PHYSICS

BOOKS - HC VERMA

HEAT AND TEMPERATURE

Example

1. The presssure of the gas in a constant volume gas thermometer at steam point

(373.15K) is $1.50 \times 10^4 Pa$. What will be the pressure of the triple point of water?

Watch Video Solution

2. The pressure of air in the bulb of a constant volume gas thermometer of $0^o C$ and $100^o C$ are $73.00 cm$ and $100 cm$ of mercury respectively. Calculate the pressure at the room temperature $20^o C$.

Watch Video Solution

Worked Out Examples

1. The pressure of the gas in a constant volume gas thermometer is 80cm of mercury in melting ice at $1 atm$. When the bulb is placed in a liquid, the pressure becomes $160 cm$ of mercury. Find the temperature of the liquid.

Watch Video Solution

2. In a constant volume gas thermometer, the pressure of the working gas is measured by the difference in the levels of mercury in the two arms of a U-tube connected to the gas at one end. When the bulb is placed at the room temperature $27.0^0 C$, the mercury column in the arm open to atmosphere stands $5.00 cm$ above the level of mercury in the other arm. When the bulb is placed in a hot liquid, the difference of mercury levels becomes $45.0 cm$. Calculate the temperature of the liquid. (Atmospheric pressure $= 75.0 cm$ of mercury).

Watch Video Solution

3. The resistances of a platinum resistance thermometer at the ice point, the steam point and the boiling point of sulphur are $2.50, 3.50$ and 6.50Ω respectively. Find the boiling point of sulphur on the platinum scale. The ice point and the steam point measure 0^0 and 100^0 respectively.

Watch Video Solution

4. A platinum resistance thermometer reads 0^0 and 100^0 at the ice point and boiling point of water respectively. The resistance of a platinum wire varies with Celsius temperature θ as $R_t = R_0(1 + \alpha\theta + \beta\theta^2)$, where $\alpha = 3.8 \times 10^{-3}\ \hat{}\ 0C^{-1}$ and $\beta = -5.6 \times 10^{-7}\ \hat{}\ 0C^{-2}$. What will be the reading of this thermometer if it is placed in a liquid bath maintained at 50^0C?

Watch Video Solution

5. A platinum resistance thermometer is constructed which reads , 0^0 at ice point and 100^0 at steam point. Let t_p denote temperature on this scale and let t denote the temperature on a mercury on a mercury thermometer scale. The resistance of the platinum coil varies with t as $R_1 = R_0(1 + \alpha t + \beta t^2)$. Derive an expression for the resistance as a function of T_p.

Watch Video Solution

6. An iron rod of length 50 cm is joined at an end to aluminium rod of length 100 cm. All measurements refer to $20^0 C$. Find the length of the composite system at $100^o C$ and its average coefficient of linear expansion. The coefficient of linear expansion of iron and aluminium are $12X10^{-6}C^{-1}$ and $24X10^{-6}C^{-1}$ respectively.

Watch Video Solution

7. An iron ring measuring 15.00 cm in diameter is a be shrunk on a pulley which is 15.05 cm in diameter. All measurements refer to the room temperature $20^0 C$. To What minimum temperature should the ring be heated to make the job possible? Calculate the strain developed in the ring when in comes to the room temperature. Coefficient of linear expansion of iron $= 12 \times 10^{-6} C^{-1}$.

Watch Video Solution

8. A pendulum clock consists of an iron rod connected to a small, heavy bob. If it is designed to keep correct time at $20^0 C$, how fast or slow will it go in 24 hours at $40^0 C$? Coefficient of linear expansion of iron $= 1.2 \times 10^{-5} C^{-1}$.

Watch Video Solution

9. A pendulum clock that keeps the correct time on the earth is taken to the moon. It will run

Watch Video Solution

10. The density of an ideal gas is $1.25 \times 10^{-3} gcm^{-3}$ at STP. Calculate the molecular weight of the gas.

Watch Video Solution

11. A sphere of diameter 7.0 cm and mass 266.5 g float in a bath of liquid. As the temperature is raised, the sphere begins to sink at a temperature of $35^0 C$. If the density of liquid is

$1.527 gcm^{-3}$ at $0^{o}C$, find the coefficient of cubical expansion of the liquid. Neglect the expansion of the sphere.

