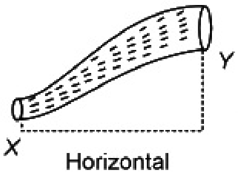
Question1

An ideal fluid is flowing in a non-uniform cross-sectional tube X Y (as shown in the figure) from end X to end Y . If K_1 and K_2 are the kinetic energy per unit volume of the fluid at X and Y respectively, then the correct option is :



[NEET 2024 Re]

Options:

A.

$K_1 = K_2$

B.

$2K_1 = K_2$

C.

$K_1 > K_2$

D.

$K_1 < K_2$

Answer: C

Solution:

According to Bernoulli's principle,

Kinetic energy per unit volume + Potential energy per unit volume + Pressure = Constant

$\frac{1}{2}\rho V^2 + \rho g h + P =$ constant

Apply Bernoulli's principle at point X and Y ,

$P + K_1 + \rho g(0) = P + K_2 + \rho g(\text{h})$

$K_1 = K_2 + \rho g h$

$K_1 > K_2$

Question2

The maximum elongation of a steel wire of 1m length if the elastic limit of steel and its Young's modulus, respectively, are $8 \times 108 Nm^{-2}$ and $2 \times 10^{11} Nm^{-2}$, is:

[NEET 2024]

Options:

A.

4mm

B.

0.4mm

C.

40mm

D.

8mm

Answer: A

Solution:

In the case for maximum elongation,

Stress = Elastic limit

$$\delta_{max} = \frac{\sigma_{elastic} \times L}{\text{Young's modulus}} = \frac{8 \times 10^8 \times 1}{2 \times 10^{11}} = 4 \times 10^{-3}$$

$= 4 \text{ mm}$

i.e. maximum elongation is 4 mm

Question3

A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is $0.07 Nm^{-1}$, then the excess force required to take it away from the surface is

[NEET 2024]

Options:

A.

19.8 mN

B.

198N

C.

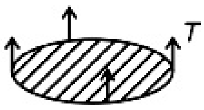
1.98 mN

D.

99N

Answer: A

Solution:



Excess force $= T \times 2\pi R$

$= \frac{7}{100} \times 2 \times 3.14 \times \frac{4.5}{100}$

$= 197.82 \times 10^{-4}$

$= 19.8 \times 10^{-3} N$

$= 19.8\, mN$

Question4

A metallic bar of Young's modulus, $0.5 \times 10^{11} Nm^{-2}$ and coefficient of linear thermal expansion $10^{-5} {}^\circ C^{-1}$, length 1m and area of cross-section $10^{-3}\ m^2$ is heated from $0^\circ C$ to $100^\circ C$ without expansion or bending. The compressive force developed in it is :

[NEET 2024]

Options:

A.

$5 \times 10^3 N$

B.

$50 \times 10^3 N$

C.

$100 \times 10^3 N$

D.

$2 \times 10^3 N$

Answer: B

Solution:

Thermal strain = Longitudinal strain $= \alpha \Delta T$

$\Rightarrow$ Longitudinal strain, $\delta = 10^{-5} \times 10^{2} = 10^{-3}$

$\Rightarrow$ Compressive stress $= \delta \times$ Young's Modulus

$= 10^{-3} \times 0.5 \times 10^{11}$

$= 0.5 \times 10^{8}$

$\Rightarrow$ Compressive force $= 0.5 \times 10^{8} \times 10^{-3} = 0.5 \times 10^{5}$

$= 5 \times 10^{4} \times \frac{10}{10}$

$= 50 \times 10^{3}$N

Question5

Let a wire be suspended from the ceiling (rigid support) and stretched by a weight W attached at its free end. The longitudinal stress at any point of cross-sectional area A of the wire is

[NEET 2023]

Options:

A.

WIA

B.

W/2A

C.

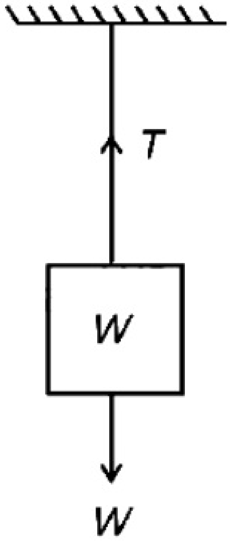
Zero

D.

2WIA

Answer: A

Solution:



Longitudinal stress $= \frac{\text{Internal restoring force}}{\text{Area}} = \frac{F_{ext}}{\text{Area}}$

Stress $= \frac{W}{A}$

Question6

The amount of energy required to form a soap bubble of radius 2cm from a soap solution is nearly (surface tension of soap solution = $0.03 \mathrm{Nm}^{-1}$)

[NEET 2023]

Options:

A.

5.06×10^{-4}J

B.

3.01×10^{-4}J

C.

50.1×10^{-4}J

D.

30.16×10^{-4}J

Answer: B

Solution:

Amount of energy required $= [S \times \Delta A] \times 2$

$\Rightarrow$ Energy required $= [0.03 \times 4 \times \pi \times 4 \times 10^{-4}] \times 2$

$= 3.015 \times 10^{-4}$J

Question7

The venturi-meter works on

[NEET 2023]

Options:

A.

Bernoulli's principle

B.

The principle of parallel axes

C.

The principle of perpendicular axes

D.

Huygens's principle

Answer: A

Solution:

Venturi-meter works on the Bernoulli's principle.

Question8

The amount of elastic potential energy per unit volume (in SI unit) of a steel wire of length 100cm to stretch it by 1mm is (if Young's modulus of the wire = $2.0 \times 10^{11} Nm^{-2}$) :

[NEET 2023 mpr]

Options:

A.

10^{11}

B.

10^{17}

C.

10^{7}

D.

10^{5}

Answer: D

Solution:

$$\frac{E.P.E}{Volume} = \frac{1}{2}(\text{ stress})(\text{strain})$$

$$= \frac{1}{2}(Y)(\text{ strain })^2$$

$$= \frac{1}{2}(Y)\left(\frac{\Delta L}{L}\right)^2$$

$$= \frac{1}{2}(2 \times 10^{11})\left(\frac{1 \times 10^{-3}}{100 \times 10^{-2}}\right)^2$$

$$= 10^5$$

Question9

Which of the following statement is not true?

[NEET 2023 mpr]

Options:

A.

Coefficient of viscosity is a scalar quantity

B.

Surface tension is a scalar quantity

C.

Pressure is a vector quantity

D.

Relative density is a scalar quantity

Answer: C

Solution:

Solution:

Pressure is a scalar quantity.

Question10

The viscous drag acting on a metal sphere of diameter 1mm, falling

through a fluid of viscosity 0.8Pa s with a velocity of 2m s^{-1} is equal to :

[NEET 2023 mpr]

Options:

A.

15×10^{-3}N

B.

30×10^{-3}N

C.

1.5×10^{-3}N

D.

20×10^{-3}N

Answer: A

Solution:

Solution:

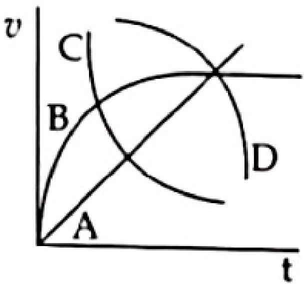
$F = 6\pi r\eta v$

$= (6)(3.14)\left(\frac{1 \times 10^{-3}}{2}\right)(0.8 \times 10^{-1})(2)$

$= 1.5 \times 10^{-3}N$

Question11

A spherical ball is dropped in a long column of a highly viscous liquid. The curve in the graph shown, which represents the speed of the ball (v) as a function of time (t) is
[NEET-2022]



Options:

A. A

B. B

C. C

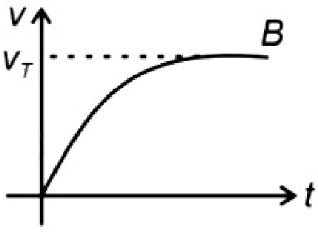
D. D

Answer: B

Solution:

Solution :

Initial speed of ball is zero and it finally attains terminal speed



Question12

If a soap bubble expands, the pressure inside the bubble [NEET-2022]

Options:

A. Decreases

B. Increases

C. Remains the same

D. Is equal to the atmospheric pressure

Answer: A

Solution:

Solution :

Excess pressure inside the bubble $= \Delta P = \frac{4T}{R}$

$P_{in} = P_{out} + \frac{4T}{R}$

as 'R' increases 'P' decreases

Question13

Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The stretching of a spring is determined by the shear modulus of the material of the spring.
Reason (R): A coil spring of copper has more tensile strength than a steel spring of same dimensions.

In the light of the above statements, choose the most appropriate answer from the options given below
[NEET-2022]

Options:

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

B. Both (A) and (R) are true and (R) is not the correct explanation of (A)

C. (A) is true but (R) is false

D. (A) is false but R) is true

Answer: C

Solution:

Solution :

It is true that stretching of spring is determined by shear modulus of the spring as when coil spring is stretched neither its length nor its volume changes, there is only change in its shape.

Tensile strength of steel is more than that of copper.

Hence Assertion is true and reason is false.

Question14

Two copper vessels A and B have the same. base area but of different shapes. A take twice the volume of water as that B requires to fill upto a particular common height. Then the correct statement among the following is: ,
[NEET Re-2022]

Options:

A. Vessel B weighs twice that of A.

B. Pressure on the base area of vessels A and B is same.

C. Pressure on the base area of A and B is not same.

D. Both vessels A and B weigh the same.

Answer: B

Solution:

Solution :

Since water is filled upto same height so pressure at the bottom will be same.

