EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

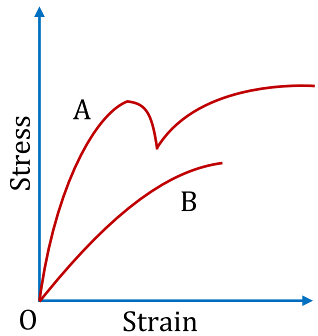
Elasticity

1. Two blocks of masses 1 *kg* and 2 *kg* are connected by a metal wire going over a smooth pulley. The breaking stress of metal is $\frac{40}{3\pi}\times10^{6}\,N/m^{-2}$. What should be the minimum radius of wire used, if it should not be broken? ($g = 10ms^{-2}$)

(A) 0.5 *mm* (B) 1 *mm* (C) 1.5 *mm* (D) 2 *mm*

PEH157

2. The diagram show stress versus strain curve for the materials *A* and *B*. From the curves we infer that

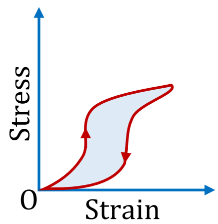


(A) *A* is brittle but *B* is ductile (B) *A* is ductile and *B* is brittle

(C) both *A* and *B* are ductile (D) both *A* and *B* are brittle

PEH158

3. The diagram shows a stress-strain graph for a rubber band.



Consider of the following statements.

I. It will be easier to compress this rubber than expand it.

II. Rubber does not return to its original length after it is stretched.

III. The rubber band will get heated if it is stretched and released.

Which of these can be deduced from the graph

(A) III only (B) II and III (C) I and III (D) I only

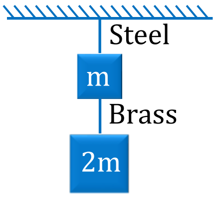
PEH159

4. Overall changes in volume and radii of a uniform cylindrical steel wire are 0.2% and 0.002% respectively when subjected to some suitable force. Longitudinal tensile stress acting on the wire is:- ($Y = 2.0 \times 10^{11}\ Nm^{-2}$)

(A) $3.2 \times 10^{9}\ Nm^{-2}$ (B) $3.2 \times 10^{7}\ Nm^{-2}$ (C) $3.6 \times 10^{9}\ Nm^{-2}$ (D) $3.9 \times 10^{8}\ Nm^{-2}$

PEH081

5. If the ratio of lengths, radii and Young's moduli of steel and brass wires in the figure are a, b and c respectively, then the corresponding ratio of increase in their lengths is :-



(A) $2\ a^2c/b$ (B) $3\ a/2b^2c$

(C) $2\ ac/b^2$ (D) $3\ c/2ab^2$

PEH082

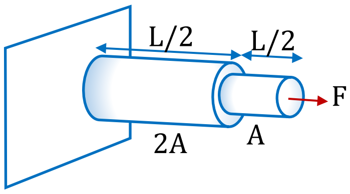
6. A 100 m long wire having cross-sectional area $6.25 \times 10^{-4}\ m^2$ and Young's modulus is $10^{10}\ Nm^{-2}$ is subjected to a load of 250 N, then the elongation in the wire will be :

(A) $6.25 \times 10^{-3}\ m$ (B) $4 \times 10^{-4}\ m$ (C) $6.25 \times 10^{-6}\ m$ (D) $4 \times 10^{-3}\ m$

PEH175

7. The bar shown in the figure is made of a single piece of material. It is fixed at one end and consists of two segments of equal length $\frac{L}{2}$ but different cross-sectional area A and $2A$. What is the change in length of the entire system under the action of an axial force F?

[Consider the shape of joint to remain circular, Y is young's modulus].

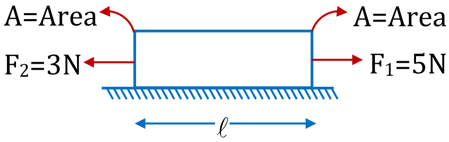


A = Area of cross section

(A) $\frac{3FL}{4AY}$ (B) $\frac{3FL}{8AY}$ (C) $\frac{3FL}{2AY}$ (D) $\frac{2FL}{3AY}$

PEH083

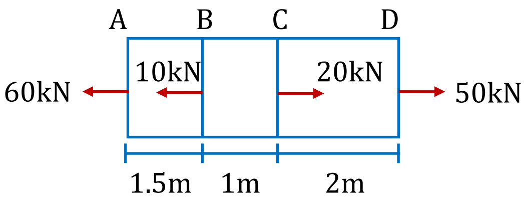
8. A block of mass M, area of cross-section A and length ℓ is placed on smooth horizontal floor. Two forces $F_1 = 5N$ and $F_2 = 3\ N$ are applied on the block as shown in the figure. If Y is Young's modulus of elasticity of material, then total extension in the length of the block will be



(A) $\frac{8\ell}{AY}$ (B) $\frac{2\ell}{AY}$ (C) $\frac{4\ell}{AY}$ (D) $\frac{5\ell}{2AY}$

PEH084

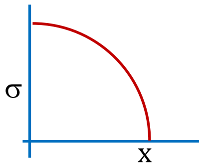
9. A Steel rod of cross-sectional area $1m^2$ is acted upon by forces as shown in the Fig. Determine the total elongation of the bar. Take $Y = 2.0 \times 10^{11} N/m^2$.

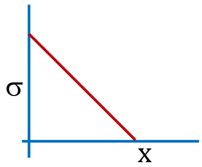


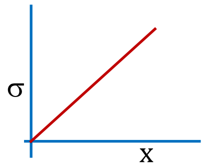
(A) 1.3 μm (B) 1.7 μm (C) 0.9 μm (D) 1.2 μm

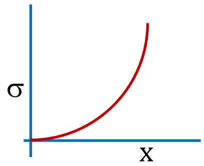
PEH160

10. A uniform rod rotating in gravity free region with certain constant angular velocity. The variation of tensile stress with distance x from axis of rotation is best represented by which of the following graphs.

(A) 

(B) 

(C) 

(D) 

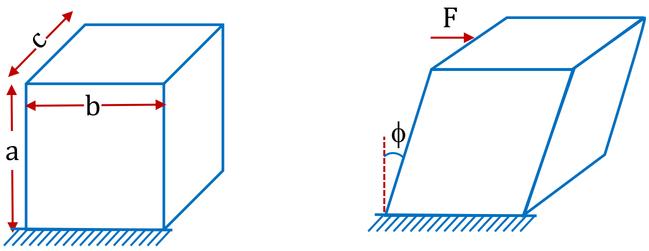
PEH085

11. A solid sphere of radius R made of 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. When a mass m is placed on the piston to compress the liquid, the fractional change in the radius of the sphere $\delta R/R$ is:-

(A) mg/AK (B) $mg/3AK$ (C) mg/A (D) $mg/3AR$

PEH087

12. A cuboidal block of sides a, b and c is fixed on ground. The top is pushed by a horizontal force F as shown. The angle ϕ by which the block deforms is : (η is modulus of rigidity)



(A) $\dfrac{F}{ab\eta}$ (B) $\dfrac{F}{ac\eta}$ (C) $\dfrac{F}{bc\eta}$ (D) $\dfrac{F}{\sqrt{b^2+c^2}\,\eta}$

PEH089

13. When a steel wire fixed at one end is pulled by a constant force F at its other end, its length in equilibrium increases by l. Which of the following statements is not correct?

(A) Work done by the external force is Fl.

(B) Some heat is produced in the wire in the process.

(C) The elastic potential energy of the wire is $Fl/2$.

(D) The heat produced is equal to half of the elastic potential energy of the wire.

PEH090

14. 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

PEH177

15. A cylindrical wire of radius 1 mm, length 1 m, Young's modulus = $2 \times 10^{11}\ N/m^2$, Poisson's ratio $\mu = \pi/10$ is stretched by a force of 100 N. Its radius will become

(A) 0.99998 mm (B) 0.99999 mm (C) 0.99997 mm (D) 0.99995 mm

PEH091

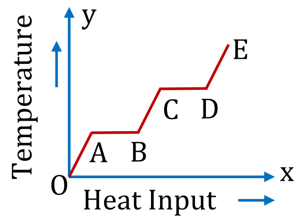
16. The length of wire becomes l_1 and l_2 when 100 N and 120 N tensions are applied respectively. If $10\ l_2 = 11\ l_1$, the natural length of wire will be $\frac{1}{x}\ l_1$. Here the value of x is ____.

(A) 2 (B) 5 (C) 8 (D) 10

PEH178

Calorimetry

17. A solid material is supplied with heat at a constant rate. The temperature of material is changing with heat input as shown in the figure. What does slope DE represents?



(A) latent heat of liquid (B) latent heat of vapour

(C) heat capacity of vapour (D) inverse of heat capacity of vapour

PEH058

18. 10 gm of ice at 0°C is kept in a calorimeter of water equivalent 10 gm. How much heat should be supplied to the apparatus to evaporate the water thus formed? (Neglect loss of heat)

(A) 6200 cal (B) 7200 cal (C) 13600 cal (D) 8200 cal

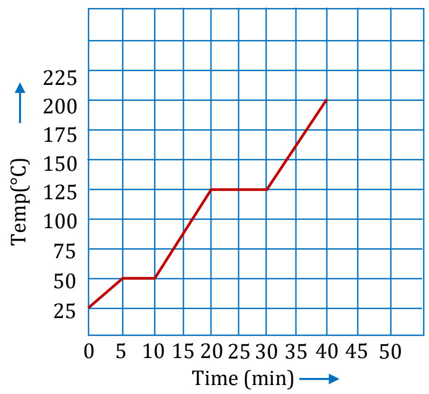
PEH059

19. In a container of negligible heat capacity 100 gm of a liquid at 20°C is heated. Specific heat of the liquid varies with temperature given as $s = (100T + 500)\ J/kg\text{-}°C$, where T is in °C. Find the amount of heat required to raise the temperature of the liquid to 40°C.

(A) 5000 J (B) 6000 J (C) 7000 J (D) 8000 J

PEH060

20. The graph shown in the figure represent change in the temperature of 5 kg of a substance as it absorbs heat at a constant rate of 42 $kJ\ min^{-1}$. The latent heat of vaporization of the substance is :



(A) 630 $kJ\ kg^{-1}$ (B) 126 $kJ\ kg^{-1}$ (C) 84 $kJ\ kg^{-1}$ (D) 12.6 $kJ\ kg^{-1}$

PEH061

21. Two bodies of specific heats S_1 and S_2 having same heat capacities are combined to form a single composite body. Specific heat of composite body is -

(A) $S_1 + S_2$ (B) $\frac{S_1+S_2}{2}$ (C) $\frac{2S_1S_2}{S_1+S_2}$ (D) $\frac{1}{S_1}+\frac{1}{S_2}$

PEH062

22. A gas heater raises temperature of 1kg of water by 30°C in 10min. How long will it take the same heater to raise 3kg of oil through the same temperature rise if the specific heat of water is twice that of oil (assuming that there is no heat loss)

(A) 15 *min* (B) 5 *min* (C) 30 *min* (D) 60 *min*

PEH064

23. There are three liquids *A, B* and *C*. The mass, heat capacity and temperature for liquid *A* is (m_A, C_A and T_A), for liquid *B* is (m_B, C_B and T_B) and for liquid *C* is (m_C, C_C and T_C) respectively. If all the three liquids are mixed, then final temperature would be :-

(A) $\frac{C_AT_A+C_BT_B+C_CT_C}{C_A+C_B+C_C}$ (B) $\frac{m_AC_AT_A+m_BC_BT_B+m_CC_CT_C}{m_AC_A+m_BC_B+m_CC_C}$

(C) $\frac{m_AT_A+m_BT_B+m_CT_C}{m_A+m_B+m_C}$ (D) $\left(\frac{T_A}{m_A}+\frac{T_B}{m_B}+\frac{T_C}{m_C}\right)(m_A+m_B+m_C)$

PEH068

24. A continuous flow water heater (geyser) has an electrical power rating = 2 kW and efficiency of conversion of electrical power into heat = 80%. If water is flowing through the device at the rate of 100 cc/sec, and the inlet temperature is 10°C, the outlet temperature will be

(A) 12.2°C (B) 13.8°C (C) 20°C (D) 16.5°C

PEH069

25. If 10 gram of ice at 0°C is mixed with 10 gram of water at 40°C. The final mass of water in mixture is (Latent heat of fusion of ice = 80 cal/gm; specific heat of water = 1 cal/gm °C)

(A) 10 gram (B) 15 gram (C) 18 gram (D) 20 gram

PEH072

26. Find the amount of heat supplied to decrease the volume of an ice water mixture by 1 cm^3 without any change in temperature. (ρ_{ice} = 0.9 ρ_{water}, L_{ice} = 80 cal/gm).

(A) 360 *cal* (B) 500 *cal* (C) 720 *cal* (D) none of these

PEH074

27. A thermally insulated vessel contains some water at 0°C. The vessel is connected to a vacuum pump to pump out water vapour. This results in some water getting frozen. It is given latent heat of vaporization of water at 0°C = 21 × 10^5 J/kg and latent heat of freezing of water = 3.36 × 10^5 J/kg. The maximum percentage amount of water that will be solidified in this manner will be:-

(A) 86.2% (B) 33.6% (C) 21% (D) 24.36%

PEH076

28. A lead ball at 30°C is dropped from a height of 6.2 km. The ball is heated due to the air resistance and it completely melts just before reaching the ground. The molten substance falls slowly on the ground. Calculate the latent heat of fusion of lead. Specific heat capacity of lead = 126 $J\ kg^{-1}°C^{-1}$ and melting point of lead = 330°C. Assume that any mechanical energy lost is used to heat the ball. Use g = 10 $m\ s^{-2}$.

(A) 6 × 10^3 $J\ kg^{-1}$ (B) 1.2 × 10^4 $J\ kg^{-1}$ (C) 1.8 × 10^4 $J\ kg^{-1}$ (D) 2.4 × 10^4 $J\ kg^{-1}$

PEH161

29. On a winter day the temperature of the tap water is 20°*C* whereas the room temperature is 5°*C*. Water is stored in a tank of capacity 500 cm^3 for household use. If it were possible to use the heat liberated by the water to lift a 10 *kg* mass vertically, how high can it be lifted as the water comes to the room temperature ? Take $g = 10\ m/s^2$.

(A) 255 *m* (B) 275 *m* (C) 295 *m* (D) 315 *m*

PEH162

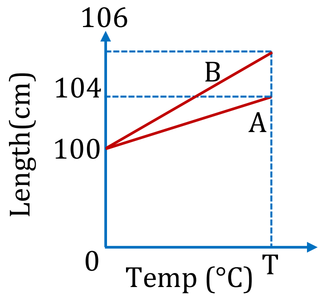
Thermal Expansion

30. A hole is made in a metal plate, when the temperature of metal is raised then the diameter of the hole will :-

(A) Decrease
(B) Increase
(C) Remain same
(D) Answer depends upon the initial temperature of the metal

PEH100

31. The variation of lengths of two metal rods *A* and *B* with change in temperature are shown in figure. The ratio of $\frac{\alpha_A}{\alpha_B}$ is



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

PEH101

32. Two rods one of aluminium of length l_1 having coefficient of linear expansion α_a, and other steel of length l_2 having coefficient of linear expansion α_s are joined end to end. The expansion in both the rods is same on variation of temperature. Then the value of $\frac{l_1}{l_1 + l_2}$ is

(A) $\frac{\alpha_s}{\alpha_a + \alpha_s}$ (B) $\frac{\alpha_s}{\alpha_a - \alpha_s}$ (C) $\frac{\alpha_a + \alpha_s}{\alpha_s}$ (D) None of these

PEH102

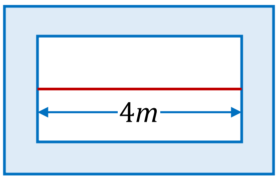
33. A rod of length 2*m* at 0°*C* and having expansion coefficient $\alpha = (3x + 2) \times 10^{-6}\ °C^{-1}$ where *x* is the distance (in *cm*) from one end of rod. The length of rod at 20°*C* is :

(A) 2.124 *m* (B) 3.24 *m* (C) 2.0120 *m* (D) 3.124 *m*

PEH104

34. A fine steel wire of length 4*m* is fixed rigidly in a heavy brass frame as shown in figure. It is just taut at 20°*C*. The tensile stress developed in steel wire if whole system is heated to 120°*C* is :–

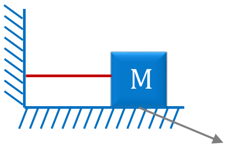
(Given $\alpha_{brass} = 1.8 \times 10^{-5}\ °C^{-1}$, $\alpha_{steel} = 1.2 \times 10^{-5}\ °C^{-1}$, $Y_{steel} = 2 \times 10^{11}\ Nm^{-2}$, $Y_{brass} = 1.7 \times 10^{7}\ Nm^{-2}$)



(A) $1.02 \times 10^4\ Nm^{-2}$ (B) $1.2 \times 10^8\ Nm^{-2}$
(C) $1.2 \times 10^6\ Nm^{-2}$ (D) $6 \times 10^8\ Nm^{-2}$

PEH105

35. A wire having cross-sectional area S is attached to wall on one side and a block of mass M on the other side which placed on a horizontal surface having coefficient of friction μ as shown. Material of wire has coefficient of thermal expansion α and Young's modulus Y. At initial temperature there is no stress in the wire. Now the wire is cooled. At what decrease in temperature the block will begin to move?



(A) $\frac{\mu Mg}{\alpha YS}$ (B) $\frac{2\mu Mg}{\alpha YS}$ (C) $\frac{\mu Mg}{2\alpha YS}$ (D) none

PEH106

36. An aluminium sphere is heated from $0°C$ to $100°C$. The change in the volume of the sphere of radius $10\ cm$ is ($\gamma_{Al} = 5.4 \times 10^{-5}/°C$) is

(A) $20 cm^3$ (B) $12.3\ cm^3$ (C) $22.6\ cm^3$ (D) $28.9\ cm^3$

PEH107

37. The bulk modulus of copper is $1.4 \times 10^{11}\ Pa$ and the coefficient of linear expansion is $1.7 \times 10^{-5}\ (C°)^{-1}$. What hydrostatic pressure is necessary to prevent a copper block from expanding when its temperature is increased from $20°C$ to $30°C$?

(A) $6.0 \times 10^5\ Pa$ (B) $7.1 \times 10^7\ Pa$ (C) $5.2 \times 10^6\ Pa$ (D) $40\ atm$

PEH108

38. The coefficient of apparent expansion of a liquid in a copper vessel is C and in a silver vessel is S. The coefficient of volume expansion of copper is γ_c. What is the coefficient of linear expansion of silver?

(A) $\frac{(C+\gamma_c+S)}{3}$ (B) $\frac{(C-\gamma_c+S)}{3}$ (C) $\frac{(C+\gamma_c-S)}{3}$ (D) $\frac{(C-\gamma_c-S)}{3}$

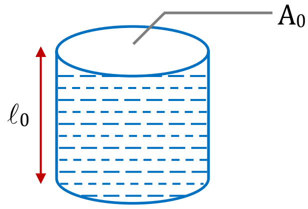
PEH110

39. Density of substance at $0°C$ is $10\ g/cc$ and at $100°C$, its density is $9.7\ g/cc$. The coefficient of linear expansion of the substance will be–

(A) $10^2\ °C^{-1}$ (B) $10^{-2}\ K^{-1}$ (C) $10^{-3}\ K^{-1}$ (D) $10^{-4}\ °C^{-1}$

PEH115

40. The figure shows a glass tube (linear co-efficient of expansion is α) completely filled with a liquid of volume expansion co-efficient γ. On heating length of the liquid column does not change. Choose the correct relation between γ and α.