Watch Video Solution

12. An iron rod and a copper rod lie side by side. An the temperature is changed, the difference in the length of the rods remains constant at a value of 10 cm. Find the lengths at $0^{o}C$. Coefficients of linear expansion of iron and copper are

$1.1 \times 10^{-5} C^{-1}$ and $1.7 \times 10^{-5} C^{-1}$ respectively.

Watch Video Solution

13. A uniform steel wire of cross-sectional area $0.20 mm^2$ is held fixed by clamping its two ends. Find the extra force exerted be each clamp on the wire if the wire is cooled from $100^0 C \rightarrow 0^o C$. Young's modulus of steel $= 2.0 \times 10^{11} Nm^{-2}$. Coefficient of linear expansion of $= 1.2 \times 10^{-5} C^{-1}$.

Watch Video Solution

14. A glass vessel of volume $100cm^{-3}$ is filled with mercury and is heated from $25^{o}c$ to $75^{o}c$ .What volume of mercury will overflow? Coefficient of linear expansion of glass= $1.8 \times 10^{-6}c^{-1}$ and coefficient of volume expansion of mercury is $1.8 \times 10^{-4}C^{-1}$.

Watch Video Solution

15. A barometer reads 75.0 cm on a steel scale. The room temperature is $30^{o}C$. The scale is correctly graduated for 0^{C}. The coefficient of linear expansion of steel is $\alpha = 1.2 \times 10^{-5} C^{-1}$ and the coefficient of volume expansion of mercury is $\sigma = 1.8 \times 10^{-4} C^{-1}$. ? Find the correct atmospheric pressure.

Watch Video Solution

Question For Shor Answer

1. If two bodies are in thermal equilibrium in one frame, will they be in the thermal equilibrium in all frames?

Watch Video Solution

2. Does the temperature of a body depend on the frame from which it is observed?

Watch Video Solution

3. It the heard sometimes that mercury is used in defining the temperature scale because it expands uniformly with the temperature. If the temperature scale is not yet defined, is it logical to say that a substance expands uniformly with the temperature.

Watch Video Solution

4. In defining the ideal gas temperature scale, It is assumed thet the pressure of the gas at constant volume is proportional to the temperature T. How can we verify wheter this is true of not? Are we using the kinetic theory of gases? Are we using the experimental result that the pressure is proportional to temperature?

Watch Video Solution

5. Can the bulb of a thermometer be made of an adiabatic wall?

Watch Video Solution

6. Why do marine animals live deep inside of lake when the surface of the lake freezes?

Watch Video Solution

7. The length of a brass rod is found to be smaller on a hot summer day that on a cold winter day as measured by the same aluminium scale. Do we conclude that brass shrinks on heating.

Watch Video Solution

8. If mercury and glass had equal coefficient of volume expansion, could we make a mercury thermometer in a glass tube?

Watch Video Solution

9. The density of water at $4^0 C$ is supposed to be $1000 kgm^{-3}$. It is same at the sea level and at a high altitude?

Watch Video Solution

10. A tightly closed metal lid of a glass bottle can be opened more easily if it is put in hot water for some time. Explain.

Watch Video Solution

11. If an automobile engine is overheated, it is cooled by putting water on it. It is advised that the water should be put slowly with engine running. Explain the reason.

Watch Video Solution

12. Is it possible for two bodies to be in thermal equilibrium if they are not in contact?

Watch Video Solution

13. A spherical shell is heated. The Volume changes according to the equation $V_\theta = V_0(1 + \gamma_\theta)$. Does the volume refer to the volume encloded by the shell or the volume of the marerial making up the shell?