Question15

A The terminal velocity of a copper ball of radius 5 mm falling through a

tank of oil at room temperature is $10\,cm\,s^{-1}$. If the viscosity of oil at room temperature is $0.9\,kg\,m^{-1}\,s^{-1}$, the viscous drag force is:
[NEET Re-2022]

Options:

A. $4.23 \times 10^{-6}N$

B. $8.48 \times 10^{-3}N$

C. $8.48 \times 10^{-5}N$

D. $4.23 \times 10^{-3}N$

Answer: B

Solution:

Given, $r = 5\text{ mm} = 5 \times 10^{-3}\text{m}$ $V_t = 10\text{ cm s}^{-1} = 10 \times 10^{-2}\text{m}^{-1}\text{s}$

Viscous drag force

$F = 6\pi\eta r V_t$

$F = 6 \times \pi \times 0.9 \times 5 \times 10^{-3} \times 10 \times 10^{-2}$

$F = 84.78 \times 10^{-4}$

$F = 8.478 \times 10^{-3}\text{N}$

Question16

Two rods one made of copper and other made of steel of the same length and same cross sectional area are joined together. The thermal conductivity of copper and steel are $385 Js^{-1}K^{-1}m^{-1}$ and $50 Js^{-1}K^{-1}m^{-1}$ respectively. The free ends of copper and steel are held at $100^{\circ}C$ and $0^{\circ}C$ respectively. The temperature at the junction is, nearly:
[NEET Re-2022]

Options:

A. $88.5^{\circ}C$

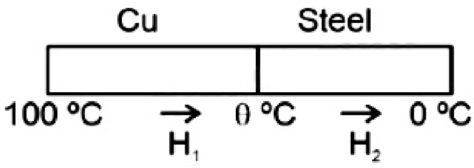
B. $12^{\circ}C$

C. $50^{\circ}C$

D. $73^{\circ}C$

Answer: A

Solution:



$H_1 = H_2$

$$\frac{K_{Cu}A[100-\theta]}{l} = \frac{K_{steel}A[\theta-0]}{l}$$

$385[100-\theta] = 50[\theta-0]$

$\Rightarrow \theta = 88.5^{\circ}C$ [junction temperature]

Question17

The velocity of a small ball of mass M and density d, when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is $\frac{d}{2}$, then the viscous force acting on the ball will be [NEET 2021]

Options:

A. $\frac{Mg}{2}$

B. Mg

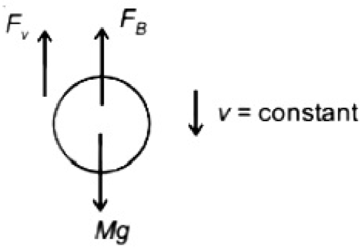
C. $\frac{3}{2}Mg$

D. $2Mg$

Answer: A

Solution:

Solution:
I. Let F_v be the viscous force and F_B be the Bouyant force acting on the ball.



Then, when body moves with constant velocity
$Mg = F_B + F_v \quad [a = 0]$
$F_v = Mg - F_B$
$= dVg - \frac{d}{2}.Vg \quad (M = dVg)V =$ volume of ball.
$= \frac{d}{2}Vg$
$F_v = \frac{M}{2}g$

Question18

A wire of length L, area of cross section A is hanging from a fixed support. The length of the wire changes to L_1 when mass M is suspended from its free end. The expression for Young's modulus is : [2020]

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Options:

A. $\frac{Mg(L_1 - L)}{AL}$

B. $\frac{MgL}{AL_1}$

C. $\frac{MgL}{A(L_1 - L)}$

D. $\frac{MgL_1}{AL}$

Answer: C

Solution:

Solution:

(c) Stress $= \frac{\text{force}}{\text{cross-section area}} = \frac{Mg}{A}$

Strain $= \frac{\text{change in length}}{\text{original length}} = \frac{\Delta L}{L} = \frac{L_1 - L}{L}$

Young's modulus, $Y = \frac{\text{stress}}{\text{strain}} = \frac{MgL}{A(L_1 - L)}$

Question19

**A capillary tube of radius r is immersed in water and water rises in it to a height h. The mass of the water in the capillary is 5g. Another capillary tube of radius 2r is immersed in water. The mass of water that will rise in this tube is :
[2020]**

Options:

A. 5.0g

B. 10.0g

C. 20.0g

D. 2.5g

Answer: B

Solution:

(b) Force of surface tension balances the weight of water in capillary tube.
$F_S = 2\pi rT\cos\theta = mg$
Here, T and θ are constant.
So, $m \propto r$
Let m_1 and m_2 be the mass of water in two capillary tube.
$\therefore \frac{m_2}{m_1} = \frac{r_2}{r_1}$
$\Rightarrow \frac{m_2}{5.0} = \frac{2r}{r}$ $(\because r_2 = 2r)$
$\Rightarrow m_2 = 10.0g$

Question20

A copper rod of 88cm and an aluminium rod of unknown length have their increase in length independent of increase in temperature. The length of aluminium rod is
$(\alpha_{Cu} = 1.7 \times 10^{-5}K^{-1}, \alpha_{Al} = 2.2 \times 10^{-5}K^{-1})$
(NEET 2019)

Options:

A. 68cm

B. 6.8cm

C. 113.9cm

D. 88cm

Answer: A

Solution:

As per question, $l_{Cu}' + l_{Al}' = l_{Cu} + l_{Al}$
or, $\Delta l_{Cu} = -\Delta l_{Al}$ or, $l_{Cu}\alpha_{Cu}\Delta T = -l_{Al}\alpha_{Al}\Delta T$
$|l_{Al}| = \frac{l_{Cu}\alpha_{Cu}}{\alpha_{Al}} = \frac{88 \times 1.7 \times 10^{-5}}{2.2 \times 10^{-5}} = 68cm$

Question21

A small hole of area of cross-section $2mm^2$ is present near the bottom of a fully filled open tank of height 2m. Taking $g = 10m/s^2$, the rate of flow of water through the open hole would be nearly
(NEET 2019)

Options:

A. $6.4 \times 10^{-6} m^3 / s$

B. $12.6 \times 10^{-6} m^3 / s$

C. $8.9 \times 10^{-6} m^3 / s$

D. $2.23 \times 10^{-6} m^3 / s$

Answer: B

Solution:

Solution:
According to Torricelli's theorem, Velocity, $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 2} = 6.32 m / s$
From equation of continuity, Volume of liquid flowing per second, $Q = Av = 2 \times 10^{-6} \times 6.32 = 12.6 \times 10^{-6} m^3 / s$

Question22

When a block of mass M is suspended by a long wire of length L, the length of the wire becomes (L + l). The elastic potential energy stored in the extended wire is
(NEET 2019)

Options:

A. $\frac{1}{2} M gL$

B. $M gl$

C. $M gL$

D. $\frac{1}{2} M gl$

Answer: D

Solution:

$$\text{Stress} = \frac{F}{A} = \frac{Mg}{A}$$
$$\text{Strain} = \frac{\Delta L}{L} = \frac{L + l - L}{L} = \frac{l}{L}$$
Energy stored in the wire is,

$$U = \frac{1}{2} \times \text{Stress} \times \text{Strain} \times \text{Volume}$$
$$= \frac{1}{2} \times \frac{Mg}{A} \times \frac{l}{L} \times A \times L = \frac{1}{2} M gl$$

Question23

A soap bubble, having radius of 1mm, is blown from a detergent solution having a surface tension of $2.5 \times 10^{-2} N / m$.
The pressure inside the bubble equals at a point Z_0 below the free surface of water in a container. Taking $g = 10 m / s^2$, density of water $= 10^3 kg / m^3$, the value of Z_0 is
(NEET 2019)

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Options:

A. 0.5cm

B. 100cm

C. 10cm

D. 1cm

Answer: D

Solution:

The pressure at a point Z_0 below the surface of water,
$P_{Z_0} = P_0 + \rho g Z_0$
Also, pressure inside a soap bubble,
$P = P_0 + \frac{4T}{R}$ As per question, $P_{Z_0} = P$
$\therefore P_0 + \frac{4T}{R} = P_0 + \rho g Z_0$
$Z_0 = \frac{4T}{R\rho g} = \frac{4 \times 2.5 \times 10^{-2}}{1 \times 10^{-3} \times 10^3 \times 10}$
$= 1 \times 10^{-2} m = 1cm$

Question24

Two small spherical metal balls, having equal masses, are made from materials of densities ρ_1 and $\rho_2 (\rho_1 = 8\rho_2)$ and have radii of 1mm and 2mm, respectively. They are made to fall vertically (from rest) in a viscous medium whose coefficient of viscosity equals η and whose density is $0.1\rho_2$. The ratio of their terminal velocities would be
(OD NEET 2019)

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Options:

A. $\frac{79}{72}$

B. $\frac{19}{36}$

C. $\frac{39}{72}$

D. $\frac{79}{36}$

Answer: D

Solution:

Terminal velocity, $v = \frac{2r^2(\rho - \sigma)g}{9\eta}$

Ratio of terminal velocity of spherical metal

balls, $\frac{v_1}{v_2} = \frac{\frac{2}{9}(1)^2(8\rho_2 - 0.1\rho_2)}{\frac{2}{9}(2)^2(\rho_2 - 0.1\rho_2)}$

$\Rightarrow \frac{v_1}{v_2} = \frac{7.9\rho_2}{4(0.9\rho_2)} = \frac{79}{36}$

Question25

The stress-strain curves are drawn for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y. We can say that materials X and Y are likely to be (respectively)
(Odisha NEET 2019)

Options:

A. ductile and brittle

B. brittle and ductile

C. brittle and plastic

D. plastic and ductile

Answer: B

Solution:

Solution:
Fracture point and ultimate strength point is close for material X, hence X is brittle in nature and both points are far apart for material Y hence it is ductile.