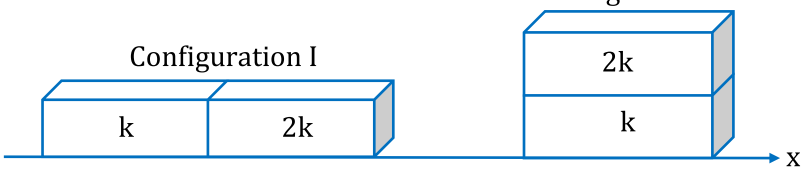


(A) $\gamma = \alpha$ (B) $\gamma = 2\alpha$ (C) $\gamma = 3\alpha$ (D) $\gamma = \frac{\alpha}{3}$

PEH116

Heat Transfer (Conduction)

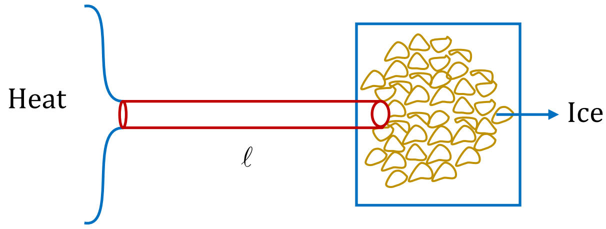
41. Two rectangular blocks, having identical dimensions, can be arranged either in configuration I or in configuration II as shown in the figure. One of the blocks has thermal conductivity k and the other $2k$. The temperature difference between the ends along the x-axis is the same in both the configurations. It takes $9s$ to transport a certain amount of heat from the hot end to the cold end in the configuration I. The time to transport the same amount of heat in the configuration II is :-



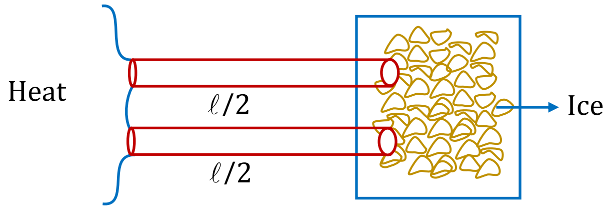
(A) 2.0 s (B) 3.0 s (C) 4.5 s (D) 6.0 s

PEH117

42. A rod of length 'λ' and cross-section *'A'* is used to melt a piece of ice as shown.



Now if the rod broken into two equal parts and is arranged as shown.

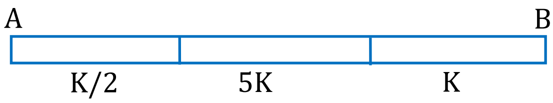


Time taken to melt ice in second case becomes.

(A) Half (B) One-forth (C) Twice (D) Four times

PEH118

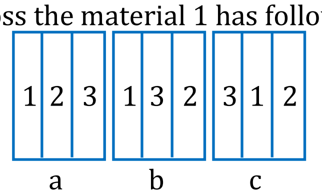
43. A composite rod made of three rods of equal length and cross-section as shown in the fig. The thermal conductivities of the materials of the rods are $K/2$, $5K$ and K respectively. The end A and end B are at constant temperatures. All heat entering the end A goes out of the end B, there being no loss of heat from the sides of the bar. The effective thermal conductivity of the bar is



(A) $15K/16$ (B) $6K/13$ (C) $5K/16$ (D) $2K/13$

PEH119

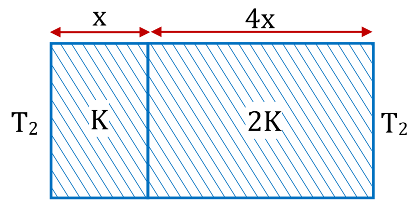
44. Figure shows three different arrangements of materials 1, 2 and 3 to form a wall. Thermal conductivities are $k_1 > k_2 > k_3$. The left side of the wall is 20°C higher than the right side. Temperature difference ΔT across the material 1 has following relation in three cases :



(A) $\Delta T_a > \Delta T_b > \Delta T_c$ (B) $\Delta T_a = \Delta T_b = \Delta T_c$ (C) $\Delta T_a = \Delta T_b > \Delta T_c$ (D) $\Delta T_a = \Delta T_b < \Delta T_c$

PEH120

45. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively are T_2 and T_1($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is f, with $\left(\frac{A(T_2 - T_1)K}{x}\right)$ f equals to-



(A) 1 (B) 1/2 (C) 2/3 (D) 1/3

PEH121

46. One end of a 2.35m long and 2.0cm radius aluminium rod (K = 235 $W.m^{-1}K^{-1}$) is held at 20°C. The other end of the rod is in contact with a block of ice at its melting point. The rate in $kg.s^{-1}$ at which ice melts is [Take latent heat of fusion for ice as $\frac{10}{3} \times 10^5 J.kg^{-1}$]

(A) $48\pi \times 10^{-6}$ (B) $24\pi \times 10^{-6}$ (C) $2.4\pi \times 10^{-6}$ (D) $4.8\pi \times 10^{-6}$

PEH124

47. One end of a conducting rod is maintained at temperature 50°C and at the other end, ice is melting at 0°C. The rate of melting of ice is doubled if:

(A) the temperature is made 200°C and the area of cross-section of the rod is doubled

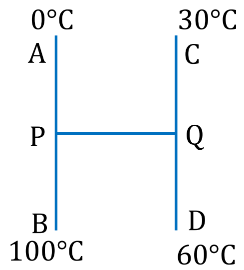
(B) the temperature is made 100°C and length of rod is made four times

(C) area of cross-section of rod is halved and length is doubled

(D) the temperature is made 100°C and the area of cross-section of rod and length both are doubled.

PEH125

48. Three identical rods AB, CD and PQ are joined as shown. P and Q are mid points of AB and CD respectively. Ends A, B, C and D are maintained at 0°C, 100°C, 30°C and 60°C respectively. The direction of heat flow in PQ is

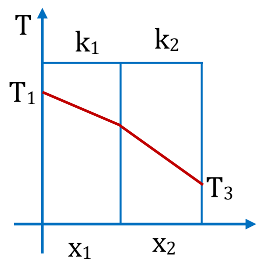


(A) from P to Q (B) from Q to P

(C) heat does not flow in PQ (D) data not sufficient

PEH127

49. The temperature drop through each layer of a two layer furnace wall is shown in figure. Assume that the external temperature T_1 and T_3 are maintained constant and $T_1 > T_3$. If the thickness of the layers x_1 and x_2 are the same, which of the following statements are correct.



(A) $k_1 > k_2$

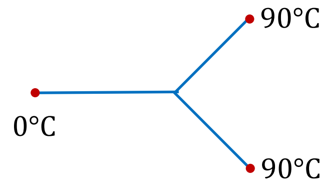
(B) $k_1 < k_2$

(C) $k_1 = k_2$ but heat flow through material (1) is larger then through (2)

(D) $k_1 = k_2$ but heat flow through material (1) is less than that through (2)

PEH128

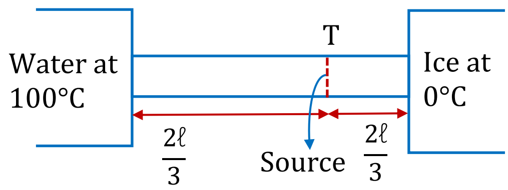
50. Three rods made of same material and having the same cross section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at $0°C$ and $90°C$ respectively. The temperature of the junction of the three rods will be :



(A) $45°C$ (B) $60°C$ (C) $30°C$ (D) $20°C$

PEH129

51. The rod connecting two reservoir and connected to a source is as shown in diagram. The rod is in steady state. Find the temperature of source, so that rate of melting of ice is 16 times that rate of vaporization. (Latent heat of vaporization is 540 Cal/gm and latent heat of fusion is 80 Cal/gm)



(A) $540°C$ (B) $580°C$ (C) $640°C$ (D) $740°C$

PEH134

52. In a $20m$ deep lake, the bottom is at a constant temperature of $4°C$. The air temperature is constant at $-10°C$. The thermal conductivity of ice is 4 times that water. Neglecting the expansion of water on freezing, the maximum thickness of ice will be

(A) $\frac{20}{11}m$ (B) $\frac{200}{11}m$ (C) $20\ m$ (D) $10\ m$

PEH136

Heat Transfer (Radiation)

53. A body cools in 7 minutes from $60°C$ to $40°C$. The temperature of the surrounding is $10°C$. The temperature of the body after the next 7 minutes will be:

(A) 32°C (B) 30°C (C) 28°C (D) 34°C

PEH180

54. A body cools from $80°C$ to $60°C$ in 5 minutes. The temperature of the surrounding is $20°C$. The time it takes to cool from $60°C$ to $40°C$ is:

(A) $500\ s$ (2) $\frac{25}{3}\ s$ (3) $450\ s$ (4) $420\ s$

PEH181

55. Two spheres of the same material have radii $1\ m$ and $4\ m$ and temperatures $4000\ K$ and $2000\ K$ respectively. The ratio of the energy radiated per second by the first sphere to that by the second is-

(A) 1 : 1 (B) 16 : 1 (C) 4 : 1 (D) 1 : 9

PEH138

56. A cubical block of mass 1.0 *kg* and edge 5.0 *cm* is heated to 227°*C*. It is kept in an evacuated chamber maintained at 27°*C*. Assuming that the block emits radiation like a blackbody, find the rate at which the temperature of the block will decrease. Specific heat capacity of the material of the block is 400 *J*/*kg*-*K*.

(A) 0.09°*C*/*s* (B) 0.12°*C*/*s* (C) 0.15°*C*/*s* (D) 0.18°*C*/*s*

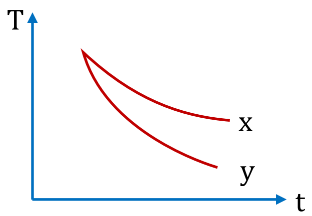
PEH163

57. A black metal foil is warmed by radiation from a small sphere at temperature '*T*' and at a distance '*d*'. It is found that the power received by the foil is *P*. If both the temperature and distance are doubled, the power received by the foil will be :

(A) 16 *P* (B) 4 *P* (C) 2 *P* (D) *P*

PEH139

58. If emissivity of bodies *X* and *Y* are e_x and e_y and absorptive power are A_x and A_y then



(A) $e_y > e_x$; $A_y > A_x$ (B) $e_y < e_x$; $A_y < A_x$ (C) $e_y > e_x$; $A_y < A_x$ (D) $e_y = e_x$; $A_y = A_x$

PEH140

59. 'Gulab Jamuns' (assumed to be spherical) are to be heated in an oven. They are available in two sizes, one twice bigger (in radius) than the other. Pizzas (assumed to be discs) are also to be heated in oven. They are also in two sizes, one twice big (in radius) than the other. All four are put together to be heated to oven temperature. Choose the correct option from the following:

(A) Both size gulab jamuns will get heated in the same time.

(B) Smaller gulab jamuns are heated before bigger ones.

(C) Smaller pizzas are heated before bigger ones.

(D) Bigger pizzas are heated before smaller ones.

PEH141

60. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperatures 2*T* and 3*T* respectively. The temperature of the middle (i.e. second) plate under steady state condition is :

(A) $\left(\frac{65}{2}\right)^{1/4} T$ (B) $\left(\frac{97}{4}\right)^{1/4} T$ (C) $\left(\frac{97}{2}\right)^{1/4} T$ (D) $(97)^{1/4} T$

PEH144

61. If the temperature of the sun were to increase from *T* to 2*T* and its radius from *R* to 2*R*, then the ratio of the radiant energy received on earth to what it was previously, will be-

(A) 4 (B) 16 (C) 32 (D) 64

PEH146

62. Spheres P and Q are uniformly constructed from the same material which is a good conductor of heat and the radius of Q is thrice the radius of P. The rate of fall of temperature of P is x times that of Q when both are at the same surface temperature. The value of x is :

(A) 1/4 (B) 1/3 (C) 3 (D) 4

PEH148

63. A black body calorimeter filled with hot water cools from $60°C$ to $50°C$ in 4 min and $40°C$ to $30°C$ in 8 min. The approximate temperature of surrounding is :

(A) $10°C$ (B) $15°C$ (C) $20°C$ (D) $25°C$

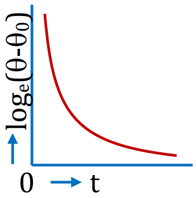
PEH149

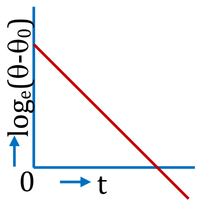
64. A system S receives heat continuously from an electrical heater of power $10W$. The temperature of S becomes constant at $50°C$ when the surrounding temperature is $20°C$. After the heater is switched off, S cools from $35.1°C$ to $34.9°C$ in 1 minute. The heat capacity of S is

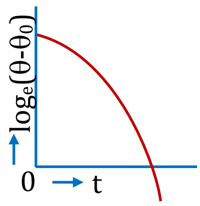
(A) $100J/°C$ (B) $300J/°C$ (C) $750J/°C$ (D) $1500J/°C$

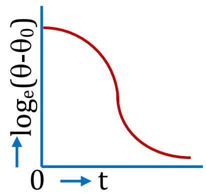
PEH150

65. A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is :

(A) 

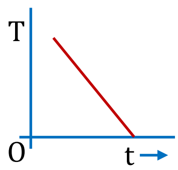
(B) 

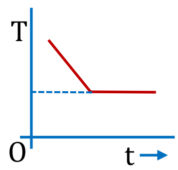
(C) 

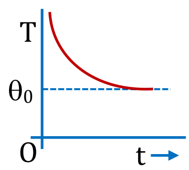
(D) 

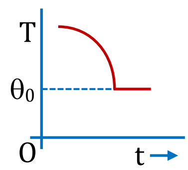
PEH155

66. If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0 the graph between the temperature T of the metal and time t will be closed to:

(A) 

(B) 

(C) 

(D) 

PEH156

67. According to Wien's displacement law the wavelength of peak emission from a body is inversely proportional to the temperature of the body in kelvin. Two stars A and B with surface temperatures 3000 kelvin and 6000 kelvin respectively, are at the same distance from the Earth. They are of equal radius. The correct statement about the radiations emitted by the two stars is

(A) Both A and B will look equally bright in visible.

(B) A will look brighter than B in infrared.

(C) B will look brighter than A in infrared.

(D) A will emit more in the visible range than B in the infrared.

PEH164

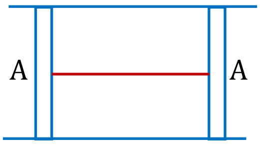
KTG

68. At a temperature T K, the pressure of 4.0g argon in a bulb is p. The bulb is put in a bath having temperature higher by 50K than the first one. 0.8g of argon gas had to be removed to maintained original pressure. The temperature T is equal to

(A) 510 K (B) 200 K (C) 100 K (D) 73 K

PKT044

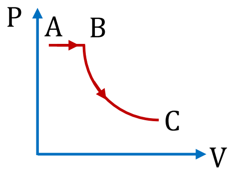
69. A cylindrical tube of cross-sectional area A has two air tight frictionless pistons at its two ends. The pistons are tied with a straight piece of metallic wire. The tube contains a gas at atmospheric pressure P_0 and temperature T_0. If temperature of the gas is doubled then the tension in the wire is

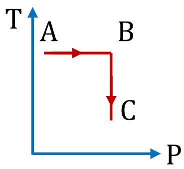


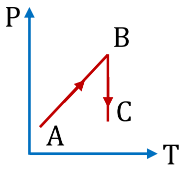
(A) 4 $P_0 A$ (B) $P_0A/2$ (C) $P_0 A$ (D) 2 $P_0 A$

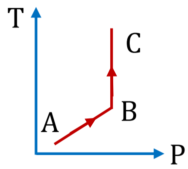
PKT047

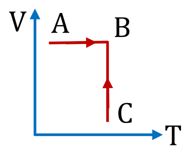
70. A process is shown in the diagram. Which of the following curves may represent the same process?



(A) 

(B) 

(C) 

(D) 

PKT048

71. An open and wide glass tube is immersed vertically in mercury in such a way that length 0.05 m extends above mercury level. The open end of the tube is closed and the tube is raised further by 0.43m. The length of air column above mercury level in the tube will be

(Take P_{atm} = 76 cm of mercury)

(A) 0.215 m (B) 0.2 m (C) 0.1 m (D) 0.4 m

PKT052

72. A barometer tube, containing mercury, is lowered in a vessel containing mercury until only 50 cm of the tube is above the level of mercury in the vessel. If the atmospheric pressure is 75 cm of mercury, what is the pressure at the top of the tube ?

(A) 33.3 kPa (B) 66.7 kPa (C) 3.33 MPa (D) 6.67 MPa

PKT053

73. The value of the ratio C_p/C_v for hydrogen is 1.67 at 30 K but decreases to 1.4 at 300 K as more degrees of freedom become active. During this rise in temperature (assume H_2 as ideal gas),

(A) C_p remains constant but C_v increases

(B) C_p decreases but C_v increases

(C) Both C_p and C_v decrease by the same amount

(D) Both C_p and C_v increase by the same amount

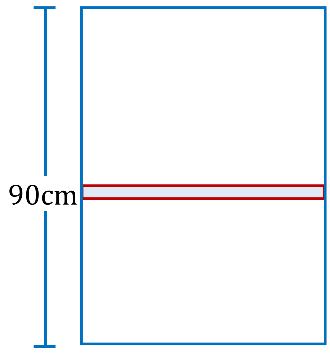
PKT056

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

(A) 450°*C* (B) 177°*C* (C) 40.5°*C* (D) 243 °*C*

PKT145

75. Figure shows a vertical cylindrical vessel separated in two parts by a frictionless piston free to move along the length of the vessel. The length of the cylinder is 90 *cm* and the piston divides the cylinder in the ratio of 5 : 4. Each of the two parts of the vessel contains 0.1 mole of an ideal gas. The temperature of the gas is 300 *K* in each part. Calculate the mass of the piston.



(A) 12.7 *kg* (B) 16.9 *kg* (C) 21 *kg* (D) 18.2 *kg*

PKT146

76. The root mean square velocity of molecules of gas is

(A) Proportional to square of temperature (T^2).

(B) Inversely proportional to square root of temperature $\sqrt{\frac{1}{T}}$.

(C) Proportional to square root of temperature $\sqrt{T}$.

(D) Proportional to temperature (T).

PKT168

77. The ratio of speed of sound in hydrogen gas to the speed of sound in oxygen gas at the same temperature is:

(A) 4 : 1 (B) 1 : 2 (C) 1 : 4 (D) 1 : 1

PKT169

First Law of Thermodynamics

78. Two monoatomic ideal gas at temperature T_1 and T_2 are mixed. There is no loss of energy. If the masses of molecules of the two gases are m_1 and m_2 and number of their molecules are n_1 and n_2 respectively. The temperature of the mixture will be:

(A) $\frac{T_1+T_2}{n_1+n_2}$ (B) $\frac{T_1}{n_1}+\frac{T_2}{n_2}$ (C) $\frac{n_2T_1+n_1T_2}{n_1+n_2}$ (D) $\frac{n_1T_1+n_2T_2}{n_1+n_2}$

PKT057

79. The value of $C_P - C_v$ is 1.09 R for a gas sample in state A and is 1.00 R in state B. Let T_A, T_B denote the temperature and P_A and P_B denote the pressure of the states A and B respectively. Then

(A) $P_A < P_B$ and $T_A > T_B$
(B) $P_A > P_B$ and $T_A > T_B$
(C) $P_A = P_B$ and $T_A < T_B$
(D) $P_A > P_B$ and $T_A < T_B$

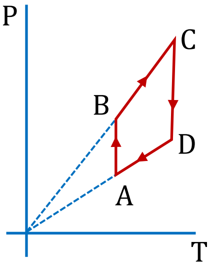
PKT063

80. An ideal gas expands isothermally from a volume V_1 to V_2 and then compressed to original volume V_1 adiabatically. Initial pressure is P_1 and final pressure is P_3. The total work done is W. Then

(A) $P_3 > P_1$, $W > 0$
(B) $P_3 < P_1$, $W < 0$
(C) $P_3 > P_1$, $W < 0$
(D) $P_3 = P_1$, $W = 0$

PKT067

81. Pressure versus temperature graph of an ideal gas is shown in figure



(A) During the process AB work done by the gas is positive
(B) During the process CD work done by the gas is negative
(C) During the process BC internal energy of the gas is increasing
(D) None

PKT069

82. The first law of thermodynamics can be written as $\Delta U = \Delta Q + \Delta W$ for an ideal gas. Which of the following statements is correct?

(A) ΔU is always zero when no heat enters or leaves the gas
(B) ΔW is the work done by the gas in this written law.
(C) ΔU is zero when heat is supplied and the temperature stays constant
(D) $\Delta Q = -\Delta W$ when the temperature increases very slowly.

