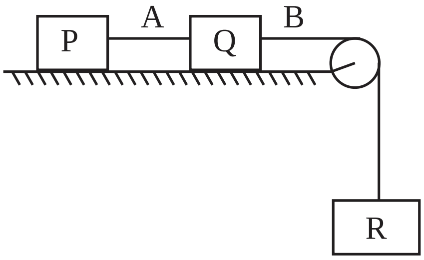
RACE
Regular Analysis Through Continuous Exercise

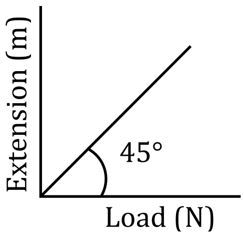
Elasticity : RACE-01

1. Each of three blocks P, Q and R shown in figure has a mass of 3 kg. Each of the wire A and B has cross-sectional area 0.005 cm^2 and Young's modulus 2×10^{11} $N\ m^{-2}$. Neglecting friction, the longitudinal strain on wire B is ____ $\times 10^{-4}$. (Take $g = 10$ m/s^2)



2. As shown in the figure, in an experiment to determine Young's modulus of a wire, the extension-load curve is plotted. The curve is a straight line passing through the origin and makes an angle of 45° with the load axis. The length of wire is 62.8 cm and its diameter is 4 mm. The Young's modulus is found to be $x \times 10^4$ Nm^{-2}.

The value of x is ____.



3. One end of a metal wire is fixed to a ceiling and a load of 2 kg hangs from the other end. A similar wire is attached to the bottom of the load and another load of 1 kg hangs from this lower wire. Then the ratio of longitudinal strain of upper wire to that of the lower wire will be___.

[Area of cross section of wire = 0.005 cm^2, $Y = 2 \times 10^{11}$ Nm^{-2} and $g = 10$ ms^{-2}]

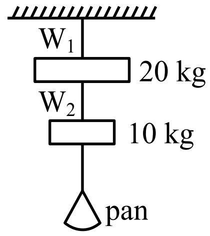
4. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire 'B' will be (wires having uniform circular cross sections)

(A) 6.06×10^{-2} mm (B) 2.77×10^{-2} mm (C) 3.0×10^{-2} mm (D) 6.9×10^{-2} mm

5. A wire of length 'L' and radius 'r' is clamped rigidly at one end. When the other end of the wire is pulled by a force f, its length increases by 'ℓ'. Another wire of same material of length '$2L$' and radius '$2r$' is pulled by a force '$2f$'. Then the increase in its length will be :

(A) 2ℓ (B) ℓ (C) $4\ \ell$ (D) $\ell/2$

6. Wires W_1 and W_2 are made of same material having the breaking stress of 1.25×10^9 N/m^2. W_1 and W_2 have cross-sectional area of $8 \times 10^{-7}\ m^2$ and $4 \times 10^{-7}\ m^2$, respectively. Masses of 20 kg and 10 kg hang from them as shown in the figure. The maximum mass that can be placed in the pan without breaking the wires is ____ kg. (Use g = 10 m/s^2)



7. An object of mass m is suspended at the end of a massless wire of length L and area of cross-section, A. Young modulus of the material of the wire is Y. If the mass is pulled down slightly its frequency of oscillation along the vertical direction is:

(A) $f = \frac{1}{2\pi}\sqrt{\frac{YA}{mL}}$ (B) $f = \frac{1}{2\pi}\sqrt{\frac{YL}{mA}}$ (C) $f = \frac{1}{2\pi}\sqrt{\frac{mA}{YL}}$ (D) $f = \frac{1}{2\pi}\sqrt{\frac{mL}{YA}}$

8. An aluminium rod with Young's modulus $Y = 7.0 \times 10^{10}\ N/m^2$ undergoes elastic strain of 0.04%. The energy per unit volume stored in the rod in SI unit is:

(A) 5600 (B) 8400 (C) 2800 (D) 11200

9. The length of metallic wire is ℓ_1 when tension in it is T_1. It is ℓ_2 when the tension is T_2. The original length of the wire will be –

(A) $\frac{\ell_1 + \ell_2}{2}$ (B) $\frac{T_2\ell_1 + T_1\ell_2}{T_1 + T_2}$ (C) $\frac{T_2\ell_1 - T_1\ell_2}{T_2 - T_1}$ (D) $\frac{T_1\ell_1 - T_2\ell_2}{T_2 - T_1}$

10. A solid sphere of radius r made of a soft material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area a floats on the surface of the liquid, covering entire cross section of cylindrical container. When a mass m is placed on the surface of the piston to compress the liquid, the fractional decrement in the radius of the sphere, $\left(\frac{dr}{r}\right)$, is :

