THERMAL EXPANSION OF MATERIALS
EXPANSION OF SOLIDS
PREVIOUS EAMCET QUESTIONS
ENGINEERING

1. A clock pendulum made of invar has a period of 0.5 sec, at 20^0C. If the clock is used in a climate where the temperature averages to 30^0C, how much time does the clock lose in each oscillation? (For invar, a = $9\times10^{-70}C$, g= constant) **(2009 E)**

1) 2.25×10^{-6} sec 2) 2.25×10^{-7} 3) 5×10^{-7} sec 4) 1.125×10^{-6} sec

Ans : 1

Sol: Loss or gain of time per day = $\frac{1}{2}\propto\Delta t\times86,400$

$= \frac{1}{2}\times9\times10^{-7}\times10\times86,400$

$= 4.5\times10^{-6}\times86,400$

Time lose by the clock in each oscillation

$= \frac{4.5\times10^{-6}\times86,400}{86,400}\times0.5 = 2.25\times10^{-6}S$

2. One litre of oxygen at a pressure of 1 atm and two litres of nitrogen at a pressure of 0.5 atm. are introduced into a vessel of volume 1 litre. If there is no change in temperature, the final pressure of the mixture of gas (in atm) is **(2008 E)**

1) 1.5 2) 2.5 3) 2 4) 4

Ans : 3

Sol: Resultant pressure = $\frac{P_1V_1+P_2V_2}{V_1+V_2}=\frac{1\times1+0.5\times2}{1}=2$

3. There is some change in length when a 33000 N tensile force is applied on a steel rod of area of cross-section 10^{-3} m^2. The change of temperature required to produce the same elongation if the steel rod is heated, is (The modulus of Elasticity is N/m^2 and the coefficient of linear expansion of steel is). **(2008 E)**

1) 20^0C 2) 15^0C 3) 10^0C4) 0^0C

Ans : 3

Sol: Thermal force = $yA\propto\Delta t\Rightarrow\Delta t=\frac{F}{yA\alpha}$

$=\frac{33000}{3\times10^{11}\times10^{-3}\times1.1\times10^{-5}}$

= 10^0C

4. A pendulum clock gives correct time at 20°C at a place where g = 10 m/s^2. The pendulum consists of a light steel rod connected to a heavy ball. If it is taken to a different place where g = 10.01 m/s^2, at what temperature the pendulum gives correct time ? (α of steel is 10^{-5}/°C)

1) 30 °C 2) 60 °C 3) 100 °C 4) 120 °C

Ans : 4

Sol: Time period of simple pendulum T = $2\pi\sqrt{\frac{l}{g}}$

$$\Rightarrow \frac{L_1}{g_1} = \frac{L_2}{g_2}$$

But L_2 = L_1 $\left(1+\alpha\left(t_2 - t_1\right)\right)$

$$\Rightarrow \frac{L_1}{g_1} = \frac{L_1\left[1+\alpha\left(t-20\right)\right]}{g_2}$$

$$\Rightarrow \alpha\left(t-20\right) = \frac{10.01}{10} - 1$$

$$\therefore t = 120^0 C$$

5. Two gases A and B having same pressure P, volume V and absolute temperature T are mixed. If the mixture has the velocity and temperature as V and T respectively, then the pressure of the mixture is

1) 2P 2) P 3) P/2 4) 4P [2007]

Ans : 1

Sol: At constant temperature, Resultant pressure = $P_R = \frac{P_1V_1 + P_2V_2}{V_1 + V_2} = \frac{PV + PV}{V} = 2P$

6. The temperature of a thin uniform circular disc, of one metre diameter is increased by 10°C. The percentage increase in moment of inertia of the disc about an axis passing through its centre and perpendicular to the circular face (linear coefficient of expansion = 11×10^{-6}/°C) [2006]