PKT070

83. Water is heated in an open pan where the air pressure is 10^{+5} Pa. The water remains a liquid, which expands by a small amount as it is heated. Determine the ratio of the heat absorbed by the water to the work done by water. (g for water = $10^{-3}/C$, $S = 1$ cal/$gm°C$)

(A) 4.2×10^3
(B) 4.2×10^5
(C) 4.2×10^2
(D) 4.2×10^4

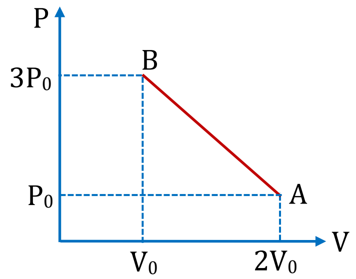
PKT071

84. A vertical cylinder with heat-conducting walls is closed at the bottom and is fitted with a smooth light piston. It contains one mole of an ideal gas. The temperature of the gas is always equal to the surrounding's temperature, T_0. The piston is moved up slowly to increase the volume of the gas to η times. Which of the following is incorrect?

(A) Work done by the gas is $RT_0 \ln \eta$.
(B) Work done against the atmosphere is $RT_0(\eta - 1)$.
(C) There is no change in the internal energy of the gas.
(D) The final pressure of the gas is $\frac{1}{(\eta - 1)}$ times its initial pressure.

PKT073

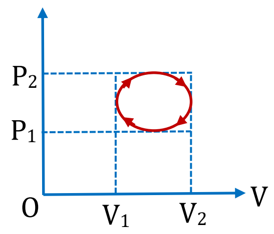
85. A thermodynamic process is to be operated from A to B, as shown in the graph below. Find the work done in the process :-



(A) P_0V_0 (B) $2P_0V_0$ (C) $-2P_0V_0$ (D) $-P_0V_0$

PKT075

86. In a cyclic process shown on the $P - V$ diagram the magnitude of the work done is :



(A) $\pi\left(\frac{P_2 - P_1}{2}\right)^2$ (B) $\pi\left(\frac{V_2 - V_1}{2}\right)^2$

(C) $\frac{\pi}{4}(P_2 - P_1)(V_2 - V_1)$ (D) $\pi(P_2V_2 - P_1V_1)$

PKT077

87. A polyatomic gas with six degrees of freedom does $25J$ of work when it is expanded at constant pressure. The heat given to the gas is :-

(A) $100J$ (B) $150J$ (C) $200J$ (D) $250J$

PKT080

88. 2 moles of a monoatomic gas are expanded to double its initial volume, through a process P/V = constant. If its initial temperature is 300 K, then which of the following is not true.

(A) $\Delta T = 900\ K$ (B) $\Delta Q = 3200\ R$ (C) $\Delta Q = 3600\ R$ (D) $W = 900\ R$

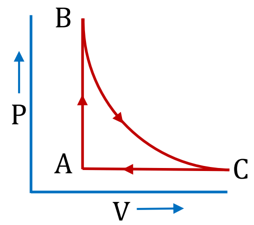
PKT081

89. One mole of an ideal gas at temperature T_1 expends according to the law $\frac{P}{V^2} = a$ (constant). The work done by the gas till temperature of gas becomes T_2 is :

(A) $\frac{1}{2}R(T_2 - T_1)$ (B) $\frac{1}{3}R(T_2 - T_1)$ (C) $\frac{1}{4}R(T_2 - T_1)$ (D) $\frac{1}{5}R(T_2 - T_1)$

PKT082

90. One mole of monoatomic ideal gas undergoes a cyclic process $ABCA$ as shown in figure. Process BC is adiabatic. The temperatures at A, B and C are 300, 600 and 450K respectively. Choose the correct statement(s).



(A) In process CA change in internal energy is $225R$.

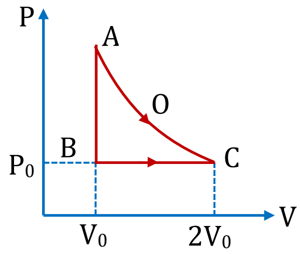
(B) In process AB change in internal energy is $-150R$.

(C) In process BC change in internal energy is $-225R$.

(D) Change in internal energy during the whole cyclic process is $+150R$.

PKT083

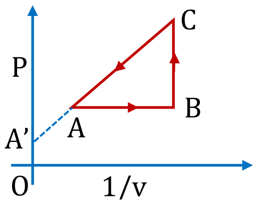
91. An ideal gas is taken from point A to point C on P-V diagram through two process AOC and ABC as shown in the figure. Process AOC is isothermal



(A) Process AOC requires more heat than process ABC.
(B) Process ABC requires more heat than process AOC.
(C) Both process AOC and ABC require same amount of heat.
(D) Data is insufficient for comparison of heat requirement for the two processes.

PKT084

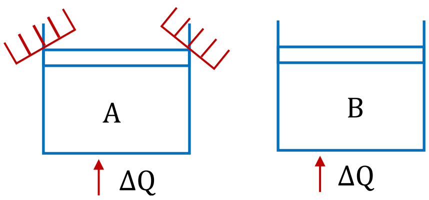
92. An enclosed ideal gas is taken through a cycle as shown in the figure. Then



(A) Along AB, temperature decreases while along BC temperature increases.
(B) Along AB, temperature increases while along BC the temperature decreases.
(C) Along CA work is done by the gas and the internal energy remains constant.
(D) Along CA work is done on the gas and internal energy of the gas increases.

PKT085

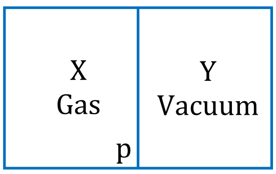
93. Two identical vessels A and B contain equal amount of ideal monoatomic gas. The piston of A is fixed but that of B is free. Same amount of heat is absorbed by A and B. If B's internal energy increases by 100 J the change in internal energy of A is :-



(A) 100 J (B) $\frac{500}{3}J$ (C) 250 J (D) none of these

PKT086

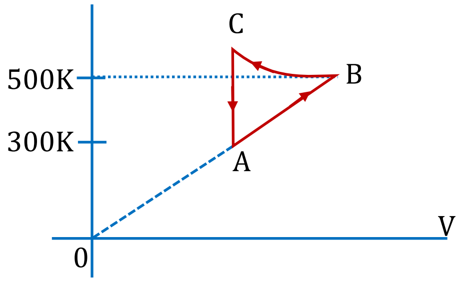
94. A closed container is fully insulated from outside. One half of it is filled with an ideal gas X separated by a plate P from the other half Y which contains a vacuum as shown in figure. When P is removed, X moves into Y. Which of the following statements is correct?



(A) No work is done by X
(B) X decreases in temperature
(C) X increases in internal energy
(D) X doubles in pressure

PKT110

95. Consider the cyclic process *ABCA*, shown in figure, performed on a sample of 2.0 mole of an ideal gas. A total of 1200 J of heat is withdrawn from the sample in the process. Find the work done by the gas during the part *BC*.



(A) –4480 J (B) –4520 J (C) –4540 J (D) –4460 J

PKT147

Second Law of Thermodynamics

96. A Carnot engine whose source temperature is at 400 K takes 100 $kcal$ of heat at this temperature in each cycle and gives 70 $kcal$ to the sink. Calculate,

(i) the temperature of the sink and

(ii) the efficiency of the engine.

(A) 280 K, 30 % (B) 270 K, 30% (C) 280 K, 10 % (D) None of these

PKT093

97. A Carnot engine takes 3×10^6 cal of heat from reservoir at 627° and gives it to a sink at 27°C. Then work done by the engine is :-

(A) 4.2×10^6 J (B) 8.4×10^6 J (C) 16.8×10^6 J (D) zero

PKT094

98. The coefficient of performance of a refrigerator working between 10° C and 20° C is :–

(A) 1 (B) 28.3 (C) 29.3 (D) 3.53

PKT097

99. A refrigerator freezes 5 kg of water at 0°C into ice at 0°C in a time interval of 20 minutes. Assume that room temperature is 20°C. Calculate the minimum power needed to accomplish it ?

(A) 24.4 Watt (B) 0.1025 Watt (C) 0.0244 Watt (D) 102.5 Watt

PKT098

100. An ideal refrigerator operates according to the reverse Carnot cycle and transmits heat from a cold source with water at a temperature of 0°C to a boiler with water at a temperature of 100°C. What amount of water must be frozen in the cooler to convert 1 kg of water into vapour in the boiler?

(A) 4.94 kg (B) 3.24 kg (C) 5.63 kg (D) 2.12 kg

PKT099

101. An inventor claims to have a heat engine that has an efficiency of 40% when it operates between a high temperature reservoir of 150°C and a low temperature reservoir of 30°C. This engine:

(A) Must violate the zeroth law of thermodynamics

(B) Must violate the first law of thermodynamics

(C) Must violate the second law of thermodynamics

(D) Must violate the third law of thermodynamics

PKT100

102. According to the second law of thermodynamics:
(A) Heat energy cannot be completely converted to work
(B) Work cannot be completely converted to heat energy
(C) For all cyclic processes we have $dQ/T < 0$
(D) The reason all heat engine efficiencies are less than 100% is friction, which is unavoidable

PKT101

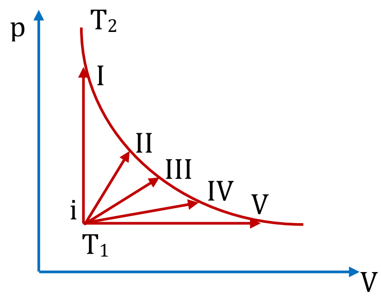
103. Oxygen (10 grammes) is heated from t_1 = 50°C to t_2 = 150°C. Find the change in entropy if the oxygen is heated: (1) isochorically, (2) isobarically.
(A) $\Delta S_V = 1.76\ J/K$; $\Delta S_P = 2.46\ J/K$
(B) $\Delta S_V = \Delta S_P = 1.76\ J/K$
(C) $\Delta S_V = \Delta S_P = 2.46\ J/K$
(D) $\Delta S_V = 2.46\ J/K$; $\Delta S_P = 1.76\ J/K$

PKT107

104. An ideal gas expands into a vacuum in a rigid vessel. As a result there is :
(A) a change in entropy
(B) an increase of pressure
(C) a change in temperature
(D) a decrease of internal energy

PKT108

105. An ideal gas is taken reversibly from state i, at temperature T_1, to any of the other states labelled, I, II, III, IV and V on the p-V diagram below. All are at the same temperature T_2. Rank the five processes according to the change in entropy of the gas, least to greatest :
(A) I, II, III, IV, V
(B) V, IV, III, II, I
(C) I, then II, III, IV, and V tied
(D) I, II, III and IV tied, then V



PKT109

106. A metallic object cools from temperature T_1 to temperature T_2. The specific heat of object varies as $C = a + bT^2$ (where T is in kelvin). The change in specific entropy of the object during the cooling process is :
(A) $a\ln\left(\frac{T_2}{T_1}\right)+0.5b\left(T_2^2-T_1^2\right)$
(B) $a\ln\left(\frac{T_2}{T_1}\right)$
(C) $a\ln\left(T_1+T_2\right)+0.5b\left(T_2^2-T_1^2\right)$
(D) $a\ln\left[a+b\left(\frac{T_1+T_2}{2}\right)\right]$

PKT148

107. The change in entropy between the two adiabatic lines of a Carnot cycle is 1 $kcal/deg$. The temperature difference between the two isothermal lines is equal to 100°C. What amount of heat will be converted into work during this cycle?
(A) 420 kJ (B) 840 kJ (C) 210 kJ (D) 105 kJ

PKT149

108. Which one of the following pairs of equations describes an irreversible heat engine?
(A) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} < 0$
(B) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} < 0$
(C) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} > 0$
(D) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} > 0$

PKT150

MULTIPLE CORRECT TYPE QUESTIONS

Calorimetry

109. 50 gm ice at – 10°C is mixed with 20 gm steam at 100°C. When the mixture finally reaches its steady state inside a calorimeter of water equivalent 1.5 gm then :

[Assume calorimeter was initially at 0°C, Take latent heat of vaporization of water = 540 cal/gm, Latent heat of fusion of water = 80 cal/gm, specific heat capacity of water = 1 cal/gm°C, specific heat capacity of ice = 0.5 cal/gm°C]

(A) Mass of water remaining is : 67.4 gm (B) Mass of steam remaining is : 2.6 gm

(C) Mass of water remaining is : 67.87 gm (D) Mass of steam remaining is : 2.13 gm

PEH073

Thermal Expansion

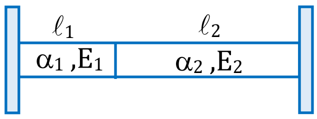
110. A bimetallic strip is formed out of two identical strips one of copper and the other of brass. The coefficient of linear expansion of the two metals are α_C and α_B. On heating, the temperature of the strip goes up by ΔT and the strip bends to form an arc of radius of curvature R. Then R is

(A) proportional at ΔT (B) inversely proportional to ΔT

(C) proportional to $|\alpha_B - \alpha_C|$ (D) inversely proportional to $|\alpha_B - \alpha_C|$

PEH113

111. Two rods of different materials are placed between massive walls as shown in figure. The cross section of the rods is A their moduli of elastically are E_1 and E_2 respectively. If rods are heated by T degrees, then (coefficients of linear expansion of material of rods are α_1 and α_2 respectively)



(A) the strain produced in both rods is equal.

(B) the stress produced in both the rods is equal.

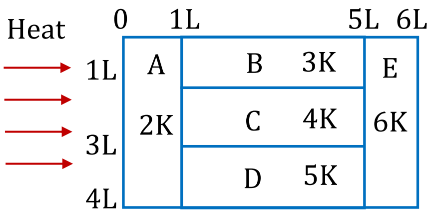
(C) the force exerted by one rod on the other is $\dfrac{\alpha_1\ell_1 + \alpha_2\ell_2}{\dfrac{\ell_1}{E_1} + \dfrac{\ell_2}{E_2}} AT$.

(D) the force exerted by one rod on the other is $\dfrac{(E_1 - E_2)^2 A}{E_1 + E_2}$.

PEH114

Heat Transfer (Conduction)

112. A composite block is made of slabs A, B, C, D and E of different thermal conductivities (given in terms of a constant K) and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat 'Q' flows only from left to right through the blocks. Then in steady state:



(A) heat flow through A and E slabs are same.

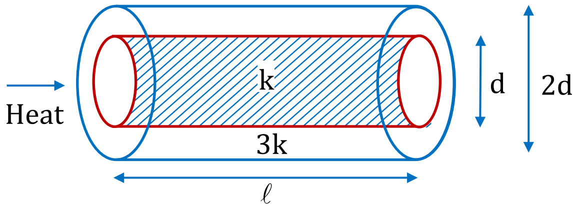
(B) heat flow through slab E is maximum.

(C) temperature difference across slab E is smallest.

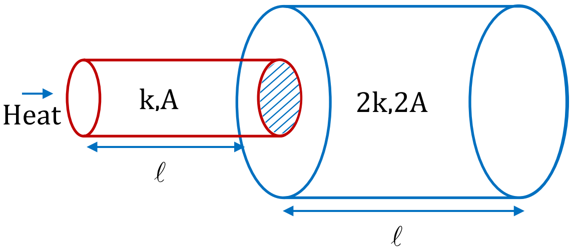
(D) heat flow through C = heat flow through B + Heat flow through D.

PEH131

113. Different combination of cylinder are shown in the figure. Select the correct alternatives for the thermal resistance of the following combinations :



A thin cylinder of diameter 'd' is surrounded by another cylinder.



A : Area of cross-section
k : Thermal conductivity
ℓ : Length of cylinder
d : diameter of cylinder

(A) Thermal resistance of '1' combination is $\dfrac{2\ell}{5k\pi d^2}$

(B) Thermal resistance of '2' combination is $\dfrac{4\ell}{5kA}$

(C) Thermal resistance of '1' combination is $\dfrac{5\ell}{2k\pi d^2}$

(D) Thermal resistance of '2' combination is $\dfrac{5\ell}{4kA}$

PEH132

Heat Transfer (Radiation)

114. A metal cylinder of mass 0.5 kg is heated electrically by a 12 W heater in a room at 15°C. The cylinder temperature rises to 25°C in 5 min and finally becomes constant at 45°C. Assuming that the rate of heat loss is proportional to the excess temperature over the surroundings

(A) The rate of loss of heat of the cylinder to surrounding at 20°C is 2 W

(B) The rate of loss of heat of the cylinder to surrounding at 45°C is 2 W

(C) Specific heat capacity of metal is $\dfrac{240}{\ln(3/2)} J/kg°C$

(D) None of these

PEH165

KTG

115. Let v_{av}, v_{rms} and v_p respectively denote mean speed, root mean square speed and the most probable speed of the molecule in an ideal monoatomic gas at absolute temperature T. The mass of a molecule is m then :

(A) no molecule can have speed greater than v_{rms}

(B) no molecule can have speed less than $v_p/\sqrt{2}$

(C) $v_p < v_{av} < v_{rms}$

(D) the average kinetic energy of a molecule is $3/4\ m v_p^2$

PKT049

116. In a mixture of nitrogen and helium kept at room temperature. As compared to a helium molecule nitrogen molecule hits the wall

(A) With greater average speed
(B) with smaller average speed
(C) with greater average kinetic energy
(D) with smaller average kinetic energy.

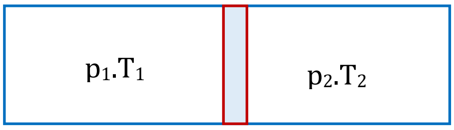
PKT050

117. A gas expands such that its initial and final temperature are equal. Also, the process followed by the gas traces a straight line on the *P-V* diagram :

(A) The temperature of the gas remains constant throughout.
(B) The temperature of the gas first increases and then decreases
(C) The temperature of the gas first decreases and then increases
(D) The straight line has a negative slope.

PKT051

118. Figure shows an adiabatic cylindrical tube of volume V_0 divided in two parts by a frictionless adiabatic separator. Initially, the separator is kept in the middle, an ideal gas at pressure p_1 and temperature T_1 is injected into the left part and another ideal gas at pressure p_2 and temperature T_2 is injected into the right part. $\frac{C_p}{C_v} = \gamma$ is the same for both the gases. The separator is slid slowly and is released at a position where it can stay in equilibrium. Find



(A) The volumes of the two parts are $\frac{p_1^{1/\gamma}V_0}{p_1^{1/\gamma}+p_2^{1/\gamma}}$ and $\frac{p_2^{1/\gamma}V_0}{p_1^{1/\gamma}+p_2^{1/\gamma}}$ respectively.

(B) The volumes of the two parts are $\frac{p_2^{1/\gamma}V_0}{p_1^{1/\gamma}+p_2^{1/\gamma}}$ and $\frac{p_1^{1/\gamma}V_0}{p_1^{1/\gamma}+p_2^{1/\gamma}}$ respectively.

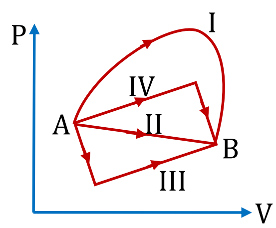
(C) The heat given to the gas in the left part is zero.

(D) The final common pressure of the gases is $\left(\frac{p_1^{1/\gamma}+p_2^{1/\gamma}}{2}\right)^{\gamma}$.

PKT151

First Law of Thermodynamics

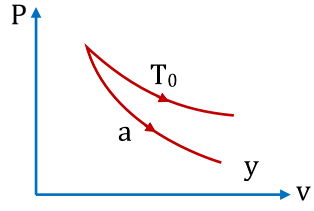
119. Figure shows the *P-V* diagram of an ideal gas undergoing a change of state from *A* to *B*. Four different parts I, II, III and IV as shown in the figure may lead to the same change of state.



(A) Change in internal energy is same in IV and III cases, but not in I and II.
(B) Change in internal energy is same in all the four cases.
(C) Work done is maximum in case I
(D) Work done is minimum in case II.

