes by
1. 0^0C 2. 10^0C 3. 20^0 C 4. 170^0 C

KEY

01. 1	02. 3	03. 2	04. 1	05. 1
06. 4	07. 4	08. 2	09. 2	10. 2
11. 2				

PREVIOUS EAMCET QUESTIONS

1. The coefficient of apparent expansion of a liquid when determined using two different vessels A and B are γ_1 and γ_2 respectively. If the coefficient of linear expansion of the vessel A is α, the coefficient of linear expansion of the vessel B is **(EAMCET 2002 E)**
1. $\frac{\alpha\gamma_1\gamma_2}{\gamma_1+\gamma_2}$ 2. $\frac{\gamma_1-\gamma_2}{2\alpha}$
3. $\frac{\gamma_1-\gamma_2+\alpha}{3}$ 4. $\frac{\gamma_1-\gamma_2}{3}+\alpha$

2) The densities of a liquid at 0^0C and 100^0C are respectively 1.0127 and 1. A specific gravity bottle is filled with 300gm of the liquid at 0^0C up to the brim and it is heated to 100^0C. Then the mass of the liquid expelled in grams is [Coefficient of linear expansion of glass = $9\times10^{-6}/^0$C] **(EAMCET2003 E)**
1. $\frac{3}{10.1}$ 2. $\frac{3}{1.01}$ 3. $\frac{3.81}{1.0127}$ 4. $\frac{3.81}{0.0127}$

3) At 0^0C the densities of a cork and a liquid in which the cork floats are d_1 and d_2 respectively. The coefficient of expansion for the material of the cork and the liquid are γ and 100 γ respectively. If the cork sinks when the temperature of the liquid is 't^0C' then the ratio $\frac{d_1}{d_2}$ is **(EAMCET 2004 E)**
1) $\frac{1+100\gamma t}{1+\gamma t}$ 2) $\frac{1+\gamma t}{1+100\gamma t}$
3) $\frac{100+\gamma t}{1+\gamma t}$ 4) $\frac{1+\gamma t}{100+\gamma t}$

4) A specific gravity bottle is filled upto the brim with mercury of 400g, at 0^0C. When heated to 90^0C, the mass of the mercury that over flows from the specific gravity bottle is : (Coefficient of apparent expansion of mercury in glass is $\frac{1}{6500}/^0$C) **[2001 M]**
1) 5.46g 2) 6.54g 3) 10.92g 4) 13.08 g

5. When a liquid in a glass vessel is heated, its apparent expansion is $10.30\times10^{-4}/^0$C. Same liquid when heated in a metallic vessel, its apparent expansion is $10.06\times10^{-4}/^0$ C. The coefficient of linear expansion of metal is ($\alpha_{glass} = 9\times10^{-6}/^0$C) **(EAMECT 2K, E)**
1. $51\times10^{-6}/^0$C 2. $43\times10^{-6}/^0$C
3. $25^{-6}/^0$C 4. $17\times10^{-6}/^0$C

6. A glass flask of volume 200cm^3 is completely filled with mercury at 20^0C. The amount of mercury that spit over when the flask is heated to 80^0C (Coefficient of volume expansion of glass is $27\times10^{-6}/^0$ C, γ mercury $0.18\times10^{-3}/^0$C) **[EAMCET '97]**
1) 2.16cm^3 2) 0.032cm^3
3) 1.84cm^3 4) 2.40cm^3

7. The coefficient of real expansion of mercury is $18\times10^{-5}/^0$C. The thermometer bulb has a volume of $10^{-6}m^3$ and the cross section of the stem is 0.002 sq.cm. Assuming that the bulb is filled with mercury at 0^0C, the length of the mercury column at 100^0C will be **[EAMCET '97]**
1) 9 cm 2) 18 cm 3) 9 mm 4) 18mm

8) Coefficient of real expansion of mercury is $0.18\times10^{-3}/^0$C. If the density of mercury at 0^0C is 13.6 gm/cc its density at 473K will be **[EMACET'96]**
1. 13.11 gm/c.c. 2. 13.65gm/c.c.
3. 13.51 gm/c.c. 4. 13.22 gm/c.c.

