EXERCISE 1

1. The specific heat of water is more than of iron. What do you mean by it?
2. Why do different materials have different specific heats?
3. Why water is a very useful cooling agent?
4. Why latent heat of vaporization of a material is greater than that of latent heat of fusion?
5. A gas can have any value of specific heat depending upon how heating is carried on. Explain.
6. What is the foundation of thermodynamics?
7. Is it possible that there is a change in the temperature of a body without giving/taking heat to/from it?
8. The internal energy of a compressed gas is less than that of the rarified gas at the same temperature. Why?
9. What happens to the air temperature in a valley when cold air blowing across the mountain tops descends in the valley?
10. A box with rigid insulating walls is divided with two parts by a portion. An ideal gas occupies half the box and the other half is completely evacuated. The portion is suddenly removed. Will there be any temperature change in the gas?
11. Absolute zero is not the temperature of zero energy. Explain.
12. Why do electrons in insulators not contribute to conductivity?
13. Stainless steal cooking pan are fitted with extra copper bottom. Why?
14. The tile floor feels colder than wooden floor, even through both floor materials are at the same temperature. Why?
15. The bulb of one thermometer is spherical while that of the other is cylindrical. Both have equal amounts of mercury. Who will respond quickly to the temperature?
16. Why do two layers of cloth of equal thickness provide warmer covering than a single layer of cloth of double thickness?
17. A blanket which keeps us warm in winter is able to protect ice from melting. Explain.
18. Animals in the forest find shelter from cold in holes in the snow. Why?
19. Why do frozen pipes brust ?
20. All objects radiate electromagnetic energy. Why do not they lose all their thermal energy by radiation and cool down to 0 K?
21. On a winter night you feel warmer when clouds cover the sky than when the sky is clear. Why?
22. Why does a good absorber of radiant energy appear black?
23. Why is pupil of the eye black?

EXERCISE 2

1. A steel scale is to be prepared such that the millimeter intervals are to be accurate within 6×10^{-5} mm. The maximum permissble temperature variation during the ruling of the millimeter marks $(\alpha = 12\times10^{-6}C^{-1})$ is

(A) 4.0ºC (B) 4.5ºC (C) 5.0ºC (D) 5.5ºC.

2. A meter washer has a hole of diameter d_1 and an external diameter d_2, where $d_2 = 3d_1$. On heating, d_2 increases by 0.3%. Then d_1 will

(A) decrease by 0.1% (B) decrease by 0.3%

(C) increase by 0.1% (D) increase by 0.3%.

3. If I is the moment of inertia of a solid body, the change in I corresponding to a small change in temperature ΔT is

(A) $\alpha I\Delta T$ (B) $\frac{1}{2}\alpha I\Delta T$ (C) $2\alpha I\Delta T$ (D) $3\alpha I\Delta T$.

4. At 4ºC, 0.98 of the volume of a body is immersed in water. The temperature at which the entire body gets immersed in water $(\gamma_w = 3.3\times10^{-4}K^{-1})$ is (neglect the expansion of the body)

(A) 40.8ºC (B) 64.6ºC (C) 60.6ºC (D) 58.8ºC.

5. If α is the coefficient of linear expansion, the change in the period t of a physical pendulum with temperature change of ΔT is

(A) $\frac{1}{2}\alpha t\,\Delta T$ (B) $\frac{1}{4}\alpha t\,\Delta T$ (C) $\frac{3}{4}\alpha t\,\Delta T$ (D) $\frac{1}{3}\alpha t\,\Delta T$.

6. Heat capacity is equal to the product of :

(A) mass and gas constant (B) mass and specific heat

(C) latent heat and volume of water (D) mass and Avogadro number

7. One kilogram of ice at 0°C is mixed with one kilogram of water at 80°C. The final temperature of the mixture is (Take specific heat of water = 4200 kJ/kg-°C, Latent heat of ice = 336 kJ/kg)

(A) 0°C (B) 40°C (C) 50°C (D) 60°C

8. One gram of ice at 0ºC is added to 5 grams of water at 10ºC. If the latent heat of ice be 80 cal/gm.,then the final temperature of the mixture is :

(A) 5ºC (B) 0ºC (C) –5ºC (D) None of the above

9. 250 gm of water and an equal volume of alcohol of mass 200 gm are placed successively in the same calorimeter and cools from 60ºC to 55ºC in 130 sec and 67 sec respectively. If the water equivalent of the calorimeter is 10 gm., then the specific heat of alcohol in cal/gm × ºC is :

(A) 1.30 (B) 0.67 (C) 0.62 (D) 0.985

10. The weight of a person is 60 kg. If he gets 10 calories of heat through food and the efficiency of his body is 28%, then upto how much height he can climb ? Take g = 10 m s^{-2}

(A) 100 cm (B) 196 cm (C) 400 cm (D) 1000 cm.

11. An ideal gas expands according to the law $pV^2 = \text{const}$. The molar heat capacity C is :

(A) $C_V + R$ (B) $C_V - R$ (C) $C_V + 2R$ (D) $C_V - 3R$.

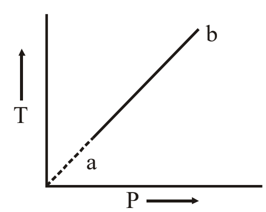
12. The water equivalent of 10g of aluminium, if its specific heat is 0.2 cal/g°C will be -

(A) 8g (B) 2g (C) 1 g (D) 4g

13. Two identical containers joined by a small pipe initially contain the same gas at pressure p_0 and absolute temperature T_0. One container is now maintained at the same temperature while the other is heated to $2T_0$. The common pressure of the gases will be :

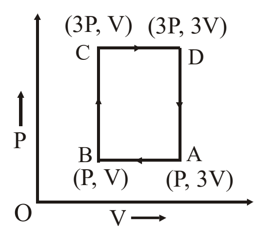
(A) $\frac{2}{3}p_0$ (B) $\frac{4}{3}p_0$ (C) $\frac{5}{3}p_0$ (D) $2p_0$.

14. An ideal gas changes from state a to state b as shown in figure. What is the work done by the gas in the process ?



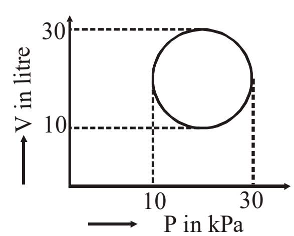
(A) zero (B) positive (C) negative (D) infinite.

15. An ideal monoatomic gas is taken round the cycle ABCDA as shown in following *P-V* diagram. The work done during the cycle is :



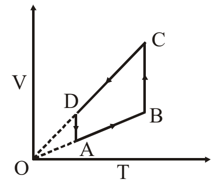
(A) PV (B) 2PV (C) 4PV (D) zero.

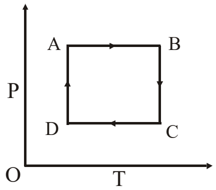
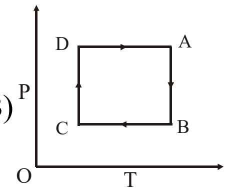
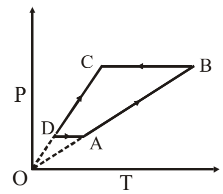
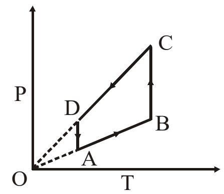
16. Heat energy absorbed by a system in going through a cyclic process shown in figure, is :



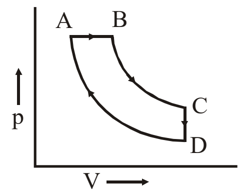
(A) $10^7 \pi J$ (B) $10^4 \pi J$ (C) $10^2 \pi J$ (D) $10^{-3} \pi J$.

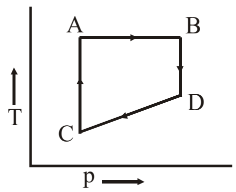
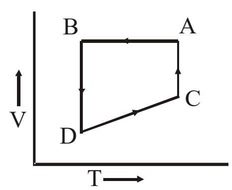
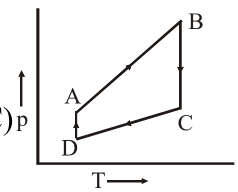
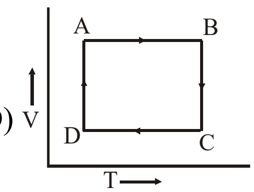
17. A cyclic process is shown on the V – T diagram. The same process on a P – T diagram is shown by



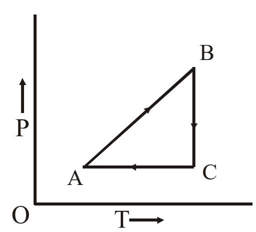
(A)  (B)  (C)  (D)  .

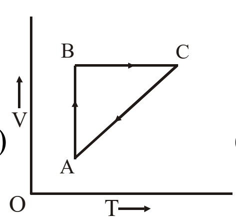
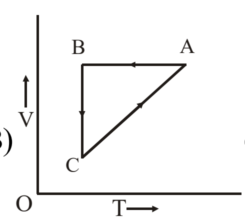
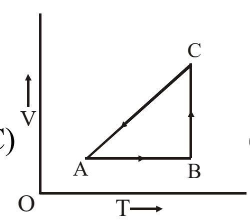
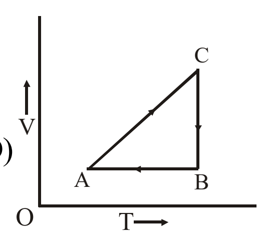
18. A cyclic process ABCD is shown in the $p-V$ diagram. Which of the following curves represent the same process ?



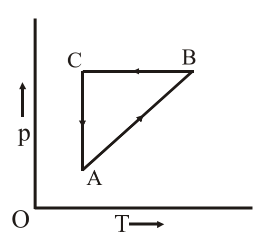
(A)  (B)  (C)  (D)  .

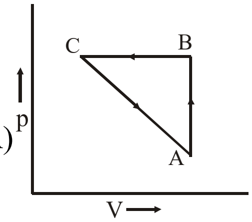
19. A cyclic process is shown in the *p-T* diagram. Which of the curves show the same process on a *V-T* diagram ?

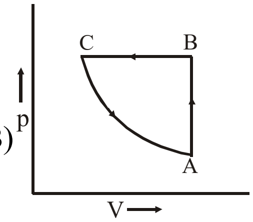


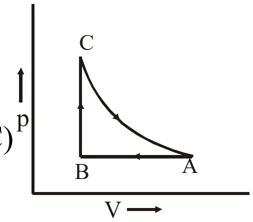
(A)  (B)  (C)  (D)  .

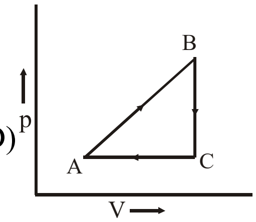
20. A cyclic process is shown in the *p-T* diagram. Which of the curves show the same process on a *P-V* diagram ?



(A) 

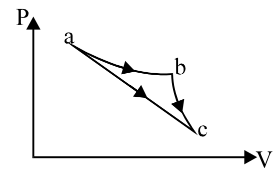
(B) 

(C) 

(D) 

.

21. In the PV diagram of figure, an ideal gas does 5 J of work when taken along the process ab and 4J when taken along process bc. What is the change in internal energy of gas when it is taken along the straight path from a to c? Out of two curves in the graph one is an isothermal process and other is an adiabatic process.



(A) –1 J (B) – 4 J (C) 9 J (D) 1 J

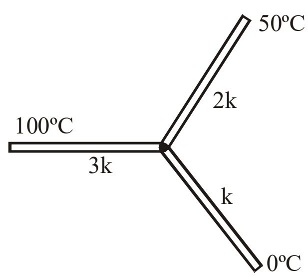
22. A brass ball of mass 100g is heated to 100ºC and then dropped into 200g of turpentine in a calorimeter at 15ºC. The final temperature is found to be 23ºC. The specific heat of turpentine. Take specific heat of brass as 0.09calg/ºC and water equivalent of calorimeter as 4g is -

(A) 5.42 cal/gºC (B) 0.40 cal/gºC (C) 0.42 cal/gºC (D) 0.41 cal/gºC

23. 200g of water at 98ºC is mixed with 200cm^3 of milk of density 1.03 at 30ºC contained in a brass vessel of thermal capacity equal to that of 8g of water and the temperature of the mixture is 64ºC. The specific heat of milk will be -

(A) 0.42 cal/gºC (B) 0.03 cal/gºC (C) 0.12 cal/gºC (D) 2.42 cal/gºC

24. Three rods of the same dimensions have thermal conductivities $3k$, $2k$ and k. They are arranged as shown, with their ends at 100ºC, 50ºC and 0ºC. The temperature of their junction is



(A) 75ºC (B) $\frac{200}{3}$ ºC (C) 40ºC (D) $\frac{100}{3}$ ºC.

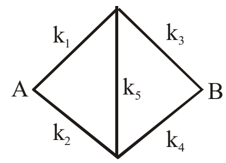
25. Radiation from a black body at the thermodynamic temperature T_1 is measured by a small detector at distance d_1 from it. When the temperature is increased to T_2 and the distance to d_2, the power received by the detector is unchanged. What is the ratio d_2/d_1?

