PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

TEMPERATURE, ZEROTH LAW OF THERMODYNAMICS AND THERMAL EXPANSION

Sample Problem

1. Suppose you come across old scientific notes that describe a temperature scale called Z on which the boiling point of water is $65.0^{\circ} Z$ and the freezing point is $-14.0^{\circ} Z$. To what temperature on the Fahrenheit scale would a temperature of

$T = -98.0^\circ Z$ corresponds ? Assume that the Z scale is linear , that is , the size of a Z degree is the same every where on the Z scale.

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2. A steel wire of $2.0mm^2$ cross- section is held straight(but under no tension) by attaching it firmly to two points a distance $1.50m$ apart at $30^\circ C$. If the temperature now decreases to $-10^\circ C$ and if the two points remain fixed, what will be the tension in the wire ? For steel, $Y = 20.0000MPa$.

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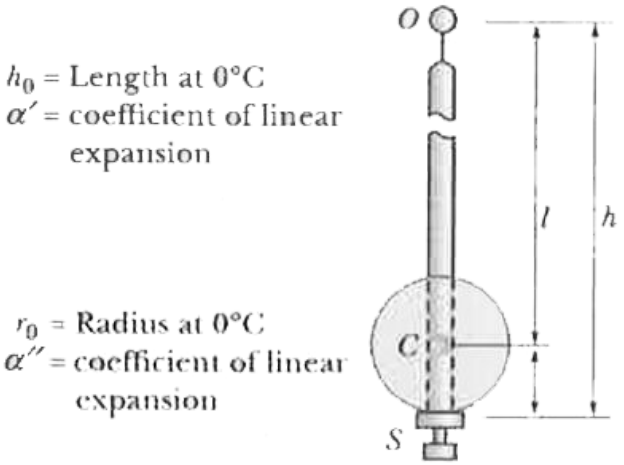
3. A second's pendulum clock has shown in Fig . It is compensated for temperature change by using differential

expression of the light rod and the heavy bob. This keeps the center of oscillation of the pendulum at a fixed distance below the point of suspension. Find the length of the light rod, h_0 and radius r_0 , of the heavy bob of this pendulum . Given that $\alpha'' > > \alpha'$



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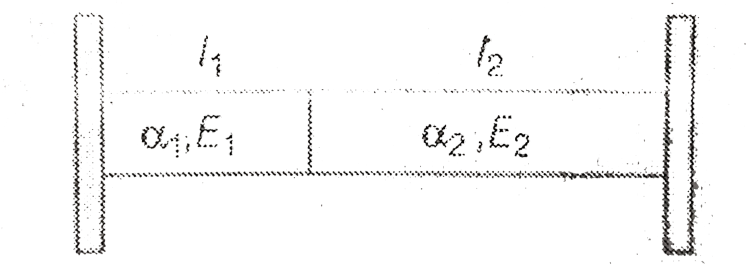
4. Two rods of different materials are placed between massive walls as shown in figure. The cross section of the rods is A,

their moduil of elastricity are E_1 and E_2 respectively. If rods are heated by t degrees, then (coefficients of liner expansion of material of rods are α_1 and α_2 respectively)



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5. Two steel plates plates are soldered on two sides of a copper plate .What tensions will arise in the plates if the temperature is increaased by $t^\circ C$? All the plates have the same cross- sections the coefficents of expansion ofcopper and steel are α_c and α_s and thier Young 's modulus . are Y_c and $Y_s$repectively Aera of rach interface +A.

[HInt : The net expansion (thermai + elastic) is the same for

the all the plates .THe tensile force on each steel plate is half the tensile force onthe cooper plate.]

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6. On a hot day in Las Vegas, an oil trucks loaded 37000 L of diesel fuel. He encountered cold weather on the way to New York, where the temperature was 23.0 K lower than in Las Vegas , and where he delivered his entire load. How many liters did he deliver ? The coefficient of volume expansion for diesel fuel is $9.50 \times 10^{-4} / {}^{\circ} C$, and the coefficient of linear expansion for his steel truck is $11 \times 10^{-6} / {}^{\circ} C$

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7. A glass flask whose volume is exactly 1000 at $0^\circ C$ is completely filled with mercury at this temperature . When the flask and mercury are heated to $100^\circ C$, it is found that $15.4cm^3$ of mercury overflows. If the coefficient of volume expansion of mercury is $1.8 \times 10^{-4}/K$, calculate the coefficient of volume expansion of glass.

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8. A glass cylinder contains $m_0 = 100g$ of mercury at a temperature of $t_0 = 0^\circ C.$ When temperature becomes $t_1 = 20^\circ C$ the cylinder contains $m_1 = 99.7g$ of mercury The coefficient of volume expansion of mercury $\gamma_{He} = 18 \times \left(10^{-5}/^\circ C$ Assume that the temperature of the

mercury is equal to that of the cylinder. The coefficient of linear expansion of glass α is

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9. A 1-L flask contains some mercury. It is found that at different temperature, the volume of air inside the flask remains the same. What is the volume of mercury in the flask, given that the coefficient of linear expansion of glass $= 9 \times 10^{-6} / {}^{\circ} C$ and the coefficient of volume expansion of $Hg = 1.8 \times 10^{-4} / {}^{\circ} C$?