9) A glass bottle weights 50gm and 1060gm when filled with a liquid. When it at 100^0C, 10gm of the liquid overflows. If $\gamma_r = 2\times10^{-4}/^0$C the co-efficient of linear expansion of the container is
1. $\frac{1}{3}\times10^{-4}/^0C$ 2. $3\times10^{-4}/^0C$
3. $6\times10^{-4}/^0C$ 4. $1\times10^{-4}/^0C$

10) When a liquid taken in along cylindrical vessel of material with linear coefficient of expansion α is heated, the level of liquid did not change. The volume coefficient of expansion of liquid is
1. $\frac{\alpha}{3}$ 2. 3α 3. α 4. α^3

11) The apparent coefficient of expansion of liquid, when heated in a copper vessel is C and when heated in a silver vessel is S. If A is the linear coefficient of expansion of silver is

1. $\frac{C+S-3A}{3}$ 2. $\frac{C+3A-S}{3}$

3. $\frac{S+3A-C}{3}$ 4. $\frac{C+S+3A}{3}$

12) A vertical column of liquid 50 cm long at 50^0C balances another column of same liquid 60cm long at 100^0C. The coefficient of absolute expansion of the liquid is __________

1) $5x10^{-6}/^0$C 2) $5x10^{-3}/^0$C

3) $2x10^{-3}/^0$C 4) $10^{-3}/^0$C

13) A glass bulb of volume 250 c.c. is filled with mercury at 20^0C and the temperature is raised to 100^0C If the coefficient of linear expansion of glass is $9x10^{-6}/^0$C then coefficient of absolute expansion is

1) 3.06 c.c 2) 2.94 c.c.

3) 6.12 c.c. 4) None

14) Density of mercury at 0^0C is 13.6 cm/c.c. and real expansion of mercury at 200^0C is 13.6 gm/c.c. and real expansion of mercury is $1.8x10^{-4}/^0$C. The density of mercury at 200^0C is

1) 13.65gm/cc 2) 13.11gm/cc

3) 13.51gm/cc 4) 13.22gm/cc

15) The density of liquid when heated

1) Deceases 2) increases

3) Does not change

4) May Increase or decrease depending on the pressure.

KEY

01. 4	02. 2	03. 1	04. 1	05. 4
06. 3	07. 1	08. 1	09. 1	10. 2
11. 2	12. 2	13. 1	14. 2	15. 1

NEW MODEL QUESTIONS

1) A liquid of coefficient of real expansion γ is partly filled in a vessel of coefficient of linear expansion $\gamma/3$. When the system is heated, then.

a) The volume of space above liquid remains same.

b) The level of liquid relative to vessel remains same.

c) The fraction of volume of liquid in vessel remains same.

1) Only (a) is correct

2)Only (b) & (c) are correct

3) Only © is true 4) All are true

2. Apparent expansion of a liquid depends upon

a) Nature of liquid b) Nature of vessel

c) Temperature rise d) Scale of temperature

1) Only (a) is true 2) (a) & (b) are true

3) (a) , (b) & (c) are true

4) (a), (b), (c),(d) are true

3. **LIST -I** **LIST -II**

a) App. expansion e) Nature of vessel and liquid

b) Real expansion f) Nature of liquid

c) γ_a g) Nature of Vessel&liquid and temperature

d) γ_r h) Nature of liquid&temp.

1) a-e, b-f, c-g, d-h 2) a-f, b-g, c-h, d-e

3) a-g, b-h,c-e, d-f. 4) a-h, b-e, c-f, d-g.