(A) $\frac{Ka}{3mg}$ (B) $\frac{mg}{3Ka}$ (C) $\frac{mg}{3Ka}$ (D) $\frac{Ka}{mg}$

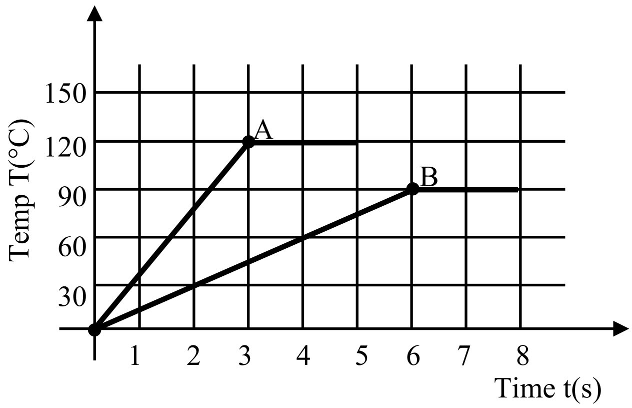
ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	2	5	3	D	B	40	A	A	C	B

RACE
Regular Analysis Through Continuous Exercise

Calorimetry : RACE-02

1. Two different metal bodies A and B of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is :



(A) $\frac{8}{3}$ (B) $\frac{3}{8}$ (C) $\frac{3}{4}$ (D) $\frac{4}{3}$

2. Heat energy of 184 kJ is given to ice of mass 600 g at $-12°C$, Specific heat of ice is 2222.3 $J\ kg^{-1°}\ C^{-1}$ and latent heat of ice in 336 kJ/kg^{-1}

(a) Final temperature of system will be $0°C$.

(b) Final temperature of the system will be greater than $0°C$.

(c) The final system will have a mixture of ice and water in the ratio of 5 : 1.

(d) The final system will have a mixture of ice and water in the ratio of 1 : 5.

(e) The final system will have water only.

Choose the correct answer from the options given below:

(A) a and d only (B) b and d only (C) a and e only (D) a and c only

3. A faulty thermometer reads $5°C$ in melting ice and $95°C$ in steam. The correct temperature on absolute scale will be.......... K when the faulty thermometer reads $41°C$.

4. A calorimeter of water equivalent 20 g contains 180 g of water at $25°C$. 'm' grams of steam at $100°C$ is mixed in it till the temperature of the mixture is $31°C$. The value of 'm' is close to (Latent heat of water = 540 cal g^{-1}, specific heat of water = 1 cal $g^{-1}\ °C^{-1}$)

(A) 2.6 (B) 2 (C) 4 (D) 3.2

5. A 100 g of iron nail is hit by a 1.5 kg hammer striking at a velocity of 60 ms^{-1}. What will be the rise in the temperature of the nail if one fourth of energy of the hammer goes into heating the nail? [Specific heat capacity of iron = 0.42 $Jg^{-1}\ °C^{-1}$]

(A) $675°C$ (B) $1600°C$ (C) $16.07°C$ (D) $6.75°C$

6. A geyser heats water flowing at a rate of 2.0 kg per minute from 30°C to 70°C. If geyser operates on a gas burner, the rate of combustion of fuel will be ___________ g min^{-1}

[Heat of combustion = 8×10^3 Jg^{-1}, Specific heat of water = 4.2 Jg^{-1} °C^{-1}]

7. When 100 g of a liquid A at 100°C is added to 50 g of a liquid B at temperature 75°C, the temperature of the mixture becomes 90°C. The temperature of the mixture, if 100 g of liquid A at 100°C is added to 50 g of liquid B at 50°C, will be :-

(A) 80°C (B) 60°C (C) 70°C (D) 85°C

8. A thermally insulated vessel contains 150g of water at 0°C. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°C itself. The mass of evaporated water will be closest to :

(Latent heat of vaporization of water = 2.10×10^6 $J\ kg^{-1}$ and Latent heat of Fusion of water = 3.36×10^5 $J\ kg^{-1}$)

(A) 130 g (B) 35 g (C) 20 g (D) 150 g

9. A water heater of power 2000 W is used to heat water. The specific heat capacity of water is 4200 $J\ kg^{-1}\ K^{-1}$. The efficiency of heater is 70%. Time required to heat 2 kg of water from 10°C to 60°C is ________s.

(Assume that the specific heat capacity of water remains constant over the temperature range of the water).