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10. An aluminium cube of side $20cm$ floats in mercury. How much farther will the block sink when tempereture rises from

$27^\circ C$ to $77^\circ C$? Density of aluminium and mercury at $27^\circ C$ are 2.7 and $13.6g/$ while the coeficient of volume expansion of mercury and linear expansion of aluminium are $1.8 \times 10^{-4}/^\circ C$ and $23 \times 10^{-6}/^\circ C$ respectively.

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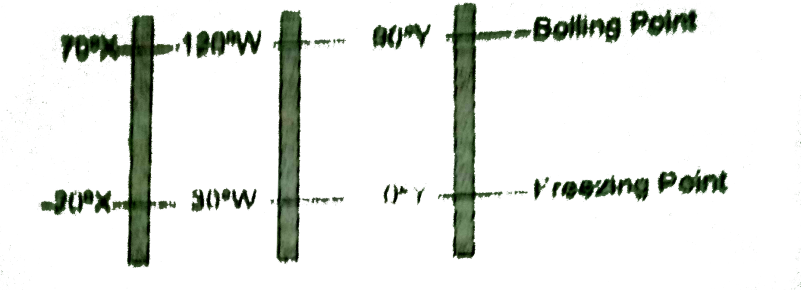
Checkpoint

1. The figure shows three temperature scales with the freezing and boiling points of water indicated.



(a) Rank the size of a degree on these scales, greatest first.

(b) Rank the following temperatures, highest first : $50^{\circ} X$, $50^{\circ} W$ and $50^{\circ} Y$.

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2. A metre scale was calibrated at $0^{\circ} C$. If at $40^{\circ} C$ is given the distance between two fixed points A and B as 12 mm (see figure) then what is the actual distance between them , given that coefficient of thermal expansion $a = 10^{-5} / {}^{\circ} C$.

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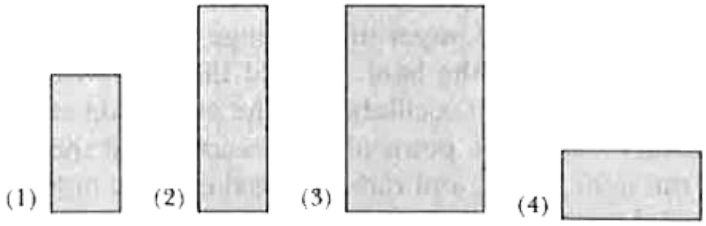
3. The figure here shows four rectangular metal plates, with sides of , L , 2L or 3L. They are all made of the same material , and their temperature is to be increased by the same amount , Rank the plates according to the expected increase in (a) their vertical heights and (b) their areas , greatest first.



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4. Why is only iron or steel used as reinforcement in concrete structures, while others metals ,duralumin for example , are never employed ?

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5. A metallic sheet is 50 cm long and 20 cm wide at $0^\circ C$. If it is heated to $60^\circ C$, what will be its area? Given that $\alpha = 10^{-4}/^\circ C$.

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6. In Fig , if $h_1 - h_0 = 1.0cm, h_0 = 100cm,$ and $t = 20^\circ C$, what is the value of γ for the liquid ?

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7. A sinker of weight w_0 has an apparent weight w_1 when weighed in a liquid at a temperature t_1 and w_2 when weight in the same liquid at temperature t_2. The coefficient of cubical

expansion of the material of sinker is β. What is the coefficient of volume expansion of the liquid.

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8. A glass cylinder contains $m_0 = 100g$ of mercury at a temperature of $t_0 = 0^\circ C$. When temperature becomes $t_1 = 20^\circ C$ the cylinder contains $m_1 = 99.7g$ of mercury The coefficient of volume expansion of mercury $\gamma_{He} = 18 \times \left(10^{-5}/^\circ C$ Assume that the temperature of the mercury is equal to that of the cylinder. The coefficient of linear expansion of glass α is

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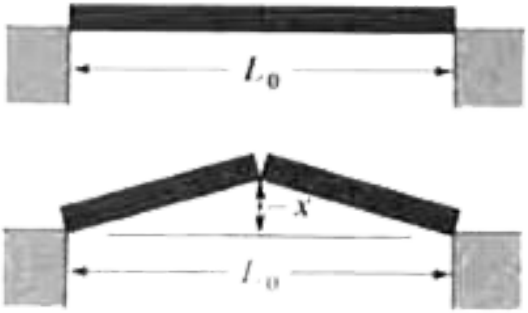
Problems

1. As a result of a temperature rise of $64^\circ C$, a bar with a crack at centre buckles upward (Fig . 18-20). The fixed distance L_0 is 3.77 m and the coefficient of linear expansion of the bar is Find the rise $25 \times 10^{-6} / ^\circ C$ of the centre .



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2. On a liner X temperature scale , water freezes at $-125.0^\circ X$ and boils at $360.0^\circ X$. On a linear Y temperature scale water freezes at $-70.00^\circ Y$ and boils at $-30.00^\circ Y$. A temperature of $50.00^\circ Y$ corresponds to what temperature on the X scale ?

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3. The volume of a solid aluminum ball with initial radius 20 cm increase by $347cm^3$ when the ball is heated . What is the temperature change ?