(A) $\frac{T_2}{T_1}$ (B) $\left(\frac{T_2}{T_1}\right)^2$ (C) $\left(\frac{T_1}{T_2}\right)^2$ (D) $\left(\frac{T_2}{T_1}\right)^4$.

26. A black body radiates power P and maximum energy is radiated by it around a wavelength λ_0. The temperature of the black body is now changed such that it radiated maximum energy around the wavelength $\frac{3\lambda_0}{4}$. The power radiated by it now is

(A) $\frac{256}{81}P$ (B) $\frac{16}{9}P$ (C) $\frac{64}{27}P$ (D) $\frac{4}{3}P$.

27. Five rods having thermal conductivities k_1, k_2, k_3, k_4 and k_5 are arranged as shown. The points *A* and *B* are maintained at different temperature such that no thermal current flows through the central rod.



(A) $k_1k_4 = k_2k_3$ (B) $k_1 = k_3, k_2 = k_4$ (C) $k_1k_3 = k_2k_4$ (D) $\frac{k_1}{k_4} = \frac{k_3}{k_2}$.

28. A point source of heat of power *P* is placed at the center of a spherical shell of mean radius *R*. The material of the shell has thermal conductivity *k*. If the temperature difference between the outer and the inner surface of the shell is not to exceed *T*, then the thickness of the shell should not be less than

(A) $\frac{2\pi R^2 kT}{P}$ (B) $\frac{4\pi R^2 kT}{P}$ (C) $\frac{\pi R^2 kT}{P}$ (D) $\frac{\pi R^2 kT}{4P}$.

29. Three rods *A, B* and *C* have the same dimensions. Their thermal conductivities are k_A, k_B and k_C respectively. *A* and *B* are placed end to end, with their free ends kept at a certain temperature difference. C is placed separately, with its ends kept at the same temperature difference. The two arrangements conduct heat at the same rate. k_C must be equal to

(A) $k_A + k_B$ (B) $\frac{k_A k_B}{k_A + k_B}$ (C) $\frac{1}{2}(k_A + k_B)$ (D) $2.\left(\frac{k_A k_B}{k_A + k_B}\right)$.

30. A solid at temperature T_1 is kept in an evacuated chamber at temperature $T_2 > T_1$. The rate of increase of temperatrue of the body is proportional to

(A) $T_2 - T_1$ (B) $T_2^2 - T_1^2$ (C) $T_2^4 - T_1^4$ (D) $T_2^3 - T_1^3$

EXERCISE 3

1. A steel ruler exactly 20 cm long is graduated to give correct measurements at 20ºC.
(a) Will it give readings that are too long or too short at lower temperatures ?
(b) What will be the actual length of the ruler be when it is used in the desert at a temperature of 40ºC? $\alpha_{steel} = 1.2\times10^{-5}$ (ºC)$^{-1}$.

2. An isosceles triangle is formed with a rod of length l_1 and coefficient of linear expansion α_1 for the base and two thin rods each of length l_2 and coefficient of linear expansion α_2 for the two pieces, if the distance between the apex and the midpoint of the base remain unchanged as the temperature is varied show that $\frac{l_1}{l_2} = 2\sqrt{\frac{\alpha_2}{\alpha_1}}$.

3. A solid body floats in a liquid at a temperature t = 50ºC being completely submerged in it. What percentage of the volume of the body is submerged in the liquid after it is cooled to t_0 = 0ºC, if the coefficient of cubic expansion for the solid is $\gamma_S = 0.3\times10^{-5}$ ºC^{-1} and of the liquid $\gamma_l = 8\times10^{-5}$ ºC^{-1}.

4. A metre scale is made of steel and measures correct length at 16ºC. What will be the percentage error if the scale is used
(a) on a summer day when temperature is 46ºC and
(b) on a winter day when the temperature is 6ºC ? Coefficient of linear expansion of steel $= 11\times10^{-6}$ ºC^{-1}.

5. Two straight thin bars, one of brass and the other of steel are joined together at 0ºC side by side by short steel cross-pieces one cm long, the centre lines of the brass being one cm apart. When heated to 100ºC, the composite bar becomes bent into the arc of a circle. Calculate the radius of this circle.

6. Ethyl alcohol has boiling point of 78ºC, a freezing point of –114ºC, a heat of vaporization of 879 kJ/kg, heat of fusion of 109 kJ/kg, and a specific heat of 2.43 kJ/kg.K. How much energy must be removed from 0.510 kg of ethyl alcohol that is initially a gas at 78ºC so that it becomes a solid at –114ºC?

7. Steam at 100ºC is allowed to pass into a vessel containing 10 grams of ice and 100 grams of water at 0ºC, until all the ice is melted and the temperature is raised to 5ºC. Neglecting water equivalent of the vessel and the loss due to radiation etc., calculate how much steam is condensed. (The latent heat of steam is 536 and latent heat of ice is 80 calories).

8. Ice at 0ºC is added to 200 g of water initially at 70ºC in a vacuum flask. When 50g of ice has been added and has all melted the temperature of the flask and contents is 40ºC. When a further 80g of ice has been added and has all melted the temperature of the whole becomes 10ºC. Find the specific latent heat of fusion of ice.

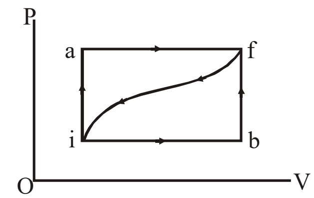
9. Three liquids P, Q and R are given. 4kg of P at 60ºC and 1 kg of R at 50ºC when mixed produce a resultant temperature 55ºC. A mixture of 1 kg of P at 60ºC and 1kg of Q at 50ºC shows a temperature of 55ºC. What will be the resulting temperature when 1 kg of Q at 60ºC is mixed with 1 kg of R at 50ºC ?

10. In a container of negligible mass 30 g of steam at 100ºC is added to 200g of water that has a temperature of 40ºC. If no heat is lost to the surroundings, what is the final temperature of the system? Also find masses of water and steam in equilibrium. Take L_v = 539 cal/g and c_{water} = 1cal/g ºC.

11. One mole of a certain ideal gas is contained under the weightless piston of a vertical cylinder at a temperature *T*. The space over the piston opens into the atmosphere of pressure p_0. What work has to be done in lifting the piston slowly so that the volume of the gas under the piston increases isothermally *n* times?

12. Two perfect diatomic gases at absolute temperature T_1 and T_2 are mixed. There is no loss of energy. Find the temperature of the mixture if masses of the molecules are m_1 and m_2 and the number of molecules in the gases are n_1 and n_2 .

13. When a system is taken from state *i* to state *f* along the path *iaf*, it is found that Q = 50 cal and W = 20 cal. Along the path *ibf*, Q = 36 cal (figure)



(a) What is W along the path *ibf* ?

(b) If W = - 13 cal for the curved return path *f i,* what is Q for this path ?

(c) Take U_i = 10 cal. What is U_f ?

(d) If U_b = 22 cal, what is Q for the process *ib* and for the process *bf* ?

14. The initial pressure and volume of a given mass of gas $\left(\frac{C_P}{C_V}=\gamma\right)$ are P_0 and V_0. The gas can exchange heat with the surrounding.

(a) It is slowly compressed to a volume $\frac{V_0}{2}$ and then suddenly compressed to $V_0/4$. Find the final pressure.

(b) If the gas is suddenly compressed from the volume V_0 to $V_0/2$ and then slowly compressed to $V_0/4$, what will be the final pressure ?

15. A vessel of volume V = 30 ℓ contains ideal gas at the temperature 0°C. After a portion of the gas has been let out, the pressure in the vessel is decreased by Δp = 0.78 atm (the temperature remaining constant). Find the mass of the released gas. The gas density under the normal conditions ρ = 1.3 g/ℓ.

16. Two identical vessels are connected by a tube with a valve letting the gas pass from one vessel into the other if the pressure difference $\Delta p \geq 1.10$atm. Initially there was a vacuum in one vessel while the other contained ideal gas at a temperature t_1 = 27°C and pressure p_1 = 1 atm. Then both vessels were heated to a temperature t_2 = 107°C. Up to what value will the pressure in the first vessel (which had vacuum initially) increase?

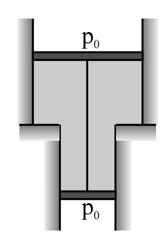
17. A vessel of volume V = 7.5 ℓ contains a mixture of ideal gases at a temperature T = 300 K. v_1 = 0.10 mole of oxygen, v_2 = 0.20 mole of nitrogen, and v_3 = 0.30 mole of carbon dioxide. Assuming the gases to be ideal, find

(a) the pressure of the mixture;

(b) the mean molar mass M of the given mixture which enters its equation of state pV = (m/M)RT, where m is the mass of the mixture.

18. A vertical cylinder closed from both ends is equipped with an easily moving piston dividing the volume into two parts, each containing one mole of air. In equilibrium at T_0 = 300 K the volume of the upper part is η = 4 times greater than that of the lower part. At what temperature will the ratio of these volumes be equal to η' = 3?

19. A smooth vertical tube having two different sections is open from both ends and equipped with two pistons of different areas as shown in figure. Each piston slides within a respective tube section. One mole of an ideal gas is enclosed between the pistons tied with a non-stretchable thread. The cross-sectional area of the upper piston is ΔS = 10 cm^2 greater than that of the lower one. The combined mass of the two pistons is equal to m = 5 kg. The outside air pressure is p_0 = 1 atm. By how many kelvins must the gas between the pistons be heated to shift the pistons through ℓ = 5 cm?



20. The operating temperature of a tungsten filament in an incandescent lamp is 2000 K and its emissivity is 0.30. Find the surface area of the filament of a 25 watt lamp.

Stefan constant $= 5.67 \times 10^{-8}\ \mathrm{W\,m^{-2}\,K^{-4}}$.

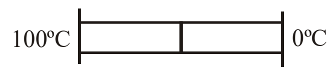
21. A tungsten heater wire of 1 meter is rated at 3 kW m^{-1} and is 5.0×10^{-4} m in diameter. It is embedded along the axis of a ceramic cylinder of diameter 0.12 m. When operating at the rated power, the wire is at 1500ºC; the outside of the cylinder is at 20ºC. Find the thermal conductivity of the ceramic.

22. A blackened solid copper sphere of radius 2 cm is placed in an evacuated enclosure whose walls are kept at 100ºC. At what rate must energy be supplied to the sphere to keep its temperature constant at 127ºC ? Stefan constant $= 5.67 \times 10^{-8}\ \mathrm{J\,m^{-2}\,K^{-4}}$

23. The ends of a meter stick are maintained at 100ºC and 0ºC. One end of a rod is maintained at 25ºC. Where should its other end be touched on the meter stick so that there is no heat current in the rod in steady state ?

24. A copper sphere is suspended in an evacuated chamber maintained at 300 K. The sphere is maintained at a constant temperature of 500 K by heating it electrically. A total of 210 W of electric power is needed to do it. When the surface of the copper sphere is completely blankened, 700 W is needed to maintain the same temperature of the sphere. Calculate the emissivity of copper.

25. Two rods shown in figure have identical geometrical dimensions. They are in contact with two heat bath at temperature 100ºC and 0ºC. The temperature of the junction is 70ºC. Find the temperature of the junction if the rods are interchanged.