10. A body of mass 25 kg is dragged on a rough horizontal floor for one hour with a speed of 2 kmh^{-1}. The coefficient of friction for the surface in contact is 0.5 and half the heat produced is absorbed by the body. If specific heat of body is 0.1 cal g^{-1}(°C^{-1}) and g = 9.8 ms^{-2}, then the rise in temperature of body is :-

(A) 39 K (B) 59.5 K (C) 84.5 K (D) 11.6 K

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	B	A	313	B	C	42 gm/min	A	C	300	D

RACE
Regular Analysis Through Continuous Exercise

Thermal Expansion : RACE-03

1. A hole is drilled in a metal sheet. At $27°C$, the diameter of hole is 5 cm. When the sheet is heated to $177°C$, the change in the diameter of hole is $d \times 10^{-3}$ cm. The value of d will be ______ if coefficient of linear expansion of the metal is $1.6 \times 10^{-5}/°C$.

2. At what temperature a gold ring of diameter 6.230 cm be heated so that it can be fitted on a wooden bangle of diameter 6.241cm? Both the diameters have been measured at room temperature ($27°C$).

(Given: coefficient of linear thermal expansion of gold $\alpha_L = 1.4 \times 10^{-5}\ K^{-1}$)

(A) 125.7°C (B) $91.7°C$ (C) $425.7°C$ (D) $152.7°C$

3. Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T', the coefficient of linear expansion of the metal sheet is 'α'. The metal sheet is heated uniformly, by a small temperature ΔT, so that its new temperature is $T + \Delta T$. Calculate the increase in the volume of the metal box.

(A) $3a^3\alpha\Delta T$ (B) $4a^3\alpha\Delta T$ (C) $4\pi a^3\alpha\Delta T$ (D) $\frac{4}{3}\pi a^3\alpha\Delta T$

4. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : When a rod lying freely is heated, no thermal stress is developed in it.

Reason R : On heating the length of the rod increases.

In the light of the above statements, choose the correct answer from the options given below:

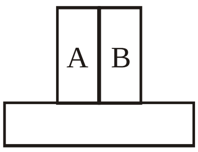
(A) Both A and R are true but R is NOT the correct explanation of A

(B) A is false but R is true

(C) A is true but R is false

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

5. A bimetallic strip consists of metals A and B. It is mounted rigidly as shown. The metal A has higher coefficient of expansion compared to that of metal B. When the bimetallic strip is placed in a cold both, it will :



(A) Bend towards the right (B) Not bend but shrink

(C) Neither bend nor shrink (D) Bend towards the left

6. Two rods A and B of identical dimensions are at temperature $30°C$. If A is heated upto $180°C$ and B upto $T°C$, then the new lengths are the same. If the ratio of the coefficients of linear expansion of A and B is 4 : 3, then the value of T is :-

(A) $270°C$ (B) $230°C$ (C) $250°C$ (D) $200°C$

7. At $40°C$, a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from $40°C$ to $20°C$ it regains its original length of $0.2\ m$. The value of M is close to :

(Coefficient of linear expansion and Young's modulus of brass are $10^{-5}/°C$ and $10^{11}\ N/m^2$, respectively; $g = 10\ ms^{-2}$)

(A) 1.5 kg (B) 9 kg (C) 0.9 kg (D) 0.5 kg

8. A thin cylindrical metal rod is bent into a ring with a small gap as shown in figure. On heating the system

(A) θ decreases, r and d increases (B) θ increases

(C) d & r increases (D) θ is constant

9. A unit scale is to be prepared whose length does not change with temperature and remains 20 cm, using a bimetallic strip made of brass and iron each of different length. The length of both components would change in such a way that difference between their lengths remains constant. If length of brass is 40 cm and length of iron will be ______cm.

($\alpha_{iron} = 1.2 \times 10^{-5}\ K^{-1}$ and $\alpha_{brass} = 1.8 \times 10^{-5}\ K^{-1}$).

10. Two different wires having lengths L_1 and L_2, and respective temperature coefficient of linear expansion α_1 and α_2, are joined end-to-end. Then the effective temperature coefficient of linear expansion is :

(A) $4\dfrac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}\dfrac{L_2L_1}{(L_2+L_1)^2}$ (B) $2\sqrt{\alpha_1\alpha_2}$

(C) $\dfrac{\alpha_1+\alpha_2}{2}$ (D) $\dfrac{\alpha_1L_1+\alpha_2L_2}{L_1+L_2}$

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	12	D	A	A	D	B	B	CD	60 cm	D

Regular Analysis Through Continuous Exercise

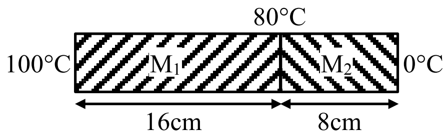
Heat Transfer(Conduction) : RACE-04

1. Two plates A and B have thermal conductivities 84 $Wm^{-1}K^{-1}$ and 126 $Wm^{-1}K^{-1}$ respectively. They have same surface area and same thickness. They are placed in contact along their surfaces. If the temperatures of the outer surfaces of A and B are kept at 100°C and 0°C respectively, then the temperature of the surface of contact in steady state is _______°C.