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4. (a) In 1983 the temperature at the Soviet Vostok station in Antarctica reached a record low of $-89.2^\circ C$, what temperature is this on the Fahrenheit scale ? (b) The highest officially recorded temperature in the continental United States was $134^\circ F$ in Death Valley, California , what is this temperature on the Celsius scale ?

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5. A vertical glass tube of length L = 1.280 000 m is half filled with a liquid at $20.000000^{\circ}C$ .How much will the height of the liquid column change when the tube and liquid are healted to 30.000 000 $^{\circ}C$? Use coefficients $\alpha_{\text{glass}} = 2.000000 \times 10^{-5}/K$ and $\beta_{\text{liquid}} = 4.000000 \times 10^{-5}/K$.

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6. An aluminum cup of cm^3 capacity is completely filled with glycerine at $22^{\circ}C$. How much glycerine , if any will spill out of the cup if the temperature of both the cup and the glycerine is increased to $28^{\circ}C$? (The coefficient of volume expansion of glycerine is $5.1 \times 10^{-4}/^{\circ}C$)

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7. At what temperature is the Fahrenheit scale reading equal to (a) three time that of the Celsius scale and (b) one-third that of the Celsius scale ?

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8. At $20^\circ C$,a brass cube has edge length 25 cm. What is the increase in the surface area when it is heated from $20^\circ C$ to $75^\circ C$?

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9. At $20^{\circ}C$, a rod is exactly 20 .05 cm long on a steel ruler. Both are placed in an over at $250^{\circ}C$, where the rod now measure 20.11 cm on the same ruler. What is the coefficient of linear expansion for the material of which the rod is made ?

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10. An aluminium - alloy rod has a length of 10.000 cm at $20.000^{\circ}C$ and a length of at the oiling point of water . (a) what is the length of the rod at the freezing point of water ? What is the temperature if the length of the rod is 10.009 cm?

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11. An aluminium flagpole is 30 m high . By how much does its length increase as the temperature increases by $15^{\circ} C$?

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12. A steel rod is 3 cm in diameter at $-10.00^{\circ} C$. A brass ring has an interior diameter of 2.992 cm at $-10.00^{\circ} C$. At what common temperature will the ring just slide onto the rod ?

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13. Suppose that on a linear temperature scale X, water boils at $-72.0^{\circ} X$ and freezes at $-123.0^{\circ} X$. What is a temperature of 59.0 K on the X scale ? (Approximate water's boiling point as 373K .)

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14. What is the volume of a lead ball at $20.00^\circ C$ if the ball's volume at $60.00^\circ C$ is $33.58 cm^3$?

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15. A circular hole in an aluminium plates is 3.115 cm in diameter at $0.000^\circ C$. What is its diameter when the temperature of the plate is raised to $180.0^\circ C$?

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16. When the temperature of a copper coin is raised by $100^\circ C$, its diameter increase by 0.20% To two significant figures, give

the percent increase in (a) the area of a face ,(b) the thickness, (c) the volume , and (d) the mass of the coin. (e) Calculate the coefficient of linear expansion of the coin.

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17. When the temperature of a metal cylinder is raised from $47.4^{\circ}C$ to $100^{\circ}C$, its length increases by 0.10% (a) Find the percent change in density .(b) What is the metal ? Use Table 18-2

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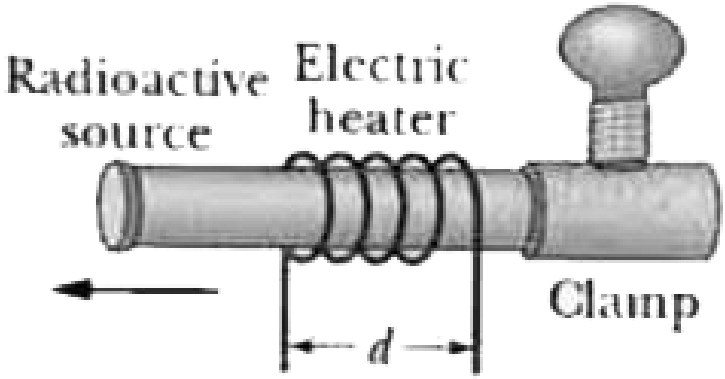
18. In a certain experiment , a small radioactive source must move at selected extremely slow speeds This motion is accomplished by fastening the source to one end of an

aluminium rod and heating the central section of the rod in Fig has length d = 2.00 cm. at what constant rate must the temperature of the rod be changed if the source is to move at a constant speed of 150 nm/ s ?



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19. A rectangular plate of glass initially has the dimensions 0.200 m by 0.300 m . The coefficient of linear expansion for the glass is $9.00 \times 10^{-6} / K$. What is the change in the plate's area if it's temperature is increased by 20.0 K ?

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20. A pendulum clock gives correct time at $20^\circ C$at a place where g $= 9.800ms^{-2}$.The pendulum consists of a light steel rod connected to a heavy ball. It is taken to a different place where g $= 9.788ms^2$. At what temperature will it give correct time ? coefficient of linear expansion of steel $= 12 \times 10^{-6\circ} C^{-1}$.

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21. The densities of wood and benzene at $0^\circ C$ are $880kg/m^3$ and $900kg/m^3$ respectively. The coefficients of volume expansion are $1.2 \times 10^{-3}/'^\circ C$ for wood and

$1.5 \times 10^{-3} / {}^{\circ} C$ for benzene. At what temperature will a piece of wood just sink in benzene?