Watch Video Solution

Objective 1

1. A system X is neither in thermal equilibrium with Y nor with Z. The systems Y and Z

A. must be in thermal equilibrium

B. cannot be in thermal equilibrium

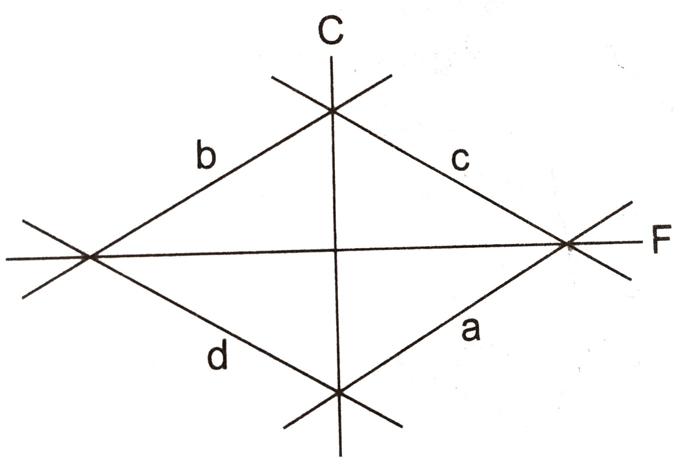
C. may be in thermal equilibrium.

D.

Answer: 3

Watch Video Solution

2. Which of the curves in figure represents the relation between Celsius and Fahrenheit temperatures?



Watch Video Solution

3. which of the following pairs may give equal numerical values of the temperature of a body?

A. Fahrenheit and kelvin

B. Celsius and kelvin

C. Kelvin and platinum

D.

Answer:

Watch Video Solution

4. For a constant volume gas thermometer, one should fill the gas at

A. low temperature and low presssure

B. low temperature and high presssure

C. high temperature and low presssure

D. high temperature and high presssure

Answer: C

Watch Video Solution

5. Consider the following statements. (A)The coefficient of linear expansion has dimension k^{-1}. (B) The coefficient of volume expansion has dimension k^{-1}.

A. A and B are both correct.

B. A is correct and B is wrong.

C. B is correct and A is wrong.

D. A and B are both wrong.

Answer:

Watch Video Solution

6. A metal sheet with a circular hole is heated. The hole will

A. gets larger

B. gets smaller

C. remains of the same size

D. gets deformed.

Answer:

Watch Video Solution

7. Two identical rectangular strips. One of copper and the other of steel, are riveted together to from a bimetallic strip $(\alpha_{copper} > \alpha_{steel})$. On heating. This strip will

A. remain straight

B. bend with copper on convex side

C. bend with steel on convex side

D. get twisted.

Answer:

Watch Video Solution

8. If the temperature of a uniform rod is slighely increased by Δt its moment of inertia I about perpendicular bisector increases by

A. zero

B. $\alpha I \Delta t$

C. $2\alpha I\Delta t$

D. $3\alpha I\Delta t$

Answer:

Watch Video Solution

9. If the temperature of a uniform rod is slightly increased by Δt, its moment of inertia I about a line parallel to itself will increased by

A. zero

B. $\alpha I \Delta t$

C. $2\alpha I \Delta t$

D. $3\alpha I \Delta t$.

Answer:

Watch Video Solution

10. The temperature of water at the surface of a deep lake is $2^{\circ} C$. The temperature expected at the bottom is

A. $0^0 C$

B. $2^0 C$

C. $4^0 C$

D. $6^0 C$

Answer:

Watch Video Solution

11. An aluminium sphere is dipped into water at $10^\circ C$ .If the temperature is increased, the force of buoyancy

A. will increase

B. will decrease

C. will remain constant

D. may increase or decrease depending on the radius of the sphere

Answer:

Watch Video Solution

12. An aluminium sphere is dipped into water at $10^{\circ} C$ .If the temperature is increased, the force of buoyancy

A. will increase

B. will decrease

C. will remain constant

D. may increade of depending on the radium of the sphere.

Answer:

Watch Video Solution

Objective 2

1. A spinning wheel is brought in contact with an identical wheel spinning identical speed. The wheels slow down under the action of friction. Which of the following energies of the frist wheel decrease.

A. a) Kinetic

B. b) Total

C. c) Mechanical

D. d) Internal

Answer:

Watch Video Solution

2. A Spinning wheel A is brought in contact with another wheel, B initially at rest. Becouse of the friction at contact, the second wheel also starts spinning. Which of the following energies of the wheel B increase?