EXERCISE 4

1. A circular hole in an aluminium plate is 2.54 cm in diameter at 0 °C . What is the diameter when the temperature of the plate is raised to 100°C ? [Given $\alpha_{Al} = 2.3 \times 10^{-5}$ /°C]

(A) 2.4558 (B) 2.5458 (C) 1.4558 (D) 1.5458

2. A steel scale measures the length of a copper as 80.0 cm when both are at 20 °C , the calibration temperature for the scale . What would the scale read for the length of the rod when both are at 40°C? [α for steel = 11×10^{-6} per°C and α for Cu = 17×10^{-6} per°C]

(A) 80.0096 cm (B) 80.9600 cm (C) 81.0096 cm (D) 81.9600 cm

3. A metal sphere of radius r and specific heat S is rotated about its axis passing through its centre at a speed of n rotations per second. It is suddenly stopped and 50% of its energy is used in increasing its temperature, then the rise in the temperature of the sphere is :

(A) $\frac{2}{5}\frac{\pi^2 n^2 r^2}{S}$ (B) $\frac{1}{10}\frac{\pi^2 n^2}{r^2 S}$ (C) $\frac{7}{8}\pi r^2 n^2 S$ (D) none of these

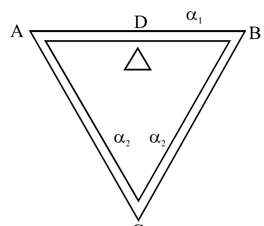
4. An equilateral triangle ABC is formed by joining three rods of equal length and D is the mid point of AB . The coefficient of linear expansion for AB is α_1 and for AC and BC is α_2. Find the relation between α_1 and α_2, if distance DC remain constant for small changes in temperature :

(A) $\alpha_1 = \alpha_2$

(B) $\alpha_1 = 2\alpha_2$

(C) $\alpha_2 = 4\alpha_1$

(D) $\alpha_1 = \frac{1}{2}\alpha$

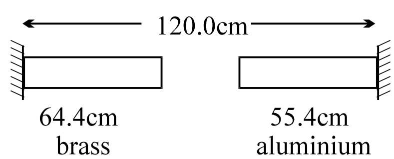


5. The loss is weight of a solid when immersed in a liquid at 0 °C is W_0 and at t °C , it is W . If the cubical coefficient of expansion of solid and liquid be γ_s and γ_ℓ respectively, then W is equal to :

(A) $W_0[1+(\gamma_s-\gamma_\ell)t]$ (B) $W_0[1-(\gamma_s-\gamma_\ell)t]$

(C) $W_0(\gamma_s-\gamma_\ell)t$ (D) $W_0 t/(\gamma_s-\gamma_\ell)$

6. A brass rod is 64.4 cm long and an aluminium rod is 55.4 cm long when both rods are at an initial temperature of 0ºC. The rods are placed in line with a gap of 0.2 cm between them. The distance between the far ends of the rods is maintained at 120.0 cm throughout. The temperature is raised until the two rods are barely in contact. The coefficients of linear expansion of bras and aluminium are 2.0×10^{-5} k^{-1} and 2.4×10^{-5} k^{-1}, respectively. In figure, the ratio of the increase in the length of the aluminium rod to that of the brass rod, is closest to :



(A) 1.12 (B) 1.20 (C) 1.29 (D) 1.03

7. A thin steel ring of inner diameter 40 cm and cross-sectional area 1 mm^2, is heated until it easily slides on a rigid cylinder of diameter 40.05 cm . [For steel , $\alpha = 10^{-5}$ /ºC , Y = 200 GPa]
When the ring cools down, the tension in the ring will be :

(A) 1000 N (B) 500 N (C) 250 N (D) 100 N

8. The density of steel at 0 ºC is 8.0 g/cc. At what temperature is density lesser by 0.1 %? Co-efficient of linear expansion of steel is 10^{-5} /ºC.

(A) 37.2 ºC (B) 33.3 ºC (C) 55.4 ºC (D) 40.2 ºC

9. 100 g of water at 100°C and 100 g of ice at 0°C are mixed then final temperature of mixture is :

(A) 2°C (B) 1°C (C) 0°C (D) –1°C

10. 300 g of water at 25 °C and 100 g of ice at 0°C were mixed . What will be the final temperature of mixture .

(A) 25 °C (B) 10 °C (C) 15 °C (D) 0 °C

11. Assuming no heat loses , the heat released by the condensation of x g of steam at 100°C can be used to convert y g of ice at 0°C into water at 100°C, the ratio of x : y is :

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

12. 50 g of copper is heated to increase its temperature by 10°C. If the same quantity of heat is given to 10 g of water, the rise in its temperature is [Specific heat of copper = 420 J/kg-°C, Specific heat of water = 4200 J/kg–°C]

(A) 5°C (B) 6°C (C) 7°C (D) 8°C

14. The coefficient of volume expansion for an ideal gas at constant pressure is :

(A) $\gamma = T$ (B) $\gamma = 1/T$ (C) $\gamma = 1/T^2$ (D) $\gamma = \sqrt{T}$

15. A diatomic gas does 100J of work when it expanded isobarically. The heat given to the gas during this process is :

(A) 700J (B) 350J (C) 175J (D) 1050J

16. The initial pressure and volume of a given mass of a gas ($C_p/C_v = \gamma$) are p_0 and V_0. The gas can exchange heat with the surrounding. The gas is compressed in two following ways (A) and (B) i.e.,

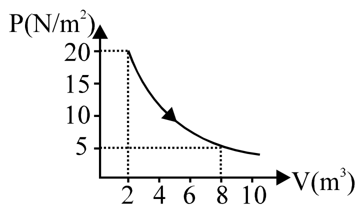
(a) It is slowly compressed to a volume $V_0/2$ and then suddenly compressed to $V_0/4$

(b) If the gas is suddenly compressed from the volume V_0 to $V_0/2$ and then slowly compressed to $V_0/4$, then

(A) final pressure in a is greater than b (B) final pressure in a is less than b

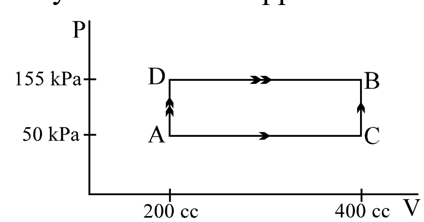
(C) final pressure in a is equal to b (D) data not sufficient to predict

17. A perfect gas undergoes changes in pressure and volume as shown. During this change :



(A) dQ = 0 (B) dW is +ve (C) dT = 0 (D) dU = 0

18. 50 cal of heat should be supplied to take a system from the state A to the state B through the path ACB as shown in figure . Find the quantity of heat to be supplied to take it from A to B via ADB



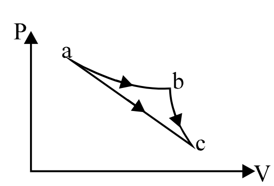
(A) 55 cal

(B) 310 cal

(C) 25 cal

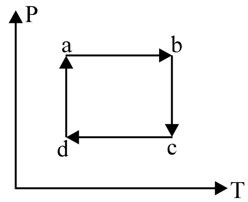
(D) 110 cal

19. In the PV diagram of figure, an ideal gas does 5 J of work when taken along the process ab and 4J when taken along process bc. What is the change in internal energy of gas when it is taken along the straight path from a to c? Out of two curves in the graph one is of isothermal process and other is of adiabatic process.



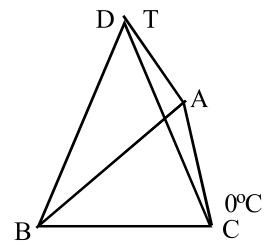
(A) –1 J (B) – 4 J (C) 9 J (D) 1 J

20. On a PT diagram a cyclic process performed on an ideal gas is shown . The volume is maximum at state



(A) a (B) b (C) c (D) d

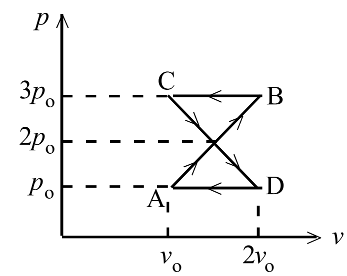
21. Six similar bars each of thermal resistance R are joined to form a regular tetrahedron as shown in the figure. Point D is maintained is maintained at a constant temperature T°C, and point C at 0°C. Temperature of junction A is :



(A) $\frac{T}{4}$ (B) $\frac{T}{3}$

(C) $\frac{T}{2}$ (D) $\frac{T}{5}$

22. A thermodynamic system undergoes cyclic process ABCDA as shown in the figure. The work done by the system is



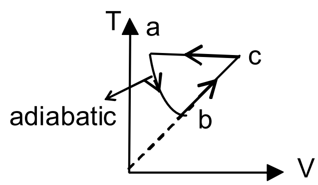
(A) $p_o v_o$

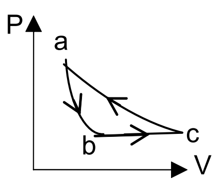
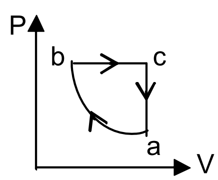
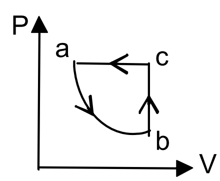
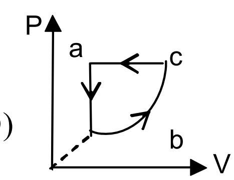
(B) $2p_o v_o$

(C) $\frac{p_o v_o}{2}$

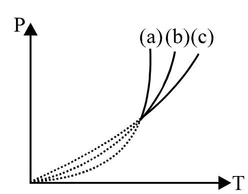
(D) zero

23. PV curve for the process whose VT curve is



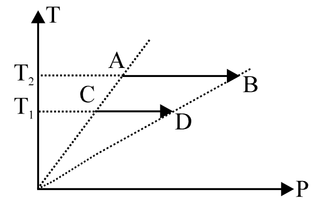
(A)  (B)  (C)  (D) 

24. P-T diagram for Ne, H_2 and CH_4 gas sample for adiabatic process is given. Which of the three curves corresponds to Ne ?



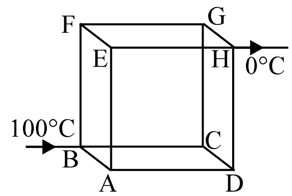
(A) a (B) b (C) c (D) can't be decided

25. Two moles of an ideal gas is taken through two processes once A to B, and C to D seperately. The processes are shown on PT diagram. The work done by the gas in process AB is three times the work done in process CD, then what is the ratio of T_2/T_1.



(A) 1/3 (B) 3 (C) 1/6 (D) 6

26. Twelve identical conducting rods form the sides of a uniform cube of side *l*. In the steady state, B and H ends of the cube are maintained at 100°C and 0°C. Find the temperature of the junction 'A'.



(A) 80°C (B) 60°C (C) 40°C (D) 70°C

27. A cylinder of radius R made of a material of thermal conductivity K_1, is surrounded by cylindrical shell of inner radius R and outer radius 2R made of material of thermal conductivity K_2. The two ends of thecombined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in a steady state. The effective thermal conductivity of the system is

(A) $K_1 + K_2$ (B) $\frac{K_1K_2}{K_1+K_2}$ (C) $\frac{K_1+3K_2}{4}$ (D) $\frac{3K_1+K_2}{4}$

28. The temperature coefficient of resistance of a conductor varies as $\alpha(T) = 3T^2 + 2T$. If R_0 is resistance at T = 0 and R be resistance at T then

(A) $R = R_0(6T+2)$ (B) $R = 2R_0(3+2T)$

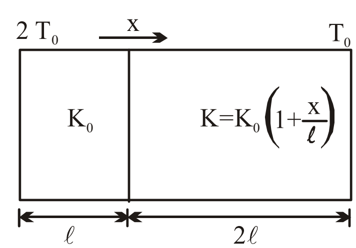
(C) $R = R_0(1+T^2+T^3)$ (D) $R = R_0(1-T+T^2+T^3)$

29. A copper calorimeter of mass 60g contains 400g of water at 38ºC. When 158g of ice is added, the temperature falls to 5ºC. The latent heat of fusion of ice will be, if the specific heat of calorimeter is 0.1 cal/gºC will be -

(A) 79.2 cal/g (B) 79.4 cal/g (C) 79.8 cal/g (D) 80.8 cal/g

30. The temperature at the interface for steady flow of heat through the slab, if heat conductivity of first slab of length 'ℓ' is K_0 and is uniform every where but the conductivity of second slab of length '2ℓ' varies with the distance 'x' measured from the interface according to the law

$K = K_0\left(1+\frac{x}{\ell}\right)$ is : (The temperature at the boundries of the composite slab are $2T_0$ and T_0)



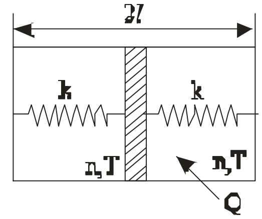
(A) $T' = \left(\frac{2\ell n2+1}{\ell n2+1}\right)T_0$ (B) $T' = \left(\frac{2\ell n3+1}{\ell n3+1}\right)T_0$

(C) $T' = \left(\frac{2\ell n3+1}{\ell n3-1}\right)T_0$ (D) $T' = \left(\frac{4\ell n3+1}{\ell n3+1}\right)T_0$

EXERCISE 5

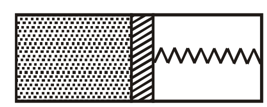
1. Ice at 0ºC is added to 200 g of water initially at 70ºC in a vacuum flask. When 50 g of ice has been added and has all melted the temperature of the flask and contents is 40ºC. When a further 80 g of ice has been added and has all melted the temperature of the whole becomes 10ºC. Find the specific latent heat of fusion of ice.

2. A horizontal cylindrical vessel of length $2l$ is separated by a thin heat-insulating piston into two equal parts each of which contains n moles of an ideal monatomic gas at a temperature T. The piston is connected to the end faces of the vessel by undeformed springs of rigidity k each (figure). When an amount of heat Q is supplied to the gas in the right part, the piston is displaced to the left by a distance $x = l/2$.



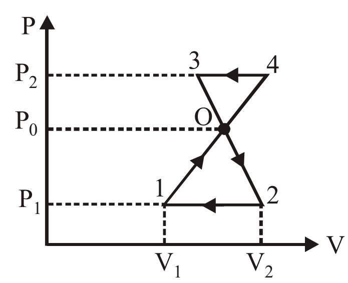
Determine the amount of heat Q' given away at the temperature T to a thermostat with which the gas in the left part is in thermal contact all the time.

3. A thermally insulated vessel is divided into two parts by a heat-insulating piston which can move in the vessel without friction. The left part of the vessel contains one mole of an ideal monatomic gas, and the right part is empty. The piston is connected to the right wall of the vessel through a spring whose length in free state is equal to the length of the vessel (figure). Determine the heat capacity C of the system, neglecting the heat capacities of the vessel, piston and spring.