Question26

A small sphere of radius 'r ' falls from rest in a viscous liquid. As a

result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to (NEET 2018)

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Options:

A. r^3

B. r^2

C. r^5

D. r^4

Answer: C

Solution:

Solution:
The viscous drag force, $F = 6\pi\eta rv$
where $v =$ terminal velocity
$\therefore$ The rate of production of heat = power = force × terminal velocity
$\Rightarrow$ Power $= 6\pi\eta rv \cdot v = 6\pi\eta rv^2$ .... (i)
$\because$ Terminal velocity $v = \frac{2r^2(\rho - \sigma)g}{9\eta}$
$\therefore v \propto r^2$
Now, power $= 6\pi\eta r\left[\frac{4r^4(\rho - \sigma)^2}{81\eta^2}g^2\right]$
or Power $\propto r^5$.

Question27

Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount?
(NEET 2018)

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Options:

A. 9F

B. 6F

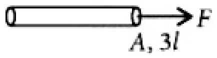
C. 4F

D. F

Answer: A

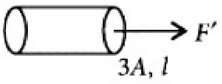
Solution:

Young's modulus, $Y = \frac{F l}{A \Delta l}$
since initial volume of wires are same
∴ Their areas of cross sections are A and 3A and lengths are $3l$ and l respectively.



For wire 1 $\Delta l = \left(\frac{F}{AY}\right) 3l$ .... (i)

For wire 2, let F' force is applied $\frac{F'}{3A} = Y \frac{\Delta l}{l}$



$\Rightarrow \Delta l = \left(\frac{F'}{3AY}\right) l$ .... (ii)

From eqns (i) and (ii),

$\left(\frac{F}{AY}\right) 3l = \left(\frac{F'}{3AY}\right) l \Rightarrow F' = 9F$

Question28

The power radiated by a black body is P and it radiates maximum energy at wavelength, λ_0. If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes n_p. The value of n is
(NEET 2018)

Options:

A. $\frac{3}{4}$

B. $\frac{4}{3}$

C. $\frac{256}{81}$

D. $\frac{81}{256}$

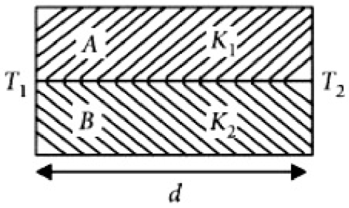
Answer: C

Solution:

Solution:
From Wien's law, $\lambda_{max} T = $ constant
So, $\lambda_{max_1} T_1 = \lambda_{max_2} T_2$
$\Rightarrow \lambda_0 T = \frac{3\lambda_0}{4} T' \Rightarrow \frac{T'}{T} = \frac{4}{3}$
According to Stefan-Boltzmann law, energy emitted unit time by a black body is $Ae\sigma T^4$, i.e. power radiated.
$\therefore P \propto T^4$
So, $\frac{P_2}{P_1} = \left(\frac{T'}{T}\right)^4 \Rightarrow n = \left(\frac{4}{3}\right)^4 = \frac{256}{81}$

Question29

Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2 The thermal conductivity of the composite rod will be



(2017 NEET)

Options:

A. $\frac{3(K_1 + K_2)}{2}$

B. $K_1 + K_2$

C. $2(K_1 + K_2)$

D. $\frac{K_1 + K_2}{2}$

Answer: D

Solution:

Solution:

Equivalent thermal conductivity of the composite rod in parallel combination will be, $\frac{K = K_1 A_1 + K_2 A_2}{A_1 + A_2} = \frac{K_1 + K_2}{2}$

Question30

A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be
(2017 NEET)

Options:

A. 450

B. 1000

C. 1800

D. 225

Answer: C

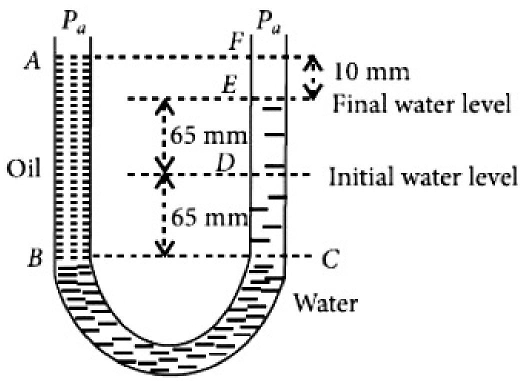
Solution:

Solution:
According to Stefan-Boltzman law, rate of energy radiated by a black body is given as
$E = \sigma A T^4 = \sigma 4\pi R^2 T^4$
Given $E_1 = 450W$, $T_1 = 500K$, $R_1 = 12cm$
$R_2 = \frac{R_1}{2}$, $T_2 = 2T_1$, $E_2 = ?$
$\frac{E_2}{E_1} = \frac{\sigma 4\pi R_2^2 T_2^4}{\sigma 4\pi R_1^2 T_1^4} = \left(\frac{R_2}{R_1}\right)^2 \left(\frac{T_2}{T_1}\right)^4 = \frac{1}{4} \times 16 = 4$

$E_2 = E_1 \times 4 = 450 \times 4 = 1800W$

Question31

A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level (see diagram). The density of the oil is



(2017 NEET)

Options:

A. 425kgm^{-3}

B. $800 kgm^{-3}$

C. $928 kgm^{-3}$

D. $650 kgm^{-3}$

Answer: C

Solution:

Pressure at point C,
$P_c = P_a + \rho_{water} g h_{water}$
where $h_{water} = CE = (62 + 65)mm = 130mm$
Pressure at point B, $P_B = P_a + \rho_{oil} g h_{oul}$
where
$h_{oil} = AB = (65 + 65 + 10)mm = 140mm$

In liquid, pressure is same at same level of liquid,

$P_B = P_C$

$\rho_{oil} g h_{oil} = \rho_{water} g h_{water}$

$\rho_{oil} = \frac{130 \times 10^3}{140} = \frac{13}{14} \times 10^3 = 928.57 kgm^{-3}$

Question32

The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p' the fractional decrease in radius is (2017 NEET)

Options:

A. $\frac{B}{3p}$

B. $\frac{3p}{B}$

C. $\frac{P}{3B}$

D. $\frac{P}{B}$

Answer: C

Solution:

Solution:

Bulk modulus B is given as

$B = \frac{-pV}{\Delta V}$......(i)

The volume of a spherical object of radius r is given as

$V = \frac{4}{3}\pi r^3$, $\Delta v = \frac{4}{3}\pi (3r^2)\Delta r \quad \therefore \frac{V}{\Delta V} = \frac{r}{3\Delta r}$

Put this value in eqn. (i), we get

$B = \frac{pr}{3\Delta r}$

Fractional decrease in radius is, $-\frac{\Delta r}{r} = \frac{p}{3B}$

Question33

Coefficient of linear expansion of brass and steel rods are α_1 and α_2.Length of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good? (2016 NEET Phase-I)

Options:

A. $\alpha_1{}^2 l_2 = \alpha_2{}^2 l_1$

B. $\alpha_1 l_1 = \alpha_2 l_2$

C. $\alpha_1 l_2 = \alpha_2 l_1$

D. $\alpha_1 l_2{}^2 = \alpha_2 l_1{}^2$

Answer: B

Solution:

Solution:
Linear expansion of brass $= \alpha_1$
Linear expansion of steel $= \alpha_2$
Length of brass rod $= l_1$
Length of steel rod $= l_2$
On increasing the temperature of the rods by ΔT ,new lengths would be
$l_1' = l_1(1 + \alpha_1 \Delta T)$........(i)
$l_2' = l_2(1 + \alpha_2 \Delta T)$.........(ii)
Subtracting eqn. (i) from eqn. (ii), we get
$l_2' - l_1' = (l_2 - l_1) + (l_2\alpha_2 - l_1\alpha_1)\Delta T$
According to question,
$l_2' - l_1' = l_2 - l_1$ (for all temperatures)
$\therefore l_2\alpha_2 - l_1\alpha_1$ or $l_1\alpha_1 = l_1\alpha_2$

Question34

A piece of ice falls from a height h so that it melts 32. completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is [Latent heat of ice is 3.4×10^5 J/kg and g = 10 N/kg (2016 NEET Phase-1)

Options:

A. 136 km

B. 68 km

C. 34 km

D. 544 km

Answer: A

Solution:

Solution:
Gravitational potential energy of a piece of ice at a height (h) = mgh
Heat absorbed by the ice to melt completely

$\Delta Q = \frac{1}{4}mgh....(i)$

Also, $\Delta Q = mL.....(ii)$

From eqns. (i) and (ii), $mL = \frac{1}{4}mgh$ or $h = \frac{4L}{g}$

Here $L = 3.4 \times 10^5 J\,kg^{-1}$, $g = 10N\,kg^{-1}$

$\therefore$

$h = \frac{4 \times 3.4 \times 10^5}{10} = 4 \times 34 \times 10^3 = 136km$

Question35

A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3 Wien's constant, $b = 2.88 \times 10^6 nmK$. Which of the following is correct? (2016 NEET Phase-1)