1) 0.0055 2) 0.011 3) 0.022 4) 0.044

Ans : 3

Sol: For circular disc $I = \frac{MR^2}{2}$

Percentage increase in moment of inertia = $\frac{I_2 - I_1}{I_1} \times 100$

$$= \left(\frac{R_2^2 - R_1^2}{R_1^2}\right) \times 100$$

But $R_2 = R_1\left(1+\alpha t\right)$

Squaring on both sides

$$\left(\frac{I_2 - I_1}{I_1}\right) \times 100 = \frac{\left[R_1\left(1+\alpha t\right)\right]^2 - \left(R_1^2\right)}{R_1^2} \times 100$$

$$= \frac{R_1^2(1+2\alpha t)-R_1^2}{R_1^2}\times 100$$

$$= 2\alpha t\times 100$$

$$= 2\times 11\times 10^{-6}\times 10\times 100 = 0.022$$

7. The relation between the coefficient of real expansion (γ_r) and coefficient of apparent expantion (γ_a) of a liquid and the coefficient linear expantion (α_g) of the material of the container is: [EAMCET'05]

1) $\gamma_r = \alpha_g + \gamma_\alpha$ 2) $\gamma_r = \alpha_g + 3\gamma_\alpha$ 3) $\gamma_r = 3\alpha_g + \gamma_\alpha$ 4) $\gamma_r = 3(\alpha_g + \gamma_\alpha)$

Ans: 3

Sol: $r_r = r_a + r_g = r_a + 3\alpha_g$

[Since $r_g = 3\alpha_g$]

8. The difference between volume and pressure coefficient of an ideal gas is : [2005]

1) 1/273 2) 273 3) 2/273 4) zero

Ans :

Sol: $\alpha = \beta$ for any ideal gas

$$\therefore \alpha - \beta = 0$$

9. The type of a motor car contains air at 15^0C. If the temperature increases to 35^0C, the approximate percentage increase in pressure is (ignore the expansion of tyre) **(2005 E)**

1) 7 2) 9 3) 11 4) 13

Ans : 1

Sol: As $P \propto T$ from Charles law

$$\therefore \frac{P_2}{P_1} = \frac{T_2}{T_1} \Rightarrow \left(\frac{P_2 - P_1}{P_1}\right)\times 100 = \left(\frac{T_2 - T_1}{T_1}\right)\times 100$$

$$\Rightarrow \frac{\Delta P}{P}\times 100 = \frac{20}{298}\times 100 = 7$$

10. A metallic solid sphere is rotating about is diameter as axis of rotation. If the temperature is increased by 200^0C, the percentage increased in its moment of inertia is (coefficient of linear expansion of the metal = $10^{-5}/^0$C) **[2004 E]**

1. 0.1 2. 0.2 3. 0.3 4. 0.4

Ans : 4

Sol: Percentage increase in moment of inertia = $\left(\frac{I_2 - I_1}{I_1}\right)\times 100$

Given $I_1 = MR_1^2$, $I_2 = MR_2^2$

$$\Rightarrow \frac{I_2 - I_1}{I_1}\times 100 = \left(\frac{R_2^2 - R_1^2}{R_1^2}\right)\times 100$$

But $\Rightarrow R_2 = R_1(1+\propto t)$

Squaring on both sides

$$\Rightarrow \frac{I_2 - I_1}{I_1}\times 100 = \left(\frac{R_1^2(1+2\alpha t) - R_1^2}{R_1^2}\right)\times 100$$

= $2\propto t\times 100$

= $2\times 10^{-5}\times 200\times 100$

= 0.4

11. 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 = $9x10^{-6}/^0C$] **(2003 E)**

1. $\frac{3}{10.1}$ 2. $\frac{3}{1.01}$ 3. $\frac{3.81}{1.0127}$ 4. $\frac{3.81}{0.0127}$

Ans: 2

Sol: We know that $d_0 = d_t[1+r_r t] \Rightarrow r_r = \frac{d_0 - d_t}{d_{t.}t}$

$$\therefore r_r = \frac{0.0127}{1.0127\times 100} = 125\times 10^{-6}/C^0$$

$$r_a = r_r - 3\alpha_g = 125\times 10^{-6}/C^0$$

$$= 98\times 10^{-6}/C^0$$

$$r_a = \frac{mass\ of\ liquid\ \exp elled}{mass\ of\ remaining\ liquid \times rise\ in\ temp.}$$