2. Two metallic blocks M_1 and M_2 of same area of cross-section are connected to each other (as shown in figure).

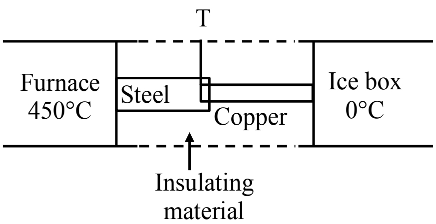
If the thermal conductivity of M_2 is K then the thermal conductivity of M_1 will be :

[Assume steady state heat conduction]



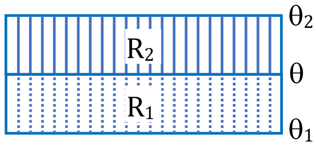
(A) 10 K (B) 8 K (C) 12.5 K (D) 2 K

3. If K_1 and K_2 are the thermal conductivities L_1 and L_2 are the lengths and A_1 and A_2 are the cross sectional areas of steel and copper rods respectively such that $\frac{K_2}{K_1}=9, \frac{A_1}{A_2}=2, \frac{L_1}{L_2}=2$. Then, for the arrangement as shown in the figure. The value of temperature T of the steel – copper junction in the steady state will be :



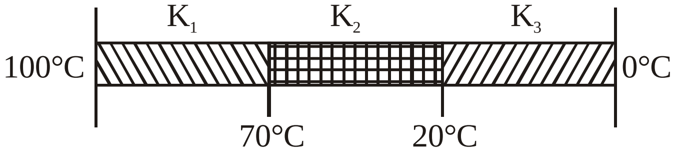
(A) 18°C (B) 14°C (C) 45°C (D) 150°C

4. The temperature θ at the junction of two insulating sheets, having thermal resistances R_1 and R_2 as well as top and bottom temperatures θ_1 and θ_2 (as shown in figure) is given by :



(A) $\frac{\theta_2 R_2 - \theta_1 R_1}{R_2 - R_1}$ (B) $\frac{\theta_1 R_2 - \theta_2 R_1}{R_2 - R_1}$ (C) $\frac{\theta_1 R_2 + \theta_2 R_1}{R_2 + R_1}$ (D) $\frac{\theta_1 R_1 + \theta_2 R_2}{R_2 + R_1}$

5. Three rods of identical cross-section and lengths are made of three different materials of thermal conductivity K_1, K_2, and K_3, respectively. They are joined together at their ends to make a long rod (see figure). One end of the long rod is maintained at 100°C and the other at 0°C (see figure). If the joints of the rod are at 70°C and 20°C in steady state and there is no loss of energy from the surface of the rod, the correct relationship between K_1, K_2 and K_3 is :



(A) $K_1 : K_3 = 2 : 3$; $K_2 : K_3 = 2 : 5$ (B) $K_1 < K_2 < K_3$

(C) $K_1 : K_2 = 5 : 2$; $K_1 : K_3 = 3 : 5$ (D) $K_1 > K_2 > K_3$

6. *A* and *B* are two points on a uniform metal ring whose centre is *C*. The angle $ACB = \theta$. *A* and *B* are maintained at two different constant temperatures. When $\theta = 180°$, the rate of total heat flow from *A* to *B* is 1.2 *W*. When $\theta = 90°$, this rate will be :

(A) 0.6 *W* (B) 0.9 *W* (C) 1.6 *W* (D) 1.8 *W*

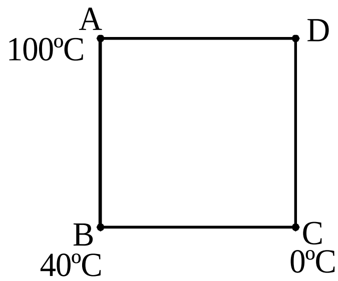
7. A point source of heat of power *P* which is placed at the centre of a spherical shell of mean radius *R*. The material of the shell has thermal conductivity *K*. If the temperature difference between the outer and the inner surface of the shell in a steady state is *T*, then the thickness of the shell is ______. (Assume very thin shell).