Options:

A. $U_1 > U_2$

B. $U_2 > U_1$

C. $U_1 = 0$

D. $U_3 = 0$

Answer: B

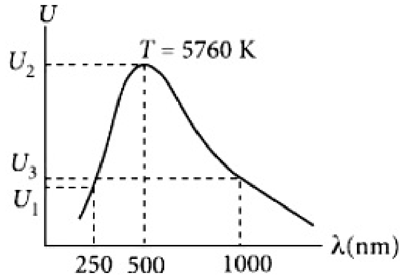
Solution:

Solution:

According to Wein's displacement law

$\lambda_m = \frac{b}{T} = \frac{2.88 \times 10^6 nmK}{5760K} = 500nm$

Clearly from graph, $U_1 < U_2 < U_3$



Question36

Two non-mixing liquids of densities p and np (n > 1) are put in a container. The height of each liquid is A. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length pL (p < 1) in the denser liquid. The density d is

equal to
(2016 NEET Phase-I)

Options:

A. $\{2+(n-1)p\}\rho$

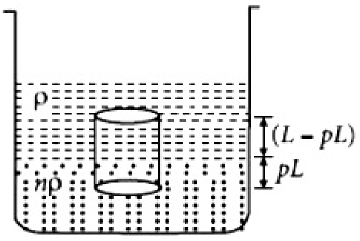
B. $\{1+(n-1)p\}\rho$

C. $\{1+(n+1)p\}\rho$

D. $\{2+(n+1)p\}\rho$

Answer: B

Solution:



d = density of cylinder
A = area of cross-section of cylinder
Using law of floatation,
Weight of cylinder = Upthrust by two liquids
$L \times A \times d \times g = n\rho \times (pL \times A)g + \rho(L - pL)Ag$
$d = np\rho + \rho(1-p) = (np + 1 - p)\rho$

$d = \{1+(n-1)p\}\rho$

Question37

A rectangular film of liquid is extended from (4cm × 2cm) to(5cm × 4cm).If the work done is 3×10^{-4}J, the value of the surface tension of the liquid is
(2016 NEET Phase-II)

Options:

A. 0.250N m^{-1}

B. 0.125N M^{-1}

C. 0.2N m^{-1}

D. 8.0N m^{-1}

Answer: B

Solution:

Solution:
Work done = Surface tension of film x Change in area of the film

or W=T×ΔA
Here, $A_1 = 4cm \times 2cm = 8cm^2$
$A - 2 = 5cm \times 4cm = 20cm^2$
$\Delta A = 2(A_2 - A_1) = 24cm^2 = 24 \times 10^{-4} m^2$
$W = 3 \times 10^{-4} J$, $T = ?$
$\therefore T = \frac{W}{\Delta A} = \frac{3 \times 10^{-4}}{24 \times 10^{-4}} = \frac{1}{8} = 0.125 N\, m^{-1}$

Question38

Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$),having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey
(2016 NEET Phase-II)

Options:

A. $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

B. $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

C. $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

D. $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

Answer: B

Solution:

Solution:
Rise of a liquid in a capillary tube is given by,
$h = \frac{2T \cos\theta}{r\rho g}$
or $\cos\theta = hr\rho g / 2T$
where $\theta =$ angle of contact
$r =$ radius of capillary tube,
$T =$ surface tension
$\rho =$ density of liquid
now given that h, T and r are constants for all three liquids,
and $\rho_1 > \rho_2 > \rho_3$,
therefore $\cos\theta_1 > \cos\theta_2 > \cos\theta_3$
Or $\theta_1 < \theta_2 < \theta_3$
now as the liquid is rising in all three capillaries therefore angles of contact will be acute,
$0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

Question39

Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100 °C, while the other

one is at 0 °C. If the two bodies are brought into contact, then, assuming no heat loss, the final common temperature is
(2016 NEET Phase-II)

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Options:

A. 50°C

B. More than 50°C

C. less than 50°C but greater than 0°C

D. 0°C

Answer: B

Solution:

Solution:
Since, heat capacity of material increases with increase in temperature so, body at 100 °C has more heat capacity than body at 0 °C. Hence, final common temperature of the system will be closer to 100 °C
$\therefore T_c > 50°C$

Question40

A body cools from a temperature 3T to 2T in 10 minutes. The room temperature is T. Assume that New ton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be (2016 NEET Phase-II)

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Options:

A. $\frac{7}{4}T$

B. $\frac{3}{2}$ T

C. $\frac{4}{3}$ T

D. T

Answer: B

Solution:

Solution:
According to Newton's law of cooling
$\frac{dT}{dt}K(T - T_s)$
For two cases, $\frac{dT_1}{dT} = K(T_1 - T_s)$ and $\frac{dT_2}{dt} = K(T_2 - T_s)$

Here, $T_s = T$, $T_1 = \frac{3T + 2T}{2} = 2.5T$

and $\frac{dT_1}{dt} = \frac{3T - 2T}{10} = \frac{T}{10}$

$T_2 = \frac{2T + T'}{2}$ and $\frac{dT_2}{dt} = \frac{2T - T'}{10}$

So, $\frac{T}{10} = K(2.5T - T)$.....(i)

$\frac{2T - T'}{10} = K\left(\frac{2T + T'}{2} - T\right)$........(ii)

Dividing eqn. (i) by eqn. (ii), we get

$\frac{T}{2T - T'} = \frac{(2.5T - T)}{\left(\frac{2T + T'}{2} - T\right)}$

$\frac{2T + T'}{2} - T = (2T - T') \times \frac{3}{2}$

$T' = 3(2T - T')$ or $4T' = 6T$

$\therefore T' = \frac{3}{2}T$

Question41

The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is (2015)

Options:

A. $\frac{VR^2}{n^3r^2}$

B. $\frac{V^2R}{nr}$

C. $\frac{VR^2}{n^2r^2}$

D. $\frac{VR^2}{nr^2}$

Answer: D

Solution:

Solution:
Let the speed of the ejection of the liquid through the holes be v. Then according to the equation of continuity,

$\pi R^2 V = n\pi r^2 v$ or $v = \frac{\pi R^2 V}{n\pi r^2} = \frac{VR^2}{nr^2}$

Question42

Water rises to a height h in capillary tube. If the length of capillary tube above the surface of water is made less than h, then

(2015)

Options:

A. water rises upto a point a little below the top and stays there

B. water does not rise at all.

C. water rises upto the tip of capillary tube and then starts overflowing like a fountain.

D. water rises upto the top of capillary tube and stays there without overflowing

Answer: D

Solution:

Solution:
Water will not overflow but will change its radius of curvature.

Question43

The value of coefficient of volume expansion of glycerin is $5 \times 10^{4} K^{-1}$.The fractional change in the density of glycerin for a rise of 40°C in its temperature, is (2015)

Options:

A. 0.025

B. 0.010

C. 0.015

D. 0.020

Answer: D

Solution:

Solution:
Let ρ_0 and ρ_T be densities of glycerin at 0°C and T°C respectively.Then
$\rho_T = \rho_0(1 - \gamma \Delta T)$
Where γ is the of volume expansion of glycerine and ΔT is rise in temperature.
$\frac{\rho_T}{\rho_0} = 1 - \gamma \Delta T$ or $\gamma \Delta T = 1 - \frac{\rho_T}{\rho_0}$
Thus, $\frac{\rho_0 - \rho_T}{\rho_0} = \gamma \Delta T$
Here, $\gamma = 5 \times 10^{-4} K^{-1}$ and $\Delta T = 40°C = 40K$
∴ The fractional change in the density of glycerin
$= \frac{\rho_0 - \rho_T}{\rho_0} = \gamma \Delta T = (5 \times 10^{-4} K^{-1})(40K) = 0.020$

Question44

The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of
(2015)

Options:

A. 4 : 1

B. 1 : 1

C. 1 : 2

D. 2 : 1

Answer: D

Solution:

Solution:
Let L and A be length and area of cross section of each wire. In order to have the lower ends of the wires to be at the same level (i.e. same elongation is produced in both wires), let weights W_s and W_b are added to steel and brass wires respectively.Then
By definition of Young's modulus, the elongation produced in the steel wire is

$$\Delta L_s = \frac{W_s L}{Y_s A} \qquad \left(as Y = \frac{W/A}{\Delta L/L}\right)$$

and that in the brass wire is

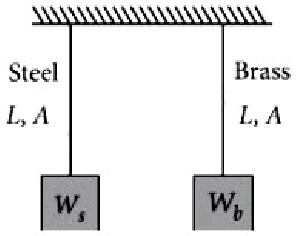
$$\Delta L_b = \frac{W_b L}{Y_b A}$$

But $\Delta L_s = \Delta L_b$ (given)

$$\therefore \frac{W_s L}{Y_s A} = \frac{W_b L}{Y_b A} \text{ or } \frac{W_s}{W_b} = \frac{Y_s}{Y_b}$$

As $\frac{Y_s}{Y_b} = 2$ (given)

$$\therefore \frac{W_s}{W_b} = \frac{2}{1}$$



Question45

The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow

will be
(2015 Cancelled)

Options:

A. 8.0 J/s

B. 4.0 J/s

C. 44.0 J/s

D. 16.8 J/s

Answer: B

Solution:

Solution:
Rate of heat flow through a rod is given by
$\frac{dQ}{dt} = -KA\frac{dT}{dx}$
Let length of the rod be L
Case I : $\frac{dT}{dx} = \frac{\Delta T}{\Delta x} = \frac{110-100}{L} = \frac{10}{L}$
$\therefore \frac{dQ_1}{dt} = -KA\frac{10}{L}$....(i)
Also, $\frac{dQ_1}{dt} = 4J\,s^{-1}$.........(ii)
Case II: $\frac{dT}{dx} = \frac{\Delta T}{\Delta x} = \frac{210-200}{L} = \frac{10}{L}$
$\therefore \frac{dQ_2}{dt} = -KA\frac{10}{L}$......(iii)
So, from equations (i), (ii) and (iii)
$\frac{dQ_2}{dt} = \frac{dQ_1}{dt} = 4J\,s^{-1}$

Question46

A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250m^2.Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be ($\rho_{air} = 1.2kg/m^3$)
(2015, Cancelled)

Options:

A. 2.4×10^5N ,upwards

B. 2.4×10^5N ,downwards

C. 4.8×10^5N , downwards

D. 4.8×10^5N , upwards

Answer: A

Solution:

Solution:
By Bernoulli's theorem,
$P_1 + \frac{1}{2}\rho v_1{}^2 = P_2 + \frac{1}{2}\rho v_2{}^2$
inside outside
Assuming that the roof width is very small
Pressure difference, $P_1 - P_2 = \frac{1}{2}\rho(v_2{}^2 - v_1{}^2)$
Here, $\rho = 1.2 kgm^{-3}$, $v_2 = 40 ms^{-1}$, $v_1 = 0$
$A = 250 m^2$
$P_1 - P_2 = \frac{1}{2} \times 1.2(40^2 - 0^2)$
$= \frac{1}{2} \times 1.2 \times 1600 = 960 N\, m^{-2}$
Force acting on the roof $F = (P_1 - P_2) \times A = 960 \times 250$
$= 2.4 \times 10^5 N$ upwards

Question47

The approximate depth of an ocean is 2700 m. The compressibility of water is $45.4 \times 10^{-11} Pa^{-1}$ and density of water is $10^3 kg/m^3$.What fractional compression of water will be obtained at the bottom of the ocean?
(2015 Cancelled)

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Options:

A. 1.2×10^{-2}

B. 1.4×10^{-2}

C. 0.8×10^{-2}

D. 1.0×10^{-2}

Answer: A

Solution:

Depth of ocean d = 2700 m
Density of water, $\rho = 10^3 kgm^{-3}$
Compressibility of water, $K = 45.4 \times 10^{-11} Pa^{-1}$
$\frac{\Delta V}{V} = ?$
Excess pressure at the bottom $\Delta P = \rho g d$
$= 103 \times 10 \times 2700 = 27 \times 10^6$Pa
We know, $B = \frac{\Delta P}{(\Delta V / V)}$
$\left(\frac{\Delta V}{V}\right) = \frac{\Delta P}{B} = K \,.\, \Delta P \quad \left(\because K = \frac{1}{B}\right)$
$= 45.4 \times 10^{-11} \times 27 \times 10^6 = 1.2 \times 10^{-2}$

Question48

On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperatures of P, Q and R, then it can be concluded from the above observations that
(2015, Cancelled)

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Options:

A. $T_P < T_R < T_Q$

B. $T_P < T_Q < T_R$

C. $T_P > T_Q > T_R$

D. $T_P > T_R > T_Q$

Answer: D

Solution:

Solution:
According to Wien's displacement law
$\lambda_m T = \text{constant}$ ....(i)
For star P , intensity of violet colour is maximum
For star Q, intensity of red colour is maximum.
For star R, intensity of green colour is maximum.
Also $\lambda_r > \lambda_g > \lambda_v$
Using equation (i), $T_r < T_g < T_v$
$T_Q < T_R < T_P$

Question49

Copper of fixed volume V is drawn into wire of length l. When this wire is subjected to a constant force F, the extension produced in the wire is Δl . Which of the following graphs is a straight line?
(2014)

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Options:

A. Δl versus $1/l$

B. Δl versus l^2

C. Δl versus $\frac{1}{l^2}$

D. Δl versus l

Answer: B

Solution:

Solution:
As V=Al ....(i)
where A is the area of cross-section of the wire.

Young's modulus, $Y = \frac{\left(\frac{F}{A}\right)}{\left(\frac{\Delta l}{l}\right)} = \frac{Fl}{A\Delta l}$

$\Delta l = \frac{Fl}{YA} = \frac{Fl^2}{YV}$ (Using (i))

$\Delta l \propto l^2$

Hence, te graph between Δl and l^2

Question50

A certain number of spherical drops of a liquid of radius r coalesce to form a single drop of radius R and volume V If T is the surface tension of the liquid, then
(2014)

Options:

A. energy $= 4VT\left(\frac{1}{r} - \frac{1}{R}\right)$ is released

B. energy $= 3VT\left(\frac{1}{r} + \frac{1}{R}\right)$ is absorbed

C. energy $= 3VT\left(\frac{1}{r} - \frac{1}{R}\right)$ is released

D. energy is neither released nor absorbed.

Answer: C

Solution:

Solution:
Let n droplets each of radius r coalesce to form a big drop of radius R.
$\therefore$ Volume of n droplets = Volume of big drop

$n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow n = \frac{R^3}{r^3}$ .... (i)

Volume of big drop, $V = \frac{4}{3}\pi R^3$ .... (ii)

Initial surface area of n droplets,

$A_i = n \times 4\pi r^2 = \frac{R^3}{r^3} \times 4\pi r^2$ (Using (i))

$= 4\pi \frac{R^3}{r} = \left(\frac{4}{3}\pi R^3\right)\frac{3}{r} = \frac{3V}{r}$ (Using (ii))

Final surface area of big drop

$A_f = 4\pi R^2 = \left(\frac{4}{3}\pi R^3\right)\frac{3}{R} = \frac{3V}{R}$ (Using (ii))

Decrease in surface area

$\Delta A = A_i - A_f = \frac{3V}{r} - \frac{3V}{R} = 3V\left(\frac{1}{r} - \frac{1}{R}\right)$

∴ Energy released = Surface tension × Decrease in surface area

$= T \times \Delta A = 3VT\left(\frac{1}{r} - \frac{1}{R}\right)$

Question51

Steam at 100°C is passed into 20 g of water at 10°C. When water acquires a temperature of 80°C, the mass of water present will be [Take specific heat of water = $1 \text{cal g}^{-1}{}^{\circ}C^{-1}$ and latent heat of steam = 540cal g^{-1}]
(2014)

Options:

A. 24 g

B. 31.5 g

C. 42.5 g

D. 22.5 g

Answer: D

Solution:

Solution:

Here, Specific heat of water, $s_w = 1$ cal $g^{-1}{}^{\circ}C^{-1}$ Latent heat of steam, $L_s = 540$ cal g^{-1}

Heat lost by m g of steam at 100˚C to change into water at 80˚C is

$Q_1 = mL_s + ms_w \Delta T_w$

$= m \times 540 + m \times 1 \times (100 - 80)$

$= 540m + 20m = 560m$

Heat gained by 20g of water to change its temperature from 10˚C to 80˚C is

$Q_2 = m_w s_w \Delta T_w = 20 \times 1 \times (80 - 10) = 1400$

According to principle of calorimetry, $Q_1 = Q_2$ ∴ $560m = 1400$ or $m = 2.5g$

Total mass of water present

$= (20 + m)g = (20 + 2.5)g = 22.5g$

Question52

Certain quantity of water cools from 70°C to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is
(2014)

Options:

A. 45°C

B. 20°C

C. 42°C

D. 10°C

Answer: A

Solution:

Solution:
Let T_s be the temperature of the surroundings.
According to Newton's law of cooling

$$\frac{T_1 - T_2}{t} = K\left(\frac{T_1 + T_2}{2} - T_s\right)$$

For first 5 minutes,

$T_1 = 70^\circ C, T_2 = 60^\circ C, t = 5$ minutes

$$\therefore \frac{70 - 60}{5} = K\left(\frac{70 + 60}{2} - T_s\right)$$

$$= K(65 - T_s) \quad \cdots\cdots\cdots\cdots\cdot (i)$$

For next 5 minutes,

$T_1 = 60^\circ C, T_2 = 54^\circ C, t = 5$ minutes

$$\therefore \frac{60 - 54}{5} = K\left(\frac{60 + 54}{2} - T_s\right)$$

$$\frac{6}{5} = K(57 - T_s) \quad \cdots\cdots (ii)$$

Divide eqn. (i) by eqn. (ii), we get

$$\frac{5}{3} = \frac{65 - T_s}{57 - T_s}$$

$$285 - 5T_s = 195 - 3T_s$$

$$2T_s = 90 \quad \text{or} \quad T_s = 45^\circ C$$

Question53

A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using (2013 NEET)

Options:

A. Kirchhoff's Law

B. Newton’s Law of cooling

C. Stefan’s Law

D. Wien’s displacement Law

Answer: D

Solution:

Solution:
According to Wien’s displacement law
$\lambda_m T = \text{constant}$

$\lambda_m = \frac{\text{constant}}{T}$

So when a piece of iron is heated, λ_m decreases i.e. with rise in temperature the maximum intensity of radiation emitted gets shifted towards the shorter wavelengths. So the colour of the heated object will change that of longer wavelength (red) to that of shorter (reddish yellow) and when the temperature is sufficiently high and all wavelengths are emitted, the colour will become white.