A. a) Kinetic

B. b) Total

C. c) Mechanical

D. d) Internal

Answer:

Watch Video Solution

3. A body A is Placed on a railway platform and an identical body B in a moving train. Which of the following energies of B are greater than those of A as seen from the ground?

A. a) Kinetic

B. b) Total

C. c) Mechanical

D. d) Internal

Answer:

Watch Video Solution

4. In which of the following pairs of temperature scales, the size of a degree is identical?

A. Mercury scale and ideal gas scale

B. Celsius scale and mercury scale

C. Celsius scale and ideal gas scale

D. Ideal gas scale and absolute scale

Answer:

Watch Video Solution

5. A solid object is placed in water contained in an adiabatic container for some time. The temperature of water falls during the period and there is no appreciable change in the shape of the object. The temperature of the solid object

A. must have increased

B. must have decreased

C. may have increased

D. may have remained constant.

Answer:

Watch Video Solution

6. As the temperature is increased, the time period of a pendulum

A. increases proportionately with temperature

B. increases

C. decreases

D. remains constant

Answer:

Watch Video Solution

Exercise

1. The steam point and the ice point of a mercury thermometer are marked as $80^\circ C$ and $20^\circ C$. What will be the temperature in centigrade mercury scale when this thermometer reads $32^\circ C$?

Watch Video Solution

2. A constant volume thermometer registers a pressure of $1.500 \times 10^4 Pa$ at the triple point of water and a pressure of $2.050 \times 10^4 Pa$ at the normal boiling point. What is the temperature at the normal boiling point?

Watch Video Solution

3. A gas thermometer measures the temperature from the variation of pressure of a sample of gas. If the pressure measured at the melting point of lead is 2.20 times the pressure measured at the triple point of water, find the melting point of lead.

Watch Video Solution

4. The pressure measured by a constant volume gas thermometer is 40 kPa at the triple point of water. What will be the pressure measured at the boiling point of water $(100^{\circ} C)$?

Watch Video Solution

5. The pressure of the gas in a constant volume gas thermometer is 70 kPa at the ice point. Find the pressure at the steam point.

Watch Video Solution

6. The pressure of the gas in a constant volume gas thermometer are 80 cm, 90 cm and 100 cm of mercury at the ice point, the steam point and in a heated wax bath respectively. Find the temperature of the wax bath.

Watch Video Solution

7. In a callender's compensated constant pressure air thermometer, the volume of the bulb is 1800 cc. When the bulb is kept immersed in a vessel. 200 cc of mercury has to be poured out. Calculate the temperature of the vessel.

Watch Video Solution

8. A platinum resistance thermometer reads 0° when its resistance is 80Ω and 100° when its resistance is 90Ω. Find the temperature at the platinum scale at which the resistance is 86Ω.

Watch Video Solution

9. A resistance thermometer reads $R = 20.0\Omega, 27.5\Omega,$ and 50.0Ω at the ice point $(0^\circ C)$, the steam point $(100^\circ C)$ and the zinc point $(420^\circ C)$ respectively. Assuming that the resistance varies with temperature as $R_\Theta = R_0(1 + \alpha\Theta + \beta\Theta^2)$, find the values of R_0, α and β. Here Θ represents the temperature on Celsius scale.

Watch Video Solution

10. A concrete slab has a length of 10 m on a winter night when the temperature is $0^\circ C$. Find the length of the slab on a summer day when the temperature is $35^\circ C$. The coefficient of linear expansion of concrete is $1.0 \times 10^{-5} C^{-1}$.

Watch Video Solution

11. A meter scale made of steel is calibrated at $20^\circ C$ to give correct reading. Find the distance between 50 cm mark and 51 cm mark if the scale is used at $10^{\circ} C$. Coefficient of linear expansion of steel is $1.1 \times 10^{-5} C^{-1}$

Watch Video Solution

12. A railway track (made of iron) is laid in winter when the average temperature is $18^{\circ} C$. The track consists of sections of $12m$ placed one after the other. How much gap should be left between two such sections so that there in no compression during summer when the maximum temperature goes to $48^{\circ} C$?

Coefficient of linear expansion of iron $= 11 \times 10^{-5} C^{-1}$.