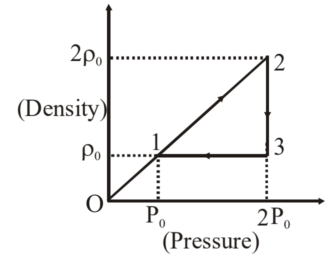
4. A vertical cylinder of cross-sectional area S contains one mole of an ideal monatomic gas under a piston of mass M. At a certain instant, a heater which transmits to a gas an amount of heat q per unit time is switched on under the piston. Determine the established velocity v of the piston under the condition that the gas pressure under the piston is constant and equal to p_0, and the gas under piston is thermally insulated.

5. Determine the work A done by an ideal gas during a closed cycle $1 \to 4 \to 3 \to 2 \to 1$ shown in figure. If $p_1 = 10^5\,Pa$, $p_0 = 3 \times 10^5\,Pa$, $p_2 = 4 \times 10^5\,Pa$, $V_2 - V_1 = 100\ell$, and segments 4-3 and 2-1 of the cycle are parallel to the V-axis.

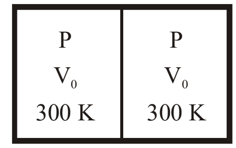


6. The density (ρ) versus pressure (P) graph of an ideal gas (monoatomic) undergoing a cyclic process is shown in figure. The gas taken has molecular weight M and one mole of gas is taken.

(a) Find work done in each process
(b) Find heat rejected by gas in one complete cycle.
(c) Find the efficiency of the cycle.



7. A heat conducting piston can move freely inside a closed, thermally insulated cylinder with an ideal gas $(\gamma = 5/3)$. At equilibrium the piston divides the cylinder into two equal parts, the temperature of gas being equal to 300 K. The piston is slowly displaced by an external agent. Find the temperature of gas when the volume of the greater section is seven times the volume of the smaller section.



8. 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.

9. Gaseous hydrogen contained initially under standard conditions in a sealed vessel of volume V = 5.0 ℓ was cooled by $\Delta T = 55$K. Find how much the internal energy of the gas will change and what amount of heat will be lost by the gas.

10. Calculate the value of $\gamma = C_P/C_V$ for a gaseous mixture consisting of $v_1 = 2$ moles of oxygen and $v_2 = 3$ moles of carbon dioxide. The gases are assumed to be ideal.

11. Find the specific heat capacities C_V and C_P for a gaseous mixture consisting of 7 g of nitrogen and 20 g of argon. The gases are assumed to be ideal.

12. Find the molar heat capacity of an ideal gas in a polytropic process pV^n = constant if the adiabatic exponent of the gas is equal to γ. At what values of the polytropic constant n will the heat capacity of the gas be negative?

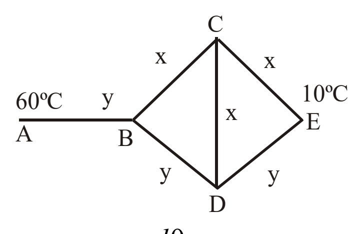
13. An ideal gas whose adiabatic exponent equals γ is expanded according to the law $p = \alpha V$, where α is a constant. The initial volume of the gas is equal to V_0. As a result of expansion the volume increases η times. Find :
(a) the increment of the internal energy of the gas;
(b) the work performed by the gas;
(c) the molar heat capacity of the gas in the process

14. One mole of an ideal gas whose adiabatic exponent equals γ undergoes a process $p = p_0 + \alpha/V$, where p_0 and α are positive constants. Find
(a) heat capacity of the gas as a function of its volume;
(b) the internal energy increment of the gas, the work performed by it, and the amount of heat transferred to the gas, if its volume increased from V_1 to V_2.

15. For the case of an ideal gas find the equation of the process (in the variables T, V) in which the molar heat capacity varies as :
(a) $C = C_V + \alpha T$; (b) $C = C_V + \beta V$; (c) $C = C_V + aP$, and α, β and a are constant

16. The diameter of a gas bubble formed at the bottom of a pond is d = 4 μm. When the bubble rises to the surface its diameter increases n = 1.1 times. Find how deep is the pond at that spot. The atmospheric pressure is standard, the gas expansion is assumed to be isothermal.

17. Three rods of material *x* and three rods of material *y* are connected as shown in figure. All the rods are of identical length and cross-sectional area. If the end *A* is maintained at 60ºC and the junction *E* at 10ºC, calculate temperature of junctions *B, C* and *D*. The thermal conductivity of *x* is 0.92 cal/cm-sºC and that of *y* is 0.46 cal/cm-sºC.



18. A hot body placed in a surrounding of temperature θ_0 obeys Newton's law of cooling $\frac{d\theta}{dt} = -k(\theta - \theta_0)$.
Its temperature at $t = 0$ is θ_1. The specific heat capacity of the body is *s* and its mass is *m*. Find
(a) The maximum heat that the body can lose and
(b) The time starting from $t = 0$ in which it will lose 90% of this maximum heat.

EXERCISE 6

NEW IIT-JEE PATTERN QUESTIONS

MULTIPLE CHOICE ANSWER TYPE

1. Two rods of length L_1 and L_2 are made of materials of co-efficients of linear expansions α_1 and α_2 respectively such that $L_1\alpha_1 = L_2\alpha_2$. The temperature of the rods is increased by ΔT and correspondingly the change in their respective lengths ΔL_1 and ΔL_2.

(A) $\Delta L_1 \neq \Delta L_2$

(B) $\Delta L_1 = \Delta L_2$

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

(D) data is insufficient to arrive at a conclusion

2. A uniform cylinder of steel of mass M, radius R is placed on frictionless bearings and set to rotate about its vertical axis with angular velocity ω_0. After the cylinder has reached the specified state of rotation it is heated without any mechanical contact from temperature T_0 to $T_0 + \Delta T$. If $\frac{\Delta I}{I}$ is the fractional change in moment of inertia of the cylinder and $\frac{\Delta\omega}{\omega_0}$ be the fraction change in the angular velocity of the cylinder and α be the coefficient of linear expansion, then

(A) $\frac{\Delta I}{I} = \frac{2\Delta R}{R}$ (B) $\frac{\Delta I}{I} = \frac{\Delta\omega}{\omega_0}$ (C) $\frac{\Delta\omega}{\omega_0} = -2\alpha\Delta T$ (D) $\frac{\Delta I}{I} = -\frac{2\Delta R}{R}$

3. Equal masses of three substances A, B and C have temperatures 10°C, 25°C and 40°C respectively. When A and B are mixed, the temperature of mixture is 15°C and when B and C are mixed the temperature of the mixture is 30°C. Then :

(A) $S_B = 2S_A$ (B) $S_A = 4S_C$ (C) $S_A = 2S_B$ (D) $S_B = 3S_C$

4. When two samples at different temperatures are mixed, the temperature of the mixture can be :

(A) lesser than lower or greater than higher temperature

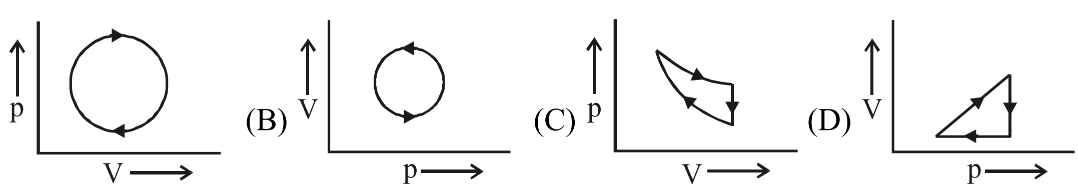
(B) equal to lower or higher temperature

(C) greater than lower but lesser than higher temperature

(D) average of lower and higher temperatures.

5. The following are the p-V diagrams for cyclic processes for a gas. In which of these processes is heat absorbed by the gas ?

(A) (B) (C) (D)



6. The internal energy of a system remains constant when it undergoes :

(A) a cyclic process

(B) an isothermal process

(C) an adiabatic process

(D) any process in which the heat given out by the system is equal to the work done on the system

7. The molar specific heat for a gas may have a value given by :

(A) $C_V = \frac{dU}{dT}$ (B) $C_P = \left(\frac{dQ}{dT}\right)_P$

(C) $C = \frac{dU}{dT} + P\frac{dV}{dT}$ (D) data insufficient

8. An ideal gas is heated from temperature T_1 to T_2 under various conditions. The correct statement(s) is/are

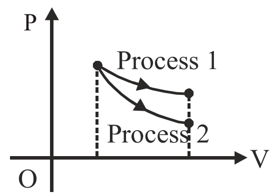
(A) $\Delta U = nC_V(T_2 - T_1)$ for isobaric, isochoric and adiabatic process

(B) work is done at expense of internal energy in an adiabatic process and both have equal values

(C) $\Delta U = 0$ for an isothermal process

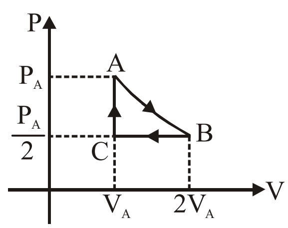
(D) $C = 0$ for an adiabatic process

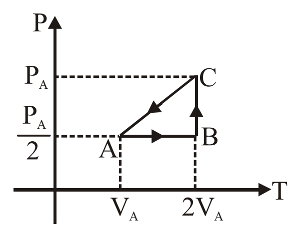
9. The indicator diagram for two process 1 and 2 carried on an ideal gas is shown in figure. If m_1 and m_2 be the slopes $\left(\frac{dP}{dV}\right)$ for process 1 and process 2 respectively, then

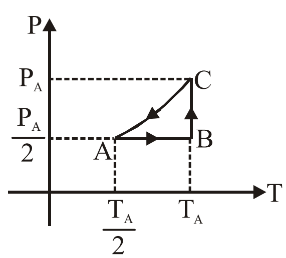


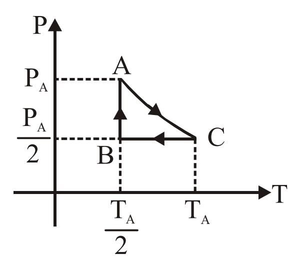
(A) $m_1 = m_2$ (B) $m_1 > m_2$ (C) $m_1 < m_2$ (D) $m_2 C_V = m_1 C_P$

10. Three moles of an ideal gas $\left(C_P = \frac{7}{2}R\right)$ at pressure P_A and temperature T_A is isothermally expanded to twice its initial volume. It is then compressed at constant pressure to its original volume. Finally the gas is compressed at constant volume to its original pressure P_A. The correct $P-V$ and $P-T$ diagrams indicating the process are

(A)


(B)


(C)


(D)


11. A solid sphere and a hollow sphere of the same material and of equal radii are heated to the same temperature.

(A) Both will emit equal amount of radiation per unit time in the beginning.

(B) Both will absorb equal amount of radiation from the surrounding in the beginning.

(C) The initial rate of cooling (dT/dt) will be the same for the two spheres.

(D) The two spheres will have equal temperatures at any instant.

12. Monoatomic, diatomic and triatomic gases whose initial volume and pressure are same, each is compressed till their pressure becomes twice the initial pressure. Then :

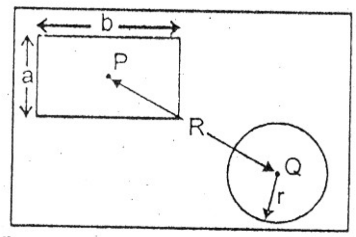
(A) if the compression is isothermal, then their final volumes will be same

(B) if the compression is adiabatic, then their final volumes will be different

(C) if the compression is adiabatic, then triatomic gas will have maximum final volume

(D) if the compression is adiabatic, then monoatomic gas will have maximum final volume

13. There is a rectangular metal plate in which two cavities in the shape of rectangle and circle are made, as shown with dimensions. P and Q are centres of these cavities. On heating the plate, which of the following quantities increase ?



(A) πr^2 (B) ab (C) R (D) b

14. 25g of steam is passed into a calorimeter containing 300g of water at 0ºC. The final temperature of water in the calorimeter is found to be 49ºC. The latent heat of steam. Nelgect the heat absorbed by calorimeter.