Question54

The wettability of a surface by a liquid depends primarily on (2013 NEET)

Options:

A. density

B. angle of contact between the surface and the liquid

C. viscosity

D. surface tension

Answer: B

Solution:

Solution:
The wettability of a surface by a liquid depends primarily on angle of contact between the surface and the liquid.

Question55

The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied? (2013 NEET)

Options:

A. length = 200 cm, diameter = 2 mm

B. length = 300 cm, diameter = 3 mm

C. length = 50 cm, diameter = 0.5 mm

D. length = 100 cm, diameter = 1 mm

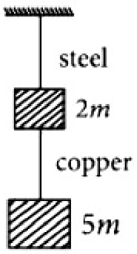
Answer: C

Solution:

Solution:
Young's modulus,
$Y = \frac{F L}{A \Delta L} = \frac{4F L}{\pi D^2 \Delta L}$ or $\Delta L = \frac{4F L}{\pi D^2 Y}$
where F is the force applied, L is the length, D is the diameter and ΔL is the extension of the wire respectively.
As each wire is made up of same material therefore their Young's modulus is same for each wire.
For all the four wires, Y, F (= tension) are the same.
$\therefore \Delta L \propto \frac{L}{D^2}$
In (a) $\frac{L}{D^2} = \frac{200\text{cm}}{(0.2\text{cm})^2} = 5 \times 10^3 \text{cm}^{-1}$
In (b) $\frac{L}{D^2} = \frac{300\text{cm}}{(0.3\text{cm})^2} = 3.3 \times 10^3 \text{cm}^{-1}$
In (c) $\frac{L}{D^2} = \frac{50\text{cm}}{(0.05\text{cm})^2} = 20 \times 10^3 \text{cm}^{-1}$
In (d) $\frac{L}{D^2} = \frac{100\text{cm}}{(0.1\text{cm})^2} = 10 \times 10^3 \text{cm}^{-1}$
Hence, ΔL is maximum in (c).

Question56

If the ratio of diameters, lengths and Young's modulus of steel and copper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be



(KN NEET 2013)

Options:

A. $\frac{5q}{(7sp^2)}$

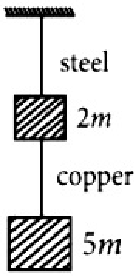
B. $\frac{7q}{5sp^2}$

C. $\frac{2q}{(5sp)}$

D. $\frac{7q}{(5sp)}$

Answer: B

Solution:



As $Y = \frac{F L}{A \Delta L} = \frac{4F L}{\pi D^2 \Delta L}$

$\Delta L = \frac{4F L}{\pi D^2 Y}$

$\therefore \frac{\Delta L_S}{\Delta L_C} = \frac{F_S}{F_C} \frac{L_S}{L_C} \frac{D_C^2}{D_S^2} \frac{Y_C}{Y_S}$

where subscripts S and C refer to copper and steel respectively.

Here, $F_S = (5m + 2m)g = 7mg$

$F_C = 5mg$

$\frac{L_S}{L_C} = q, \frac{D_S}{D_C} = p, \frac{Y_S}{Y_C} = s$

$\therefore \frac{\Delta L_S}{\Delta L_C} = \left(\frac{7mg}{5mg}\right)(q)\left(\frac{1}{p}\right)^2\left(\frac{1}{s}\right) = \frac{7q}{5p^2 s}$

Question57

Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2, respectively. If the rate of heat conduction in 1 is four times that in 2 , then (KN NEET 2013)

Options:

A. $K_1 A_1 = 4K_2 A_2$

B. $K_1 A_1 = 2K_2 A_2$

C. $4K_1 A_1 = K_2 A_2$

D. $K_1 A_1 = K_2 A_2$

Answer: A

Solution:

Solution:

Let L be length of each rod. Rate of heat flow in rod 1 for the temperature difference ΔT is

$H_1 = \frac{K_1 A_1 \Delta T}{L}$

Rate of heat flow in rod 2 for the same difference ΔT is $H_2 = \frac{K_2 A_2 \Delta T}{L}$

As per question, $H_1 = 4H_2$ $\frac{K_1 A_1 \Delta T}{L} = 4 \frac{K_2 A_2 \Delta T}{L}$;

$K_1 A_1 = 4K_2 A_2$

Question58

A fluid is in streamline flow across a horizontal pipe of variable area of cross section. For this which of the following statements is correct? (KN NEET 2013)

Options:

A. The velocity is maximum at the narrowest part of the pipe and pressure is maximum at the widest part of the pipe.

B. Velocity and pressure both are maximum at the narrowest part of the pipe.

C. Velocity and pressure both are maximum at the widest part of the pipe.

D. The velocity is minimum at the narrowest part of the pipe and the pressure is minimum at the widest part of the pipe.

Answer: A

Solution:

Solution:
According to equation of continuity,
$Av =$ constant
Therefore, velocity is maximum at the narrowest part and minimum at the widest part of the pipe.
According to Bernoulli's theorem for a horizontal pipe,
$P + \frac{1}{2}\rho v^2 =$ constant
Hence, when a fluid flow across a horizontal pipe of variable area of cross-section its velocity is maximum and pressure is minimum at the narrowest part and vice versa.

Question59

The density of water at 20°C is $998 kg / m^3$ and at 40°C is $992 kg / m^3$. The coefficient of volume expansion of water is (KN NEET 2013)

Options:

A. $3 \times 10^{-4} / {}^\circ C$

B. $2 \times 10^{-4} / {}^\circ C$

C. $6 \times 10^{-4} / {}^\circ C$

D. $10^{-4} / {}^\circ C$

Answer: A

Solution:

As $\rho_{T_2} = \frac{\rho_{T_1}}{(1 + \gamma \Delta T)} = \frac{\rho_{T_1}}{1 + \gamma(T_2 - T_1)}$

Here, $T_1 = 20^\circ C$, $T_2 = 40^\circ C$

$\rho_{20} = 998 kg / m^3$, $\rho_{40} = 992 kg / m^3$

$\therefore 992 = \frac{998}{1 + \gamma(40 - 20)}$

$992 = \frac{998}{1 + 20\gamma}$ or $992(1 + 20\gamma) = 998$

$1 + 20\gamma = \frac{998}{992}$ or $20\gamma = \frac{998}{992} - 1 = \frac{6}{992}$

$\gamma = \frac{6}{992} \times \frac{1}{20} = 3 \times 10^{-4} / ^\circ C$

Question60

If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q?
(σ stands for Stefan's constant)
(2012)

Options:

A. $\frac{Q}{4\pi R^2 \sigma}$

B. $\left(\frac{Q}{4\pi R^2 \sigma}\right)^{-\frac{1}{2}}$

C. $\left(\frac{4\pi R^2 Q}{\sigma}\right)^{-\frac{1}{4}}$

D. $\left(\frac{Q}{4\pi R^2 \sigma}\right)^{\frac{1}{4}}$

Answer: D

Solution:

Solution:
According to Stefan's law, $Q = \sigma A T^4$

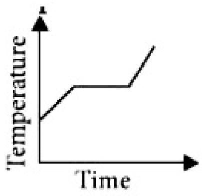
or $T = \left(\frac{Q}{\sigma A}\right)^{\frac{1}{4}} = \left(\frac{Q}{\sigma 4\pi R^2}\right)^{\frac{1}{4}}$

Question61

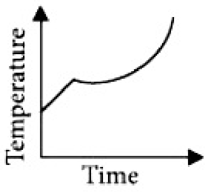
Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time?
(2012)

Options:

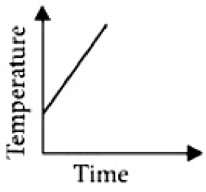
A.



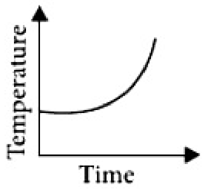
B.



C.



D.



Answer: A

Solution:

Solution:
Temperature of liquid oxygen will first increase in the same phase. Then, the liquid oxygen will change to gaseous phase during which temperature will remain constant. After that temperature of oxygen in gaseous state will increase. Hence option (a) represents corresponding temperature-time graph.