PKT076

120. Two gases have the same initial pressure, volume and temperature. They expand to the same final volume, one adiabatically and the other isothermally:



(A) The final temperature is greater for the isothermal process

(B) The final pressure is greater for the isothermal process

(C) The work done by the gas is greater for the isothermal process

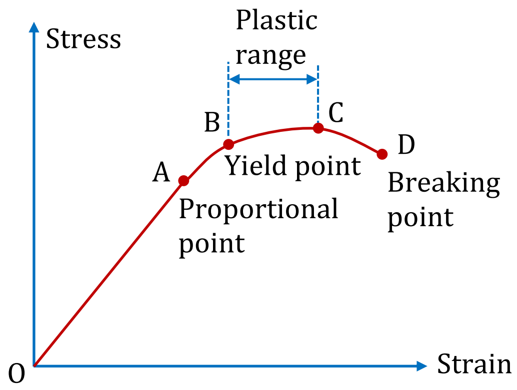
(D) All the above options are incorrect

PKT090

COMPREHENSION TYPE QUESTIONS

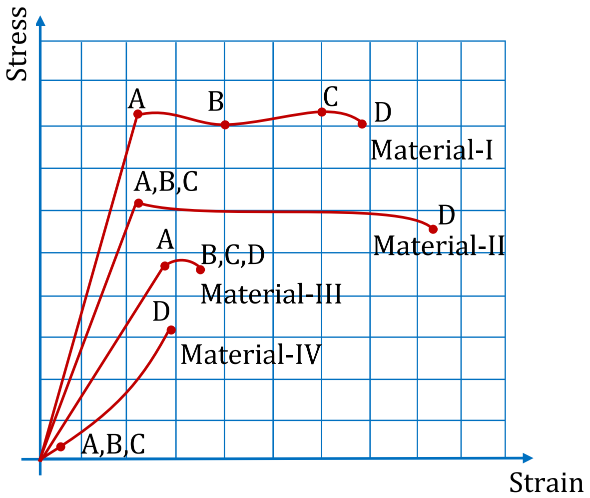
PARAGRAPH FOR QUESTION NO. 121 TO 123

Figure shows the relationship between tensile stress and strain for a typical material. Below the proportional point A, stress is directly proportional to strain which means Young's modulus (Y) is a constant. In this region the material obeys Hooke's law.



Provided the strain is below the yield point 'B' the material returns to its original shape and size when the force is removed. Beyond the yield point, the material retains a permanent deformation after the stress is removed. For stresses beyond the yield point, the material exhibit plastic flow, which means that it continues to elongate for little increases in the stress. Beyond C a local constriction occurs. The material fractures at D (i.e., breaking point).

The graph below shows the stress- strain curve for 4 different materials.



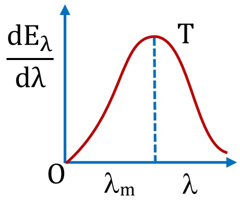
121. Material which is good for making wires by stretching is
(A) Material-I (B) Material-II (C) Material-III (D) Material-IV
PEH093

122. Material which is most brittle is
(A) Material-I (B) Material-II (C) Material-III (D) Material-IV
PEH094

123. If you bought a new shoe which bites in the beginning and later on fits perfectly, then the material used to making the shoe is
(A) Material-I (B) Material-II (C) Material-III (D) Material-IV
PEH095

PARAGRAPH FOR QUESTION NO. 124 AND 125

The figure shows a radiant energy spectrum graph for a black body at a temperature *T*.

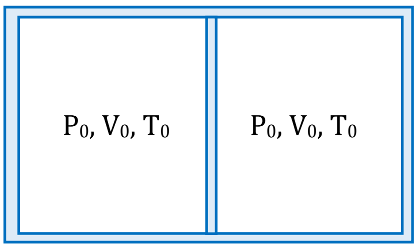


124. Choose the **CORRECT** statement(s)
(A) The radiant energy is not equally distributed among all the possible wavelengths
(B) For a particular wavelength the spectral intensity is maximum
(C) The area under the curve is equal to the total rate at which heat is radiated by the body at that temperature
(D) None of these
PEH151

125. If the temperature of the body is raised to a higher temperature T', then choose the **CORRECT** statement(s)
(A) The intensity of radiation for every wavelength increases
(B) The maximum intensity occurs at a shorter wavelength
(C) The area under the graph increases
(D) The area under the graph is proportional to the fourth power of temperature
PEH152

PARAGRAPH FOR QUESTION NO. 126 TO 128

One mole of a monoatomic ideal gas occupies two chambers of a cylinder partitioned by means of a movable piston. The walls of the cylinder as well as the piston are thermal insulators. Initially equal amounts of gas fill both the chambers at (P_0, V_0, T_0). A coil is burnt in the left chamber which absorbs heat and expands, pushing the piston to the right. The gas on the right chamber is compressed until the pressure becomes 32 P_0.



126. The final volume of left chamber is :

(A) $\frac{V_0}{8}$ (B) $\frac{15}{8}V_0$ (C) $\frac{7}{8}V_0$ (D) $\frac{9}{8}V_0$

PKT102

127. The work done on the gas in the right chamber is :

(A) $\frac{9}{2}P_0V_0$ (B) $-\frac{9}{2}P_0V_0$ (C) $\frac{13}{2}P_0V_0$ (D) $\frac{17}{2}P_0V_0$

PKT103

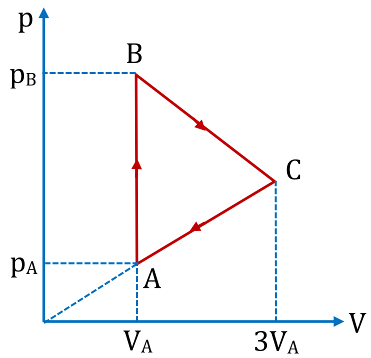
128. The change in internal energy of the gas in the left chamber is :

(A) $\frac{186}{4}RT_0$ (B) $\frac{177}{4}RT_0$ (C) $\frac{59}{2}RT_0$ (D) $\frac{131}{4}RT_0$

PKT104

PARAGRAPH FOR QUESTION NO. 129 AND 130

A sample of ideal gas is taken through the cyclic process shown in the figure. The temperature of the gas at state A is $T_A = 200\ K$. At states B and C the temperature of the gas is the same.

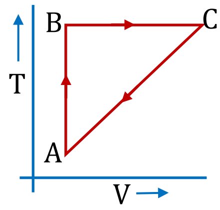


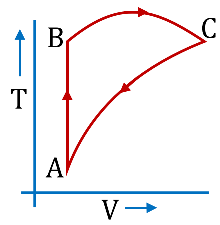
129. Net work done by the gas in the process is

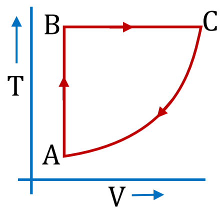
(A) 2 P_AV_A (B) 4 P_AV_A (C) 6 P_AV_A (D) 8 P_AV_A

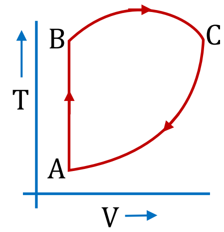
PKT105

130. Which of the following graphs best represent the cyclic process in T-V diagram.

(A)


(B)


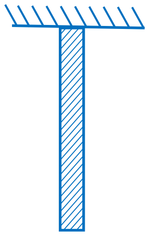
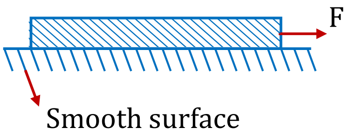
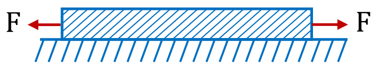
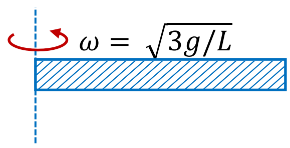
(C)


(D)


PKT106

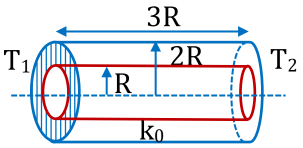
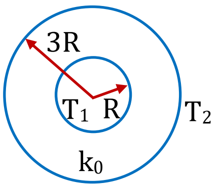
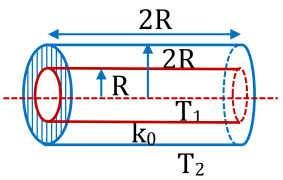
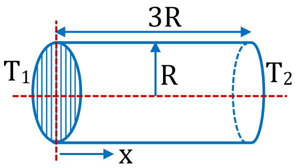
MATRIX MATCH TYPE QUESTION

131. In Column-I different configuration of uniform rod of mass m, length 'L', cross-sectional area 'A' and Young's modulus of elasticity 'Y' are as shown. Match the column-I with column–II.

Column–I	**Column–II**
(A)  A rod is hanging vertically with fixed support	(P) Total elongation in the rod is $\frac{mgL}{2AY}$
(B)  A constant force $F = mg$ is applied at one end of the rod.	(Q) Total elongation in the rod is $\frac{mgL}{AY}$
(C)  Equal and opposite forces ($F = mg$) are applied at both end of the rod	(R) Uniform stresses developed in the rod.
(D)  A rod is rotating with constant angular velocity about end point in gravity free space.	(S) Non-uniform stress developed in the rod.
	(T) Elastic potential energy stored in the rod is $\frac{m^2g^2L}{6AY}$

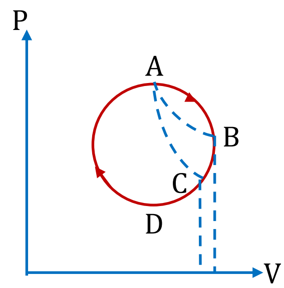
PEH096

132. Entries in column-I consists of diagrams of thermal conductors. The type of conductor and direction of heat flows are listed below. Entries in column-II consists of the magnitude of rate of heat flow belonging to any of the entries in column-I. If temperature difference in all the cases is $(T_1 - T_2)$, then match column.

Column-I		**Column-II**	
(A)		(P)	$6\pi k_0 R(T_1 - T_2)$
(B)	 Thick spherical shell, radial flow	(Q)	$\dfrac{\pi k_0 R}{3\ln 2}(T_1 - T_2)$
(C)	 Thick cylindrical shell, radial flow	(R)	$\pi k_0 R(T_1 - T_2)$
(D)	 Thick cylindrical shell, radial flow	(S)	$\dfrac{4\pi k_0 R}{\ln 2}(T_1 - T_2)$

PEH135

133. For an ideal gas a process *PV* diagram is a circle. An adiabatic from *A* passes through *C*. An isotherm from *A* passes through *B*. We take a part of the circular cyclic process. Comment on the sign of the quantity of column-I.



Column-I		**Column-II**
(A) Heat given to the gas in going from *A* to *C* along circle	(P)	Positive
(B) Heat given to the gas in going from *B* to *C* along circle	(Q)	Negative
(C) Heat given to the gas in going from *C* to *D* along circle	(R)	Zero
	(S)	can't be said

PKT152

134. List–I describes thermodynamic processes in four different systems. List–II gives the magnitudes (either exactly or as a close approximation) of possible changes in the internal energy of the system due to the process.

List-I		**List-II**	
(I)	10^{-3} *kg* of water at 100°*C* is converted to steam at the same temperature, at a pressure of 10^5 *Pa*. The volume of the system changes from 0^{-6} m^3 to 10^{-3} m^3 in the process. Latent heat of water = 2250 *kJ*/*kg*.	(P)	2 *kJ*
(II)	0.2 moles of a rigid diatomic ideal gas with volume *V* at temperature 500 *K* undergoes an isobaric expansion to volume 3 *V*. Assume $R = 8.0$ *J* mol^{-1}*K*$^{-1}$.	(Q)	7 *kJ*
(III)	On mole of a monatomic ideal gas is compressed adiabatically from volume and pressure 2 *kPa* to volume.	(R)	4 *kJ*
(IV)	Three moles of a diatomic ideal gas whose molecules can vibrate, is given 9 *kJ* of heat and undergoes isobaric expansion.	(S)	5 *kJ*
		(T)	3 *kJ*

PKT153

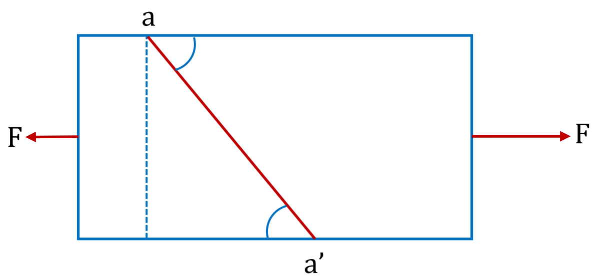
EXERCISE - S

Elasticity

1. 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 the same material of length $2L$ and radius $2r$, is pulled by a force $2f$. Find the increase in length of this wire.

PEH077

2. Consider a long steel bar under a tensile stress due to forces $\vec{F}$ acting at the edges along the length of the bar (Fig.). Consider a plane making an angle θ with the length. What are the tensile and shearing stresses on this plane?

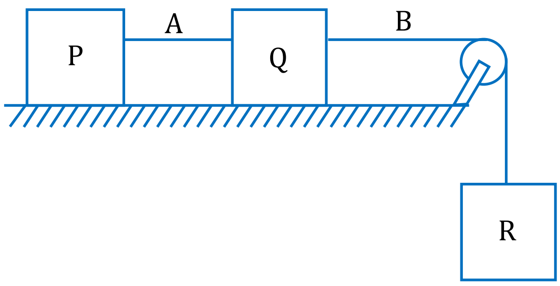


(a) For what angle is the tensile stress a maximum?

(b) For what angle is the shearing stress a maximum?

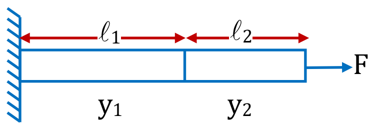
PEH079

3. Each of the three blocks P, Q and R shown in figure has a mass of 3 kg. Each of the wires A and B has cross-sectional area 0.005 cm^2 and Young's modulus 2×10^{11} N/m^2. Neglect friction. Find the longitudinal strain developed in each of the wires. Take g = 10 m/s^2.



PEH166

4. Find the



(i) Net elongation of composite rod approximately. ($x \times 10^{-11}m$) then x =

(ii) Y_{eq} of the composite rod ($x \times 10^{11}N/m^2$)

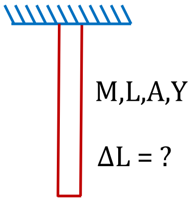
(Assume A = area of cross section of each rod), then x =

$\ell_1 = \ell_2 = 1m$, $F = 2N/m^2$, $A = 1sq.m^2$

$y_1 = 2 \times 10^{11}$ N/m^2, $y_2 = 3 \times 10^{11}$ N/m^2

PEH167

5. Let a rope of mass M and length L and young's modulus of elasticity Y and cross-sectional area A is hung vertically. Calculate the increase in length.



PEH168

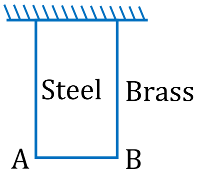
6. A light rigid bar AB is suspended horizontally from two vertical wires, one of steel and one of brass, as shown in figure. Each wire is 2.00 m long. The diameter of the steel wire is 0.60 mm and the length of the bar AB is 0.20 m. When a mass of 10 kg is suspended from the centre of AB bar remains horizontal.

(i) What is the tension in each wire?

(ii) Calculate the extension of the steel wire and the energy stored in it.

(iii) Calculate the diameter of the brass wire.

(iv) If the brass wire were replaced by another brass wire of diameter 1 mm, where should the mass be suspended so that AB would remain horizontal? The Young modulus for steel = 2.0×10^{11} Pa, the Young modulus for brass = 1.0×10^{11} Pa.



PEH086

Calorimetry

7. An aluminium container of mass 100 gm contains 200 gm of ice at – 20°C. Heat is added to the system at the rate of 100 cal/s. Find the temperature of the system after 4 minutes.

(Specific heat of ice = 0.5 and L = 80 cal/gm, specific heat of Al = 0.2 cal/gm-°C)

PEH075

8. A copper calorimeter of mass 100 gm contains 200 gm of a mixture of ice and water. Steam at 100°C under normal pressure is passed into the calorimeter and the temperature of the mixture is allowed to rise to 50°C. If the mass of the calorimeter and its contents is now 330 gm, what was the ratio of ice and water in the beginning? Neglect heat losses.

Given : Specific heat capacity of copper = 0.42×10^3 $J\ kg^{-1}K^{-1}$,

Specific heat capacity of water = 4.2×10^3 $J\ kg^{-1}K^{-1}$,

Specific heat of fusion of ice = 3.36×10^5 $J\ kg^{-1}$

Latent heat of condensation of steam = 22.5×10^5 Jkg^{-1}

PEH169

Thermal Expansion

9. If two rods of length L and 2 L having coefficients of linear expansion α and 2α respectively are connected so that total length becomes 3 L, determine the average coefficient of linear expansion of the composite rod.

PEH099

10. A clock pendulum made of invar has a period of 0.5 sec at 20°C. If the clock is used in a climate where average temperature is 30°C, approximately. How much fast or slow will the clock run in 10^6 sec. ($\alpha_{invar} = 1 \times 10^{-6}/°C$)

PEH103

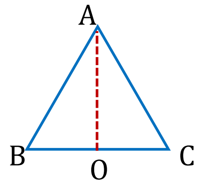
11. An iron bar (Young's modulus = $10^{11}\ N/m^2$, $\alpha = 10^{-6}/°C$) 1 m long and $10^{-3}\ m^2$ in area is heated from $0°C$ to $100°C$ without being allowed to bend or expand. Find the compressive force developed inside the bar.

PEH111

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

PEH170

13. Three aluminium rods of equal length form an equilateral triangle ABC. Taking O (mid point of rod BC) as the origin. Find the increase in Y-coordinate of center of mass per unit change in temperature of the system. Assume the length of the each rod is $2m$, and $\alpha_{al} = 4\sqrt{3}\times10^{-6}\ /°C$



PEH171

14. A metal rod A of $25cm$ lengths expands by 0.050 cm, when its temperature is raised from $0°C$ to $100°C$. Another rod B of a different metal of length $40cm$ expands by 0.040 cm for the same rise in temperature. A third rod C of $50cm$ length is made up of pieces of rods A and B placed end to end expands by $0.03cm$ on heating from $0°C$ to $50°C$. Find the lengths of each portion of the composite rod.

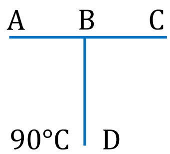
PEH172

15. Two rods made of different materials are placed between massive walls. The cross section of the rods are A_1 and A_2, their lengths L_1 and L_2 coefficients of linear expansion α_1 and α_2 and the moduli of elasticity of their materials Y_1 and Y_2 respectively. If the rods are heated by $t°C$, find the force F with which the rods act on each other.

PEH174

Heat Transfer (Conduction)

16. Three conducting rods of same material and cross-section are shown in figure. Temperature of A, D and C are maintained at $20°C$, $90°C$ and $0°C$. Find the ratio of length BD and BC if there is no heat flow in AB.



PEH122

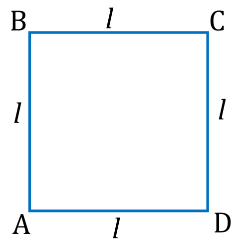
17. A lagged stick of cross section area 1 cm^2 and length 1 m is initially at a temperature of $0°C$. It is then kept between 2 reservoirs of temperature $100°C$ and $0°C$. Specific heat capacity is 10 $J/kg°C$ and linear mass density is 2 kg/m. Find:

(a) temperature gradient along the rod in steady state.

(b) total heat absorbed by the rod to reach steady state.

PEH123

18. In the square frame of side l of metallic rods, the corners A and C are maintained at T_1 and T_2 respectively. The rate of heat flow from A to C is ω. If A and D are instead maintained T_1 and T_2 respectively. Find the total rate of heat flow.



PEH126

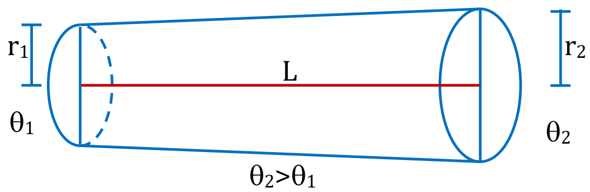
19. A metal rod AB of length $10x$ has its one end A in ice at $0°C$ and the other end B in water at $100°C$. If a point P on the rod is maintained at $400°C$, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ. [Neglect any heat loss to the surrounding]

PEH130

20. One end of copper rod of uniform cross-section and of length 1.5 meters is in contact with melting ice and the other end with boiling water. At what point along its length should a temperature of $200°C$ be maintained, so that in steady state, the mass of ice melting is equal to that of steam produced in the same interval of time? Assume that the whole system is insulated from the surroundings.

PEH133

21. Find the rate of heat flow through a cross section of the rod shown in figure($\theta_2 > \theta_1$). Thermal conductivity of the material of the rod is K



PEH175

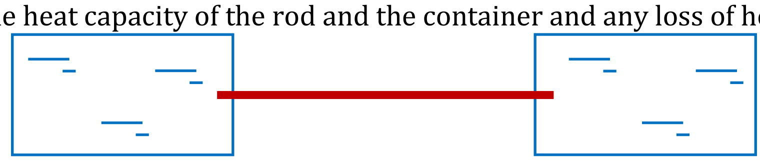
22. A rod of negligible heat capacity has length 20 cm, area of cross section 1.0 cm^2 and thermal conductivity 200 $W\,m^{-1}\,°C^{-1}$. The temperature of one end is maintained at $0°C$ and that of the other end is slowly and linearly varied from $0°C$ to $60°C$ in 10 minutes. Assuming no loss of heat through the sides, find the total heat transmitted through the rod in these 10 minutes.