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22. A glass window pane is exactly 20 cm by 30 cm at $10^{\circ} C$ .By how much has its area increase when it's temperature is C $40^{\circ} C$, assuming that it can expand freely ?

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23. A pendulum clock with a pendulum made of Invar $\left(a = 0.7 \times 10^{-6} / {}^{\circ} C\right)$ has a period of 0.5 and is accurate at $25^{\circ} C$. If the clock is used in a country where the temperature average $35^{\circ} C$, What correction is necessary at the end of a month (30 days) to the time given by the clock?

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24. Two constant-volume gas thermometers are assembled, one with nitrogen and the other with hydrogen , Both contain enough gas so that $p_3 = 78kPa$. (a) What is the difference between the pressure in the two thermometers if both bulbs are in boiling water ? (Hint : See Fig 18-5) (b) Which gas is at higher pressure ?

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Practice Questions Single Correct Choice Type

1. In constructing a thermometer it is necessary to use a substance that

A. expands with rising temperature.

B. expands linearly with rising temperature

C. will not freeze

D. undergoes some change when heated or cooled .

Answer: D

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2. What is the limiting low temperature of a physical object?

A. There is no limiting low temperature

B. 0 K

C. $0^\circ C$

D. $0^\circ F$

Answer: B

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3. A balloon is filled with cold air and placed in a warm room. It is NOT in thermal equilibrium with the air of the room until

A. it rises to the ceiling

B. it sinks to the floor.

C. it stops expanding

D. it starts to contract.

Answer: C

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4. Three thermometer are placed in a closed, insulated box and are allowed to reach thermal equilibrium . One is calibrated in Fahrenheit degrees, one in Celsius degrees, and one in Kelvins. The Celsius thermometer reads $-40^{\circ}C$ and the Kelvin thermometer reads 233 K. Which one of the following statements is necessarily true ?

A. The Kelvin thermometer should read - 233 K

B. The Kelvin thermometer should read -313 K

C. The Fahrenheit thermometer must read $-40^{\circ}0$ F.

D. If water were found within the box, it must be in the liquid state .

Answer: C

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5. Suppose object C is in thermal equilibrium with object A and with object B. The zeroth law of thermodynamics states

A. that C will always be in thermal equilibrium with both A and B .

B. that C must transfer energy to both A and B .

C. that A is in thermal equilibrium with B.

D. that A cannot be in thermal equilibrium with B .

Answer: C

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6. The " triple point " of a substance is that point for which the temperature and pressure are such that :

A. Only solid and liquid are in equilibrium.

B. Only liquid and vapor are in equilibrium.

C. Only solid and vapor are in equilibrium.

D. Solid, liquid and vapor are all in equilibrium .

Answer: D

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7. Metal pipes used to carry water sometimes burst in the winter. This is because

A. Water contracts upon freezing while the metal expands at lower temperatures .

B. The metal contracts to a greater extent that the water

C. The interior of the pipe contracts less than the out side of the pipe.

D. Water expands upon freezing while the metal contracts at lower temperatures.

Answer: D

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8. A constant - volume gas thermometer is used to measure the temperature of an object . When the thermometer is in contact with water at its triple point (273K) the pressure in the thermometer is $8.50 \times 10^4 Pa$. When it is contact with the object the pressure is $9.650 \times 10^4 Pa$. The real temperature of the object is

A. 41.0 K

B. 114 K

C. 241 K

D. 310 K

Answer: D

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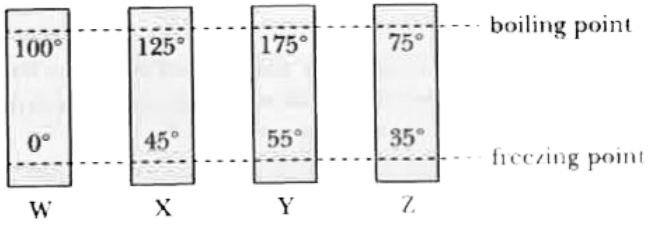
9. The diagram shows four thermometers. labeled W,X,Y and Z. The freezing and boiling points of water are indicated . Rank the thermometers according to the size of a degree in their scales, smallest to largest .



A. W,X,Y,Z

B. Y,W,X,Z

C. Z,Y,W,X

D. Z,X,W,Y

Answer: D

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10. Which one of following properties could not be used as a temperature sensitive property in the construction of thermometer ?

A. The change in mass of a solid.

B. The change in the volume of a liquid .

C. The change in length of a metal rod.

D. The change in electrical resistance of a wire.

Answer: A

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11. There is a temperature at which the reading on the Kelvin scale is numerically

A. equal to that on the Celsius scale.

B. lower than that on the Celsius scale

C. equal to that on the Fahrenheit scale .

D. less than zero .

Answer: C

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12. The coefficient of linear expansion of aluminium is $23 \times 10^{-6} / {}^{\circ}C$. A circular hole in an aluminium plate 2.725 is cm in diameter at $0^{\circ}C$ .What is the diameter of the hole if the temperature of the plate is raised to $100^{\circ}C$?