Question62

A slab of stone of area $0.36 m^2$ and thickness 0.1m is exposed on the lower surface to steam at 100°C.A block of ice at 0°C rests on the upper

surface of the slab.In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is
(Given latent heat of fusion of ice $= 3.36 \times 10^5 J\,kg^{-1}$)
(2012 Mains)

Options:

A. 1.24 J/m/s°C

B. 1.29 J/m/s°C

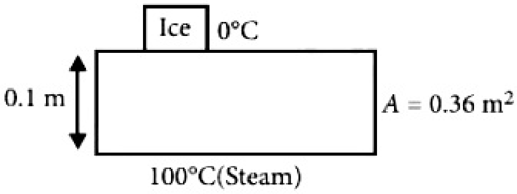
C. 2.05 J/m/s°C

D. 1.02 J/m/s°C

Answer: A

Solution:

Solution:



Heat flows through the slab in t s is

$$Q = \frac{K A(T_1 - T_2)t}{L} = \frac{K \times 0.36 \times (100-0) \times 3600}{0.1}$$

$$= \frac{K \times 0.36 \times 100 \times 3600}{0.1}$$

So ice melted by this heat is $m_{ice} = \frac{Q}{L_f}$

or $Q = m_{ice} L_f = 4.8 \times 3.36 \times 10^5$

From (i) and (ii), we get

$$\frac{K \times 0.36 \times (100-0) \times 3600}{0.1} = 4.8 \times 3.36 \times 10^5$$

$$K = \frac{4.8 \times 3.36 \times 10^5 \times 0.1}{0.36 \times 100 \times 3600} = 1.24 J\ / m / s / ^\circ C$$

Question63

A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?
(2010)

Options:

A. $\frac{Q}{4}$

B. $\frac{Q}{16}$

C. 2Q

D. $\frac{Q}{2}$

Answer: B

Solution:

Solution:
The amount of heat flows in time t through a cylindrical metallic rod of length L and uniform area of cross-section $A(= \pi R^2)$ with its ends maintained at temperatures T_1 and $T_2 (T_1 > T_2)$ is given by

$Q = \frac{KA(T_1 - T_2)t}{L}$......(i)

where AT is the thermal conductivity of the material of the rod

Area of cross-section of new rod $A' = \pi\left(\frac{R}{2}\right)^2$

$= \frac{\pi R^2}{4} = \frac{A}{4}$....(ii)

As the volume of the rod remains unchanged

$\therefore AL = A'L'$

where L' is the length the new rod

or $L' = L\frac{A}{A'}$...........(iii)

$= 4L$ (Using (ii))

Now, the amount of heat flows in same time t in the new rod with its ends maintained at the same temperatures T_1 and T_2 is given by $Q' = \frac{KA'(T_1 - T_2)t}{L'}$..........(iv)

Substituting the values of A' and L' from equations (ii) and (iii) in the above equation, we get

$Q' = \frac{K\left(\frac{A}{4}\right)(T_1 - T_2)t}{4L} = \frac{1}{16}\frac{KA(T_1 - T_2)t}{L}$

$= \frac{1}{16}Q$ (Using (i))

Question64

The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature T K is given (where σ is Stefan's constant) (2010)

Options:

A. $\frac{\sigma r^2 T^4}{R^2}$

B. $\frac{\sigma r^2 T^4}{4\pi r^2}$

C. $\frac{\sigma r^2 T^4}{r^4}$

D. $\frac{4\pi\sigma r^2 T^4}{R^2}$

Answer: A

Solution:

According to the Stefan Boltzmann law, the power radiated by the star whose outer surface radiates as a black body at temperature T K is given by
$P = \sigma 4\pi r^2 T^4$
Where,
r = radius of the star
σ = Stefan's constant
The radiant power per unit area received at a distance R from the centre of a star is

$$S = \frac{P}{4\pi R^2} = \frac{\sigma 4\pi r^2 T^4}{4\pi R^2} = \frac{\sigma r^2 T^4}{R^2}$$

Question65

A black body at 227°C radiates heat at the rate of $7 \text{cal}/\text{cm}^2\text{s}$. At a temperature of 727°C, the rate of heat radiated in the same units will be (2009)

Options:

A. 50

B. 112

C. 80

D. 60

Answer: B

Solution:

Rate of heat radiated at $(227 + 273)\text{K} = 7 \text{cal}/(\text{cm}^2\text{s})$
Rate of heat radiated at $(727 + 273)\text{K} = x$
By Stefan's law, $7 \propto (500)^4$
$x \propto (1000)^4$
$\therefore \frac{x}{7} = 2^4 \Rightarrow x = 7 \times 2^4 = 112 \text{cal}/(\text{cm}^2\text{s})$

Question66

The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperatures T_1 and $T_2 (T_1 > T_2)$. The rate of heat transfer, $\frac{dQ}{dt}$, through the rod in a steady state is given by (2009)

Options:

A. $\frac{dQ}{dt} = \frac{k(T_1 - T_2)}{LA}$

B. $\frac{dQ}{dt} = kLA(T_1 - T_2)$

C. $\frac{dQ}{dt} = \frac{kA(T_1 - T_2)}{L}$

D. $\frac{dQ}{dt} = \frac{kL(T_1 - T_2)}{A}$

Answer: C

Solution:

Similar to I=V/R

$\frac{dQ}{dt} = \frac{kA}{L}(T_1 - T_2)$

k=conductivity of the rod

Question67

On a new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are 39°W and 239°W respectively. What w ill be the temperature on the new scale, corresponding to a temperature of 39°C on the Celsius scale? (2008)

Options:

A. 200°W

B. 139°W

C. 78°W

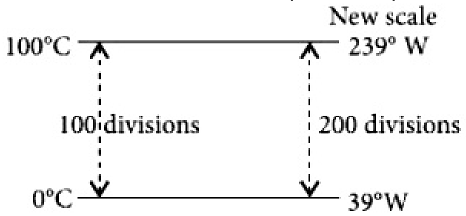
D. 117°W

Answer: D

Solution:

Solution:

$\therefore 39°C = 39 \times 2 + 39 = (78 + 39)°W = 117°W$



Question68

A black body is at 727°C. It emits energy at a rate which is proportional to
(2007)

Options:

A. $(1000)^4$

B. $(1000)^2$

C. $(727)^4$

D. $(727)^2$

Answer: A

Solution:

Solution:
According to Stefan's law, rate of energy radiated $E \propto T^4$
where T is the absolute temperature of a black body.
$\therefore E \propto (727 + 273)^4$ or $E \propto [1000]^4$

Question69

A black body at 1227°C emits radiations with maximum intensity at a wavelength of 5000Å. If the temperature of the body is increased by 1000°C, the maximum intensity will be observed at
(2006)

Options:

A. 3000Å

B. 4000Å

C. 5000Å

D. 6000Å

Answer: A

Solution:

Solution:
According to Wein's displacement law,
$\lambda_{max} T = $ constant

$\therefore \frac{\lambda_{max_1}}{\lambda_{max_2}} = \frac{T_2}{T_1}$

or $\lambda_{max_2} = \frac{\lambda_{max_1} \times T_1}{T_2} = \frac{5000 \times 1500}{2500} = 3000Å$

Question70

Which of the following rods, (given radius r and length l) each made of the same material and whose ends are maintained at the same temperature will conduct most heat?
(2005)

©

Options:

A. $r = r_0, l = l_0$

B. $r = 2r_0, l = l_0$

C. $r = r_0, l = 2l_0$

D. $r = 2r_0, l = 2l_0$.

Answer: B

Solution:

Solution:

Heat conducted $= \frac{KA(T_1 - T_2)t}{l} = \frac{K\pi r^2(T_1 - T_2)t}{l}$

The rod with the maximum ratio of $\frac{A}{l}$ will conduct most.

Here the rod with $r = 2r_0$ and $l = l_0$ will conduct most.

Question71

If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum, then
(2004)

©

Options:

A. $\lambda_m \propto T^4$

B. λ_m is independent of T

C. $\lambda_m \propto T$

D. $\lambda_m \propto T^{-1}$

Answer: D

Solution:

Solution:
Wein's displacement law
$\lambda_m T = $ constant ,$\lambda_m \propto T^{-1}$

Question72

Consider a compound slab consisting of two different materials having equal thicknesses and thermal conductivities K and 2K , respectively. The equivalent thermal conductivity of the slab is
(2003)

©

Options:

A. $\frac{2}{3}K$

B. $\sqrt{2}K$

C. 3K

D. $\frac{4}{3}K$

Answer: D

Solution:

Solution:
The thermal resistances can be added as they are in series. But, note that the width of the combined slab is twice the width of individual slab.
So, we have:
$\Rightarrow \frac{2L}{K_{eq}A} = \frac{L}{KA} + \frac{L}{2KA}$
$\Rightarrow K_{eq} = \frac{4K}{3}$

Question73

Unit of Stefan's constant is
(2002)

©

Options:

A. watt m^2K^4

B. watt m^2 / K^4

C. watt / m^2K

D. watt / m^2K^4

Answer: D

Solution:

Solution:
Unit of Stefan's constant is watt/m^2K^4.

Question74

Consider two rods of same length and different specific heats (S_1, S_2), conductivities (K_1, K_2) and area of cross-sections (A_1, A_2) and both having temperatures T_1 and T_2 at their ends. If rate of loss of heat due to conduction is equal, then
(2002)

Options:

A. $K_1A_1 = K_2A_2$

B. $\frac{K_1A_1}{S_1} = \frac{K_2A_2}{S_2}$

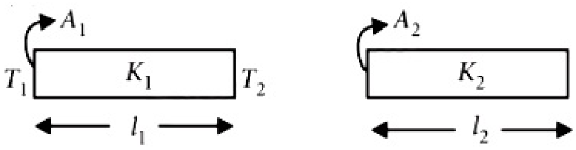
C. $K_2A_1 = K_1A_2$

D. $\frac{K_2A_1}{S_2} = \frac{K_1A_2}{S_1}$

Answer: A

Solution:

Solution:



Rate of heat loss in rod 1 = $Q_1 = \frac{K_1A_1(T_1 - T_2)}{l_1}$

Rate of heat loss in rod 2 = $Q_2 = \frac{K_2A_2(T_1 - T_2)}{l_2}$

By problem, $Q_1 = Q_2$.