4. **LIST -I** **LIST - II**

a) Mass of liquid expelled on heating e) $\frac{m_1}{1+\gamma\Delta t}$

b) Corrected Barometric height f) $\frac{d_1-d_2}{d_2\Delta t}$

c) Coefficient of real expansion of liquid g) $\frac{\gamma_a m_1 \Delta t}{1+\gamma_a\Delta t}$

d) Mass of liquid remaining on heating h) $h_0\left[1-(\gamma_r-\alpha)\Delta t\right]$

1) a-g, b-h, c-f, d-e 2) a-h, b-e, c-g, d-h

3) a-e, b-f, c-g, d-h. 4) a-f,b-g, c-h, d-e

5. **LIST -I** **LIST-II**

a) γ_g is +ve & < γ_r e) liquid level does not change

b) γ_g is - ve f) liquid level increases continuosly

c) $\gamma_g = \gamma_r$ g) liquid level decreases.

d) $\gamma_g > \gamma_r$ h) liquid level first decreases and then increases.

1) a-g, b-e, c-f, d-h 2) a-h, b-f, c-e, d-g.

3) a-e, b-f, c-g,d-h 4) a-f, b-g,c-h,d-e

6. **Assertion(A):** It is observed that when a liquid is heated in a vessel its level does not change.

Reason (R): co-efficient of real of the liquid = co- efficient of volume expansion of the vessel

1) Both A and R are true and R is the correct explanation of A

2) Both A & R are true but R is not the correct explanation of A.

3) A is true but R is false

4) A is false but R is true

7. **Assertion(A):** when a liquid with co-efficient of γ is heated in a vessel of coefficient of linier expansion $\frac{\gamma}{3}$, the level of liquid in the vessel re mains un changed.
Reason (R): $\gamma_a = \gamma_r - \gamma_g = \gamma_r - 3\alpha = 0$
1) Both A and R are true and R is the correct explanation of A
2) Both A & R are true but R is not the correct explanation of A.
3) A is true but R is false 4) A is false but R is true

8. **Assertion(A):** Real expansion of liquid does not depend up on material of container.
Reason (R): Liquids have no definite shape. They acquire the mouth of the containers in which they are taken.
1) Both A and R are true and R is the correct explanation of A
2) Both A & R are true but R is not the correct explanation of A.
3) A is true but R is false 4)A is false but R is true

9. **Assertion(A):** A wooden block is floating on a liquid. when the temperature of the liquid is increased the volume of the block immersed in the liquid increases.
Reason (R): As temperature increases, the density of liquid decreases.
1) Both A and R are true and R is the correct explanation of A
2) Both A & R are true but R is not the correct explanation of A.
3) A is true but R is false 4) A is false but R is true

10. **Assertion(A):** when a liquid in a container is heated first the level of the liquid falls down and then rises .
Reason (R): when the liquid in a container is heated first the container undergoes expansion and generally the expansion of the liquid is greater then that of solid .
1) Both A and R are true and R is the correct explanation of A
2) Both A & R are true but R is not the correct explanation of A.
3) A is true but R is false 4) A is false but R is true

11. **Assertion(A):** when a beaker containing liquid is heated the center of mass of the system first falls down then rises up above the initial position.
Reason (R): The liquid in the beaker undergoes expansion on heating and the expansion of liquid is more than that of beaker.
1) Both A and R are true and R is the correct explanation of A
2) Both A & R are true but R is not the correct explanation of A.
3) A is true but R is false 4) A is false but R is true

12. Identify the correct statement from the following:
a) The liquids have two coefficient of expansions as they do not have definite shape and size.
b) The apparent expansion of liquid may be equal to zero.
c) The expansion of liquids is less than the solids.
d) The real expansion of liquids depends on the nature of material of the container.
1) Only a & b are true 2) a,b & c are true
3) a,b & d are true 4) All are true

13. Identify the correct statements from the following:
a) The apparent expansion of liquid depends on the expansion of material of the container
b) The real expansion of the liquids depends on the density of the liquid.
c) The expansion of liquid with respect to the container is called the apparent expansion.
1) Only a & b are true 2) Only b & c are true
3) a,b & c are true 4) Only a & c are true

KEY

01. 2	02. 3	03. 2	04. 1	05. 2
06. 1	07. 1	08. 2	09. 1	10. 1
11. 1	12. 1	13. 3		

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