A. 0.0063 cm

B. 2.728 cm

C. 2.731 cm

D. 2.757 cm

Answer: C

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13. A thermometer indicates $98.6^{\circ}C$. It may be

A. outdoors on a cold day.

B. in a comfortable room.

C. in a cup of hot tea.

D. in a normal person's mouth.

Answer: C

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14. A copper plate has a length of 0.1 m and a width of 0.12 m at $25^{\circ}C$. The plate is uniformly heated to $175^{\circ}C$. If the liner expansion coefficient for copper is $1.7 \times 10^{-5}/^{\circ}C$ what is

the change in the area of the plate as a result of the increase in temperature ?

A. $2.6 \times 10^{-5} m^2$

B. $6.1 \times 10^{-5} m^2$

C. $3.2 \times 10^{-6} m^2$

D. $4.9 \times 10^{-7} m^2$

Answer: B

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15. It is more difficult to measure the coefficient of volume expansion of a liquid than that of a solid because

A. no relation exists between linear and volume expansion coefficients.

B. a liquid tends to evaporate.

C. a liquid expands too much when heated .

D. the containing vessel also expands.

Answer: D

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16. A steel string guitar is strung so that there is negligible tension in the strings at a temperature of $24.9^\circ C$. The guitar is taken to an outdoor winter concert where the temperature of the string decrease to $-15.1^\circ C$. The cross-sectional area of a particular string is $5.5 \times 10^{-6} m^2$. The distance between

the points where the string is attached does not change . For steel , Young's modulus is $2.0 \times 10^{11} N/m^2$, and the coefficient of linear expansion is $1.2 \times 10^{-5}/^{\circ}C$. Use your knowledge of liner thermal expansion and stress to calculate the tension in the string at the concert.

A. 530 N

B. 240 N

C. 120 N

D. 60 N

Answer: A

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17. The strips of iron and zinc are riveted together to from a bimetallic strip which bends when heated . The iron is on the inside of the bend because

A. it has a higher coefficient of linear expansion .

B. it has a lower coefficient of linear expansion .

C. it has a higher specific heat .

D. it has a lower specific heat .

Answer: B

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18. The coefficient of linear expansion of a certain of a certain solid is $9 \times 10^{-6} / {}^{\circ} C$ Assuming this solid behaves like most

solids , what is its coefficient of volume expansion ?

A. $9.1 \times 10^{-6} / {}^{\circ} C$

B. $2.7 \times 10^{-6} / {}^{\circ} C$

C. $27 \times 10^{-6} / {}^{\circ} C$

D. $729 \times 10^{-6} / {}^{\circ} C$

Answer: C

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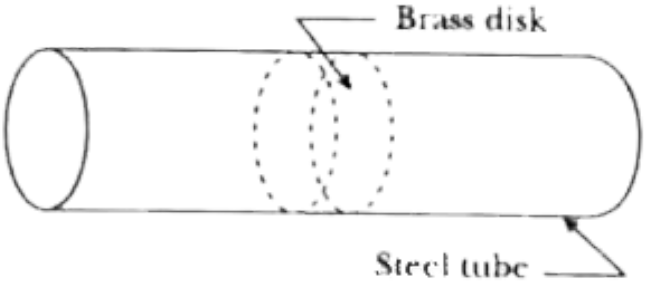
19. The given figure shows a brass disk tightly filled into a steel tube. The coefficient of linear expansion of the brass is 2.00×10^{-5} per ${}^{\circ} C$. The system was assembled by cooling the disks in dry ice $(- 57^{\circ} C)$ to enable them to just slide into the close-fitting tube. If the diameter of a disk is 80.00

mm at $43^{\circ} C$, what is its diameter in the dry ice?



A. 78.400 mm

B. 79.998 mm

C. 80.160 mm

D. 79.840 mm

Answer: D

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20. A tanker ship is filled with $2.25 \times 10^5 m^3$ of gasoline at a refinery in southern Texas when the temperature is $17.2^\circ C$ .When the ship arrives in New York City, the temperature is $1.3^\circ C$. If the coefficient of volume expansion for gasoline is $9.50 \times 10^{-4} / {}^\circ C$, how much has the volume of the gasoline decreased when it is unloaded in New York ?

A. $1.50 \times 10^{-2} m^3$

B. $66.2 m^3$

C. $1290 m^3$

D. $3400 m^3$

Answer: D

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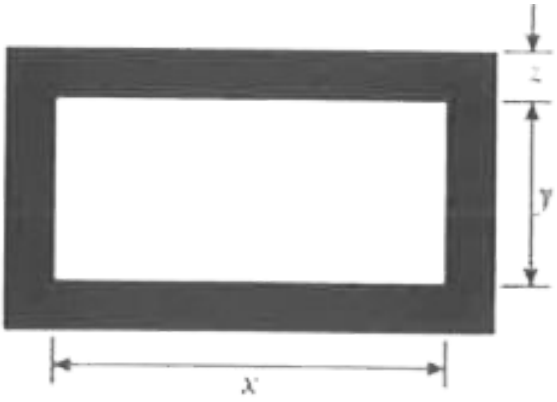
21. The figure shows a rectangular brass plate at $0^\circ C$. in which there is cut a rectangular hole of dimensions indicated .if the temperature of the plate is raised to $150^\circ C$, then



A. x will increase and y will decrease .

B. both x and y will decrease

C. x will decrease and y will increase

D. both x and y will increase.

Answer: D

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22. The coefficient of volume expansion for gold is $4.20 \times 10^{-5} / {}^{\circ}C$. The density of gold is 19 300 kg/m^3 at $0.0^{\circ}C$. What is the density of gold at $1050^{\circ}C$?