Watch Video Solution

13. A circular hole of diameter 2.00 cm is made in an aluminum are at $0^{\circ} C$. What will be the diameter at $100^{\circ} C$? $Alpha$ for aluminum $= 2.3 \times 10^{-5} C^{-1}$.

Watch Video Solution

14. Two meter scales, one of steel and the other of aluminum, agree at $20^\circ C$. Calculate the ratio aluminum-centimeter/steel-centimeter at (a) $0^\circ C$, (b) $40^\circ C$ and (c) $100^\circ C$. $\alpha_{steel} = 1.1 \times 10^{-5} C^{-1}$ and $\alpha_{aluminum} = 2.3 \times 10^{-5} C^{-1}$.

Watch Video Solution

15. A meter scale is made up of steel and measures correct length at $16^\circ C$. What will be the percentage error if this scale is used (a) on a summer day when the temperature is $46^\circ C$.

Watch Video Solution

16. A meter scale is made of steel reads accurately at $20^\circ C$. In a sensitive experiment, distance accurate up to 0.055 mm in 1 m are required. Find the range of temperature in which the experiment can be performed with this meter scale. Coefficient of linear expansion of steel $= 11 \times 10^{-6} {}^\circ C^{-1}$.

Watch Video Solution

17. The density of water at $0^{\circ}C$ is $0.998gcm^{-3}$ at $4^{\circ}C$ is $1.00gcm^{-3}$. Calculate the average coefficient of volume expansion of water in the temperature range $0^{\circ}C$ to $4^{\circ}C$.

Watch Video Solution

18. Find the ratio of the lengths of an iron rod and an aluminum rod for which the difference in the lengths in independent of temperature.

Coefficients of linear expansion of iron and aluminum are $12 \times 10^{-6} C^{-1}$ and $23 \times 10^{-6} C^{-1}$respectively.

Watch Video Solution

19. A pendulum clock gives correct time at $20^{\circ} C$at a place where $g = 9.800 ms^{-2}$.The pendulum consists of a light steel rod connected to a heavy ball. It is taken to a different place where $g = 9.788 ms^{-2}$. At what temperature will it give correct time ?

coefficient of linear expansion of steel $= 12 \times 10^{-6} C^{-1}$.

Watch Video Solution

20. An aluminum plate fixed in a horizontal position has a hole of diameter 2.000 cm. A steel sphere of diameter 2.005 cm rests on this hole. All the lengths refer to a temperature of $10^{\circ} C$.The temperature of the entire system is slowly increased. At what temperature will the ball fall down? coefficient of linear expansion of aluminum is $23 \times 10^{-6} C^{-1}$ and that of steel is $11 \times 10^{-6} C^{-1}$.

View Text Solution

21. A glass window is to be fit in an aluminum frame. The temperature on the working day is $40^{\circ} C$ and the glass window measures exactly $20 cm \times 30 cm$. What should be the size of the aluminum frame so that there is no stress on the glass in winter even if the temperature drops to $0^\circ C$? Coefficients of linear expansion for glass and aluminum are $9.0 \times 10^{-6} C^{-1}$ and $24 \times 10^{-6} C^{-1}$ respectively.

Watch Video Solution

22. The volume of a glass vessel is 1000 cc at $20^\circ C$. What volume of mercury should be poured into it at this temperature so that the volume of the remaining space does not change with temperature? Coefficients of cubical expansion of mercury and glass are

$1.8 \times 10^{-4} C^{-1}$ and $9.0 \times 10^{-6} C^{-1}$.

respectively.

Watch Video Solution

23. A aluminum can of cylindrical shape contains $500 cm^3$ of water. The area of the inner cross section of the can is $125 cm^2$. All measurements refer to $10^\circ C$. Find the rise in the water level if the temperature increases to $80^\circ C$. The coefficient of linear expansion of aluminum $= 23 \times 10^{-6} C^{-1}$ and the average coefficient of volume expansion of water= $3.2 \times 10^{-4} C^{-1}$ respectively.

Watch Video Solution

24. A glass vessel measures exactly 10cm xx 10 cm xx 10 cm at $0^{\circ} C$. It is filled completely with mercury at this temperature. When the temperature is raised to $10^{\circ} C$, $1.6 cm^{3}$ of mercury overflows. Calculate the coefficient of volume expansion of mercury. coefficient of linear expansion of glass $= 6.5 \times 10^{-6} C^{-1}$.