(A) 517 cal/g (B) 637 cal/g (C) 737 cal/g (D) 537 cal/g

15. An ideal gas is taken from the state A (pressure P, volume V) to the state B (pressure P/2, volume 2V) along a straight line path in the P–V diagram. Select the correct statement(s) from the following:

(A) The work done by the gas in the process A to B exceeds the work that would be done by it if the system were taken from A to B along an isotherm

(B) In the T-V diagram, the path AB becomes a part of the parabola

(C) In the P-T diagram, the path AB becomes a part of the hyperbola

(D) In going from A to B the temperature T of the gas first increases to a maximum value and then decreases

16. Suppose that the volume of a certain ideal gas is to be doubled by one of the following processes

(1) isothermal expansion (2) adiabatic expansion

(3) free expansion (4) expansion at constant pressure

If E_1, E_2, E_3 and E_4 respectively are the changes in average kinetic energy of the molecules for the above four processes, then :

(A) $E_2 = E_3$ (B) $E_1 = E_3$ (C) $E_1 > E_4$ (D) $E_4 > E_3$

17. In Newton's law of cooling, $\frac{d\theta}{dt} = -k(\theta - \theta_0)$, the constant 'k' is proportional to :

(A) A, surface area of the body (B) S, specific heat of the body

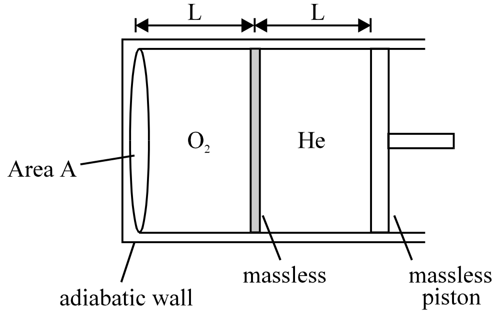
(C) $\frac{1}{m}$, m being mass of the body (D) e, emmisivity of the body

18. A vessel contains a mixture of one mole of oxygen and two moles of nitrogen at 300 K. The ratio of the average rotational kinetic energy per O_2 molecule to that per N_2 molecule is

(A) 1 : 1 (B) 1 : 2

(C) 2 : 1 (D) depends on the moments of inertia of the two molecules

19. A cylinder contains He and O_2 of equal volume. They are separated by massless freely moving piston as shown. If the gas is adiabatically compressed by moving the piston so that volume of He becomes half. Finally :



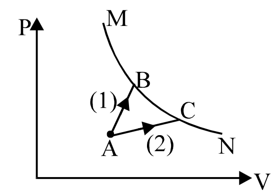
(A) pressure in He chamber will be equal to pressure in O_2 chamber

(B) pressure in He chamber will be less than pressure in O_2 chamber

(C) volume of He chamber will be equal to volume of O_2 chamber

(D) volume of O_2 chamber will be $LA/(2)^{25/21}$

20. An ideal gas takes part in two thermodynamical processes in which it is heated from the same initial state to the same final temperature. The processes are shown on PV diagram by straight lines 1 and 2. MN is an isothermal curve.



(A) Change in internal energy in process (1) and (2) is equal

(B) work done in process AB is more than work done in process AC

(C) heat exchange in process AC is more than heat exchange in process AB

(D) work done in process AC is more than work done in process BC

21. Internal energy of an ideal diatomic gas at 300K is 100J. In this 100J

(A) potential energy = 0 J (B) rotational kinetic energy = 40 J

(C) Translational kinetic energy = 60 J (D) Translational kinetic energy = 100J

22. An air bubble of radius r rises from the bottom of a pond of depth H. When it reaches the free surface, its radius becomes 3r. The bubble expands due to

(A) Isothermal process (B) Adiabatic process

(C) Adiabatic or Isothermal Process (D) both Adiabatic & Isothermal process

23. It takes 15 minutes for an electric kettle to heat a certain quantity of water from 0ºC to boiling point (100ºC). It requires 80 minute so turn all the water at 100ºC into steam. The latent heat of steam will be-

(A) 523.3 cal/g (B) 513.3 cal/g (C) 533.3 cal/g (D) 533 cal/g

24. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [ρ = density of the gas].

The gas is initially at temperature T, pressure P and density ρ.

The gas expands such that density changes to $\frac{\rho}{2}$

(A) The pressure of the gas changes to $\sqrt{2}P$

(B) The temperature of the gas changes to $\sqrt{2}T$

(C) The graph of the above process on the P-T diagram is parabola

(D) The graph of the above process on the P-T diagram is hyperbola

25. At ordinary temperatures, the molecules of an ideal gas have only translational and rotational kinetic energies. At high temperatures they may also have vibrational energy. As a result of this at higher temperatures

(C_V = molar heat capacity at constant volume)

(A) $C_V = \frac{3}{2}R$ for a monoatomic gas

(B) $C_V > \frac{3}{2}R$ for a monoatomic gas

(C) $C_V < \frac{5}{2}$ for a diatomic gas

(D) $C_V > \frac{5}{2}$ for a diatomic gas

REASONING TYPE

26. **Statement -1 :**

In adiabatic compression the internal energy and temperature of the system get decreased.

Statement -2 :

The adiabatic compression is a slow process.

27. **Statement -1 :**

The isothermal curves intersect each other at a certain point.

Statement -2 :

The isothermal change are done slowly, so the isothermal curves have very little slope.

28. **Statement -1 :**

V-T graph in a process is rectangular hyperbola. Then P-T graph in the same process will be a parabola.

Statement -2 :

If V-T graph is rectangular hyperbola, with increase in T, volume will decrease and hence pressure will increase.

29. **Statement -1 :**

Heat supplied to a gas in a process is 100 J and work done by the gas in the same process is 120 J, then pressure of the gas in the process should increase.

Statement -2 :

Work done by the gas is greater than the heat supplied to the gas. Hence internal energy of the gas should decrease.

30. **Statement -1 :**

Conduction is the process by which heat is transferred from one end to another end of metal rod.

Statement -2 :

In conduction, the atoms vibrates to transfer heat from one end to another end of metal rod.

31. **Statement -1 :**

The bulb of one thermometer is spherical while that of the other is cylindrical. Both have equal amount of mercury. The response of the cylindrical bulb thermometer will be quicker.

Statement -2 :

Heat conduction in a body is directly proportional to cross-sectional area.

32. **Statement -1 :**

A common model of a solid assumes the atoms to be points executing SHM about mean lattice positions. This model cannot explain thermal expansion of solids.

Statement -2 :

The average distance over a time period of oscillation between the particles remains constant.

33. **Statement -1 :**

If temperature of a gas increases work done by it is positive.

Statement -2 :

As temperature of a gas increases its internal energy increases.

34. **Statement -1 :**

Work done by a gas in isothermal expansion is more than the work done by the gas in the same expansion adiabatically.

Statement -2 :

Temperature remains constant in isothermal expansion but not in adiabatic expansion.

35. **Statement -1 :**

The internal energy of a given sample of an ideal gas depends only its temperature according to kinetic theory of gases.

Statement -2 :

The ideal gas molecules do not exert intermolecular forces.

36. **Statement -1 :**

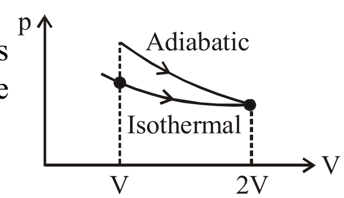
Two sphere of same material have radius r_1 and r_2 respectively and temperature 4000 K and 2000 K respectively. The energy radiated per second by first sphere must be more than second sphere.

Statement -2 :

Energy radiated by a body is given by Stefan's law as $\frac{dQ}{dt} = e\sigma AT^4$.

37. **Statement -1 :**

A gas is expanded from a volume V to 2V, first through adiabatic process then through isothermal process. Work done in isothermal process is more if final stage (i.e. pressure and volume) in both case is same.



Statement -2 :

Work done by gas is equal to area under p-V curve.

38. **Statement -1 :**

In isothermal process whole of the heat energy supplied to the body is converted into internal energy.

Statement -2 : According to the first law of thermodynamics $\Delta Q = U + P\Delta V$

39. **Statement -1 :**

A body that is a good radiator is also a good absorber of radiation at a given wavelength because

Statement -2 :

According to Kirchoff's Law the absorptivity of a body is equal to it's emissivity at a given wavelength.

40. **Statement -1 :**

In thermal conduction, energy is transferred due to chaotic motion of conduction electron and atomic vibrations from region of high temperature to low temperature.

Statement -2 :

There is overall transference of particles of conducting body.

41. **Statement -1 :**

The specific heat of a monatomic gas has value between o and 4R .

Statement -2 :

$c_P = \frac{5}{2}R$ and $c_V = \frac{3}{2}R$ for a monoatomic gas.

42. **Statement -1 :**

The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite.

Statement -2 :

Specific heat of a gas into directly proportional to change of heat in system and inversely proportional to change in temperature.

43. **Statement -1 :**

Two stars S_1 and S_2 radiate maximum energy at 360 nm and 480 nm respectively. Ratio of their absolute temperatures is 4 : 3.

Statement -2 :

According to Wien's law $\lambda T = b$ (constant)

44. **Statement -1 :**

Greater is the coefficient of thermal conductivity of a material, smaller is the thermal resistance of a rod of that material.

Statement -2 :

Thermal resistance is the ratio of temperature difference between the ends of the conductor and rate of flow of heat.

LINKED COMPREHENSION TYPE

Write Up-1

When a substance is heated, the heat gained by the substance is given by

$\Delta Q = ms\ \Delta t$. where m is the mass of substance, s = specific heat of substance and Δt is the rise in temperature. Now if the phase of the substance changes, the heat given or taken by the system will be

$\Delta Q = mL$, where m is the mass of substance & L is the latent heat of the substance.

45. 1 g of ice at 0ºC is mixed with 1 g of steam at 100ºC. After thermal equilibrium is attained the temperature of the mixture is :

(A) 1ºC (B) 50ºC

(C) 81ºC (D) 100ºC

46. In above problem, the maximum mass of ice that can be taken to get the equilibrium temperature (as calculated above) is :

(A) 1 g (B) 2 g

(C) 3 g (D) 4 g

Write Up-2

According to Newton's law of cooling rate of fall of temperature is given by

$\frac{dT}{dt} = -K(\theta - \theta_0)$, where K is constant, θ = temperature of substance & θ_0 = temperature of atmosphere.

47. A body cools from 50ºC to 40ºC in 5 minutes. The surrounding temperature is 20ºC. In what further time (in minutes) will it cools to 30ºC ?

(A) 5 (B) $\frac{15}{2}$

(C) $\frac{25}{3}$ (D) 10

48. In the previous question, what will be its temperature 5 minutes after reaching 40ºC ?

(A) 35ºC (B) $\frac{100}{3}$ ºC

(C) 32ºC (D) 30ºC

Write Up-3

A certain amount of ice is supplied heat at a constant rate for 7 minutes. For the first one minute the temperature rises uniformly with time. Then it remains constant for the next 4 minutes and again the temperature rises at uniform rate for the last two minutes. Given $S_{ice} = 0.5$ cal/gm-ºC, $L_f = 80$ cal/gm.

49. The initial temperature of ice is :

(A) - 10ºC (B) - 20ºC

(C) - 30ºC (D) - 40ºC

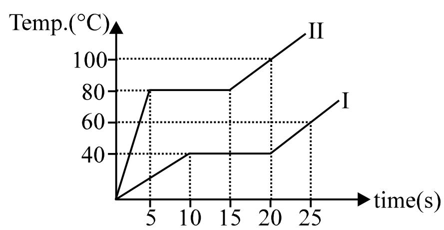
50. Final temperature at the end of 7 minutes is :

(A) 10ºC (B) 20ºC

(C) 30ºC (D) 40ºC

Write Up-4

Heat is given to equal amount of two bodies at the same rate. The variation of temperature with time is as shown in figure.



51. The ratio of melting points of body I and body II is

(A) $\frac{1}{2}$ (B) $\frac{2}{1}$ (C) $\frac{5}{3}$ (D) $\frac{3}{5}$

52. The ratio of specific heats of body I and body II is

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

53. The ratio of latent heats of body I and body II is

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

Write Up -5

A calorimeter of mass 'm' contains an equal mass of water in it. The temperature of the water and calorimeter is t_2. A block of ice of mass 'm' and temperature $t_3 < 0$ ºC is gently dropped into the calorimeter. Let C_1, C_2 and C_3 be the specific heats of calorimeter, water and ice respectively and L be the latent heat of ice.

54. The whole mixture in the calorimeter becomes ice if :

(A) $C_1t_2 + C_2t_2 + L + C_3t_3 > 0$ (B) $C_1t_2 + C_2t_2 + L + C_3t_3 < 0$

(C) $C_1t_2 + C_2t_2 - L + C_3t_3 > 0$ (D) $C_1t_2 + C_2t_2 - L - C_3t_3 < 0$

55. The whole mixture in the calorimeter becomes water if :

(A) $(C_1 + C_2)t_2 - C_3t_3 + L > 0$ (B) $(C_1 + C_2)t_2 + C_3t_3 + L > 0$

(C) $(C_1 + C_2)t_2 - C_3t_3 - L > 0$ (D) $(C_1 + C_2)t_2 + C_3t_3 - L > 0$

56. Water equivalent of calorimeter is :

(A) mC_1 (B) $\frac{mC_1}{C_2}$ (C) $\frac{mC_2}{C_1}$ (D) none of these

Write Up-6

Two mole of a monoatomic ideal gas follows the process $PV^{4/3}$ = const.

57. Which of the following statement is correct about this process

(A) It is an adiabatic process

(B) It is a process in which $\Delta Q = -\frac{1}{5}\Delta U$

(C) It is a process in which dQ = dU (always)

(D) It is a process in which dQ = – dU (always)

58. If this process is possible

(A) its molar heat capacity is negative

(B) its molar heat capacity is positive

(C) its molar heat capacity is zero

(D) molar heat capacity cann't be defined until volume or pressure is constant.