A. $20200 kg/m^3$

B. $18500 kg/m^3$

C. $19300 kg/m^3$

D. $18800 kg/^3$

Answer: B

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23. Dermatologists often remove small precancerous skin lesions by freezing them quickly with liquid nitrogen, which has a temperature of 77 K. What is this temperature on the (a) Celsius ?

A. $-196^\circ C$

B. $-321^\circ C$

C. $-164^\circ C$

D. $-242^\circ C$

Answer: A

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24. An aluminium baseball bat has a length of 0.86 m at a temperature of $17^{\circ} C$. When the temperature of the bat is raised , the bat lengthens by 0.000 16 m . Determine the final temperature of the bat.

A. $19^{\circ} C$

B. $25^{\circ} C$

C. $34^{\circ} C$

D. $29^{\circ} C$

Answer: B

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25. When the temperature of a coin is raised by $75^{\circ}C$, the coin's diameter increase by $2.3 \times 10^{-5}m$. If the original diameter of the coin is 1.8×10^{-2} m, find the coefficient of linear expansion .

A. $5.4 \times 10^{-5} / {}^{\circ}C$

B. $1.7 \times 10^{-5} / {}^{\circ}C$

C. $9.8 \times 10^{-6} / {}^{\circ}C$

D. $3.1 \times 10^{-6} / {}^{\circ}C$

Answer: B

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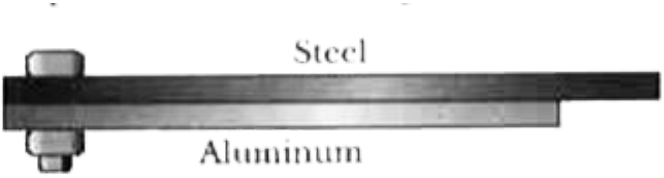
26. The given figure shows that,two thin strips of metal are bolted together at one end have the same temperature. One is steel , and the other is aluminium . The steel strip is 0.10% longer than the aluminium strip. By how much should the temperature of the strips be increased, so that the strips have the same length ?



A. $91^\circ C$

B. $99^\circ C$

C. $77^\circ C$

D. $85^\circ C$

Answer: A

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27. At a temperature of $0^\circ C$, the mass and volume of a fluid are 825 kg and $1.17m^3$. The coefficient of volume expansion is $1.26 \times 10^{-3} / {}^\circ C$. What is the density of the fluid when the temperature has risen to $20.0^\circ C$?

A. $688kg / m^3$

B. $562kg / m^3$

C. $705kg / m^3$

D. $641kg / m^3$

Answer: A

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28. A steel rod of length L_0 . has a cross sectional area A. The force required to stretch this rod by the same amount as the expansion produced by heating it through ΔT is (coefficient of linear expansion of steel is α and young's modulus for steel is Y).

A. $YA\alpha\Delta T$

B. $1/2YA\alpha\Delta T$

C. $2YA\alpha\Delta T$

D. $3YA\alpha\Delta T$

Answer: A

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29. 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 temperatures of both mercury and the metal are increased by an amount ΔT, the fraction of the volume of the metal submerged in mercury changes by the factor.....

A. $\frac{1+\gamma_2\Delta T}{1+\gamma_1\Delta T}$

B. $1+\gamma_1\Delta T$

C. $1+\gamma_2\Delta T$

D. $\frac{1-\gamma_2\Delta T}{1-\gamma_1\Delta T}$

Answer: A

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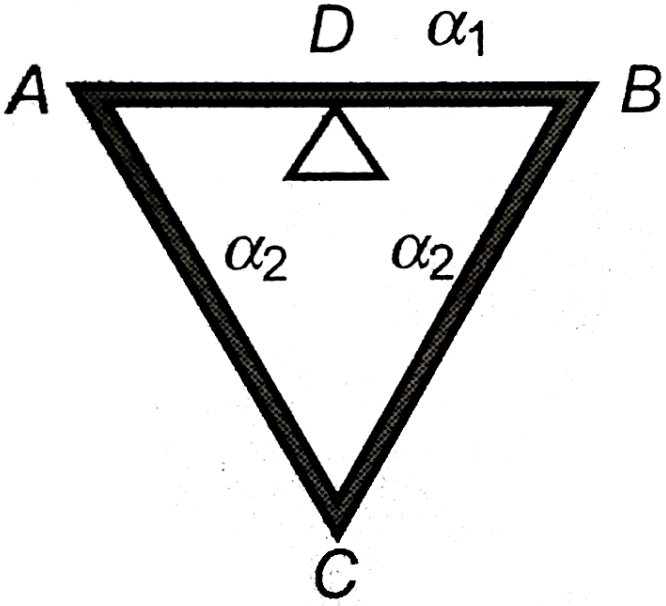
30. Three rods of equal of length are joined to from an equilateral triangle ABC. D is the midpoint of AB. The coefficient of linear expansion is α_1 for AB and α_2 for AC and BC . If the distance DC remains constant for small changes in temperature,