PEH176

23. Two bodies of masses m_1 and m_2 and specific heat capacities s_1 and s_2 are connected by a rod of length l, cross-sectional area A, thermal conductivity K and negligible heat capacity. The whole system is thermally insulated. At time $t = 0$, the temperature of the first body is T_1 and the temperature of the second body is T_2 ($T_2 > T_1$). Find the temperature difference between the two bodies at time t.

PEH177

24. Figure shows two adiabatic vessels, each containing a mass m of water at different temperatures. The ends of a metal rod of length L, area of cross section A and thermal conductivity K, are inserted in the water as shown in the figure. Find the time taken for the difference between the temperatures in the vessels to become half of the original value. The specific heat capacity of water is s. Neglect the heat capacity of the rod and the container and any loss of heat to the atmosphere.



PEH183

Heat Transfer (Radiation)

25. A hollow metallic sphere of radius 20 *cm* surrounds a concentric metallic sphere of radius 5 *cm*. The space between the two spheres is filled with a non-metallic material. The inner and outer spheres are maintained at 50°*C* and 10°*C* respectively and it is found that 100 *J* of heat passes from the inner sphere to the outer sphere per second. Find the thermal conductivity of the material between the spheres.

PEH173

26. A cylindrical block of length 0.4 *m* an area of cross-section $0.04 m^2$ is placed coaxially on a thin metal disc of mass 0.4 *kg* and of the same cross-section. The upper face of the cylinder is maintained at a constant temperature of 400*K* and the initial temperature of the disc is 300*K*. If the thermal conductivity of the material of the cylinder is 10 watt/*m*-*K* and the specific heat of the material of the disc is 600 *J*/*kg*-*K*, how long will it take for the temperature of the disc to increase to 350*K*? Assume, for purposes of calculation, the thermal conductivity of the disc to be very high and the system to be thermally insulated except for the upper face of the cylinder.

PEH142

27. Two spheres of same radius *R* have their densities in the ratio 8 : 1 and the ratio of their specific heats are 1 : 4. If by radiation their rates of fall of temperature are same, then find the ratio of their rates of losing heat.

PEH143

28. A solid copper cube and sphere, both of same mass and emissivity are heated to same initial temperature and kept under identical conditions. What is the ratio of their initial rate of fall of temperature?

PEH145

29. Two spherical bodies *A* (radius 6 *cm*) and *B* (radius 18 *cm*) are at temperatures T_1 and T_2, respectively. The maximum intensity in the emission spectrum of *A* is at 500 *nm* and in that of *B* is at 1500 *nm*. Considering then to be black bodies, what will be the ratio of the rate of total energy radiated by *A* to that of *B*?

PEH147

30. A solid receives heat by radiation over its surface at the rate of 4 *kW*. The heat convection rate from the surface of solid to the surrounding is 5.2 *kW*, and heat is generated at a rate of 1.7 *kW* over the volume of the solid. The rate of change of the average temperature of the solid is $0.5\ °C s^{-1}$. Find the heat capacity of the solid.

PEH153

31. The maximum in the energy distribution spectrum of the sun is at 4753 Å and its temperature is 6050*K*. What will be the temperature of the star whose energy distribution shows a maximum at 9506 Å.

PEH154

32. Assume that the total surface area of a human body is 1.6 m^2 and that it radiates like an ideal radiator. Calculate the amount of energy radiated per second by the body if the body temperature is 37°*C*. Stefan constant σ is $6.0 \times 10^{-8}\ W\,m^{-2}\,K^{-4}$.

PEH178

KTG

33. An insulated container containing monoatomic gas of molar mass m is moving with a velocity v_0. If the container is suddenly stopped, find the change in temperature.

PKT054

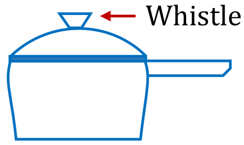
34. For a gas, $\gamma = 9/7$. What is the number of degrees of freedom of the molecules of this gas ?

PKT055

35. One mole of an ideal monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with one mole of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$. ($\gamma$ denotes the ratio of specific heat at constant pressure, to that at constant volume) find γ for the mixture ?

PKT062

36. An empty pressure cooker of volume 10 litres contains air at atmospheric pressure 10^5 Pa and temperature of $27°C$. It contains a whistle which has area of 0.1 cm^2 and weight of 100 g. What should be the temperature of air inside so that the whistle is just lifted up?



PKT058

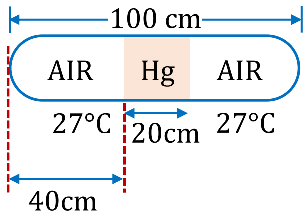
37. Find the molecular mass of a gas if the specific heats of the gas are C_P=0.2 $cal/gm°C$ and C_V = 0.15 $cal/gm°C$. [Take R = 2 cal/mole°C]

PKT059

38. 16 g of oxygen at 37°C is mixed with 14 g of nitrogen at 27°C. Find the temperature of the mixture?

PKT060

39. In the given figure a glass tube lies horizontally with the middle 20 cm containing mercury. The two ends of the tube contains air at 27°C and at a pressure 76 cm of mercury. Now the air column on one side is maintained at 0°C and the other side is maintained at 127°C. Find the new length of the air column on the cooler side. Neglect the changes in the volume of mercury and of the glass.



PKT061

40. Two vessels A and B, thermally insulated, contain an ideal monoatomic gas. A small tube fitted with a valve connects these vessels. Initially the vessel A has 2 liters of gas at 300 K and 2 × 10^5 $N\,m^{-2}$ pressure while vessel B has 4 liters of gas at 350 K and 4 × 10^5 Nm^{-2} pressure. The valve is now opened and the system reaches equilibrium in pressure and temperature. Calculate the new pressure and temperature. ($R = \frac{25}{3}$ J/mol-K)

PKT064

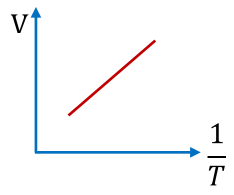
41. Find the maximum attainable temperature of an ideal gas in the following process : where (a) $p = p_0 - \alpha V^2$; (b) $p = p_0 e^{-\beta V}$, where p_0, α and β are positive constants and V is the volume of one mole of gas.

PKT065

42. An ideal gas of molar mass M is contained in a tall vertical cylindrical vessel whose base area is S and height h. The temperature of the gas is T, its pressure on the bottom base is p_0. Assuming the temperature and the free-fall acceleration g to be independent of the height, find the mass of gas in the vessel.

PKT154

47. One mole of an ideal monoatomic gas undergoes a process as shown in the figure. Find the molar specific heat of the gas in the process.

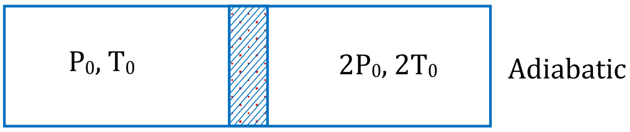


PKT087

48. Two containers A and B of equal volume V_0 / 2 each are connected by a narrow tube which can be closed by a valve. The containers are fitted with pistons which can be moved to change the volumes. Initially, the valve is open and the containers contain an ideal gas (C_p/C_v = γ) at atmospheric pressure P_0 and atmospheric temperature $2T_0$. The walls of the containers A are highly conducting and of B are non-conducting. The valve is now closed and the pistons are slowly pulled out to increase the volumes of the containers to double the original value. (a) Calculate the temperatures and pressures in the two containers. (b) The valve is now opened for sufficient time so that the gases acquire a common temperature and pressure. Find the new values of the temperature and the pressure.

PKT088

49. A cylindrical tube with adiabatic walls having volume $2V_0$ contains an ideal monoatomic gas as shown in figure. The tube is divided into two equal parts by a fixed super conducting wall. Initially, the pressure and the temperature are P_0, T_0 on the left and $2P_0$, $2T_0$ on the right. When system is left for sufficient amount of time the temperature on both sides becomes equal



(a) Find work done by the gas on the right part?

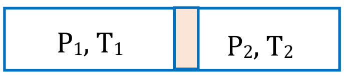
(b) Find the final pressures on the two sides.

(c) Find the final equilibrium temperature.

(d) How much heat has flown from the gas on the right to the gas on the left?

PKT113

50. In given figure, an adiabatic cylindrical tube of volume $2V_0$ is divided in two equal parts by a frictionless adiabatic separator. An ideal gas in left side of a tube having pressure P_1 and temperature T_1 where as in the right side having pressure P_2 and temperature T_2. C_p/C_v = γ is the same for both the gases. The separator is slid slowly and is released at a position where it can stay in equilibrium. Find ;



(a) the final volumes of the two parts,

(b) the heat given to the gas in the left part and

(c) the final common pressure of the gases.

PKT114

51. An amount n (in moles) of a monatomic gas at an initial temperature T_0 is enclosed in a cylindrical vessel fitted with a light piston. The surrounding air has a temperature $T_s(>T_0)$ and the atmospheric pressure is pa. Heat may be conducted between the surrounding and the gas through the bottom of the cylinder. The bottom has a surface area A, thickness x and thermal conductivity K. Assuming all changes to be slow, find the distance moved by the piston in time t.

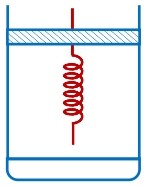
PKT158

52. Consider one mole of perfect gas in a cylinder of unit cross section with a piston attached (Fig.). A spring (spring constant k) is attached (unstretched length L) to the piston and to the bottom of the cylinder. Initially the spring is unstretched and the gas is in equilibrium. A certain amount of heat Q is supplied to the gas causing an increase of volume from V_0 to V_1.

(a) What is the initial pressure of the system?

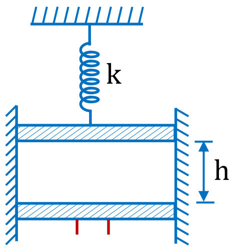
(b) What is the final pressure of the system?

(c) Using the first law of thermodynamics, write down a relation between Q, P_a, V, V_0 and k.



PKT111

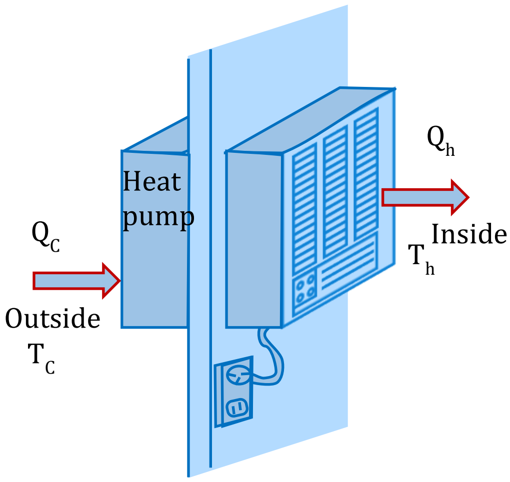
53. An ideal gas at NTP is enclosed in a adiabatic vertical cylinder having area of cross section $A = 27 cm^2$, between two light movable pistons as shown in the figure. Spring with force constant $k = 3700\ N/m$ is in a relaxed state initially. Now the lower piston is moved upwards a height $h/2$, h being the initial length of gas column. It is observed that the upper piston moves up by a distance $h/16$. Find h taking γ for the gas to be 1.5. Also find the final temperature of the gas.



PKT112

Second Law of Thermodynamics

54. A heat pump used for heating shown in figure is essentially an air conditioner installed backward. It extracts energy from colder air outside and deposits it in a warmer room. Suppose the ratio of the actual energy entering the room to the work done by the device's motor is 20.0% of the theoretical maximum ratio. Determine the energy entering the room per joule of work done by the motor, given that the inside temperature is 27.0°C and the outside temperature is –3°C.



PKT157

55. Two engines A and B have their sources at 400 K and 350 K and sinks at 350 K and 300 K respectively. Which engine is more efficient and by how much ?

PKT091

56. A Carnot engine working between 400 K and 800 K has a work output of 1200 J per cycle. What is the amount of heat energy supplied to the engine from source per cycle?

PKT092

57. The temperature insides and outside of refrigerator are 260 K and 315 K respectively. Assuming that the refrigerator cycle is reversible, calculate the heat delivered to surroundings for every joule of work done.

PKT095

58. A refrigerator takes heat from water at 0°C and transfer it to room at 27°C. If 100 kg of water is converted in ice at 0°C then calculate the work done. (Latent heat of ice is 3.4×10^5 J/kg)

PKT096

59. Find the entropy increment of one mole of carbon dioxide when its absolute temperature increases n = 2.0 times if the process of heating is : (C_v = 27 J/mol-K)

(a) isochoric ; (b) isobaric.

The gas is to be regarded as ideal.

PKT159

60. A piece of copper of mass m_1 = 300 g with initial temperature t_1 = 97°C is placed into a calorimeter in which the water of mass m_2 = 100 g is at a temperature t_2 = 7°C. Find the entropy increment of the system by the moment the temperaturese equalize. The heat capacity of the calorimeter itself is negligibly small. (s_{cu} = 0.39 J/g-K)

PKT160

61. A quantity of 0.20 mol of argon gas contained in a volume of 5.0 L mixes with 0.50 mol of neon gas contained in a volume of 5L, making a total volume of 10 L. Both gases are at the same temperature and can be regarded as ideal. Each volume is thermally isolated. What is the change in entropy ?

PKT161

EXERCISE - JEE (Main) PYQ

1. The pressure that has to be applied to the ends of a steel wire of length 10 cm to keep its length constant when its temperature is raised by 100°C is :

(For steel Young's modulus is 2×10^{11} Nm^{-2} and coefficient of thermal expansion is 1.1×10^{-5} K^{-1})

[JEE (Main) 2014]

(1) 2.2×10^7 Pa (2) 2.2×10^6 Pa (3) 2.2×10^8 Pa (4) 2.2×10^9 Pa

PEH019

2. Three rods of Copper, Brass and Steel are welded together to form a Y-shaped structure. Area of cross-section of each rod = 4 cm^2. End of copper rod is maintained at 100°C where as ends of brass and steel are kept at 0°C. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surroundings except at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is : **[JEE (Main) 2014]**

(1) 4.8 cal/s (2) 6.0 cal/s (3) 1.2 cal/s (4) 2.4 cal/s

PEH020

3. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \propto T^4$ and pressure $p = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is - **[JEE (Main) 2015]**

(1) $T \propto \frac{1}{R}$ (2) $T \propto \frac{1}{R^3}$ (3) $T \propto e^{-R}$ (4) $T \propto e^{-3R}$

PKT013

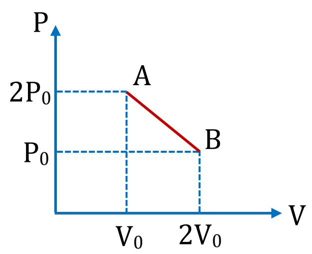
4. A pendulum clock loses 12s in a day if the temperature is 40°C and gains 4s in a day if the temperature is 20°C. The temperature at which the clock will show correct time, and the coefficient of linear expansion (α) of the metal of the pendulum shaft are respectively :- **[JEE (Main) 2016]**

(1) 55°C ; $\alpha = 1.85 \times 10^{-2}$ /°C (2) 25°C ; $\alpha = 1.85 \times 10^{-5}$ /°C

(3) 60°C ; $\alpha = 1.85 \times 10^{-4}$ /°C (4) 30°C ; $\alpha = 1.85 \times 10^{-3}$ /°C

PEH021

5. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be : **[JEE (Main) 2016]**



(1) $\frac{9P_0V_0}{nR}$ (2) $\frac{9P_0V_0}{4nR}$ (3) $\frac{3P_0V_0}{2nR}$ (4) $\frac{9P_0V_0}{2nR}$

PKT014

6. A copper ball of mass 100 *gm* is at a temperature *T*. It is dropped in a copper calorimeter of mass 100*gm*, filled with 170 *gm* of water at room temperature. Subsequently, the temperature of the system is found to be 75°*C*. *T* is given by :
(Given : room temperature = 30° *C*, specific heat of copper = 0.1 *cal/gm°C*) **[JEE (Main) 2017]**
(1) 1250°*C* (2) 825°*C* (3) 800°*C* (4) 885° *C*

PEH022

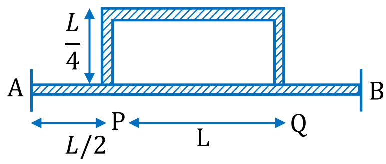
7. C_p and C_v are specific heats at constant pressure and constant volume respectively. It is observed that
$C_p - C_v = a$ for hydrogen gas
$C_p - C_v = b$ for nitrogen gas
The correct relation between *a* and *b* is : **[JEE (Main) 2017]**
(1) $a = 14\,b$ (2) $a = 28\,b$ (3) $a = \frac{1}{14}b$ (4) $a = b$

PKT015

8. Two moles of an ideal monoatomic gas occupies a volume *V* at 27°*C*. The gas expands adiabatically to a volume 2*V*. Calculate (a) the final temperature of the gas and (b) change in its internal energy. **[JEE (Main) 2018]**
(1) (a) 195 *K* (b) –2.7 *kJ* (2) (a) 189 *K* (b) –2.7 *kJ*
(3) (a) 195 *K* (b) 2.7 *kJ* (4) (a) 189 *K* (b) 2.7 *kJ*

PKT016

9. Temperature difference of 120°*C* is maintained between two ends of a uniform rod *AB* of length 2*L*. Another bent rod *PQ*, of same cross-section as *AB* and length, is connected across *AB* (See figure). In steady state, temperature difference between *P* and *Q* will be close to : **[JEE (Main) 2019]**



(1) 60°*C* (2) 75°*C* (3) 35°*C* (4) 45°*C*

PEH023

10. A thermometer graduated according to a linear scale reads a value x_0 when in contact with boiling water, and $x_0/3$ when in contact with ice. What is the temperature of an object in °*C*, if this thermometer in the contact with the object reads $x_0/2$? **[JEE (Main) 2019]**
(1) 35 (2) 25 (3) 60 (4) 40

PEH024

11. A cylinder of radius *R* is surrounded by a cylindrical shell of inner radius *R* and outer radius 2*R*. The thermal conductivity of the material of the inner cylinder is K_1 and that of the outer cylinder is K_2. Assuming no loss of heat, the effective thermal conductivity of the system for heat flowing along the length of the cylinder is: **[JEE (Main) 2019]**
(1) $K_1 + K_2$ (2) $\frac{K_1+K_2}{2}$ (3) $\frac{2K_1+3K_2}{5}$ (4) $\frac{K_1+3K_2}{4}$

PEH025

12. A bullet of mass 5*g*, travelling with a speed of 210 *m/s*, strikes a fixed wooden target. One half of its kinetic energy is converted into heat in the bullet while the other half is converted into heat in the wood. The rise of temperature of the bullet if the specific heat of its material is 0.030 *cal*/(*g*–°*C*) (1 *cal* = 4.2 × 10⁷ ergs) close to : **[JEE (Main) 2020]**
(1) 83.3°*C* (2) 87.5°*C* (3) 119.2°*C* (4) 38.4°*C*

PEH026

13. A bakelite beaker has volume capacity of 500 *cc* at 30°*C*. When it is partially filled with V_m volume (at 30°) of mercury, it is found that the unfilled volume of the beaker remains constant as temperature is varied. If $\gamma_{(beaker)} = 6 \times 10^{-6}\ °C^{-1}$ and $\gamma_{(mercury)} = 1.5 \times 10^{-4}\ °C^{-1}$, where γ is the coefficient of volume expansion, then V_m (in *cc*) is close to__________. **[JEE (Main) 2020]**

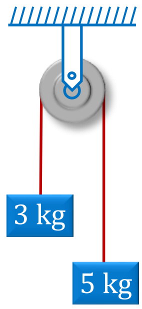
PEH027

14. Under an adiabatic process, the volume of an ideal gas gets doubled. Consequently the mean collision time between the gas molecule changes from τ_1 to τ_2. If $\frac{C_p}{C_v} = \gamma$ for this gas then a good estimate for $\frac{\tau_2}{\tau_1}$ is given by : **[JEE (Main) 2020]**

(1) $\left(\frac{1}{2}\right)^{\frac{\gamma+1}{2}}$ (2) 2 (3) $\frac{1}{2}$ (4) $\left(\frac{1}{2}\right)^{\gamma}$

PKT017

15. Two blocks of masses 3 *kg* and 5 *kg* are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\pi} \times 10^2\ Nm^{-2}$. What is the minimum radius of the wire?