8. A brass boiler has a base area of 0.15 m^2 and thickness 1.0 cm. It boils water at the rate of 6.0 kg/min when placed on a gas stove. The temperature (approximately) of the part of the flame in contact with the boiler is (Thermal conductivity of brass = 107.4 $Js^{-1}\,m^{-1}°C^{-1}$, Heat of vaporization of water = 2256×10^3 $J\text{-}kg^{-1}$)

(A) 2400 *K* (B) 240°*C* (C) 2400°*C* (D) 24000°*C*

9. Four conducting rods are joined to make a square. All rods are identical and ends *A*, *B* and *C* are maintained at given temperatures. Choose ***INCORRECT*** statement for given arrangement in steady state.

(value of $\frac{KA}{L}$ is $1\frac{J}{S°C}$, symbols have their usual meaning).



(A) Heat current in *AB* is equal to 1.5 times of heat current in *BC*.

(B) Temperature of end *D* is 50°*C*.

(C) Heat current in *AB* is equal to heat current in *BC*.

(D) Heat current withdrawn at end *B* is 20.

10. A cuboidal slab has square faces of area *A* and a width *d*. Across the square faces a temperature of *T* is maintained. The conductivity of the material varies linearly with the distance from each face from *K* to 2*K* at the middle. The rate of heat flow is

(A) $\frac{KAT}{d\ln 2}$ (B) $\frac{KAT\ln 2}{d}$ (C) $\frac{3KAT}{2d}$ (D) $\frac{3KAT}{d}$

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	40	B	C	C	A	C	$4\pi R^2 KT/P$	B	C	A

RACE
Regular Analysis Through Continuous Exercise

Heat Transfer (Radiation) : RACE-05

1. A body radiates energy $5W$ at a temperature of $127°C$. If the temperature is increased to $927°C$, then it radiates energy at the rate of–

(A) 410 W (B) 81 W (C) 405 W (D) 20 W

2. A long solid cylinder is radiating power. It is remolded into a number of smaller cylinders, each of which has the same length as original cylinder. Each small cylinder has the same temperature as the original cylinder. The total radiant power emitted by the pieces is twice that emitted by the original cylinder. How many smaller cylinders are there? Neglect the energy emitted by the flat faces of cylinder.

3. There are two solar energy collectors made up of thin aluminium sheet. They are flat and uncoated. Collector 'A' is rectangular measuring 20 cm long and 15 cm wide. Collector 'B' is circular having 20 cm diameter. If they are kept under mid-day sun for long time then.

(A) both the collectors A and B will show nearly the same temperature

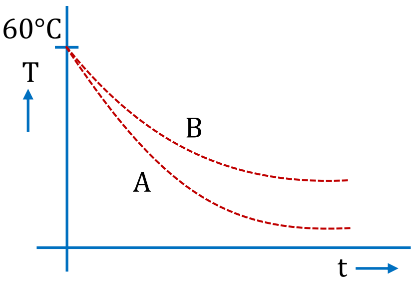
(B) collector A will show higher temperature than B

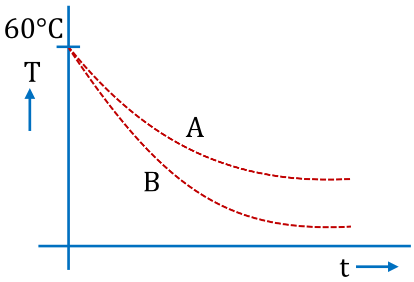
(C) collector B will show higher temperature than A

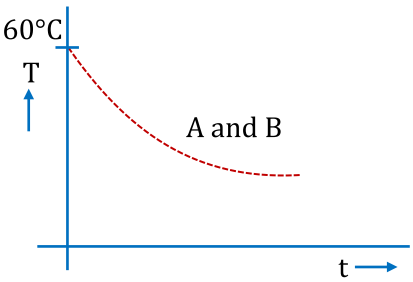
(D) there will be no rise in the temperature of the two collectors, as they are uncoated

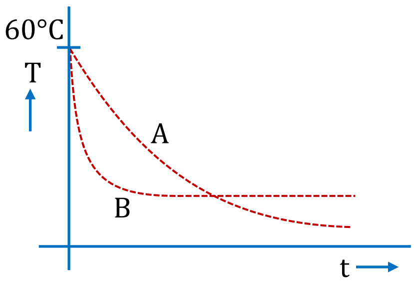
4. Two identical breakers A and B contain equal volumes of two different liquids at $60°C$ each and left to cool down. Liquid in A has density of $8 \times 10^2\ kg/m^3$ and specific heat of $2000\ J\ kg^{-1}\ K^{-1}$ while liquid in B has density of $10^3\ kg\ m^{-3}$ and specific heat of $4000\ J\ kg^{-1}\ K^{-1}$. Which of the following best describes their temperature versus time graph schematically?