On solving we get

$$r_a = \frac{3}{1.01}$$

12. A horizontal uniform glass tube of 100 cm . length sealed at both ends contains 10 cm mercury column in the middle. The temperature and pressure of air on either side of mercury column are respectively 31°C and 76 cm of mercury. If the air column at one end is kept at 0°C are the other end at 273°C, the pressure of air which is at 0°C is (in cm of Hg) **(2003 E)**

1) 76 2) 88.2 3) 102.4 4) 122

Ans: 3

Sol: From gas law $\frac{PV}{T}$ = constant

$$\frac{l_2}{T_2} = \frac{l_3}{T_3} \Rightarrow \frac{90-x}{273} = \frac{x}{546}$$

$$\therefore x = 60cm$$

$$l_2 = 90 - 60 = 30cm$$

From ideal gas equation

$$\frac{P_1V_1}{T_1}=\frac{P_3V_3}{T_3}\Rightarrow\frac{P_1l_1}{T_1}=\frac{P_3\times l_3}{T_3}$$

$$\Rightarrow\frac{76\times45}{304}=\frac{P_3\times60}{546}$$

$$\Rightarrow P_3=102.40 \text{ cm of Hg}$$

13. 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 **(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. $\frac{\gamma_1-\gamma_2}{3}+\alpha$

Ans: 4

Sol:

$$\gamma_{real}=r_{app}+3\alpha$$

$$\therefore\gamma_1+3\alpha=\gamma_2+3\alpha$$

$$\Rightarrow 3\alpha_1=\gamma_1-\gamma_2+3\alpha$$

$$\therefore\alpha_1=\frac{\gamma_1-\gamma_2}{3}+\alpha$$

14. The mass of oxygen gas occupying a volume of 11.2 lit at a temperature 27^{0}C and a pressure of 76mm of mercury in Kilo grams is (molecular weight of oxygen = 32)

1. 0.001456 2. 0.01456 3. 0.1456 4. 1.1456 **(2002 E)**

Ans: 2

Sol:

PV= nRT

$$\therefore P(22.4)=1\times R\times273 \text{ ……………………..(1)}$$

$$P(11.2)=n\times R\times300 \text{ ……………………..(2)}$$

From (1) and (2)

$$\frac{22.4}{11.2}=\frac{273}{n(300)} \qquad \therefore n=\frac{91}{200}$$

$$\therefore \text{ mass }=\frac{91}{200}(32)=14.56 \text{ gm}$$

= 0.01456 kg

15. A closed hollow insulated cylinder is filled with gas at 0^{0}C and also contains an insulated piston of negligible weight and negligible thickness at the middle point. The gas at one side of the piston is heated to 100 ^{0}C.If the piston moves 5cm, the length of the hollow cylinder is (2001)

1) 13.65cm 2) 27.3cm 3) 38.6cm 4) 64.6 cm

Ans:4

Sol: If the length of the cylinder is 'l' then $\frac{(l/2)-5}{273} = \frac{l/2+5}{373}$

$$\Rightarrow l = 64.6cm$$

16. When an air bubble of radius 'r' rises from the bottom to the surface of a lake, its radius becomes 5r / 4 (the pressure of the atmosphere is equal to the 10m height of water column).If the temperature is constant and the surface tension is neglected, the depth of the lake is (2001)

1) 3.53m 2) 6.53m 3) 9.53m 4)12.53m

Ans: 3

Sol: According to Boyle's law

$$(P_1V_1)_{At\,the\,top\,of\,the\,lake} = (P_2V_2)_{At\,the\,bottom\,of\,the\,lake}$$

$$\Rightarrow P_1V_1 = (P_1 + h)V_2$$

$$\Rightarrow 10\left[\frac{4}{3}\pi\left(\frac{5r}{4}\right)^3\right] = [10+h]\left[\frac{4}{3}\pi r^3\right]$$

$$\Rightarrow h = \frac{610}{64} = 9.53m$$

17. A steel meter scale is to be ruled so that millimeter intervals are accurate within about 5 X 10^{-5} mm at a certain temperature. The maximum temperature variation allowable during the ruling is (Coefficient of linear expansion of steel = 10X10^{-6} K^{-1}) (2001 E)