A. $\alpha_1 = \alpha_2$

B. $\alpha_1 = 2\alpha_2$

C. $\alpha_1 = 4\alpha_2$

D. $\alpha_1 = \frac{1}{2}\alpha_2$

Answer: C

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31. An iron rod of length 50 cm is joined at an end to an aluminum rod of length 100 cm. All measurements refer to $20^\circ C$. The coefficients of linear expansion of iron and aluminum are $12 \times 10^{-6}/^\circ C$ and $24 \times 10^{-6}/^\circ C$, respectively. The average coefficient of expansion of composite system is :

A. $36 \times 10^{-6}/^\circ C$

B. $12 \times 10^{-6}/^\circ C$

C. $20 \times 10^{-6}/^\circ C$

D. $48 \times 10^{-6} / {}^{\circ}C$

Answer: C

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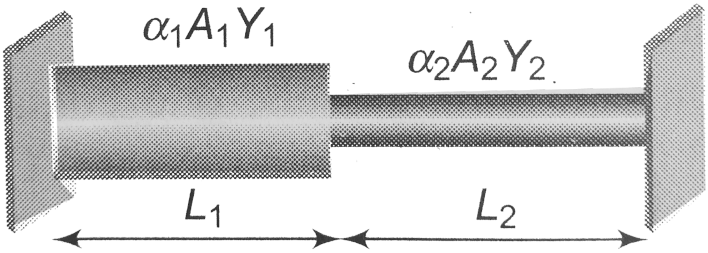
32. Two rods are joined between fixed supports as shown in the figure. Condition for no change in the length of individual rods with the increase of temperature will be

$(\alpha_1, \alpha_2 =$ linear expansion coefficient

$A_1, A_2 =$ Area of rods

$Y_1, Y_2 =$ Young modulus $)$



A. $\frac{A_1}{A_2} = \frac{\alpha_1 y_1}{\alpha_2 y_2}$

B. $\frac{A_1}{A_2} = \frac{L_1 \alpha_1 y_1}{L_2 \alpha_2 y_2}$

C. $\frac{A_1}{A_2} = \frac{L_2 \alpha_1 y_1}{L_1 \alpha_2 y_2}$

D. $\frac{A_1}{A_2} = \frac{\alpha_2 y_2}{\alpha_1 y_1}$

Answer: D

33. An iron ball (coefficient of linear expansion $= 1.2 \times \left(10^{-5} / {}^{\circ} C\right)$ has a diameter of 6 cm and is 0.010 mm too large to pass through a hole in a brass plate (coefficient of linear expansion $= 1.9 \times 10^{-5} / {}^{\circ} C$) when the ball and the plate are both at a temperature of $30^{\circ} C$ At what common

temperature of the ball and the plate will the ball just pass through the hole in the plate ?

A. $23.8^{\circ} C$

B. $53.8^{\circ} C$

C. $42.5^{\circ} C$

D. $63.5^{\circ} C$

Answer: B

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Practice Quetions More Than One Correct Choice Type

1. A vessel is partly filled with liquid. When the vessel is cooled to a lower temperature, the space in the vessel unoccupied by

the liquid remains constant. Then the volume of the liquid (V_L) volume of the vessel (V_V) the coefficient of cubical expansion of the material of the vessel (γ_v) and of the solid (γ_L) are related as

A. $\gamma_L > \gamma_V$

B. $\gamma_L < \gamma_V$

C. $\gamma_V / \gamma_L = V_V / V_L$

D. $\gamma_V / \gamma_L = V_L / V_L$

Answer: A::B

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2. A metal rod is shaped into a ring with a small gap. If this is heated,

(i) the length of the rod will increase

(ii) the gap will decrease

(iii) the gap will increase

(iv) the diameter gof the ring will increase in the same ratio as the length of the rod

A. the length of the rod will increase

B. the gap will decrease .

C. the gap will increase .

D. the diameter of the ring will increase in the same ratio as the length of the rod.

Answer: A::B::D

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3. When the temperature of a copper coin is raised by $80^\circ C$, its diameter increases by $0.2\,\%$.

A. Percentage rise in the area of a face is 0.4 %

B. Percentage rise in the thickness is 0.4%

C. Percentage rise in the Volume is 0.6%

D. Coefficient of linear expansion of copper is $0.25 \times 10^{-4}/^\circ C$.

Answer: A::C::D

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4. Two rods of length L_1 and L_2 are made of materials of coefficients of linear expansions α_1 an α_2 respectively such

that $L_1\alpha_1 = L_2\alpha_2$. The temperature of the rods is increased by ΔT and correspondingly the change in their respective lengths be ΔL_1 and ΔL_2

A. $\Delta L_1 \neq \Delta L_2$

B. $\Delta L_1 = \Delta L_2$

C. The difference in the length $(L_1 - L_2)$ is a constant and is independent of the rise of temperature

D. Data insufficient to arrive at a conclusion.

Answer: B::C

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5. When solid is heated , its length changes according to the relation $l = l_0(1 + \alpha\Delta T)$, where l is the final length , l_0 is the

initial length , ΔT is the change in temperature , and α is the coefficient of linear is called super - facial expansion. the area changes according to the relation $A = A_0(1 + \beta\Delta T)$, where A is the tinal area , A_0 is the initial area, and β is the coefficient of areal expansion.