59. If initial temperature of system is T_0 and it is compressed to η times its initial volume then work done by system is

(A) $6RT_0\left(1-\eta^{-1/3}\right)$ (B) $6RT_0\left(1-\left(\frac{1}{\eta}\right)^{-1/3}\right)$

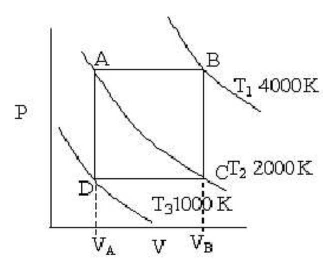
(C) $3RT_0\left(1-(\eta)^{-1/3}\right)$ (D) $3RT_0\left(1-\left(\frac{1}{\eta}\right)^{-1/3}\right)$

Write Up-7

Figure shows three isothermals at temperatures.

$T_1 = 4000K$ $T_2 = 2000K$ and $T_3 = 1000K$. When one mole of an ideal monatomic gas is taken through the path ABCDA

given $v_A = 1m^3 and v_B = 2m^3$



60. Network done by gas during the cycle

(A) 8.31 x 10^3 J (B) 16.62 x 10^3 J

(C) 4.15 x 10^3 J (D) 24.93 x 10^3 J

61. During $C \rightarrow D$

(A) 12.775×10^3 J Heat will be released (B) 20.775×10^3 J Heat will be released

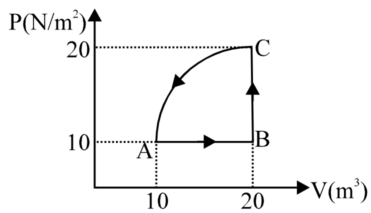
(C) 41.55×10^3 J Heat will be absorbed (D) 12.775×10^3 J Heat will be absorbed

62. Net heat absorbed by the gas during the cycle

(A) 24.93×10^3 J (B) 4.15×10^3 J (C) 16.62×10^3 J (D) 8.31×10^3 J

Write Up-8

The PV diagram for a cyclic process performed on an ideal monoatomic gas is shown in figure. The curve AC is one fourth of circle .



63. Work done by the gas in process A to B is :

(A) –100 J (B) +100 J (C) – 200 J (D) + 200 J

64. Heat absorbed by the gas in process B to C is :

(A) 150 J (B) –150 J (C) 300 J (D) Can't be calculated

65. Heat absorbed by gas in cyclic process is :

(A) -25π J (B) 25π J (C) 100π J (D) -100π J

Write Up-9

A monoatomic ideal gas sample is given heat Q. One fourth of this heat is used as work done by the gas and rest is used for increasing its internal energy.

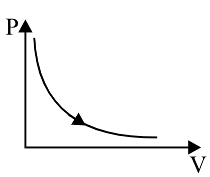
66. The molar specific heat for the gas in this process is

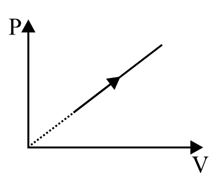
(A) $\frac{3}{2}R$ (B) $\frac{R}{2}$ (C) 2R (D) 3R

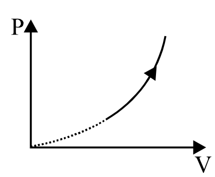
67. The equation of process in terms of volume and temperature is

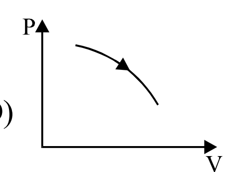
(A) $\frac{V}{T}$ = constant (B) $\frac{V}{\sqrt{T}}$ = constant (C) VT = constant (D) $V\sqrt{T}$ = constant

68. The PV diagram for the process is

(A) 

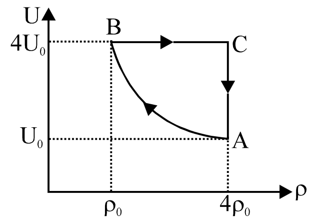
(B) 

(C) 

(D) 

Write-Up-10

Figure shows the variation of internal energy U with density ρ of one mole of an ideal monoatomic gas for a thermodynamic cycle ABCA. The curve AB on graph is a rectangular hyperbola.



69. The work done by the gas in process A to B is

(A) U_0 (B) $2U_0$ (C) $3U_0$ (D) $4U_0$

70. The work done by the gas in process B to C is

(A) $-\frac{8U_0}{3}\ln 2$ (B) $-\frac{16U_0}{3}\ln 2$ (C) $\frac{8U_0}{3}\ln 2$ (D) $-\frac{16U_0}{3}\ln 2$

71. The molar heat capacity of gas for process CA is

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

Write Up-11

The rate of flow of heat depends on the nature of material, cross-sectional area and temperature gradient . If a material of conductivity k has set up a temperature gradient in x direction , then rate of heat flow at cross-section having area A is $\frac{dQ}{dt} = \mathrm{k\ A}\ \frac{\mathrm{dT}}{\mathrm{dx}}$

Between any two points of conductor, if temperature difference is ΔT and rate of heat flow is H, then the resistance or opposition offered by the material to flow is defined as $R = \frac{\Delta T}{H}$

Now consider two very thin concentric metallic shells A and B of radii R_1 and R_2 ($R_2 > R_1$) and temperature T_1 and T_2 ($T_1 > T_2$) respectively. The hollow space between them is filled with sand of thermal conductivity k.

72. Thermal resistance offered by the sand is

(A) $\frac{1}{2\pi k}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (B) $\frac{1}{4\pi k}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (C) $4\pi k\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (D) $2\pi k\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

73. The rate of heat flow through the sand is

(A) $4\pi k(T_1 - T_2)\frac{R_1R_2}{R_2 - R_1}$ (B) $2\pi k(T_1 - T_2)\frac{R_1R_2}{R_1 - R_2}$

(C) $\frac{(T_1 - T_2)}{4\pi k}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (D) $\frac{(T_1 - T_2)}{2\pi k}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

74. The temperature T of a point at distance r from the centre in steady state condition where $R_1 < r < R_2$ is

(A) $(T_1 - T_2)\left(\frac{R_2\ (r - R_1)}{r(R_2 - R_1)}\right)$ (B) $T_1 - (T_1 - T_2)\left(\frac{R_2\ (r - R_1)}{r(R_2 - R_1)}\right)$

(C) $(T_1 - T_2)\left(\frac{R_1\ (r - R_1)}{r(R_2 - R_1)}\right)$ (D) $T_1 - (T_1 - T_2)\left(\frac{R_1\ (r - R_2)}{r(R_2 - R_1)}\right)$

Write Up-12

A gaseous mixture is enclosed in a vessel of volume V. One of the gases (A) has $\gamma\left(=\frac{C_P}{C_V}\right)=\frac{5}{3}$, while the other gas (B) has $\gamma=\frac{7}{5}$. The gases are ideal and do not react with each other. The mixture follows the equation $pV^{3/2}=$ constant, in a reversible adiabatic process.

75. The molar ratio of the two gases in the mixture is $(n_A : n_B)$

(A) 3 : 2 (B) 21 : 25 (C) 2 : 3 (D) 1 : 1

76. The gaseous mixture is expanded adiabatically and reversibly to 4 times its initial volume. The ratio of the final temperature of the mixture (on the absolute scale) to its initial temperature is

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{1}{2\sqrt{2}}$ (D) $\frac{1}{4\sqrt{2}}$

77. If the proportion of gas B in the mixture increases, then the γ of the mixture

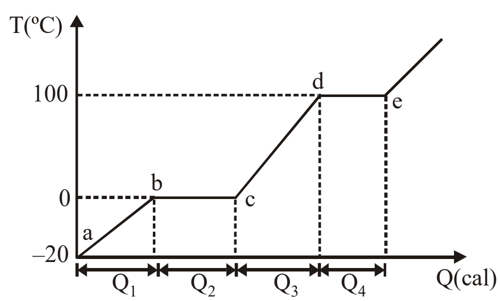
(A) increases (B) decreases

(C) remains unchanged (D) changes unpredictably

MATRIX MATCH TYPE

Match the following

78. Figure shows the temperature variation when heat is added continuously to a specimen of ice (1g) at –20°C. Specific heat of ice is 0.53 cal/g °C. Match Column-I with Column-II.

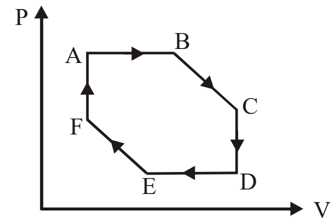


	Column I		**Column II**
(A)	Q_1 (cal)	(p)	80
(B)	Q_2 (cal)	(q)	539
(C)	Q_3 (cal)	(r)	100
(D)	Q_4 (cal)	(s)	10.6

79.

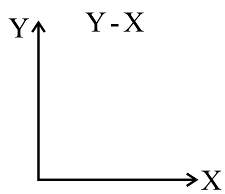
	Column I		**Column II**
(A)	Isothermal process	(p)	The pressure remains constant.
(B)	Adiabatic process	(q)	Change in internal energy is zero.
(C)	Isobaric process	(r)	Work done is positive when the volume of gas in increasing and is negative when the volume of gas is decreasing.

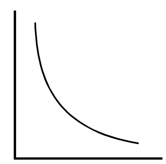
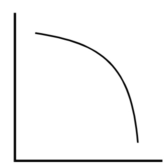
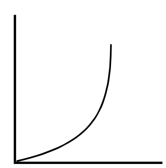
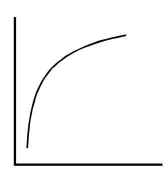
80. With reference to the P-V graph shown below, match Column-I with Column-II.
Temperature at A,B & F is T_1 and at C, D & E is T_2. Also $T_1 > T_2$



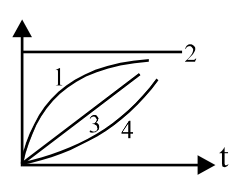
	Column I		Column II
(A)	$C \rightarrow D$	(p)	Isothermal
(B)	$B \rightarrow C$	(q)	Adiabatic compression
(C)	$F \rightarrow A$	(r)	Isochoric
(D)	$E \rightarrow F$	(s)	Adiabatic expansion

81. Respective graphs for adiabatic process taking first term on Y-axis



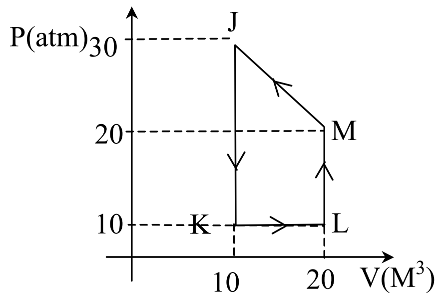
	Column I		Column II
(A)	Pressure - Temperature	(p)	
(B)	Volume - Temperature	(q)	
(C)	Pressure - Volume	(r)	
(D)	Pressure - Internal Energy	(s)	

82. A ball has surface temperature T initially at time t = 0, that is less than surrounding constant temperature T_0. On the vertical axis of the graph shown has either thermal energy radiated/absorbed per unit time or total energy radiated/absorbed till time t by the ball. Correctly match the curves marked in the graph :



	Column I	Column II	
(A)	Thermal energy emitted per unit time	(p)	1
(B)	Thermal energy absorbed per unit time	(q)	2
(C)	Total energy emitted till time t	(r)	3
(D)	Total energy absorbed till time t	(s)	4

83. Match the following for the given process:



Column - I	**Column - II**
(A) Process $J \to K$	(p) $W > 0$
(B) Process $K \to L$	(q) $w < 0$
(C) Process $L \to M$	(r) $Q > 0$
(D) Process $M \to J$	(s) $Q < 0$

84. There is an ideal gas sample. The ratio of C_P and C_V for gas sample is γ. In its initial state its pressure is P_1 and volume is V_1. Now it is expanded isothermally from volume V_1 to V_2. Then it is compressed adiabatically from volume V_2 to V_1 again

Regarding the above situation, match the following

Column I	**Column II**
(A) Heat given to system (i.e. ideal gas sample) during isothermal expansion.	(p) Positive
(B) Workdone by gas during adiabatic compression	(q) $\frac{P_1 V_1}{(\gamma - 1)}\left[\left(\frac{V_2}{V_1}\right)^{\gamma - 1} - 1\right]$
(C) Change in internal energy of gas sample during adiabatic process.	(r) $\frac{P_1 V_1}{(1 - \gamma)}\left[\left(\frac{V_2}{V_1}\right)^{\gamma - 1} - 1\right]$
(D) Change in internal energy of gas sample from most initial state to the final state.	(s) Negative.

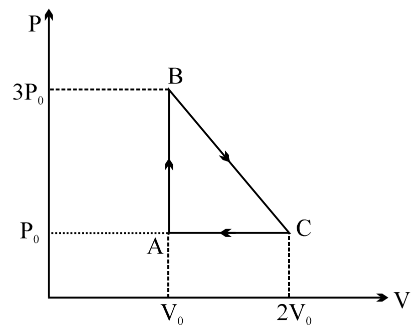
85.