1) 2^0C 2) 5^0C 3) 7^0C 4) 10^0C

Ans: 2

Sol : We know $\alpha = \frac{l_2 - l_1}{l_1(\Delta t)}$

$$\Rightarrow \Delta T = \frac{l_2 - l_1}{l_1(\alpha)} = \frac{5\times10^{-5}}{1(10\times10^{-6})} = 5^0 C$$

18. When a liquid in a glass vessel is heated, its apparent expansion is 10.30x10^{-4}/^{0}C. Same liquid when heated in a metallic vessel, its apparent expansion is 10.06x10^{-4} /^{0} C. The coefficient of linear expansion of metal is (α_{glass} = 9x10^{-6}/^{0}C) **(EAMECT 2K, E)**

1. 51x10^{-6}/^{0}C 2. 43x10^{-6}/^{0}C 3. 25^{-6}/^{0}C 4. 17x10^{-6}/^{0}C (2000 E)

Ans:4

Sol: $[\gamma_{app} + 3\alpha]_{glass} = [\gamma_{app} + 3\alpha]_{metal}$

$$= (10.3\times10^{-4}) + (27\times10^{-6})$$

$$\therefore \alpha = 17\times10^{-6} /^0 C$$

19. A vessel is filled with an ideal gas at a pressure of 10 atmospheres and temp . Half of the mass of the gas is removed from the vessel & the temp. of the remaining gas is increased to . Then the pressure of the gas in the vessel will be

1)5 atm 2)6 atm 3) 7 atm 4)8 atm (2000 E)

Ans : 2

Sol: When half the mass of the gas is removed from the vessel, the pressure of the remaining gas will be 5 atm.

$$\therefore \frac{P_1}{P_2} = \frac{T_1}{T_2}$$

P_1 = 5 atm T_2 = 300 K

T_2 = 360 k P_2 = ?

$$\therefore P_2 = \left[\frac{T_2}{T_1}\right] P_1 = \left[\frac{360}{300}\right] 5 = 6 atm$$

MEDICAL

20. A clock pendulum made of invar has a period of 0.5 sec, at 20^{0}C. If the clock is used in a climate where the temperature a verages to 30^{0}C, how much time does the clock lose in each oscillation? (For invar, a = $9\times10^{-70}C$, g= constant) **(2009 M)**

1) 2.25×10^{-6} sec 2) 2.25×10^{-7} 3) 5×10^{-7} sec 4) 1.125×10^{-6} sec

Ans : 3

Sol: Loss or gain of time per day = $\frac{1}{2}\propto\Delta t\times86,400$

$= \frac{1}{2}\times9\times10^{-7}\times10\times86,400$

$= 4.5\times10^{-6}\times86,400$

Time lose by the clock in each oscillation

$= \frac{4.5\times10^{-6}\times86,400}{86,400}\times0.5$

$= 2.25\times10^{-6}S$

21. The volume of mercury in the buld of thermometer is 10^{-6}m^2. The area of cross-section of capillary tube is 2×10^{-7} sq.m. If the temperature is raised by 100^{0}C, the increase in the length of the mercury column is: $\left(\gamma_{H_g}=18\times10^{-5}/^0c\right)$ **(2008 M)**

1)18 cm 2)0.9 cm 3)9 cm 4)1.8cm

Ans : 3

Sol: Volume = 10^{-6} m^3, Area = $2\times10^{-7}m^2$, $r=18\times10^{-5}$ $\Delta t=100^0C$

$\therefore V_2=V_1\left[1+r\Delta t\right]$

But volume = Area $\times$ length

$\Rightarrow10^{-6}=\left(2\times10^{-7}\right)l\left[1+18\times10^{-5}\times100\right]$

$\Rightarrow l=5m$

$\Rightarrow$ increase in length = 5-4.91 = 0.09 m

= 9 cm

22. A two litre glass flask contains some mercury. It is found that at the temperature the volume of the air inside the flask remains the same. The volume of the mercury inside the flask is (α for glass = $9\times10^{-6}/^0C,_\gamma$ for mercury = $1.8\times10^{-4}/^0C$) **(2008 M)**

1) 1500 c.c. 2) 150 c.c. 3) 3000 c.c 4) 300 c.c.