(Assume the emissivity of both the beakers to be the same)

(A)


(B)


(C)


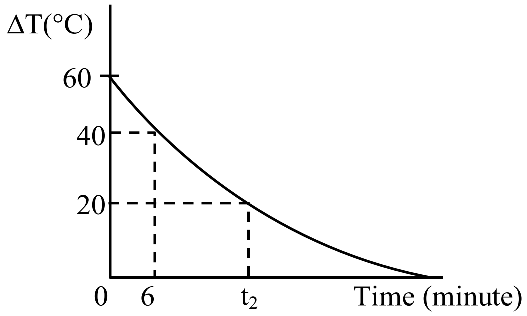
(D)


5. A bowl filled with very hot soup cools from $98°C$ to $86°C$ in 2 minutes when the room temperature is $22°C$. How long it will take to cool from $75°C$ to $69°C$?

(A) 2 minutes (B) 1.4 minutes (C) 0.5 minute (D) 1 minute

6. A body cools from $60°C$ to $40°C$ in 6 minutes. If, temperature of surroundings is $10°C$. Then, after the next 6 minutes, its temperature will be ____ $°C$.

7. In an experiment of verify Newton's law of cooling, a graph is plotted between, the temperature difference (ΔT) of the water and surroundings and time as shown in figure. The initial temperature of water is taken as $80°C$. The value of t_2 as mentioned in the graph will be ______.



8. End A of a rod AB of length L = 1.5 m and of uniform cross-sectional area is maintained at some constant temperature. The heat conductivity of the rod is k = 17 $J/s\text{-}m° K$. The other end B of this rod is radiating energy into vacuum and the wavelength with maximum energy density emitted from this end is λ_0 = 75000 Å . The emissivity of the end B is e = 1. If the temperature of the end A (in K) is 66α. Then find the value of α. (Assuming that except the ends, the rod is thermally insulated)

(Take $b = 3 \times 10^{-3}$ SI units, $\sigma = 17/3 \times 10^{-8}$ SI units)

(A) 2 (B) 4 (C) 8 (D) 10

9. Two thin metallic spherical shells of radii r_1 and r_2 ($r_1 < r_2$) are placed with their centres coinciding. A material of thermal conductivity K is filled in the space between the shells. The inner shell is maintained at temperature θ_1 and the outer shell at temperature $\theta_2(\theta_1<\theta_2)$. The rate at which heat flows radially through the material is :-

(A) $\dfrac{4\pi K r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$ (B) $\dfrac{\pi r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$ (C) $\dfrac{K(\theta_2-\theta_1)}{r_2-r_1}$ (D) $\dfrac{K(\theta_2-\theta_1)(r_2-r_1)}{4\pi r_1 r_2}$

10. Solar constant is the amount of energy received by the earth on a unit area per second. Its values is nearly 1.75×10^3 watt. A solar cooker used for heating water has solar panel of effective area 1 m^2. Only 10 % of the energy received by the solar panel is utilized for heating the contents. If time taken by this solar cooker to heat 1 litre of water from $30°C$ to $80°C$ is nearly $5x$ minutes then x is.

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	C	4	A	A	B	28	16	C	A	4

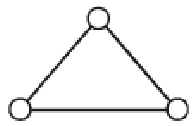
RACE
Regular Analysis Through Continuous Exercise

Kinetic Theory of Gases : RACE-06

1. The temperature at which the kinetic energy of oxygen molecules becomes double than its value at 27°C is

(A) 1227° C (B) 927°C (C) 327°C (D) 627°C

2. Consider a gas of triatomic molecules. The molecules are assumed to the triangular and made of massless rigid rods whose vertices are occupied by atoms. The internal energy of a mole of the gas at temperature T is :



(A) $\frac{9}{2}RT$ (B) $\frac{3}{2}RT$ (C) $\frac{5}{2}RT$ (D) $3RT$

3. The temperature of an ideal gas is increased from 200K to 800K. If r.m.s. speed of gas at 200K is v_0. Then, r.m.s. speed of the gas at 800 K will be:

(A) v_0 (B) $4v_0$ (C) $\frac{v_0}{4}$ (D) $2v_0$

4. The root mean square speed of molecules of nitrogen gas at 27°C is approximately:
(Given mass of a nitrogen molecule $=4.6\times10^{-26}$kg and take Boltzmann constant $k_B = 1.4\times10^{-23}\ JK^{-1}$)

(A) 523 m/s (B) 1260 m/s (C) 91 m/s (D) 27.4 m/s

5. If the r.m.s. speed of chlorine molecule is 490 m/s at 27°C, the r.m.s. speed of argon molecules at the same temperature will be (Atomic mass of argon = 39.9u, molecular mass of chlorine = 70.9u)