Column I		**Column II**	
(Processes for ideal gases)		**(Symbols have usual meaning)**	
(A)	Isothermal	(p)	$\Delta U = 0$
(B)	Isobaric	(q)	$Q = 0$
(C)	Isochoric	(r)	$W = 0$
(D)	Adiabatic free expansions	(s)	$\Delta U = nC_V\Delta T$

86. Match the quantities given in column I with column II

Column I	**Column II**
(A) Adiabatic bulk modulus	(p) $-P/V$
(B) Slope of P–V graph in isothermal process	(q) $2/(\gamma - 1)$
(C) Degree of freedom	(r) γP
(D) The ratio of molar heat capacity at constant pressure to universal gas constant R	(s) $\dfrac{\gamma}{\gamma - 1}$

87. One mole of an ideal monoatomic gas is taken round the cyclic process ABCA as shown in figure. Then :



Column I			**Column II**
(A)	the work done by the gas in complete cyclic process is	(p)	$\dfrac{P_0V_0}{2}$
(B)	magnitude of heat exchanged by the gas in the path CA	(q)	$\dfrac{3P_0V_0}{8}$
(C)	magnitude of heat exchanged by the gas in the path BC	(r)	P_0V_0
(D)	the maximum temperature attained by the gas during the cycle (considering universal gas constant R = 25/3 unit)	(s)	$\dfrac{5}{2}P_0V_0$

88.

	Column I		**Column II**
(A)	Isochoric process	(p)	$\Delta U = 0$
(B)	Isobaric process	(q)	$\Delta Q = 0$
(C)	Isothermal process	(r)	$\Delta W = 0$
(D)	Adiabatic process	(s)	$\Delta W \neq 0$

EXERCISE 1

1. What is calorimeter? What is the principle of calorimetry.
2. Define latent heat. What are S.I. units of latent heat ?
3. Define internal energy of a system.
4. What is an indicator diagram? What is its significant?
5. What is the difference between isothermal and adiabatic process?
6. Which of the two will increase the pressure an adiabatic or an isothermal process in reducing the volume to 50%?
7. Can two isothermal curve intersect. Why?
8. Define c_P and c_V. Show that $c_P > c_V$.
9. State first law of thermodynamics.
10. What are the limitations of first law of thermodynamics?
11. Distinguish between cyclic process and non-cyclic process.
12. Prove that the slope of pv graph for an adiabatic process in γ times that of isothermal process.
13. Prove for an adiabatic process

    (i) $T^{\gamma-1}$ = constant (ii) $T^{\gamma}p^{1-\gamma}$ = constant
14. Define conduction, convection and radiation.
15. Write equation for the rate of flow of heat and specify the symbols used.
16. What do you understand by a block body? What is its absorptance? What are total radiations?
17. State stefan's law. Write the value of stefan's constant. Write Stefan-Boltzmann law in a mathematical form.
18. State kirchoff's law of block body radiation. Write one application of it.
19. What do you mean by steady state ? Explain.
20. The ratio of thermal conductivities of two different metals is 5 : 3. In order to have the same thermal resistance of these metals of equal thickness, what should be the ratio of their lengths?
21. Find the difference in temperature across the surface of an iron plate 5cm thick, through 100 sq m of which heat flows at the rate of 9.6×10^5 /s (Take $k = 96\ w\ m^{-1}\ k^{-1}$)
22. Prove that for an adiabatic process PV^2 = constant, where the symbols have their usual meanings.
23. Describe the working of carnot engine. Obtain an expression for its efficiency.
24. Explain briefly the working principle of a refrigerator and obtain an expression for its coefficient of performance.
25. State newton's law of cooling and derive it from stefan boltzmann law.

EXERCISE 8

1. Which statement is incorrect ? **[AIEEE-2002]**

(A) all reversible cycles have same efficiency

(B) reversible cycle has more efficiency than an irreversible one

(C) carnot cycle is a reversible one

(D) carnot cycle has the maximum efficiency in all cycles.

2. Even carnot engine cannot give 100% efficiency because we cannot **[AIEEE-2002]**

(A) prevent radiation

(B) find ideal sources

(C) reach absolute zero temperature

(D) eliminate friction.

3. 1 mole of a gas with $\gamma = 7/5$ is mixed with 1 mole of a gas with $\gamma = 5/3$, then the value of γ for the resulting mixture is **[AIEEE-2002]**

(A) 7/5 (B) 2/5 (C) 24/16 (D) 12/7

4. If θ_i is, the inversion temperature θ_n is the neutral temperature, θ_c is the temperature of the cold junction, then **[AIEEE-2002]**

(A) $\theta_i + \theta_c = \theta_n$ (B) $\theta_i - \theta_c = 2\theta_n$ (C) $\frac{\theta_i + \theta_c}{2} = \theta_n$ (D) $\theta_c - \theta_i = 2\theta_n$

5. A strip of copper and another of germanium are cooled from room temperature to 80K. The resistance is - **[AIEEE-2003]**

(A) each of these decreases

(B) copper strip increases and that of germanium decreases

(C) copper strip decreases and that of germanium increases

(D) each of these increases

6. The thermo emf of a thermo-couple is 25μV/ºC at room temperature. A galvanometer of 40ohm resistance, capable of detecting current as low as 10^{-5} A, is connected with the thermo couple. The smallest temperature difference that can be detected by this system is **[AIEEE-2003]**

(A) 16ºC (B) 12ºC (C) 8ºC (D) 20ºC

7. Heat cannot by itself flow from a body at lower temperature to a body at higher temperature is a statement or consequence of **[AIEEE-2003]**

(A) second law of thermodynamics

(B) conservation of momentum

(C) conservation of mass

(D) first law of thermodynamics

8. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio C_P / C_V for the gas is **[AIEEE-2003]**

(A) $\frac{4}{3}$ (B) 2 (C) $\frac{5}{3}$ (D) $\frac{3}{2}$

9. Which of th following parameters does not characterize the thermodynamics state of matter?

(A) temperature (B) pressure (C) work (D) volume **[AIEEE-2003]**

10. A carnot engine takes 3×10^6 cal of heat from a reservoir at 627ºC, and gives it to a sink at 27ºC. The work done by the engine is **[AIEEE-2003]**

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

11. According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and the surroundings, and n is equal to

(A) two (B) three (C) four (D) one **[AIEEE-2003]**

12. The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be **[AIEEE-2003]**

(A) 200% (B) 100% (C) 50% (D) 300%

13. One mole of ideal monatomic gas ($\gamma = 5/3$) is mixed with one mole of diatomic gas ($\gamma = 7/5$). What is γ for the mixture? γ Denotes the ratio of specific heat at constant pressure, to that at constant volume.

(A) 35/23 (B) 23/15 (C) 3/2 (D) 4/3 **[AIEEE-2004]**

14. 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 **[AIEEE-2004]**

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

15. Which of the following statements is correct for any thermodynamics system - **[AIEEE-2004]**

(A) the change in entropy can never be zero

(B) internal energy and entropy and state functions

(C) the internal energy changes in all processes

(D) the work done in an adiabatic process is always zero.

16. Two thermally insulated vessels 1 and 2 are filled with air at temperature (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the value joining the two vessels is opened, the temperature inside the vessel at equilibrium will be **[AIEEE-2004]**

(A) $T_1T_2 (P_1V_1 + P_2V_2)/(P_1V_1 + P_2V_2T_2)$ (B) $(T_1 + T_2)/2$

(C) $T_1 + T_2$ (D) $T_1T_2 (P_1V_1 + P_2V_2)/(P_1V_1T_1 + P_2V_2T_2)$

17. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is **[AIEEE-2004]**

(A) Ec (B) 2E/c (C) E/c (D) E/c^2

18. The thermo emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\theta + b\theta^2$ in volts where the ratio a/b is 700ºC. If the cold junction is kept at 0ºC, then the neutral temperature is

(A) 1400ºC (B) 350ºC (C) 700ºC **[AIEEE-2004]**

(D) no neutral temperature is possible for this termocouple.

19. Which of the following is incorrect regarding the first law of thermodynamics? **[AIEEE-2005]**

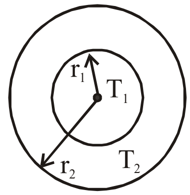
(A) It is a restatement of the principle of conservation of energy

(B) It is not applicable to any cyclic process

(C) It introduces the concept of the entropy

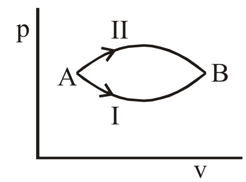
(D) It introduces the concept of the internal energy

20. The figure shows a system of two concentric spheres of radii r_1 and r_2 are kept at temperatures T_1 and T_2, respectively . The radial rate of flow of heat in a substance between the two concentric spheres is proportional to **[AIEEE-2005]**



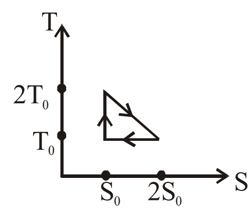
(A) $\ln\left(\frac{r_2}{r_1}\right)$ (B) $\frac{(r_2-r_1)}{(r_1r_2)}$ (C) (r_2-r_1) (D) $\frac{(r_1r_2)}{(r_2-r_1)}$

21. A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies at the processes I and II respectively, then **[AIEEE-2005]**



(A) relation between ΔU_1 and ΔU_2 can not be determined
(B) $\Delta U_1 = \Delta U_2$
(C) $\Delta U_2 < \Delta U_1$
(D) $\Delta U_2 > \Delta U_1$

22. The temperature-entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is



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

23. A gaseous mixture consists of 16g of helium and 16g of oxygen. The ratio $\frac{C_p}{C_V}$ of the mixture is

(A) 1.62 (B) 1.59 (C) 1.54 (D) 1.4**[AIEEE-2005]**

24. Assuming the sun to be a spherical body of radius R at a temperature of TK, evaluate the total radiant powered incident of earth at a distance r from the sun **[AIEEE-2006]**

(A) $4\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$ (B) $\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$ (C) $r_0^2 R^2 \sigma \frac{T^4}{4\pi r^2}$ (D) $R^2 \sigma \frac{T^4}{r^2}$

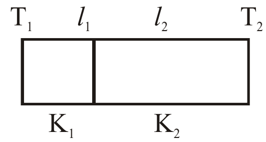
25. The work of 146kJ is performed in order to compress one kilo mole of gas adiabatically and in this process the temperature of the gas increases by 7ºC. The gas is ($R = 8.3\ J\ mol^{-1}\ K^{-1}$)

(A) diatomic (B) triatomic **[AIEEE-2006]**
(C) a mixture of monatomic and diatomic (D) monatomic

26. A carnot engine, having an efficiency of n = 1/10 as heat engine, is used as a refrigerator. If the work done on the system is 10J, the amount of energy absorbed from the reservoir at lower temperature is

(A) 100J (B) 99J (C) 90 J (D) 1J **[AIEEE-2007]**

27. One end of a thermally insulated rod is kept at a temperature T_1 and the other at l_2. The rod is composed of two sections of length l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two section is **[AIEEE-2007]**



(A) $\dfrac{(K_1l_1T_1 + K_2l_2T_2)}{(K_1l_1 + K_2l_2)}$ (B) $\dfrac{(K_2l_2T_1 + K_1l_1T_2)}{(K_1l_1 + K_2l_2)}$ (C) $\dfrac{(K_2l_1T_1 + K_1l_2T_2)}{(K_2l_1 + K_1l_2)}$ (D) $\dfrac{(K_1l_2T_1 + K_2l_1T_2)}{(K_1l_2 + K_2l_1)}$

28. If C_P and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then **[AIEEE-2007]**

(A) $C_P - C_V = 28R$ (B) $C_P - C_V = R/28$ (C) $C_P - C_V = R/14$ (D) $C_P - C_V = R$

29. An insulated container of gas has two chambers separated by an insulating partition. One of the chambers has volume V_1 and contains ideal gas at pressure P_1 and temperature T_1. The other chamber has volume V_2 and contains ideal gas at pressure P_2 and temperature T_2. If the partition is removed without doing any work on the gas, the final equilibrium temperature of the gas in the container will be **[AIEEE-2008]**

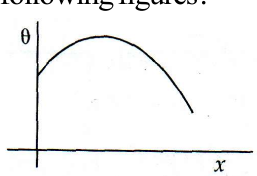
(A) $\dfrac{P_1V_1T_1 + P_2V_2T_2}{P_1V_1 + P_2V_2}$ (B) $\dfrac{P_1V_1T_2 + P_2V_2T_1}{P_1V_1 + P_2V_2}$ (C) $\dfrac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$ (D) $\dfrac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$

30. 1 kg of a diatomic gas is at a pressure of 8×10^4 N/m^2. The density of the gas is 4kg / m^3. What is the energy of the gas due to its thermal motion? **[AIEEE-2009]**

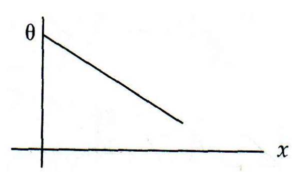
(A) 7×10^4 J (B) 3×10^4 J (C) 5×10^4 J (D) 6×10^4 J