Ans : 4

Sol: The condition for the volume of the air inside the flask remains the same at all temperatures is

$V_1r_1=V_2r_2$ or $V_lr_l=V_gr_g$

$$\Rightarrow 2\times3\times9\times10^{-6} = V_g \times 1.8\times10^{-4}$$
$$\Rightarrow r_g = 300c.c.$$

23. What fraction of the volume of a glass flask must be filled with mercury so that the volume of the empty space may be the same at all temperatures ? (α glass = 9×10^{-6} / °C, γ_{Hg} = 18.9×10^{-5} /°C) **[2007 M]**

1) 1/2 2) 1/7 3) 1/4 4) 1/5

Ans : 2

Sol: The condition for the volume of the air inside the flask remains the same at all temperatures is

$$V_l r_l = V_g r_g$$

$V_l, V_g \rightarrow$ Volumes of liquid and glass

$$V_l \times 18.9\times10^{-5} = V_g \times 3\times9\times10^{-6}$$
$$\therefore \frac{V_l}{V_g} = \frac{27\times10^{-6}}{189\times10^{-6}} = \frac{1}{7}$$

24. At a certain temperature, radius of an air bubble is doubled when it comes to the top from the bottom of a mercury column of a height 'h'. If the pressure at the **[2006 M]**

1) 5.5 2) 10.64 3) 12.45 4) 15.00

Ans : 2

Sol: According to the Boyle's law $P_1V_1 = P_2V_2$

At the bottom = $P_1V_1 = (P_0 + hdg)V_1$

At the top = $P_2V_2 = P_oV_2$

Where P_0 is the atmospheric pressure

$$\Rightarrow (P_0 + hgd)\frac{4}{3}\pi r_1^3 = P_0\left(\frac{4}{3}\pi r_2^3\right)$$
$$\Rightarrow (P_0 + hgd)r_1^3 = P_0\left(r_2^3\right)$$

On solving h = 10.64 m

25. The temperature of a gas contained in a closed vessel increases by 2°C when the pressure is increased by 2%. The initial temperature of the gas is [2006 M]

1) 200 K 2) 100 K 3) 200°C 4) 100°C

Ans : 2

Sol: From Charles law $p \propto T \Rightarrow \frac{\Delta p}{p}\times100 = \frac{\Delta T}{T}\times100$

$$\Rightarrow 2 = \frac{2}{T}\times100$$
$$\Rightarrow T = 100$$

26. At a certain temperature, radius of an air bubble is doubled when it comes to the top from the bottom of a mercury column of height 'h'. If the pressure at the top is two atmospheres, the value of 'h' in metres is

1) 5.5 2) 10.64 3) 12.45 4) 15.00 [2005 E]

Ans: 3

Sol: $r_r = r_a + r_g = r_a + 3\alpha_g$

[Since $r_g = 3\alpha_g$]

27. Equation of gas in terms of pressure p absolute temperature T and density d is

1. $\frac{P_1}{d_1T_1} = \frac{P_2}{d_2T_2}$ 2. $\frac{P_1T_1}{d_1} = \frac{P_2T_2}{d_2}$ 3. $\frac{P_1d_2}{T_2} = \frac{P_2d_1}{T_1}$ 4. $\frac{P_1d_1}{T_1} = \frac{P_2d_2}{T_2}$ **(2005 M)**

Ans : 1

Sol: From Ideal gas equation PV=mRT

$$\Rightarrow \frac{PV}{T} = constant$$

$$\Rightarrow \frac{P_1}{d_1T_1} = \frac{P_2}{d_2T_2}$$

28. Two uniform metal rods of lengths l_1 and l_2 and linear coefficients of expansion α_1 and α_2 respectively are connected to form a single rod of length $l_1 + l_2$. When the temperature of the combined rod is raised by t^oC , the length of each rod increases by the same amount. Then $\frac{\alpha_2}{\alpha_1 + \alpha_2}$ is **(2005 E)**