(A) 751.7 m/s (B) 451.7 m/s (C) 651.7 m/s (D) 551.7 m/s

6. The rms speed of oxygen molecule in a vessel at particular temperature is $\left(1+\frac{5}{x}\right)^{\frac{1}{2}}\upsilon$, where υ is the average speed of the molecule. The value of x will be:(Take $\pi=\frac{22}{7}$)

(A) 28 (B) 27 (C) 8 (D) 4

7. The mean free path of molecules of a certain gas at STP is 1500d, where d is the diameter of the gas molecules. While maintaining the standard pressure, the mean free path of the molecules at 373K is approximately :

(A) 1098d (B) 2049d (C) 750d (D) 1500d

8. A flask contains Hydrogen and Argon in the ratio 2:1 by mass. The temperature of the mixture is 30°C. The ratio of average kinetic energy per molecule of the two gases (K argon/K hydrogen) is: (Given: Atomic Weight of Ar = 39.9)

(A) 1 (B) 2 (C) $\frac{39.9}{2}$ (D) 39.9

9. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic).), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed (v_{rms}) and choose the correct answer from the options given below:

(A) $v_{rms}(mono) = v_{rms}(dia) = v_{rms}(poly)$ (B) $v_{rms}(mono) > v_{rms}(dia) > v_{rms}(poly)$

(C) $v_{rms}(dia) < v_{rms}(poly) < v_{rms}(mono)$ (D) $v_{rms}(mono) < v_{rms}(dia) < v_{rms}(poly)$

10. The number of air molecules per cm^3 increased from 3×10^{19} to 12×10^{19}. The ratio of collision frequency of air molecules before and after the increase in number respectively is

(A) 1.25 (B) 0.25 (C) 0.75 (D) 0.50

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	C	D	D	A	C	A	B	A	B	B

RACE
Regular Analysis Through Continuous Exercise

First Law of Thermodynamics : RACE-07

1. Heat is given to an ideal gas in an isothermal process.

a. Internal energy of the gas will decrease.

b. Internal energy of the gas will increase.

c. Internal energy of the gas will not change.

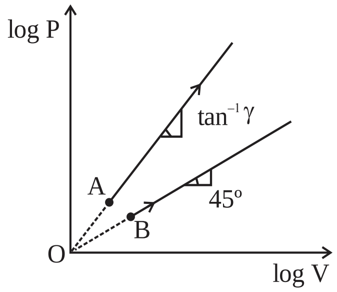
d. The gas will do positive work.

e. The gas will do negative work.

Choose the **correct** answer from the options given below :

(A) a and e only (B) b and d only (C) c and e only (D) c and d only

2. Two thermodynamical process are shown in the figure. The molar heat capacity for process A and B are C_A and C_B. The molar heat capacity at constant pressure and constant volume are represented by C_P and C_V, respectively. Choose the correct statement.



(A) $C_B=\infty, C_A=0$ (B) $C_A=0$ and $C_B=\infty$

(C) $C_P>C_B>C_A>C_V$ (D) $C_A>C_P>C_V$

3. Given below are two statements:

Statement I: If heat is added to a system, its temperature must increase.

Statement II: If positive work is done by a system in a thermodynamic process, its volume must increase.

In the light of the above statements, choose the correct answer from the options given below

(A) Statement I is true but Statement II is false

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

(D) Statement I is false but Statement II is true

4. A gas is compressed adiabatically, which one of the following statement is NOT true.

(A) There is no heat supplied to the system

(B) The temperature of the gas increases

(C) The change in the internal energy is equal to the work done on the gas.

(D) There is no change in the internal energy

5. Consider two containers A and B containing monoatomic gases at the same Pressure (P), Volume (V) and Temperature (T). The gas in A is compressed isothermally to $\frac{1}{8}$ of its original volume while the gas B is compressed adiabatically to $\frac{1}{8}$ of its original volume. The ratio of final pressure of gas in B to that of gas in A is :

(A) 8 (B) $8^{\frac{3}{2}}$ (C) $\frac{1}{8}$ (D) 4

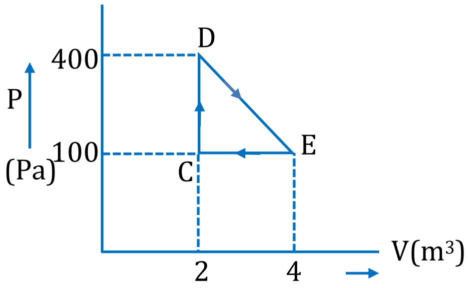
6. The thermodynamic process, in which internal energy of the system remains constant is