Watch Video Solution

25. The densities of wood and benzene at $0^{\circ}C$ are $880kgm^{-3}$ and $900kgm^{-3}$ respectively. The coefficients of volume expansion are $1.2 \times 10^{-3}C^{-1}$ for wood and $1.5 \times 10^{-3}C^{-1}$ for benzene. At what temperature will a piece of wood just sink in benzene?

Watch Video Solution

26. A steel rod of length 1 m rests on a smooth horizontal base. If it is heated from $0^{\circ} C$ to $100^{\circ} C$, what is the longitudinal strain developed?

Watch Video Solution

27. A steel rod is clamped at its two ends and rests on a fixed horizontal base. The rod is unstrained at $20^{\circ} C$. Find the longitudinal strain developed in the rod if the temperature rises to $50^\circ C$. Coefficient of linear expansion of steel $= 1.2 \times 10^{-5} C^{-1}$.

Watch Video Solution

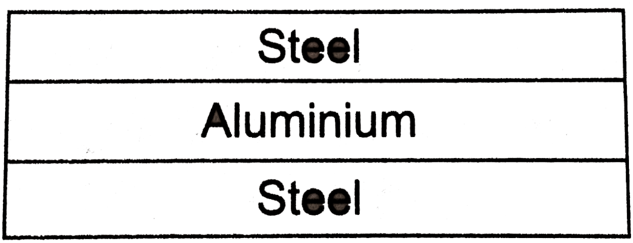
28. A steel wire of cross-sectional area $0.5 mm^2$ is held between two fixed supports. If the wire is just taut at $20^\circ C$, determine the tension when the temperature falls to $0^\circ C$. Coefficient of linear expansion of steel is $1.2 \times 10^{-5} C^{-1}$ and its Young's modulus is $2.0 \times 10^{11} Nm^{-2}$.

Watch Video Solution

29. A steel rod is rigidly clamped at its two ends. The rod is under zero tension at $20^\circ C$. If the temperature rises to $100^\circ C$, what force will the rod exert on one of the clapms? Area of cross section of the rod $= 2.00mm^2$. Coefficient of linear expansion of steel $= 12.0 \times 10^{-6} C^{-1}$ and Young's modulus of steel $2.00 \times 10^{11} Nm^{-2}$.

Watch Video Solution

30. Two steel rods and an aluminum rod of equal length l_0 and equal cross section are joined rigidly at their ends as shown in the figure below. All the rods are in a state of zero tension at $0^\circ C$. Find the length of the system when the temperature is raised to θ. Coefficient of linear expansion of aluminum and steel are α_a and α_s respectively. Young's modulus of aluminum is Y_a and of steel is Y_s.



Watch Video Solution

31. A steel ball initially at a pressure of $1.0 \times 10^5 Pa$ is heated from $20^\circ C$ to $120^\circ C$ keeping its volume constant. Find the pressure inside the ball. Coefficient of linear expansion of steel $= 12 \times 10^{-6} C^{-1}$ and bulk modulus of steel $= 1.6 \times 10^{11} Nm^{-2}$

Watch Video Solution

32. Show that moment of inertia of a solid body of any shape changes with temperature as $I = I_0(1 + 2\alpha\theta)$. Where I_0 is the moment of inertia at $0^\circ C$ and α is the coefficient of linear expansion of the solid.

Watch Video Solution

33. A torsional pendulum consists of a solid disc connected to a thin wire $(\alpha = 2.4 \times 10^{-5} C^{-1})$ at its center. Find the percentage change in the time period between peak winter $(5^{\circ} C)$ and peak summer $(45^{\circ} C)$

Watch Video Solution

34. A circular disc made of iron is rotated about its axis at a constant velocity Ω. Calculate the percentage change in the linear speed of a particle of the rim as the disc is slowly heated from $20^{\circ} C$ to $50^{\circ} C$ keeping the angular velocity constant. Coefficient of linear expansion of iron $= 1.2 \times 10^{-5} C^{-1}$.

Watch Video Solution