1) $\frac{l_1}{l_1 + l_2}$ 2) $\frac{l_1 + l_2}{l_1}$ 3) $\frac{l_2}{l_1 + l_2}$ 4) $\frac{l_1 + l_2}{l_2}$

Ans: 1

Sol: Increase in length of the first rod = increase in length of the second rod

$\Delta l_1 = \Delta l_2 \left(given\right)$

$$\Rightarrow l_1\alpha_1\Delta t = l_2\alpha_2\Delta t\left(given\right)$$

$$\Rightarrow l_1\alpha_1 = l_2\alpha_2$$

$$\Rightarrow \frac{l_1}{l_2} = \frac{\alpha_2}{\alpha_1}$$

$$\Rightarrow \frac{l_2}{l_1} = \frac{\alpha_1}{\alpha_2}$$

$$\Rightarrow \frac{l_2}{l_1} + 1 = \frac{\alpha_1}{\alpha_2} + 1$$

$$\Rightarrow \frac{l_2 + l_1}{l_1} = \frac{\alpha_1 + \alpha_2}{\alpha_2}$$

$$\Rightarrow \frac{\alpha_2}{\alpha_1 + \alpha_2} = \frac{l_1}{l_1 + l_2}$$

29. At constant pressure, the ratio of increase in volume of an ideal gas per degree rise in Kelvin temperature to its original volume is (T = absolute temperature of the gas) **(2004 M)**

1) T^2 2) T 3) 1/T 4) $1/T^2$

Ans: 3

Sol: $P \rightarrow$ constant $V_1 \propto T$

$$V_2 \propto T + 1$$

$$\text{Then } \frac{V_2}{V_1} = \frac{T+1}{T} = 1 + \frac{1}{T}$$

$$\frac{V_2}{V_1} - 1 = \frac{1}{T} \Rightarrow \frac{V_2 - V_1}{V_1} = \frac{1}{T}$$

30. A thin brass sheet at 10^0C and thin steel sheet at 20^0C have the same surface area. The common temperature at which both would have the same area (coefficient of linear expansion for brass and steel are respectively 19 x $10^{-6}/^0$C and 11 x $10^{-6}/^0$C) **(2003 M)**

1.-3.75 ^{0}C 2. -2.75^{0}C 3. 2.75 ^{0}C 4. 3.75 ^{0}C

Ans: 1

Sol:

$$S_t = S_1\left[1 + \beta\left(\Delta t\right)\right]$$

$$\therefore \alpha_{Brass}\left(t - 10\right) = \alpha_{steel}\left(t - 20\right)$$

$$\Rightarrow 19\left(t - 10\right) = 11\left(t - 20\right)$$

$$\therefore t = -3.75^0 C$$

31. If pressure of an ideal gas contains in a closed vessel is increased by 0.5% the increase in temperature is $2^0 C$ the initial temperature of the gas is **(2003 M)**

1. $27^0 C$ 2. $127^0 C$ 3. $300^0 C$ 4. $400^0 C$

Ans: 2

Sol: $\frac{P_1}{P_2} = \frac{T_1}{T_2}$ at constant volume

$$\frac{P}{P + \left(\frac{0.5}{100}\right)P} = \frac{T}{T+2}$$

$$\frac{100}{100.5} = \frac{T}{T+2} \Rightarrow T = 400K = 127^0 C$$

32. Two marks on a glass rod, 10 cm apart, are found to increase their distance by 0.08 mm, when the rod is heated from 0^0C to 100^0C. A flask made of the same glass as that of rod measures a volume 1000 c.c. at 0^0C. The volume, it measures at 100^0C in C.C is **(2002 M)**

1) 1002.4 2) 1004.2 3) 1006.4 4) 1008.2

Ans:1

Sol: We know $\alpha = \frac{\left(l_2 - l_1\right)}{l_2\left(t_2 - t_1\right)} = \frac{0.008}{\left(10\right)\left(100\right)}$

$= 8\times10^{-6} /^0 C$

$\therefore$ Coefficient of volume expansion

$$\gamma = 3\alpha = 24\times10^{-6} /^0 C$$

$$V_2 = V_1\left[1+\gamma t\right]$$

$$= 1000\left[1+\left(24\times10^{-6}\right)\left(100\right)\right]$$

= 1002.4 cc

33. A gas is heated through 1^0C in a closed vessel. Its pressure is increased by 0.4%. The initial temperature of the gas is **(2002 M)**