(Take $g = 10\ ms^{-2}$) **[JEE (Main) 2021]**

(1) 125 *cm* (2) 1250 *cm*

(3) 12.5 *cm* (4) 1.25 *cm*

PEH028

16. In 5 minutes, a body cools from 75°*C* to 65°*C* at room temperature of 25°*C*. The temperature of body at the end of next 5 minutes is ______°*C*. **[JEE (Main) 2021]**

PEH029

17. The rms speeds of the molecules of Hydrogen, Oxygen and Carbon dioxide at the same temperature are V_H, V_O and V_C respectively then : **[JEE (Main) 2021]**

(1) $V_H > V_O > V_C$ (2) $V_C > V_O > V_H$ (3) $V_H = V_O > V_C$ (4) $V_H = V_O = V_C$

PKT018

18. The bulk modulus of a liquid is $3 \times 10^{10}\ Nm^{-2}$. The pressure required to reduce the volume of liquid by 2% is : **[JEE (Main) 2022]**

(1) $3 \times 10^8\ Nm^{-2}$ (2) $9 \times 10^8\ Nm^{-2}$ (3) $6 \times 10^8\ Nm^{-2}$ (4) $12 \times 10^8\ Nm^{-2}$

PEH030

19. A Carnot engine take 5000 *kcal* of heat from a reservoir at 727°*C* and gives heat to a sink at 127°*C*. The work done by the engine is : **[JEE (Main) 2022]**

(1) $3 \times 10^6\ J$ (2) Zero (3) $12.6 \times 10^6\ J$ (4) $8.4 \times 10^6\ J$

PKT019

20. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be _______R during this transformation. **[JEE (Main) 2022]**
Where R is the gas constant.

PKT020

21. A body cools in 7 minutes from 60°C to 40°C. The temperature of the surrounding is 10°C. The temperature of the body after the next 7 minutes will be: **[JEE (Main) 2023]**

(1) 32°C (2) 30°C (3) 28°C (4) 34°C

PEH172

22. The elastic potential energy stored in a steel wire of length 20 *m* stretched through 2 *cm* is 80 *J*. The cross sectional area of the wire is________ mm^2.

(Given, $y = 2.0 \times 10^{11}\, Nm^{-2}$) **[JEE (Main) 2023]**

PEH173

23. A source supplies heat to a system at the rate of 1000 *W*. If the system performs work at a rate of 200 *W*. The rate at which internal energy of the system increases: **[JEE (Main) 2023]**

(1) 1200 *W* (2) 600 *W* (3) 500 *W* (4) 800 *W*

PKT162

24. An air bubble of volume 1 cm^3 rises from the bottom of a lake 40m deep to the surface at a temperature of 12°C. The atmospheric pressure is 1×10^5 *Pa*, the density of water is 1000 kg/m^3 and $g = 10\ m/s^2$. There is no difference of the temperature of water at the depth of 40 *m* and on the surface. The volume of air bubble when it reaches the surface will be **[JEE (Main) 2023]**

(1) 5 cm^3 (2) 2 cm^3 (3) 4 cm^3 (4) 3 cm^3

PKT163

EXERCISE - JEE (Advanced) PYQ

1. Parallel rays of light of intensity $I = 912\ Wm^{-2}$ are incident on a spherical black body kept in surroundings of temperature 300 K. Take Stefan-Boltzmann constant $\sigma = 5.7 \times 10^{-8}\ Wm^{-2}\ K^{-4}$ and assume that the energy exchange with the surroundings is only through radiation. The final steady state temperature of the black body is close to :- **[JEE (Advanced) 2014]**

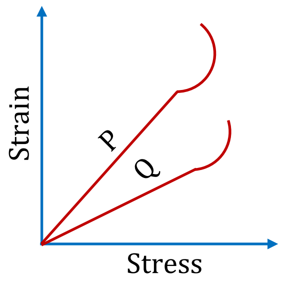
(A) 330 K (B) 660 K (C) 990 K (D) 1550 K

PEH044

2. Two spherical stars A and B emit blackbody radiation. The radius of A is 400 times that of B and A emits 10^4 times the power emitted from B. The ratio $\left(\frac{\lambda_A}{\lambda_B}\right)$ of their wavelengths λ_A and λ_B at which the peaks occur in their respective radiation curves is. **[JEE (Advanced) 2015]**

PEH045

3. In plotting stress versus strain curves for two materials P and Q, a student by mistake puts strain on the y-axis and stress on the x-axis as shown in the figure. Then the correct statement(s) is (are): **[JEE (Advanced) 2015]**



(A) P has more tensile strength than Q

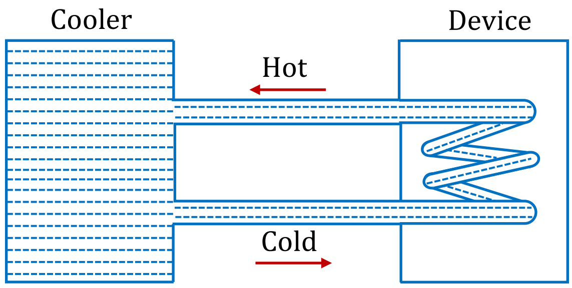
(B) P is more ductile than Q

(C) P is more brittle than Q

(D) The Young's modulus of P is more than that of Q

PEH046

4. A water cooler of storage capacity 120 litres can cool water at constant rate of P watts. In a closed circulation system (as shown schematically in the figure), the water from the cooler is used to cool an external device that generates constantly 3 kW of heat (thermal load). The temperature of water fed into the device cannot exceed 30°C and the entire stored 120 litres of water is initially cooled to 10°C. The entire system is thermally insulated. The minimum value of P (in watts) for which the device can be operated for 3 hours is : **[JEE (Advanced) 2016]**



(Specific heat of water is 4.2 $kJ\ kg^{-1}\ K^{-1}$ and the density of water is 1000 $kg\ m^{-3}$)

(A) 1600 (B) 2067 (C) 2533 (D) 3933

PEH047

5. A metal is heated in a furnace where a sensor is kept above the metal surface to read the power radiated (P) by the metal. The sensor has a scale that displays $\log_2(P/P_0)$, where P_0 is a constant. When the metal surface is at a temperature of 487°C, the sensor shows a value 1. Assume that the emissivity of the metallic surface remains constant. What is the value displayed by the sensor when the temperature of the metal surface is raised to 2767°C ? **[JEE (Advanced) 2016]**

PEH048

6. The ends Q and R of two thin wires, PQ and RS, are soldered (joined) together. Initially each of the wires has a length of 1m at 10°C. Now the end P is maintained at 10°C, while the end S is heated and maintained at 400°C. The system is thermally insulated from its surroundings. If the thermal conductivity of wire PQ is twice that of the wire RS and the coefficient of linear thermal expansion of PQ is $1.2 \times 10^{-5}\,K^{-1}$, the change in length of the wire PQ is **[JEE (Advanced) 2016]**

(A) 0.78 mm (B) 0.90 mm (C) 1.56 mm (D) 2.34 mm

PEH049

7. A gas is enclosed in a cylinder with a movable frictionless piston. Its initial thermodynamic state at pressure $P_i = 10^5\ Pa$ and volume $V_i = 10^{-3}\ m^3$ changes to a final state at $P_f = \left(\frac{1}{32}\right)\times 10^5\,Pa$ and $V_f = 8 \times 10^{-3}\ m^3$ in an adiabatic quasi-static process, such that P^3V^5 = constant. Consider another thermodynamic process that brings the system from the same initial state to the same final state in two steps: an isobaric expansion at P_i followed by an isochoric (isovolumetric) process at volumes V_f. The amount of heat supplied to the system in the two step process is approximately

[JEE (Advanced) 2016]

(A) 112 J (B) 294 J (C) 588 J (D) 813 J

PKT029

8. A human body has a surface area of approximately 1 m^2. The normal body temperature is 10 K above the surrounding room temperature T_0. Take the room temperature to be $T_0 = 300\ K$. For $T_0 = 300\ K$, the value of $\sigma T_0^4 = 460\ Wm^{-2}$ (where σ is the Stefan-Boltzmann constant). Which of the following options is/are **correct** ? **[JEE (Advanced) 2017]**

(A) The amount of energy radiated by the body in 1 second is close to 60 Joules

(B) If the surrounding temperature reduces by a small amount $\Delta T_0 << T_0$, then to maintain the same body temperature the same (living) human being needs to radiate ΔW = more energy per unit time

(C) Reducing the exposed surface area of the body (e.g. by curling up) allows humans to maintain the same body temperature while reducing the energy lost by radiation

(D) If the body temperature rises significantly then the peak in the spectrum of electromagnetic radiation emitted by the body would shift to longer wavelengths

PEH050

9. A flat plate is moving normal to its plane through a gas under the action of a constant force F. The gas is kept at a very low pressure. The speed of the plate v is much less than the average speed u of the gas molecules. Which of the following options is/are true ? **[JEE (Advanced) 2017]**

(A) The resistive force experienced by the plate is proportional to v

(B) The pressure difference between the leading and trailing faces of the plate is proportional to uv.

(C) The plate will continue to move with constant non-zero acceleration, at all times

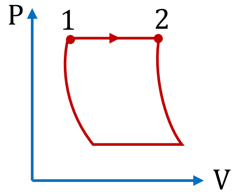
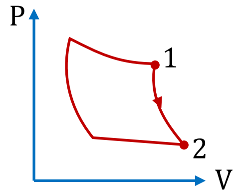
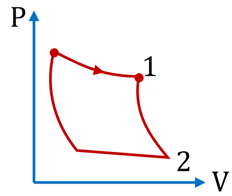
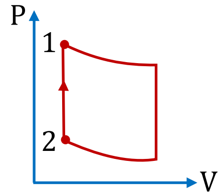
(D) At a later time the external force F balances the resistive force.

PKT030

Answer Q.10, Q.11 and Q.12 by appropriately matching the information given in the three columns of the following table.

An ideal gas is undergoing a cyclic thermodynamics process in different ways as shown in the corresponding P–V diagrams in column 3 of the table. Consider only the path from state 1 to state 2. W denotes the corresponding work done on the system. The equations and plots in the table have standard notations as used in thermodynamics processes. Here γ is the ratio of heat capacities at constant pressure and constant volume. The number of moles in the gas is n.

[JEE (Advanced) 2017]

	Column-1		Column-2		Column-3
(I)	$W_{1\to2} = \dfrac{1}{\gamma-1}(P_2V_2 - P_1V_1)$	(i)	Isothermal	(P)	
(II)	$W_{1\to2} = -PV_2 + PV_1$	(ii)	Isochoric	(Q)	
(III)	$W_{1\to2} = 0$	(iii)	Isobaric	(R)	
(IV)	$W_{1\to2} = -nRT\ln\dfrac{V_2}{V_1}$	(iv)	Adiabatic	(S)	

10. Which of the following options is the only correct representation of a process in which $\Delta U = \Delta Q - P\Delta V$?

(A) (II) (iv) (R) (B) (II) (iii) (P) (C) (II) (iii) (S) (D) (III) (iii) (P)

PKT031

11. Which one of the following options is the correct combination ?

(A) (III) (ii) (S) (B) (II) (iv) (R) (C) (II) (iv) (P) (D) (IV) (ii) (S)

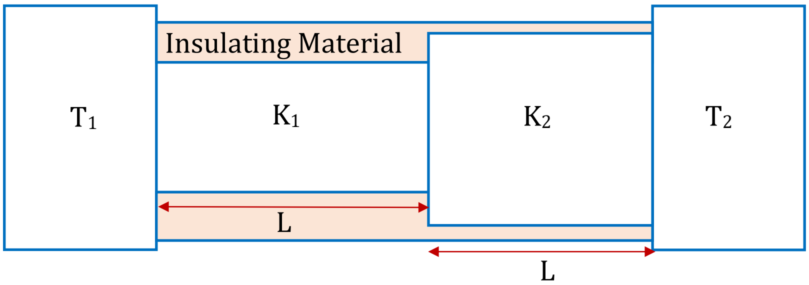
PKT032

12. Which one of the following options correctly represents a thermodynamics process that is used as a correction in the determination of the speed of sound in an ideal gas ?

(A) (III) (iv) (R) (B) (I) (ii) (Q) (C) (IV) (ii) (R) (D) (I) (iv) (Q)

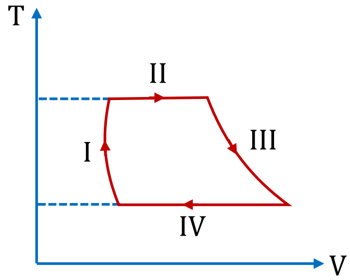
PKT033

13. Two conducting cylinders of equal length but different radii are connected in series between two heat baths kept at temperatures $T_1 = 300\ K$ and $T_2 = 100\ K$, as shown in the figure. The radius of the bigger cylinder is twice that of the smaller one and the thermal conductivities of the materials of the smaller and the larger cylinders are K_1 and K_2 respectively. If the temperature at the junction of the two cylinders in the steady state is 200 K, then K_1/K_2 = ________. **[JEE (Advanced) 2018]**



PEH051

14. One mole of a monatomic ideal gas undergoes a cyclic process as shown in the figure (where V is the volume and T is the temperature). Which of the statements below is (are) true ? **[JEE (Advanced) 2018]**



(A) Process I is an isochoric process

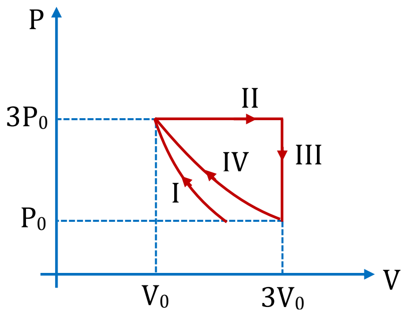
(B) In process II, gas absorbs heat

(C) In process IV, gas releases heat

(D) Processes I and II are not isobaric

PKT034

15. One mole of a monatomic ideal gas undergoes four thermodynamic processes as shown schematically in the PV-diagram below. Among these four processes, one is isobaric, one is isochoric, one is isothermal and one is adiabatic. Match the processes mentioned in List-I with the corresponding statements in List–II. **[JEE (Advanced) 2018]**



List–I	**List–II**
P. In process I	1. Work done by the gas is zero
Q. In process II	2. Temperature of the gas remains unchanged
R. In process III	3. No heat is exchanged between the gas and its surroundings
S. In process IV	4. Work done by the gas is 6 P_0V_0

(A) P $\rightarrow$ 4 ; Q $\rightarrow$ 3 ; R $\rightarrow$ 1 ; S $\rightarrow$ 2

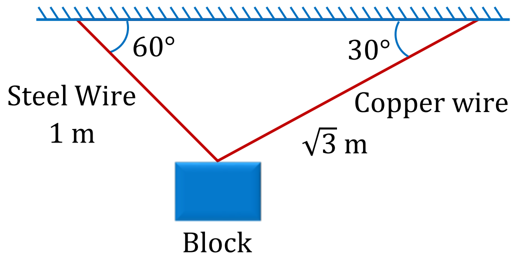
(B) P $\rightarrow$ 1 ; Q $\rightarrow$ 3 ; R $\rightarrow$ 2 ; S $\rightarrow$ 4

(C) P $\rightarrow$ 3 ; Q $\rightarrow$ 4 ; R $\rightarrow$ 1 ; S $\rightarrow$ 2

(D) P $\rightarrow$ 3 ; Q $\rightarrow$ 4 ; R $\rightarrow$ 2 ; S $\rightarrow$ 1

PKT035

16. A block of weight 100 N is suspended by copper and steel wires of same cross sectional area 0.5 cm^2 and, length $\sqrt{3}\ m$ and 1 m, respectively. Their other ends are fixed on a ceiling as shown in figure. The angles subtended by copper and steel wires with ceiling are 30° and 60°, respectively. If elongation in copper wire is ($\Delta\ell_C$) and elongation in steel wire is ($\Delta\ell_S$), then the ratio $\frac{\Delta\ell_C}{\Delta\ell_S}$ is ____.



[Young's modulus for copper and steel are $1 \times 10^{11}\ N/m^2$ and $2 \times 10^{11}\ N/m^2$ respectively]

[JEE (Advanced) 2019]

PEH052

17. A liquid at 30°C is poured very slowly into a Calorimeter that is at temperature of 110°C. The boiling temperature of the liquid is 80°C. It is found that the first 5 gm of the liquid completely evaporates. After pouring another 80 gm of the liquid the equilibrium temperature is found to be 50°C. The ratio of the Latent heat of the liquid to its specific heat will be _____°C.
[Neglect the heat exchange with surrounding] **[JEE (Advanced) 2019]**

PEH053

18. A mixture of ideal gas containing 5 moles of monatomic gas and 1 mole of rigid diatomic gas is initially at pressure P_0, volume V_0 and temperature T_0. If the gas mixture is adiabatically compressed to a volume $V_0/4$, then the correct statement(s) is/are,
(Give $2^{1.2} = 2.3$; $2^{3.2} = 9.2$; R is gas constant) **[JEE (Advanced) 2019]**

(A) The final pressure of the gas mixture after compression is in between $9P_0$ and $10P_0$

(B) The average kinetic energy of the gas mixture after compression is in between $18RT_0$ and $19RT_0$

(C) The work $|W|$ done during the process is $13RT_0$

(D) Adiabatic constant of the gas mixture is 1.6

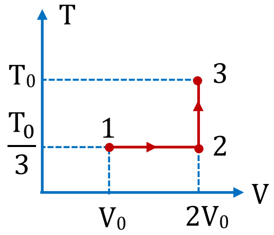
PKT036

19. **Answer the following by appropriately matching the lists based on the information given in the paragraph.** **[JEE (Advanced) 2019]**

In a thermodynamic process on an ideal monatomic gas, the infinitesimal heat absorbed by the gas is given by $T\Delta X$, where T is temperature of the system and ΔX is the infinitesimal change in a thermodynamic quantity X of the system. For a mole of monatomic ideal gas $X = \frac{3}{2}R\ln\left(\frac{T}{T_A}\right) + \left(\frac{V}{V_A}\right)R\ln$. Here, R is gas constant, V is volume of gas, T_A and V_A are constants.

	List-I		List-II
(I)	Work done by the system in process $1 \rightarrow 2 \rightarrow 3$	(P)	$\frac{1}{3}RT_0\ln 2$
(II)	Change in internal energy in process $1 \rightarrow 2 \rightarrow 3$	(Q)	$\frac{1}{3}RT_0$
(III)	Heat absorbed by the system in process $1 \rightarrow 2 \rightarrow 3$	(R)	RT_0
(IV)	Heat absorbed by the system in process $1 \rightarrow 2$	(S)	$\frac{4}{3}RT_0$
		(T)	$\frac{1}{3}RT_0(3+\ln 2)$
		(U)	$\frac{5}{6}RT_0$

If the process on one mole of monatomic ideal gas is an shown is as shown in the TV-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is



(A) I $\to$ S, II $\to$ T, III $\to$ Q, IV $\to$ U

(B) I $\to$ P, II $\to$ R, III $\to$ T, IV $\to$ S

(C) I $\to$ P, II $\to$ T, III $\to$ Q, IV $\to$ T

(D) I $\to$ P, II $\to$ R, III $\to$ T, IV $\to$ P

PKT037

20. Consider one mole of helium gas enclosed in a container at initial pressure P_1 and volume V_1. It expands isothermally to volume $4V_1$. After this, the gas expands adiabatically and its volume becomes $32V_1$. The work done by the gas during isothermal and adiabatic expansion processes are W_{iso} and W_{adia}, respectively. If the ratio $\frac{W_{iso}}{W_{adia}} = f \ln 2$, then f is _______. **[JEE (Advanced) 2020]**

PKT038

21. The filament of a light bulb has surface area 64 mm^2. The filament can be considered as a black body at temperature 2500 K emitting radiation like a point source when viewed from far. At night the light bulb is observed from a distance of 100 m. Assume the pupil of the eyes of the observer to be circular with radius 3 mm. Then

(Take Stefan-Boltzmann constant = 5.67×10^{-8} $Wm^{-2}K^{-4}$, Wien's displacement constant = 2.90×10^{-3} m-K, Planck's constant = 6.63×10^{-34} Js, speed of light in vacuum = 3.00×10^8 ms^{-1}):

[JEE (Advanced) 2021]

(A) power radiated by the filament is in the range 642 W to 645 W

(B) radiated power entering into one eye of the observer is in the range 3.15×10^{-8} W to 3.25×10^{-8} W

(C) the wavelength corresponding to the maximum intensity of light is 1160 nm

(D) taking the average wavelength of emitted radiation to be 1740 nm, the total number of photons entering per second into one eye of the observer is in the range 2.75×10^{11} to 2.85×10^{11}

PEH054

22. A container with 1 kg of water in it is kept in sunlight, which causes the water to get warmer than the surroundings. The average energy per unit time per unit area received due to the sunlight is 700 Wm^{-2} and it is absorbed by the water over an effective area of 0.05 m^2. Assuming that the heat loss from the water to the surroundings is governed by Newton's law of cooling, the difference (in °C) in the temperature of water and the surroundings after a long time will be ___________.