$\therefore \frac{K_1A_1(T_1 - T_2)}{l_1} = \frac{K_2A_2(T_1 - T_2)}{l_2}$

$\therefore K_1A_1 = K_2A_2$

Question75

For a black body at temperature 727°C, its radiating power is 60 watt and temperature of surrounding is 227°C. If temperature of black body is changed to 1227°C then its radiating power will be (2002)

Options:

A. 304W

B. 320W

C. 240W

D. 120W

Answer: B

Solution:

Solution:
Radiating power of a black body $= E_0 = \sigma(T^4 - T_0^4)A$
where σ is known as the Stefan-Boltzmann constant, A is the surface area of a black body, T is the temperature of the black body and T_0 is the temperature of the surrounding.
$\therefore 60 = \sigma(1000^4 - 500^4)$ ...(i)
[$T = 727°C = 727 + 273 = 1000K$, $T_0 = 227°C = 500K$]
In the second case, $T = 1227°C = 1500K$ and let E' be the radiating power.
$\therefore E' = \sigma(1500^4 - 500^4)$ ...(ii)
From (i) and (ii) we have
$$\frac{E'}{60} = \frac{1500^4 - 500^4}{1000^4 - 500^4} = \frac{15^4 - 5^4}{10^4 - 5^4} = \frac{50000}{9375}$$
$$\therefore E' = \frac{50000}{9375} \times 60 = 320W$$

Question76

Which of the following is best close to an ideal black body? (2002)

Options:

A. black lamp

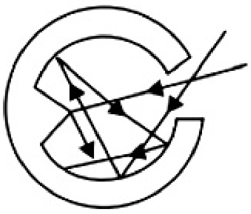
B. cavity maintained at constant temperature

C. platinum black

D. a lump of charcoal heated to high temperature.

Answer: B

Solution:



An ideal black body is one which absorbs all the incident radiation without reflecting or transmitting any part of it. Black lamp absorbs approximately 96% of incident radiation.
An ideal black body can be realized in practice by a small hole in the wall of a hollow body (as shown in figure) which is at uniform temperature. Any radiation entering the hollow body through the holes suffers a number of reflections and ultimately gets completely absorbed. This can be facilitated by coating the interior surface with black so that about 96% of the radiation is absorbed at each reflection. The portion of the interior surface opposite to the hole is made conical to avoid the escape of the reflected ray after one reflection.

Question77

The Wien's displacement law express relation between (2002)

Options:

A. wavelength corresponding to maximum energy and temperature

B. radiation energy and wavelength

C. temperature and wavelength

D. colour of light and temperature.

Answer: A

Solution:

Solution:
Wien's displacement law states that the product of absolute temperature and the wavelength at which the emissive power is maximum is constant i.e. $\lambda_{max}T = $ constant.
Therefore it expresses relation between wavelength correspondingto maximum energy and temperature.

Question78

A cylindrical rod having temperature T_1 and T_2 at its end. The rate of flow of heat Q_1 cal/sec. If all the linear dimension are doubled keeping temperature constant, then rate of flow of heat Q_2 will be (2001)

Options:

A. $4Q_1$

B. $2Q_1$

C. $\frac{Q_1}{4}$

D. $\frac{Q_1}{2}$

Answer: B

Solution:

Solution:

Heat flow rate $\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{L} = Q$

When linear dimensions are double.

$A_1 \propto r_1^2, L_1 = L$

$A_2 \propto 4r_1^2, L_2 = 2L$

so $Q_2 = 2Q_1$

Question79

A black body has maximum wavelength λ_m at $2000K$. Its corresponding wavelength at $3000K$ will be
(2000)

Options:

A. $\frac{3}{2}\lambda_m$

B. $\frac{2}{3}\lambda_m$

C. $\frac{16}{81}\lambda_m$

D. $\frac{81}{16}\lambda_m$

Answer: B

Solution:

According to Wein's law,

$\lambda_m T = \text{constant}$

$\therefore \lambda' = \left(\frac{2}{3}\right)\lambda_m$

Question80

1 gram of ice is mixed with 1 gram of steam. At thermal equilibrium, the temperature of the mixture is
(1999)

Options:

A. 100°C

B. 230°C

C. 270°C

D. 50°C

Answer: A

Solution:

Solution:
Total heat gained by ice is equal to the total heat lost by steam.
For ice to completely convert into water, heat required is $m_1L_f = 1 \times 80 = 80\text{cal}$ For steam to completely convert into water, heat released is $m_2L_v = 1 \times 540 = 540\text{cal}$ Hence, first 80 calories will not be enough for the steam to condense completely. Now, to convert melted water to 100°C from 0°C, heat required is $m_1s(100 - 0) = 1 \times 1 \times 100 = 100\text{cal}$
So, total energy required to heat ice to water 100°C is $100 + 80 = 180\text{cal}$. Hence, even this amount of energy is not enough for the steam to condense completely. Hence, the final temperature of the mixture will be 100°C.
Note- finally the mixture will consist of both steam and water at 100°C.

Question81

The radiant energy from the sun, incident normally at the surface of earth is $20\,\text{kcal}/\text{m}^2\,\text{min}$. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one?
(1998)

Options:

A. $320\,\text{kcal}/\text{m}^2\,\text{min}$

B. $40\,\text{kcal}/\text{m}^2\,\text{min}$

C. $160\,\text{kcal}/\text{m}^2\,\text{min}$

D. $80\,\text{kcal}/\text{m}^2\,\text{min}$

Answer: A

Solution:

$$E = \sigma T^4 = 20,\ T' = 2T$$
$$E' = \sigma(2T)^4 = 16\sigma T^4$$
$$= 16 \times 20 = 320\,\text{kcal}/\text{m}^2\,\text{min}$$

Question82

A black body is at a temperature of 500K. It emits energy at a rate which is proportional to
(1997)

Options:

A. $(500)^3$

B. $(500)^4$

C. 500

D. $(500)^2$.

Answer: B

Solution:

Solution:
Temperature of black body $(T) = 500K$.
Therefore total energy emitted by the black body
$(E) \propto T^4 \propto (500)^4$

Question83

A beaker full of hot water is kept in a room. If it cools from 80°C to 75°C in t_1 minutes, from 75°C to 70°C in t_2 minutes and from 70°C to 65°C in t_3 minutes, then
(1995)

Options:

A. $t_1 < t_2 < t_3$

B. $t_1 > t_2 > t_3$

C. $t_1 = t_2 = t_3$

D. $t_1 < t_2 = t_3$.

Answer: A

Solution:

The rate of cooling is directly proportional to the temperature difference of the body and the surroundings. So, cooling will be fastest in the first case and slowest in the third case.

Question84

Heat is flowing through two cylindrical rods of the same material. The diameters of the rods are in the ratio 1: 2 and the lengths in the ratio 2 : 1. If the temperature difference between the ends is same, then ratio of the rate of flow of heat through them will be
(1995)

Options:

A. 2 : 1

B. 8 : 1

C. 1 : 1

D. 1 : 8

Answer: D

Solution:

Solution:
Ratio of diameters of rod $= 1 : 2$ and ratio of their lengths $2 : 1$.
The rate of flow of heat, $(R) = \frac{KA\Delta T}{l} \propto \frac{A}{l}$.
Therefore, $\frac{R_1}{R_2} = \frac{A_1}{A_2} \times \frac{l_2}{l_1} = \left(\frac{1}{2}\right)^2 \times \frac{1}{2} = \frac{1}{8}$

Question85

If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor of
(1993)

Options:

A. 2

B. 4

C. 8

D. 16

Answer: D

Solution:

Solution:
Amount of energy radiated $\propto T^4$.

Question86

Mercury thermometer can be used to measure temperature upto (1992)

Options:

A. 260°C

B. 100°C

C. 360°C

D. 500°C

Answer: C

Solution:

Solution:
Mercury thermometer is based on the principle of change of volume with rise of temperature and can measure temperatures ranging from $-30°C$ to $357°C$

Question87

A Centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°F. What is the fall in temperature as registered by the centigrade thermometer? (1990)

Options:

A. 80°C

B. 60°C

C. 40°C

D. 30°C

Answer: C

Solution:

Solution:
Let us take the temperature of the boiling water be 100 degrees in Celsius scale and 180 degrees in Fahrenheit scale.
That is, $\frac{140-32}{180} = \frac{C}{5}$
$\text{Therefore, } 5 \times 108 = 9C, \quad C = 60 \text{ deg C}$
since, the temperature of boiling water is 100 deg C, the required fall is $100 - 60 = 40$ degrees C.
Hence, The fall in temperature as registered by centigrade thermometer is 40 degree Celsius.

Question88

Thermal capacity of 40g of aluminium ($s = 0.2\,cal / gK$) is
(1990)

Options:

A. $168 J / K$

B. $672 J / K$

C. $840 J / K$

D. $33.6 J / K$

Answer: D

Solution:

Thermal capacity $= ms = 40 \times 0.2 = 8\,cal / K = 33.6 J / K$

Question89

10gm of ice cubes at $0^{\circ}C$ are released in a tumbler (water equivalent 55g) at $40^{\circ}C$. Assuming that negligible heat is taken from the surroundings, the temperature of water in the tumbler becomes nearely ($L = 80\,cal / g$)
(1988)

Options:

A. 31°C

B. 22°C

C. 19°C

D. 15°C

Answer: B

Solution:

Let the final temperature be T
Heat required by ice $= mL + m \times s \times (T - 0) = 10 \times 80 + 10 \times 1 \times T$
Heat lost by water $= 55 \times (40 - T)$
By using law of calorimetry,
heat gained = heat lost
$800 + 10T = 55 \times (40 - T)$
$\Rightarrow T = 21.54°C = 22°C$