1. 250^0C 2. 100^0C 3. -75^0C 4. -23^0C

Ans: 3

Sol: We know $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Let the initial pressure be 100

$$\frac{100}{T} = \frac{100.4}{T+1} \Rightarrow \frac{T+1}{T} = \frac{100.4}{100}$$

$$\Rightarrow 1+\frac{1}{T} = \frac{100.4}{100}$$

$$\frac{1}{T} = \frac{100.4}{100} - 1 = \frac{0.4}{100}$$

$$\therefore T = 250K = -23^0 C$$

34. When the temperature of a body increases form t to t+ Δt, its moment of inertia increases from I to I+ ΔI. The coefficient of linear expansion of the body is . The ratio ΔI/I is : **(2001 M)**

1) Δt/t 2) 2 Δt/t 3) α Δt 4) 2 α Δt

Ans: 4

Sol : We know that the coefficient of superficial (or) aerial expansion

$$\beta = \frac{A_2 - A_1}{A_1\left(\Delta t\right)} = \frac{\Delta A}{A\left(\Delta t\right)}$$

$$\beta = \frac{\Delta A}{A\left(\Delta t\right)} = \frac{\Delta A}{A} = \beta\left(\Delta t\right)$$

But, $\frac{\Delta I}{I}\alpha\frac{\Delta A}{A}$

$$\therefore \frac{\Delta I}{I} = \beta\left(\Delta t\right) = \left(2\alpha\right)\left(\Delta t\right)$$

35. If a cylinder of diameter 1.0cm at 30^0C is to be slid into a hole of diameter 0.9997 cm in a steel plate at the same temperature, the minimum required rise in the temperature of the plate is: (Coefficient of linear expansion of steel = 12 x $10^{-6}/^0C$) **(2001 M)**

1) 25^0C 2) 35^0C 3) 45^0C 4) 55^0C

Ans:1

Sol: We know $\alpha = \frac{\Delta l}{l(\Delta t)} = \frac{\Delta l}{l(t_2 - t_1)}$

$$\Rightarrow t_2 - t_1 = \frac{\Delta l}{l\alpha} = \frac{1-0.9997}{(0.9997)(12\times10^{-6})}$$

$$= \frac{3\times10^6}{12\times9997} = 25^0 C$$

36. 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

Ans : 1

Sol: We know $\gamma_{app} = \frac{wt.of\ liquid\ \exp elled}{(wt.of\ remaining liquid)(rise\ in\ temp.)}$

$$\Rightarrow \frac{1}{6500} = \frac{x}{(400-x)(90)}$$

$$\Rightarrow x = 5.46gm$$

37. Two metal rods A and B are having their initial lengths in the ratio 2:3 and coefficients of linear expansion in the ratio 3:4. When they are heated through the same temperature difference, the ratio of their linear expansion is **(2000 M)**

1) 1:2 2) 2:3 3) 3:4 4) 4:3

Ans: 1

Sol:

$$l_1 : l_2 = 2:3$$

$$\alpha_1 : \alpha_2 = 3:4$$

For the rod 'A' $l_2 = l_1(\alpha_1)$

For the rob 'B' $l^1{}_2 = l^1{}_1(\alpha_1{}^1)$

$$l_2 : l^1{}_2 = 2(3):3(4) = 1:2$$

38. The length of a metal rod at 0^0C is 0.5m. When it is heated, its length increases by 2.7mm. The final temperature of rod is (coeff. of linear expansion of metal = 90x10^{-6}/^{0}C) **[2000, M]**

1) 20^0C 2) 30^0C 3) 40^0C 4) 60^0C

Ans : 4

Sol: We know the change in temperature

$$t_2 - t_1 = \frac{l_2 - l_1}{l_1(\propto)} = \frac{(2.7\times10^{-3})}{(0.5)(9\times10^{-5})} = 60$$

As $t_1 = 0^0 C; t_2 = 60^0 C$

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