(Ignore effect of the container, and take constant for Newton's law of cooling = 0.001 s^{-1}, Heat capacity of water = 4200 $J\,kg^{-1}\,K^{-1}$) **[JEE (Advanced) 2021]**

PEH055

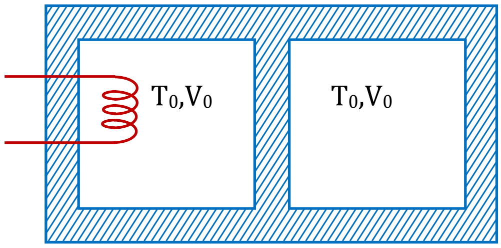
23. A small object is placed at the center of a large evacuated hollow spherical container. Assume that the container is maintained at 0 K. At time t = 0, the temperature of the object is 200 K. The temperature of the object becomes 100 K at $t = t_1$ and 50 K at $t = t_2$. Assume the object and the container to be ideal black bodies. The heat capacity of the object does not depend on temperature. The ratio (t_2/t_1) is________. **[JEE (Advanced) 2021]**

PEH056

PARAGRAPH FOR QUESTION NO. 24 and 25

A thermally insulating cylinder has a thermally insulating and frictionless movable partition in the middle, as shown in the figure below. On each side of the partition, there is one mole of an ideal gas, with specific heat at constant volume, $C_v = 2R$. Here, R is the gas constant. Initially, each side has a volume V_0 and temperature T_0. The left side has an electric heater, which is turned on at very low power to transfer heat Q to the gas on the left side. As a result the partition moves slowly towards the right reducing the right side volume to $V_0/2$. Consequently, the gas temperatures on the left and the right sides become T_L and T_R, respectively. Ignore the changes in the temperatures of the cylinder, heater and the partition.

[JEE (Advanced) 2021]



24. The value of $\frac{T_R}{T_0}$ is

(A) $\sqrt{2}$ (B) $\sqrt{3}$ (C) 2 (D) 3

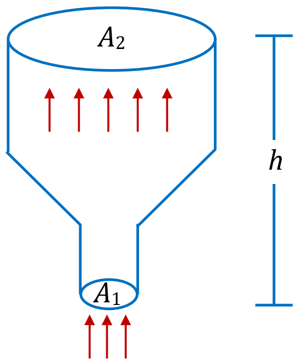
PKT039

25. The value of $\frac{Q}{RT_0}$ is

(A) $4\left(2\sqrt{2}+1\right)$ (B) $4\left(2\sqrt{2}-1\right)$ (C) $\left(5\sqrt{2}+1\right)$ (D) $\left(5\sqrt{2}-1\right)$

PKT040

26. An ideal gas of density $\rho = 0.2\ kg\ m^{-3}$ enters a chimney of height h at the rate of $\alpha = 0.8 kgs^{-1}$ from its lower end, and escapes through the upper end as shown in the figure. The cross-sectional area of the lower end is $A_1 = 0.1\ m^2$ and the upper end is $A_2 = 0.4\ m^2$. The pressure and the temperature of the gas at the lower end are 600 *Pa* and 300 *K*, respectively, while its temperature at the upper end is 150 *K*. The chimney is heat insulated so that the gas undergoes adiabatic expansion. Take $g = 10\ ms^{-2}$ and the ratio of specific heats of the gas $\gamma = 2$. Ignore atmospheric pressure. **[JEE (Advanced) 2022]**



Which of the following statement(s) is(are) correct?

(A) The pressure of the gas at the upper end of the chimney is 300 *Pa*.

(B) The velocity of the gas at the lower end of the chimney is 40 ms^{-1} and at the upper end is 20 ms^{-1}.

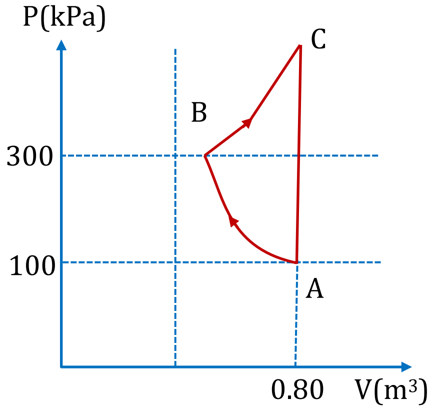
(C) The height of the chimney is 590 *m*.

(D) The density of the gas at the upper end is 0.05 $kg\ m^{-3}$.

PKT041

27. In the given *P-V* diagram, a monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is first compressed adiabatically from state *A* to state *B*. Then it expands isothermally from state *B* to state *C*. [Given: $\left(\frac{1}{3}\right)^{0.6} \simeq 0.5$, $\ln 2 \simeq 0.7$].

[JEE (Advanced) 2022]



Which of the following statement(s) is(are) correct?

(A) The magnitude of the total work done in the process $A \to B \to C$ is 144 *kJ*.

(B) The magnitude of the work done in the process $B \to C$ is 84 *kJ*.

(C) The magnitude of the work done in the process $A \to B$ is 60 *kJ*.

(D) The magnitude of the work done in the process $C \to A$ is zero.

PKT042

28. Young's modulus of elasticity *Y* is expressed in terms of three derived quantities, namely, the gravitational constant *G*, Planck's constant *h* and the speed of light *c*, as $Y = c^{\alpha} h^{\beta} G^{\gamma}$. Which of the following is the correct option ? **[JEE (Advanced) 2023]**

(A) $\alpha = 7, \beta = -1, \gamma = -2$
(B) $\alpha = -7, \beta = -1, \gamma = -2$
(C) $\alpha = 7, \beta = -1, \gamma = 2$
(D) $\alpha = -7, \beta = 1, \gamma = -2$

PEH174

29. One mole of an ideal gas expands adiabatically from an initial state (T_A, V_0) to final state (T_f, $5V_0$). Another mole of the same gas expands isothermally from a different initial state (T_B, V_0) to the same final state (T_f, $5V_0$). The ratio of the specific heats at constant pressure and constant volume of this ideal gas is γ. What is the ratio T_A/T_B? **[JEE (Advanced) 2023]**

(A) $5^{\gamma-1}$
(B) $5^{1-\gamma}$
(C) 5^{γ}
(D) $5^{1+\gamma}$

PKT164

30. A closed container contains a homogeneous mixture of two moles of an ideal monatomic gas ($\gamma = 5/3$) and one mole of an ideal diatomic gas ($\gamma = 7/5$). Here, γ is the ratio of the specific heats at constant pressure and constant volume of an ideal gas. The gas mixture does a work of 66 Joule when heated at constant pressure. The change in its internal energy is _______ Joule.

[JEE (Advanced) 2023]

PKT165

31. An ideal gas is in thermodynamic equilibrium. The number of degrees of freedom of a molecule of the gas in n. The internal energy of one mole of the gas is U_n and the speed of sound in the gas is v_n. At a fixed temperature and pressure, which of the following is the correct option ?

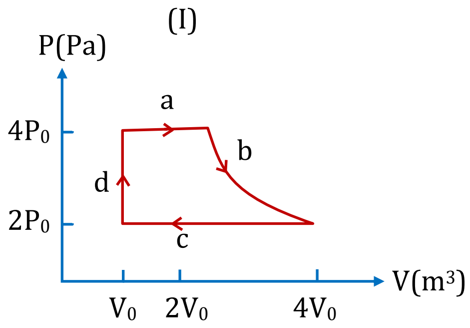
[JEE (Advanced) 2023]

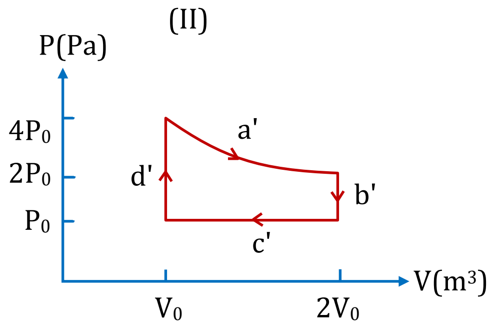
(A) $v_3 < v_6$ and $U_3 > U_6$
(B) $v_5 > v_3$ and $U_3 > U_5$
(C) $v_5 > v_7$ and $U_5 < U_7$
(D) $v_6 < v_7$ and $U_6 < U_7$

PKT166

32. One mole of an ideal gas undergoes two different cyclic processes I and II, as shown in the P-V diagrams below. In cycle I, processes a, b, c and d are isobaric, isothermal, isobaric and isochoric, respectively. In cycle II, processes a', b', c' and d' are isothermal, isochoric, isobaric and isochoric, respectively. The total work done during cycle I is W_I and that during cycle II is W_{II}. The ratio W_I / W_{II} is ______.

[JEE (Advanced) 2023]





PKT167

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. A block of ice with mass m falls into a lake. After impact, a mass of ice $m/5$ melts. Both the block of ice and the lake have a temperature of $0°C$. If L represents the heat of fusion, the minimum distance the ice fell before striking the surface is

(1) $\frac{L}{5g}$ (2) $\frac{5L}{g}$ (3) $\frac{gL}{5m}$ (4) $\frac{mL}{5g}$

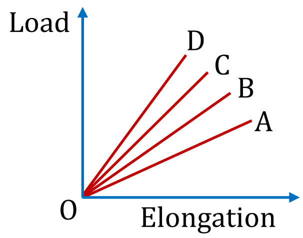
PEH001

2. The specific heat of a metal at low temperatures varies according to $S = aT^3$ where a is a constant and T is the absolute temperature. The heat energy needed to raise unit mass of the metal from $T = 1\ K$ to $T = 2\ K$ is :-

(1) $3\ a$ (2) $\frac{15a}{4}$ (3) $\frac{2a}{3}$ (4) $\frac{12a}{5}$

PEH002

3. The load versus strain graph for four wires of the same material is shown in the figure. The thickest wire is represented by the line :-



(1) OB (2) OA (3) OD (4) OC

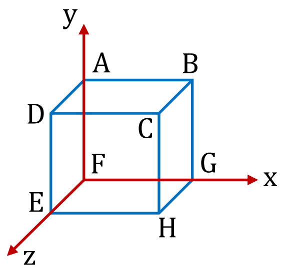
PEH003

4. The coefficients of thermal expansion of steel and a metal X are respectively 12×10^{-6} and 2×10^{-6} per$°C$. At $40°C$, the side of a cube of metal X was measured using a steel vernier callipers. The reading was 100 mm. Assuming that the calibration of the vernier was done at $0°C$, then the actual length of the side of the cube at $0°C$ will be

(1) > 100 mm (2) < 100 mm
(3) = 100 mm (4) data insufficient to conclude

PEH004

5. A cuboid *ABCDEFGH* is anisotropic with $\alpha_x = 1 \times 10^{-5}\ /°C$, $\alpha_y = 2 \times 10^{-5}\ /°C$, $\alpha_z = 3 \times 10^{-5}/°C$. Coefficient of superficial expansion of faces can be



(1) $\beta_{ABCD} = 5 \times 10^{-5}\ /°C$

(2) $\beta_{BCGH} = 4 \times 10^{-5}\ /°C$

(3) $\beta_{CDEH} = 3 \times 10^{-5}\ /°C$

(4) $\beta_{EFGH} = 2 \times 10^{-5}\ /°C$

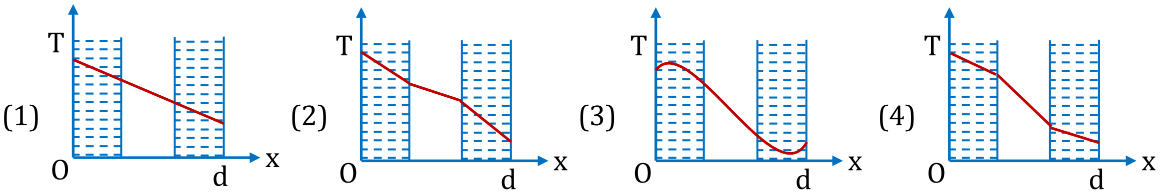
PEH005

6. Some steam at 100°*C* is passed into 1.1 *kg* of water contained in a calorimeter of water equivalent 0.02 *kg* at 15°*C* so that the temperature of the calorimeter and its contents rises to 80°*C*. What is the mass of steam condensing. (in *kg*)

(1) 0.130 (2) 0.065 (3) 0.260 (4) 0.135

PEH006

7. The wall with a cavity consists of two layers of brick separated by a layer of air. All three layers have the same thickness and the thermal conductivity of the brick is much greater than that of air. The left layer is at a higher temperature than the right layer and steady state condition exists. Which of the following graphs predicts correctly the variation of temperature *T* with distance *d* inside the cavity?



PEH007

8. A wall has two layer *A* and *B* each made of different material, both the layers have the same thickness. The thermal conductivity of the material *A* is twice that of *B*. Under thermal equilibrium the temperature difference across the wall *B* is 36°*C*. The temperature difference across the wall *A* is

(1) 6°*C* (2) 12°*C* (3) 18°*C* (4) 72°*C*

PEH008

9. Two identical conducting rods are first connected independently to two vessels, one containing water at 100°*C* and the other containing ice at 0°*C*. In the second case, the rods are joined end to end and connected to the same vessels. Let q_1 and q_2 g/s be the rate of melting of ice in the two cases respectively. The ratio q_2/q_1 is

(1) 1/2 (2) 2/1 (3) 4/1 (4) 1/4

PEH009

10. The rate of emission of radiation of a black body at 273°*C* is *E*, then the rate of emission of radiation of this body at 0°*C* will be :-

(1) $\frac{E}{16}$ (2) $\frac{E}{4}$ (3) $\frac{E}{8}$ (4) 0

PEH010

11. The power radiated by a black body is P and it radiates maximum energy around the wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy around wavelength $3/4\lambda_0$, the power radiated by it will increase by a factor of :-

(1) 4/3 (2) 16/9 (3) 64/27 (4) 256/81

PEH011

12. If the temperature of the sun were to increase from T to $2T$ and its radius from R to $2R$, then the ratio of the radiant energy received on earth to what it was previously, will be-

(1) 4 (2) 16 (3) 32 (4) 64

PEH012

13. When 2 *gms* of a gas are introduced into an evacuated flask kept at $25°C$ the pressure is found to be one atmosphere. If 3 *gms* of another gas added to the same flask the pressure becomes 1.5 atmospheres. The ratio of the molecular weights of these gases will be :-

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

PKT001

14. During an experiment an ideal gas obeys an addition equation of state P^2V = constant. The initial temperature and pressure of gas are T and V respectively. When it expands to volume $2V$, then its temperature will be:

(1) T (2) $\sqrt{2}\,T$ (3) $2\,T$ (4) $2\sqrt{2}\,T$

PKT002

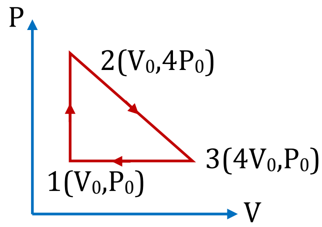
15. One mole of an ideal diatomic gas is taken through the cycle as shown in the figure.

$1 \to 2$: isochoric process

$2 \to 3$: straight line on P-V diagram

$3 \to 1$: isobaric process

The average molecular speed of the gas in the states 1, 2 and 3 are in the ratio



(1) 1 : 2 : 2 (2) $1 : \sqrt{2} : \sqrt{2}$ (3) 1 : 1 : 1 (4) 1 : 2 : 4

PKT003

16. One mole of an ideal gas is contained with in a cylinder by a frictionless piston and is initially at temperature T. The pressure of the gas is kept constant while it is heated and its volume doubles. If R is molar gas constant, the work done by the gas in increasing its volume is :-

(1) $RT\ ln\ 2$ (2) $1/2\ RT$ (3) RT (4) $3/2\ RT$

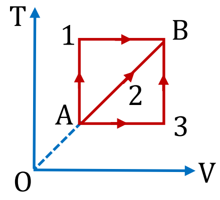
PKT004

17. A reversible adiabatic path on a P-V diagram for an ideal gas passes through state A where $P = 0.7 \times 10^5\ N/m^{-2}$ and $V = 0.0049\ m^3$. The ratio of specific heat of the gas is 1.4. The slope of path at A is :

(1) $2.0 \times 10^7\ Nm^{-5}$ (2) $1.0 \times 10^7\ Nm^{-5}$ (3) $-2.0 \times 10^7\ Nm^{-5}$ (4) $-1.0 \times 10^7\ Nm^{-5}$

PKT005

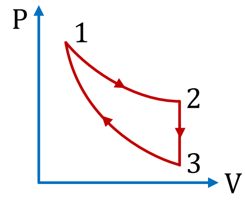
18. A given mass of a gas expands from a state A to the state B by three paths 1, 2 and 3 as shown in T-V indicator diagram. If W_1, W_2 and W_3 respectively be the work done by the gas along the three paths, then



(1) $W_1 > W_2 > W_3$ (2) $W_1 < W_2 < W_3$
(3) $W_1 = W_2 = W_3$ (4) $W_1 < W_2$, $W_1 > W_3$

PKT006

19. Three processes form a thermodynamic cycle as shown on P-V diagram for an ideal gas. Process $1 \rightarrow 2$ takes place at constant temperature ($300K$). Process $2 \rightarrow 3$ takes place at constant volume. During this process $40J$ of heat leaves the system. Process $3 \rightarrow 1$ is adiabatic and temperature T_3 is $275K$. Work done by the gas during the process $3 \rightarrow 1$ is :-



(1) – $40J$ (2) – $20J$ (3) $+40J$ (4) $+20J$

PKT007

20. At temperature T, N molecules of gas A each having mass m and at the same temperature $2N$ molecules of gas B each having mass $2m$ are filled in a container. The mean square velocity of molecules of gas B is v^2 and mean square of x component of velocity of molecules of gas A is w^2. The ratio of w^2/v^2 is :

(1) 1 (2) 2 (3) 1/3 (4) 2/3

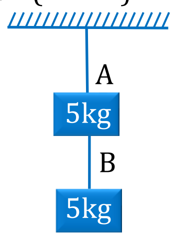
PKT008

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4,	if only correct answer is given.
Zero Marks	:	0,	if no answer is given.
Negative Marks	:	–1	for incorrect answer.

1. Two identical wires A and B of same material are loaded as shown in figure. If the elongation in wire B is 1.5 mm, what is the elongation (in mm) in A. (Mass of A and B can be neglected)



PEH013

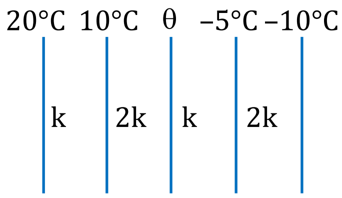
2. The temperature of 100 gm of water is to be raised from 24° C to 90° C by adding steam to it. Calculate the mass (in gm) of the steam required for this purpose.

PEH014

3. A thin walled metal tank of surface area $5m^2$ is filled with water and contains an immersion heater dissipating 1 kW. The tank is covered with 4 cm thick layer of insulation whose thermal conductivity is 0.2 $W/m\text{-}K$. The outer face of the insulation is 25^oC. Find the temperature of the tank in the steady state

PEH015

4. The figure shows the face and interface temperature of a composite slab containing of four layers of two materials having identical thickness. Under steady state condition, find the value of temperature θ.



k = Thermal conductivity

PEH016

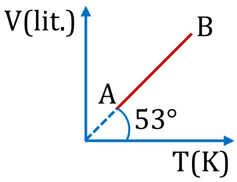
5. A vessel containing 100 gm water at $0°C$ is suspended in the middle of a room. In 15 minutes the temperature of the water rises by $2°C$. When an equal amount of ice is placed in the vessel, it melts in 10 hours. Calculate the specific heat (in $kcal/kg$) of fusion of ice.