(A) Isochoric (B) Isothermal (C) Adiabatic (D) Isobaric

7. The initial pressure and volume of an ideal gas are P_0 and V_0. The final pressure of the gas when the gas is suddenly compressed to volume $\frac{V_0}{4}$ will be : (Given γ = ratio of specific heats at constant pressure and at constant volume)

(A) $P_0(4)^{\frac{1}{\gamma}}$ (B) $P_0(D)^{\gamma}$ (C) P_0 (D) $4P_0$

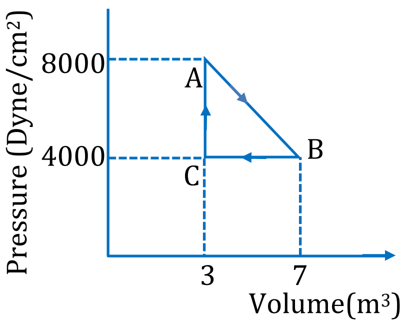
8. A thermodynamic system is taken through cyclic process. The total work done in the process is :



(A) 100 J (B) 300 J (C) Zero (D) 200 s

9. A thermodynamic system is taken from an original state A to an intermediate state B by a linear process as shown in the figure. It's volume is then reduced to the original value from B to C by an isobaric process. The total work done by the gas from A to B and B to C would be :

(A) 33800 J (B) 2200 J
(C) 800 J (D) 1200 J



10. A sample of gas at temperature T is adiabatically expanded to double its volume. The work done by the gas in the process is $\left(given, \gamma = \frac{3}{2}\right)$:

(A) $W = TR\,[\sqrt{2}-2]$ (B) $W = \frac{T}{R}[\sqrt{2}-2]$ (C) $W = \frac{R}{T}[2-\sqrt{2}]$ (D) $W = RT\,[2-\sqrt{2}]$

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	D	C	D	D	D	B	B	B	C	D

RACE
Regular Analysis Through Continuous Exercise

Second Law of Thermodynamics : RACE-08

1. A Carnot engine operating between two reservoirs has efficiency $\frac{1}{3}$. When the temperature of cold reservoir raised by x, its efficiency decreases to $\frac{1}{6}$. The value of x, if the temperature of hot reservoir is 99° C, will be:

(A) 16.5 K (B) 33 K (C) 66 K (D) 62 K

2. A Carnot engine with efficiency 50% takes heat from a source at 600K. In order to increase the efficiency to 70%, keeping the temperature of sink same, the new temperature of the source will be:

(A) 360 K (B) 1000 K (C) 900 K (D) 300 K

3. Given below are **two** statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Efficiency of a reversible heat engine will be highest at –273°C temperature of cold reservoir.

Reason R : The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as s.

In the light of the above statements, choose the **correct** answer from the options given below :

(A) **A** is true but **R** is false

(B) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

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

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

4. Two ideal Carnot engines operate in cascade (all heat given up by one engine is used by the other engine to produce work) between temperatures, T_1 and T_2. The temperature of the hot reservoir of the first engine is T_1 and the temperature of the cold reservoir of the second engine is T_2. T is temperature of the sink of first engine which is also the source for the second engine. How is T related to T_1 and T_2, if both the engines perform equal amount of work?

(A) $T = \frac{2T_1T_2}{T_1 + T_2}$ (B) $T = \sqrt{T_1T_2}$ (C) $T = \frac{T_1 + T_2}{2}$ (D) T = 0

5. Work done by a Carnot engine operating between temperatures 127°C and 27°C is 2 kJ. The amount of heat transferred to the engine by the reservoir is:

(A) 4 kJ (B) 2 kJ (C) 8 kJ (D) 2.67 kJ

6. An engine operating between the boiling and freezing points of water will have

1. efficiency more than 27%
2. efficiency less than the efficiency a Carnot engine operating between the same two temperatures.
3. efficiency equal to 27%
4. efficiency less than 27%

(A) 2, 3 and 4 only (B) 2 and 3 only (C) 2 and 4 only (D) 1 and 2 only

7. A Carnot engine operates between two reservoirs of temperatures 900 K and 300 K. The engine performs 1200 J of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is____.

8. A carnot engine having an efficiency of $\frac{1}{10}$ is being used as a refrigerator. If the work done on the refrigerator is 10 J, the amount of heat absorbed from the reservoir at lower temperature is :

(A) 99 J (B) 100 J (C) 90 J (D) 1 J

9. An engine operates by taking a monatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to _____

10. Two Carrnot engines A and B are operated in series. The first one, A, receives heat at T_1(= 600 K) and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at T_3(= 400 K). Calculate the temperature T_2 if the work outputs of the two engines are equal :

(A) 400 K (B) 600 K (C) 500 K (D) 300 K

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10
Answer	D	B	D	C	C	C	600J	C	19.04	C