A metal disc having a circular hole at its center is heated . If the metal expands on heating , the diameter of the hole

A. increases.

B. decreases

C. remains unchanged

D. increases or decreases depending on the metal .

Answer: A

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6. When solid is heated , its length changes according to the relation $l = l_0(1 + \alpha\Delta T)$, where l is the final length , l_0 is the initial length , ΔT is the change in temperature , and α is the coefficient of linear is called super - facial expansion. the area changes according to the relation $A = A_0(1 + \beta\Delta T)$, where A is the tinal area , A_0 is the initial area, and β is the coefficient of areal expansion.

On heating a liquid of coefficient of cubical or volume expansion γ in a container having coefficient of linear expansion $\gamma/3$, the level of liquid in the container

A. rises.

B. falls .

C. remain almost stationary

D. none of these .

Answer: C

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7. When solid is heated , its length changes according to the relation $l = l_0(1 + \alpha\Delta T)$, where l is the final length , l_0 is the initial length , ΔT is the change in temperature , and α is the coefficient of linear is called super - facial expansion. the area changes according to the relation $A = A_0(1 + \beta\Delta T)$, where A is the tinal area , A_0 is the initial area, and β is the coefficient of areal expansion.

The coefficient of linear expansion of brass and steel are α_1 and α_2 If we take a brass rod of length I_1 and a steel rod of length I_2 at $0^\circ C$, their difference in length remains the same at any temperature if

A. $\alpha_1 l_2 = \alpha_2 l_2$

B. $\alpha_1 l_2^2 = \alpha_2 l_1^2$

C. $\alpha_1^2 l_2 = \alpha_2^2 l_1$

D. $\alpha_1 l_1 = \alpha_2 l_2$

Answer: D

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Practice Quetions Matrix Match

1. In the given table , the column shown the lower fixed point (LEP), Column II shows the upper fixed point (UFP) and the Column III gives corresponding division on the scale for three different scales for temperature measurement .

Column I	Column II	Column III
(I) Lower fixed point: 460	(i) Upper fixed point: 80	(J) 212
(II) Lower fixed point: 32	(ii) Upper fixed point: 100	(K) 80
(III) Lower fixed point: 0	(iii) Upper fixed point: 672	(L) 100
(IV) Lower fixed point: 273.15	(iv) Upper fixed point: 212	(M) 180

Determine the features of Fahrenheit scale.

A. (III) (ii) (L)

B. (II) (iv) (M)

C. (I) (i) (M)

D. (II) (i) (K)

Answer: A::B

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2. In the given table , the column shown the lower fixed point (LEP), Column II shows the upper fixed point (UFP) and the Column III gives corresponding division on the scale for three different scales for temperature measurement .

Column I	Column II	Column III
(I) Lower fixed point: 460	(i) Upper fixed point: 80	(J) 212
(II) Lower fixed point: 32	(ii) Upper fixed point: 100	(K) 80
(III) Lower fixed point: 0	(iii) Upper fixed point: 672	(L) 100
(IV) Lower fixed point: 273.15	(iv) Upper fixed point: 212	(M) 180

Determine the features of Rankine scale.

A. (I) (ii) (K)

B. (IV) (iii) (J)

C. (II) (iii) (M)

D. (I) (iii) (J)

Answer: A::D

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3. In the given table , the column shown the lower fixed point (LEP), Column II shows the upper fixed point (UFP) and the Column III gives corresponding division on the scale for three different scales for temperature measurement .

Column I	Column II	Column III
(I) Lower fixed point: 460	(i) Upper fixed point: 80	(J) 212
(II) Lower fixed point: 32	(ii) Upper fixed point: 100	(K) 80
(III) Lower fixed point: 0	(iii) Upper fixed point: 672	(L) 100
(IV) Lower fixed point: 273.15	(iv) Upper fixed point: 212	(M) 180

Determine of features of Reaumer scale

A. (I) (i) (K)

B. (I) (i) (L)

C. (III) (i) (K)

D. (I) (iv) (L)

Answer: A::C

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Practice Quetions Integer Type

1. A pendulum clock loses 12s a day if the temperature is $40^\circ C$ and gains 4s a day if the temperature is $20^\circ C$, The temperature at which the clock will show correct time, and the co-efficient of linear expansion (α) of the metal of the pendulum shaft are respectively:

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2. The length of the steel rod which would have the same difference in length with a copper rod of length 24cm at all temperatures.

$\left(\alpha_{\text{copper}} = 18 \times 10^{-6} K^{-1} \alpha_{\text{steel}} = 12 \times 10^{-6} k^{-1}\right)$ is -

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3. Find the approximate length of the Golden Gate bridge if it is known that the steel in the roadbed expands by 0.53 m when the temperature changes from +2 to + $32^{\circ} C$.

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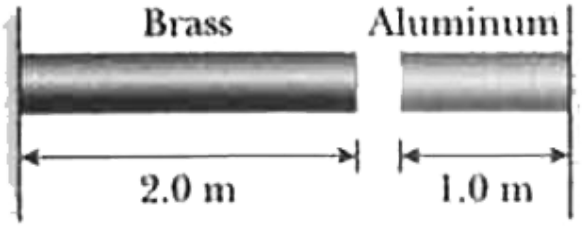
4. The brass bar and the alumiumn bar in the drawing are each attached to an immovable wall. At $28^{\circ} C$ the air gap between the rods is 1.3×10^{-3} m . At what temperature will the be closed ?



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