PEH017

6. A pan filled with hot food cools from 50.1 $°C$ to 49.9 $°C$ in 5 sec. How long (in sec.) will it take to cool from $40.1°C$ to $39.9°C$ if room temperature is $30°C$?

PEH018

7. $V\text{-}T$ curve for 2 moles of a gas is straight line as shown in the graph here. If the pressure of gas at A is P atm. Then find the value of $P/100$ ________.



PKT009

8. A mixture of 4 gm helium and 28 gm of nitrogen is enclosed in a vessel of constant volume 300 K. The quantity of heat absorbed is ΔH (in J) by the mixture to doubled the root mean velocity of its molecules. The value of $\Delta H/$ 1000 ____.
(R = Universal gas constant)

PKT010

9. If heat is added at constant volume, 6300 J of heat are required to raise the temperature of an ideal gas by 150 K. If instead, heat is added at constant pressure, 8800 joules are required for the same temperature change. When the temperature of the gas changes by 300 K, the change in the internal energy of the gas is ΔU (in J). Then the value of $\Delta U/100$ is.

PKT011

10. Ideal diatomic gas is taken through a process $\Delta Q = 2\Delta U$. If the molar heat capacity (in J/K) for the process is x, then find the value of $10x$.
(Where ΔQ is the heat supplied and ΔU is change in internal energy)

PKT012

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **EIGHT** question.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. 2 kg ice at – 20°C is mixed with 5 kg water at 20°C. Then final amount of water in the mixture would be; Given specific heat of ice = 0.5$cal/g°C$, specific heat of water = 1 $cal/g°C$, Latent heat of fusion of ice = 80 cal/g.

(A) 6 kg (B) 5 kg (C) 4 kg (D) 2 kg

PEH031

2. The volume of the bulb of a mercury thermometer at 0°C is V_0 and cross section of the capillary is A_0. The coefficient of linear expansion of glass is α_g per °C and the cubical expansion of mercury γ_m per °C. If the mercury just fills the bulb at 0°C, what is the length of mercury column in capillary at T°C.

(A) $\dfrac{V_0T(\gamma_m+3\alpha_g)}{A_0(1+2\alpha_gT)}$ (B) $\dfrac{V_0T(\gamma_m-3\alpha_g)}{A_0(1+2\alpha_gT)}$ (C) $\dfrac{V_0T(\gamma_m+2\alpha_g)}{A_0(1+3\alpha_gT)}$ (D) $\dfrac{V_0T(\gamma_m-2\alpha_g)}{A_0(1+3\alpha_gT)}$

PEH032

3. Four rods of same material with different radii r and length ℓ are used to connect two reservoirs of heat at different temperatures. Which one will conduct most heat ?

(A) r = 2cm, ℓ = 0.5m (B) r = 2cm, ℓ = 2m (C) r = 0.5cm, ℓ = 0.5m (D) r = 1 cm, ℓ = 1 m

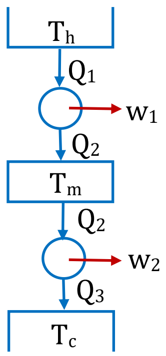
PEH033

4. A black body is at a temperature of 2880 K. The energy of radiation emitted by this object with wavelength between 499 nm and 500 nm is U_1, between 999 nm and 1000 nm is U_2 and between 1499 nm and 1500 nm is U_3. The Wien constant b = 2.88 × 10^6 nm K. Then

(A) U_1 = 0 (b) U_3 = 0 (C) $U_1 > U_2$ (D) $U_2 > U_1$

PEH034

5. Suppose that two heat engines are connected in series, such that the heat exhaust of the first engine is used as the heat input of the second engine as shown in figure. The efficiencies of the engines are h_1 and h_2, respectively. The net efficiency of the combination is given by



(A) $\eta_{net} = \eta_2 + (1 - \eta_1)\eta_2$

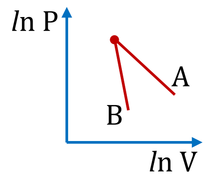
(B) $\eta_{net} = \dfrac{\eta_1}{(1-\eta_1)\eta_2}$

(C) $\eta_{net} = \eta_1 + (1 - \eta_1)\eta_2$

(D) $\eta_{net} = \dfrac{1-\eta_1}{(1-\eta_2)\eta_2}$

PKT021

6. The figure, shows the graph of logarithmic reading of pressure and volume for two ideal gases *A* and *B* undergoing adiabatic process. From figure it can be concluded that



(A) gas *B* is diatomic
(B) gas *A* and *B* both are diatomic
(C) gas *A* is monoatomic
(D) gas *B* is monoatomic and gas *A* is diatomic

PKT022

7. 1 *kg* of a gas does 20 *kJ* of work and receives 16 *kJ* of heat when it is expanded between two states. A second kind of expansion can be found between the initial and final state which requires a heat input of 9 *kJ*. The work done by the gas in the second expansion is :

(A) 32 *kJ* (B) 5 *kJ* (C) – 4 *kJ* (D) 13 *kJ*

PKT023

8. A gas is enclosed in a vessel at a constant temperature at a pressure of 5 atmosphere and volume 4 litre. Due to a leakage in the vessel, after some time, the pressure is reduced to 4 atmosphere. As a result, the

(A) volume of the gas decreased by 20%
(B) average *K.E.* of gas molecule decreases by 20%
(C) 20% of the gas escaped due to the leakage
(D) 25% of the gas escaped due to the leakage

PKT024

SECTION-II

- This section contains **SIX** questions.
- Each question has **FOUR** options for correct answer(*s*). **ONE OR MORE THAN ONE** of these four option(*s*) is (are) correct option(*s*).
- For each question, choose the correct option(*s*) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	if only (all) the correct option(*s*) is (are) chosen.
Partial Marks	:	+3	if all the four options are correct but ONLY three options are chosen.
Partial Marks	:	+2	if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks	:	+1	if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	:	0	if none of the options is chosen (i.e. the question is unanswered).
Negative Marks	:	–2	in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(*s*) (second option in this case), with or without selection of any correct option(*s*) will result in –2 marks.

9. *A* composite rod consists of a steel rod of length 25 *cm* and area 2*A* and a copper rod of length 50 *cm* and area *A*. The composite rod is subjected to an axial load *F*. If the Young's modulus of steel and copper are in the ratio 2 : 1.

(A) the extension produced in copper rod will be more .

(B) the extension in copper and steel parts will be in the ratio 2 : 1.

(C) the stress applied to the copper rod will be more.

(D) no extension will be produced in the steel rod.

PEH035

10. *A* body of mass *M* is attached to the lower end of a metal wire, whose upper end is fixed. The elongation of the wire is ℓ.

(A) Loss in gravitational potential energy of *M* is *Mgl*

(B) The elastic potential energy stored in the wire is *Mgl*

(C) The elastic potential energy stored in the wire is 1/2 *Mgl*

(D) Heat produced is 1/2 *Mgl.*

PEH036

11. Two bodies *A* and *B* have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are the same. The two bodies radiate energy at the same rate. The wavelength λ_B, corresponding to the maximum spectral radiancy in the radiation from *B*, is shifted from the wavelength corresponding to the maximum spectral radiancy in the radiation from *A* by 1.00 μm. If the temperature of *A* is 5802 *K*,

(A) the temperature of *B* is 1934 *K*

(B) $\lambda_B = 1.5\ \mu m$

(C) the temperature of *B* is 11604 *K*

(D) the temperature of *B* is 2901 *K*

PEH037

12. Two metallic sphere *A* and *B* are made of same material and have got identical surface finish. The mass of sphere *A* is four times that of *B*. Both the spheres are heated to the same temperature and placed in a room having lower temperature but thermally insulated from each other.

(A) The ratio of heat loss of *A* to that of *B* is $2^{4/3}$.

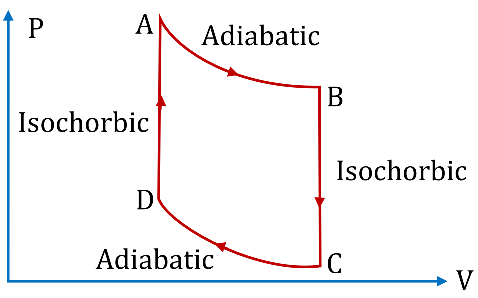
(B) The ratio of heat loss of *A* to that of *B* is $2^{2/3}$.

(C) The ratio of the initial rate of cooling of *A* to that of *B* is $2^{-2/3}$.

(D) The ratio of the initial rate of cooling of *A* to that of *B* is $2^{-4/3}$.

PEH038

13. Two moles of helium gas is taken through the cycle *ABCDA* as shown in the figure. If $T_A = 1000\ K$, $2P_A = 3P_B = 6P_C$.



(A) work done by the gas in the process *A* to *B* is 3741 *J*.

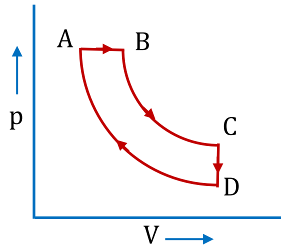
(B) heat lost by the gas in the process *B* to *C* is 10600 *J*.

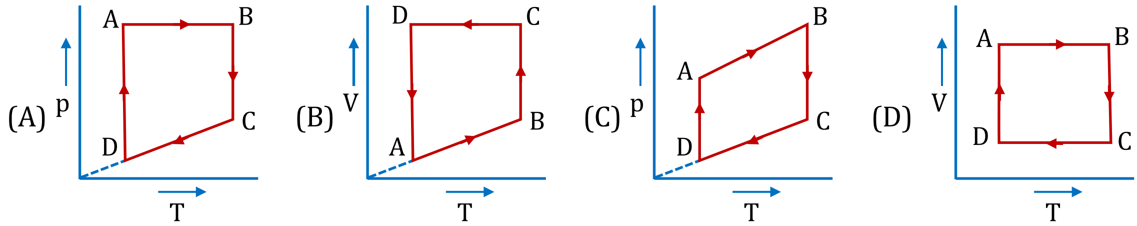
(C) temperature T_D is 2000 *K*.

(D) none of these

PKT025

14. A cyclic process *ABCD* is shown in the *p*-*V* diagram. Which of the following curves represents the same process if *BC* and *DA* are isothermal processes





PKT026

SECTION-III

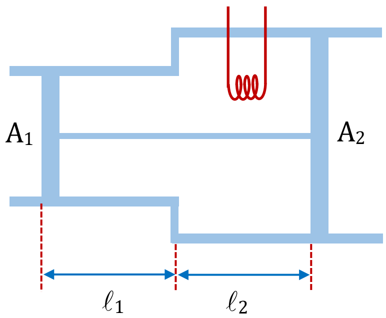
- This section contains **ONE** paragraph.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in <u>one of the following categories</u> :

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

PARAGRAPH FOR QUESTION NOS. 15 & 16

The walls of the two connecting cylinders shown in the figure are adiabatic (thermally insulating). The cross-sectional areas of the parts are A_1 and A_2. There is a well-fitting but freely moving, thermally insulating piston in each cylinder, at a distance $\ell_1 = \ell_2 = \ell$ from the point where the cross-sectional area changes. The pistons are connected to each other by a thin and rigid rod. The enclosed volume contains air. The temperature and air pressure are T_0 and p_0 both inside and outside. The heater filament inside is operated for time *t* at a power of *P*.



15. What is change in temperature (*Q* is heat energy supplied, v_0 is initial volume) :-

(A) $\Delta T = \dfrac{2}{5}\dfrac{QT_0}{p_0V_0}$ (B) $\Delta T = \dfrac{2}{7}\dfrac{QT_0}{p_0V_0}$ (C) $\Delta T = \dfrac{5}{7}\dfrac{QT_0}{p_0V_0}$ (D) $\Delta T = \dfrac{QT_0}{p_0V_0}$

PKT027

16. What is displacement (*x*) of piston till equilibrium is reached :-

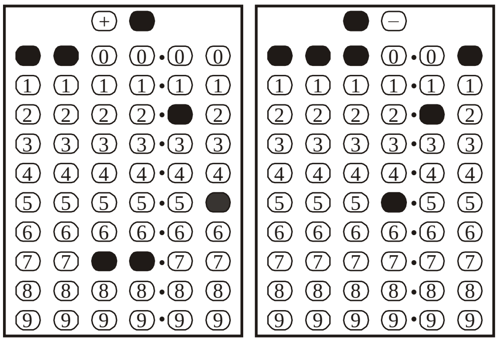
(A) $x = \dfrac{2Pt}{(A_2 - A_1)7p_0}$ (B) $x = \dfrac{2Pt}{(A_2 - A_1)5p_0}$ (C) $x = \dfrac{2Pt}{(A_2 - A_1)3p_0}$ (D) $x = \dfrac{2Pt}{(A_2 - A_1)9p_0}$

PKT028

SECTION-IV

- This section contains **FOUR** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 if ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 in all other cases.

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17. Two identical calorimeter A and B contain equal quantity of water at 20°C. A 5 gm piece of metal X of specific heat 0.2 cal g^{-1} $(C°)^{-1}$ is dropped into A and a 5 gm piece of metal Y into B. The equilibrium temperature in A is 22°C and in B 23°C. The initial temperature of both the metals is 40°C. If the specific heat of metal Y in cal g^{-1} $(C°)^{-1}$ *is* $P/85$. Then value of the P is.

PEH039

18. A steel wire of length 4.5 m and a copper wire of length 3.5 m are stretched same amount under a given load. If ratio of youngs modulli of steel to that of copper is $\frac{12}{7}$, then what is the ratio of cross sectional area of steel wire to copper wire?

PEH040

19. A hot liquid contained in a container of negligible heat capacity loses temperature at rate 3 K/min, just before it begins to solidify. The temperature remains constant for 30 min. If the ratio of specific heat capacity of liquid to specific latent heat of fusion is x/y in K^{-1} (given that rate of losing heat is constant). Then the value of $x + y$ is.

PEH041

20. A liquid takes 5 minutes to cool from 80°C to 50°C. How much time (in min.) will it take to cool from 60°C to 30°C? The temperature of surrounding is 20°C. Use exact method.

PEH042

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	A	D	B	D	A	C	A	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	B	C	D	A	D	A	D	D	C	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	C	A	A	B	B	C	A	D	D	B
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	B	A	C	B	A	C	B	C	D	B
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	A	B	A	B	D	C	D	A	A	B
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	C	B	C	A	A	B	B	A	B	C
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	D	C	B	D	B	C	C	B	C	C
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	C	A	D	B	A	C	A	D	D	C
Que.	81	82	83	84	85	86	87	88	89	90
Ans.	C	C	D	D	C	C	A	B	B	C
Que.	91	92	93	94	95	96	97	98	99	100
Ans.	A	A	B	A	B	A	B	B	D	A
Que.	101	102	103	104	105	106	107	108	109	110
Ans.	C	A	A	A	A	A	A	A	AB	BD
Que.	111	112	113	114	115	116	117	118	119	120
Ans.	BC	ACD or ABCD	AD	AC	CD	BC	BD	ACD	BC	ABC
Que.	121	122	123	124	125	126	127	128	129	130
Ans.	B	C	D	AB	ABCD	B	A	B	D	D

Que.	131	132
Ans.	(A-P,S,T), (B-P,S,T), (C-Q,R), (D-Q,S)	(A-R), (B-P), (C-S), (D-Q)
Que.	133	134
Ans.	(A-P), (B-Q), (C-Q)	(I-P), (II-R), (III-T), (IV-Q)

EXERCISE - S

1. ℓ

2. (a) $\theta = \frac{\pi}{2}$ (b) $\theta = \pi/4$.

3. Strain in wire $A = 10^{-4}$ and strain in wire $B = 2 \times 10^{-4}$

4. (i) 1.67, (ii) 2.4

5. $\Delta L = \frac{3MgL}{2AY}$ **6.** (i) 50 N, (ii) 0.045 J, 1.8×10^{-3} m (iii) 8.4×10^{-4} m, (iv) $x = 0.12$ m

7. 25.5°C **8.** 1 : 1.26 **9.** $5\alpha/3$

10. 5 sec slow **11.** 10, 000 N **12.** 5.8×10^8 Pa

13. 4×10^{-6} $m/°C$ **14.** 10cm, 40cm **15.** $F = \frac{(\alpha_1 L_1 + \alpha_2 L_2)t}{\left(\frac{L_1}{Y_1 A_1} + \frac{L_2}{Y_1 A_2}\right)}$

16. 7/2 **17.** (a) – 100°C (b) 1000 J **18.** $4/3\omega$

19. 9 **20.** 10.34 cm **21.** $\frac{K\pi r_1 r_2 (\theta_2 - \theta_1)}{L}$

22. 1800J **23.** $(T_2 - T_1)e^{-\frac{KA}{L}\left(\frac{m_1 s_1 + m_2 s_2}{m_1 s_1 m_2 s_2}\right)t}$ **24.** $\ln_2 \frac{Lms}{2KA}$

25. $3w/m-°C$ **26.** 166.3 sec **27.** 2 : 1

28. $\left(\frac{6}{\pi}\right)^{1/3}$ **29.** 9 **30.** 1000 J $(C°)^{-1}$

31. 3025 K **32.** 887J **33.** $\left(\Delta T = \frac{mv_0^{\,2}}{3R}\right)$

24. 7 **35.** $\frac{3}{2}$ **36.** 327°C

37. 40 **38.** 32°C **39.** $\left(\ell = \frac{21840}{673} cm\right)$

40. $P = \frac{10}{3} \times 10^5$ N/m^2, $T = \frac{10500}{31}$ $K \simeq 338.71$ K

41. (a) $T_{\max} = \frac{2}{3}(p_0/R)\sqrt{p_0/3\alpha}$] (b) $T_{\max} = p_0/e\beta R$ **42.** $m = (1 - e^{-Mgh/RT})\, p_0 S/g$

43. (a) 600 K, 900 K; (b) 10 J; (c) 14.9 J, 24.9 J; (d) 29.8 J

44. 1.5 **45.** $-100\,\pi J$ **46.** $Q_1 < Q_2$

47. $R/2$

48. (a) $2T_0$, $\frac{p_0}{2}$ in the vessel A and $\frac{T_0}{2^{\gamma-2}}$, $p_0/2^\gamma$ in vessel B, (b) $2T_0$, $P_0/2$

49. (a) zero (b) $\frac{3P_0}{2}$ on the left and $\frac{3P_0}{2}$ on the right (c) $\frac{3T_0}{2}$ (d) $\frac{3P_0V_0}{4}$

50. (a) $\frac{2p_1^{1/\gamma}V_0}{A}$, $\frac{2p_2^{1/\gamma}V_0}{A}$, (b) zero, (c) $(A/2)^\gamma$ where $A = p_1^{1/\gamma} + p_2^{\,1/\gamma}$

51. $\frac{nR}{P_a A}(T_S - T_0) + \left(1 - e^{-\frac{2KAt}{5nRx}}\right)$

52. (a) $P_i = P_a$ (b) $P_f = P_a + k(V - V_0)/A^2$ $V_0 = \ell A$ (c) $\Delta Q = P_a(V - V_0) + \frac{1}{2}k(V - v_0)^2 + C_v(T - T_0)$ $A = 1$

53. 1.6 m, 364 K **54.** 2 **55.** (A) 12·5% (B) 14·3%

56. 2400 **57.** 5.7 J **58.** 3.36×10^6 J

59. (a) 19 J/K.mol); (b) 25 J/(K.mol) **60.** 4.4 J/K

61. Approx. 4 J/K

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	1	2	2	4	1	2	4	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	20	1	3	57	1	3	3	2
Que.	21	22	23	24						
Ans.	3	40	4	1						

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	2	AB	B	9	A	C	C	ABD	B
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	D	4	BCD	C	2.00	270.00	ACD	D	1.77 to 1.78
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	BCD	8.33	9	A	B	B	BCD	A	A	121
Que.	31	32								
Ans.	C	2								

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	1	2	3	1	3	1	4	3	4	1
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	4	4	1	2	1	3	3	1	1	4
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	12	65	5	80	10	125	30	126	416

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	5	6	7	8
	A.	A	B	A	D	C	D	D	C
Section-II	Q.	9	10	11	12	13	14		
	A.	AC	ACD	AB	AC	AB	AB		
Section-III	Q.	15	16						
	A.	B	A						
Section-IV	Q.	17	18	19	20				
	A.	27	0.75	91	10				

Important Notes

Important Notes