31. A long metallic bar is carrying heat from one of its ends of the other end under steady-state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figures? **[AIEEE– 2009]**

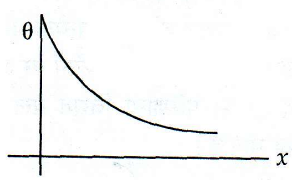
(A)



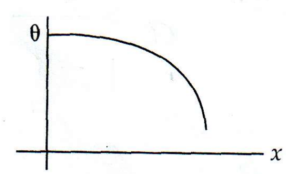
(B)



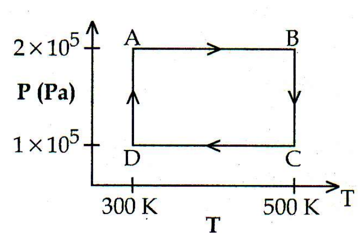
(C)



(D)



Directions : Question number 32, 33 and 34 are based on the following paragaph.
The moles of helum gas are taken over the cycle ABCDA, as shown in the P-T diagrm ?
[AIEEE – 2009]



32. Assuming the gas to be idela the work done on the gas in taking it from A to B os

(A) 200 R (B) 300 R (C) 400 R (D) 500 R

33. The work done on the gas in taking it from D to A is

(A) – 414 R (B) + 414 R (C) – 690 R (D) + 690 R

34. The net work done on the gas in the cycle

(A) zero (B) 276 R (C) 1076 R (D) 1904 R

35. A diatomic ideal gas is used in a carrno engine as the working substance. If during the adiabatic expansion part of the cycle the voulme of the gas increases from V to 32V, the efficiency of the engine is **[AIEEE-20010]**

(A) 0.25 (B) 0.5 (C) 0.75 (D) 0.99

36. 100g of water is heated from 30ºC to 50ºC ignoring the slight expansion of the water, the change in its internal energy is (specific heat of water is 4184 J/Kg/K) : **[AIEEE-2011]**

(A) 4.2 kJ (B) 8.4 kJ (C) 84 kJ (D) 3.1 kJ

37. A carnot engine operating between temperature T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62K, its efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are respectively **[AIEEE-2011]**

(A) 372 K 310 K (B) 372 K and 33K (C) 330 K and 268 K (D) 310 K and 248 K

38. Three perfect gases at absolute temperature T_1, T_2 and T_3 are mixed. The masses of molecules are m_1 m_2 and the number of molecules are n_1, n_2 and n_3 respectively. Assuming no loss of energy, the final temperature of the mixture is

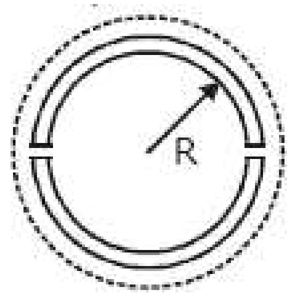
(A) $\frac{(T_1+T_2+T_3)}{3}$ (B) $\frac{n_1T_1+n_2T_2+n_3T_3}{n_1+n_2+n_3}$ **[AIEEE-2011]**

(C) $\frac{n_1T_1^2+n_2T_2^2+n_3T_3^2}{n_1T_1+n_2T_2+n_3T_3}$ (D) $\frac{n_1^2T_1^2+n_2^2T_2^2+n_3^2T_3^2}{n_1T_1+n_2T_2+n_3T_3}$

39. A thermally insulated vessel contains an ideal gas of molecules mass M and ratio of the specific heats γ. It is moving with speed v and is suddenly brought to rest. Assuming no heat is lost to be surroundings, is temperature increases by . **[AIEEE-2011]**

(A) $\frac{(\gamma-1)}{2(\gamma+1)R}Mv^2K$ (B) $\frac{(\gamma-1)}{2\gamma R}Mv^2K$ (C) $\frac{\gamma Mv^2}{2R}K$ (D) $\frac{(\gamma-1)}{2R}Mv^2K$

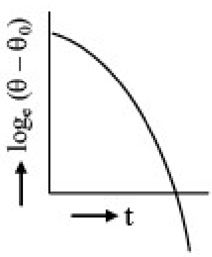
40. A wooden wheel of radius R is made of two semicircular paris (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than $2\pi R$ To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the inetal is α, and its Youngs' modulus in Y the force that one part of the wheel applies on the other part is : **[AIEEE-2012]**

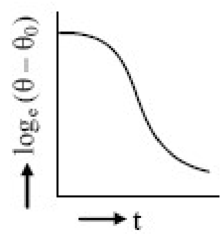


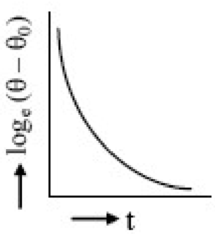
(A) $\pi SY\alpha\Delta T$ (B) $2SY\alpha\Delta T$ (C) $2\pi SY\alpha\Delta T$ (D) $SY\alpha\Delta T$

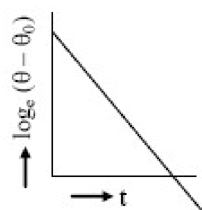
41. A carnot engine, whose efficiency is 40% takes in heat from a source maintained at a temperature of 500 K. It is desired to have an engine of efficiency 60%. Then, the intake temperature for the same exhaust (sink) temperature must be. **[AIEEE-2012]**
(A) 750 K (B) 600 K
(C) efficiency of Carnot engine cannot be made larger than 50% (D) 1200 K

42. A liquid in a beaker has temperature θ at time t and θ_0 is temperature surroundings then according to Newton's law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is. **[AIEEE-2012]**

(A) 

(B) 

(C) 

(D) 

43. Helium gas goes through a cycle ABCDA (consisting of two isobaric and two isobaric lines) as shown in figure Efficiency of this cycle is nearly (assume the gas to be close to ideal gas). **[AIEEE-2012]**
(A) 10.5 % (B) 12.5 % (C) 15.4% (D) 9.1 %

EXERCISE 9

OBJECTIVE QUESTIONS (only one option is correct)

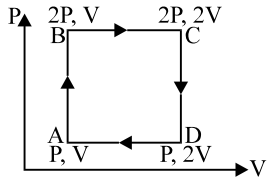
1. An ideal monoatomic gas is taken round the cycle ABCDA as shown in the P-V diagram (see figure). The work done during the cycle is : **[1983 , 1M]**

(A) PV

(B) 2 PV

(C) $\frac{1}{2}$ PV

(D) zero



2. 70 calories of heat required to raise the temperature of 2 moles of an ideal diatomic gas at constant pressure from 30 ºC to 35 ºC . The amount of heat required (in calories) to raise the temperature of the same gas through the same range (30 ºC to 35 ºC) at constant volume is :

(A) 30 (B) 50 (C) 70 (D) 90 **[1985 , 2M]**

3. Steam at 100 ºC is passed into 1.1 kg of water contained in a calorimeter of water equivalent to 0.02 kg at 15 ºC till the temperature of the calorimeter and its contents rises to 80 ºC . The mass of the steam condensed in kg is : **[1986 , 2M]**

(A) 0.130 (B) 0.065 (C) 0.260 (D) 0.135

4. If one mole of a monoatomic gas ($\gamma = 5/3$) is mixed with one mole of a diatomic gas ($\gamma = 7/5$) , the value of γ for the mixture is : **[1988 , 2M]**

(A) 1.40 (B) 1.50 (C) 1.53 (D) 3.07

5. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of a material of thermal conductivity K_2 . The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is : **[1988 , 2M]**

(A) $K_1 + K_2$ (B) $\frac{K_1 K_2}{K_1 + K_2}$ (C) $\frac{K_1 + 3K_2}{4}$ (D) $\frac{3K_1 + K_2}{4}$

6. When an ideal diatomic gas is heated at constant pressure the fraction of the heat energy supplied which increases the internal energy of the gas is : **[1990 , 2M]**

(A) 2/5 (B) 3/5 (C) 3/7 (D) 5/7

7. Three rods of identical cross-sectional area and made from the same metal from the sides of an isosceles triangle ABC, right angled at B . The points A and B are maintained at temperatures T and $\left(\sqrt{2}\right)$T respectively . In the steady state , the temperature of the point C is T_c . Assuming that only heat conduction takes place, T_c/T is : **[1995 , 2M]**

(A) $\frac{1}{2\left(\sqrt{2}-1\right)}$ (B) $\frac{3}{\sqrt{2}+1}$ (C) $\frac{1}{\sqrt{3}\left(\sqrt{2}-1\right)}$ (D) $\frac{1}{\left(\sqrt{2}+1\right)}$

8. Two metallic spheres S_1 and S_2 are made of the same material and have got identical surface finish . The mass of S_1 is thrice that of S_2 . Both the spheres are heated to the same high temperature and placed in the same room having lower temperature but are thermally insulated from each other . The ratio of the initial rate of cooling of S_1 to that S_2 is : **[1995 , 2M]**

(A) $\frac{1}{3}$ (B) $\frac{1}{\sqrt{3}}$ (C) $\frac{\sqrt{3}}{1}$ (D) $\left(\frac{1}{3}\right)^{1/3}$

9. The intensity of radiation emitted by the sun has its maximum value at a wavelength of 510 nm and that emitted by the north star has the maximum value at 350 nm . If these stars behave like blackbodies then the ratio of the surface temperature of the sun and the north star is :

(A) 1.46 (B) 0.69 (C) 1.21 (D) 0.83 **[1997 , 1M]**

10. A vessel contains 1 mole of O_2 gas (molar mass 32) at a temperature T . The pressure of the gas is P . An identical vessel containing one mole of the gas (molar mass 4) at a temperature 2T has a pressure of : **[1997 , 1M]**

(A) P/8 (B) P (C) 2 P (D) 8 P

11. A spherical black body with a radius of 12 cm radiates 450 W power at 500 K . If the radius were halved and the temperature doubled, the power radiated in watt would be : **[1997 , 1M]**

(A) 225 (B) 450 (C) 900 (D) 1800

12. Two identical containers A and B with frictionless pistons contain the same ideal gas at the same temperature and the same volume V . The mass of the gas in A is m_A and that in B is m_B . The gas in each cylinder is now allowed to expand isothermally to the same final volume 2V . The changes in the pressure in A and B are found to be ΔP and 1.5 ΔP resopectively . Then

(A) $4\ m_A = 9\ m_B$ (B) $2\ m_A = 3\ m_B$ (C) $3\ m_A = 2\ m_B$ (D) $9\ m_A = 4\ m_B$

[1998 , 2M]

13. Two cylinders A and B fitted with pistons contain equal amounts of an ideal diatomic gas at 300 K. The piston of A is free to move , while that of B is held fixed . The same amount of heat is given to the gas in each cylinder . If the rise in temperature of the gas in A is 30 K , then the rise in temperature of the gas in B is : **[1998 , 2M]**

(A) 30 K (B) 18 K (C) 50 K (D) 42 K

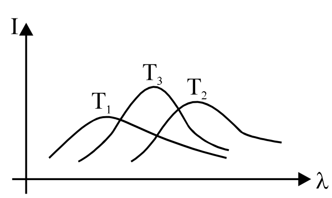
14. A black body is at a temperature of 2880 K . The energy of radiation emitted by this object with wavelength between 499 nm and 500 nm is U_1 , between 999 nm and 1000 nm is U_2 and between 1499 nm and 1500 nm is U_3 . The Wein constant, $b = 2.88 \times 10^6$ nm-K . Then

(A) $U_1 = 0$ (B) $U_3 = 0$ (C) $U_1 > U_2$ (D) $U_2 > U_1$ **[1998,2M]**

15. A monoatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston . The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly . If L_1 and L_2 are the lengths of the gas column before and after expansion respectively , then T_1/T_2 is given by : **[2000 , 2M]**

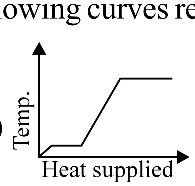
(A) $\left(\frac{L_1}{L_2}\right)^{2/3}$ (B) $\left(\frac{L_1}{L_2}\right)$ (C) $\frac{L_2}{L_1}$ (D) $\left(\frac{L_2}{L_1}\right)^{2/3}$

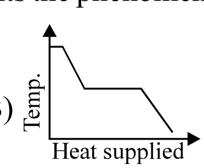
16. The plots of intensity versus wavelength for three black bodies at temperatures T_1 , T_2 and T_3 respectively are as shown . Their temperatures are such that : **[2000 , 2M]**

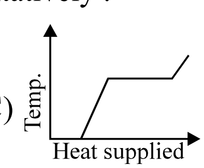


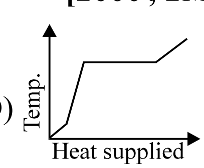
(A) $T_1 > T_2 > T_3$ (B) $T_1 > T_3 > T_2$ (C) $T_2 > T_3 > T_1$ (D) $T_3 > T_2 > T_1$

17. A block of ice at – 10 ºC is slowly heated and converted to steam at 100 ºC . Which of the following curves represents the phenomena qualitatively ? **[2000 , 2M]**

(A) 

(B) 

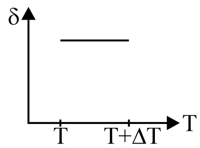
(C) 

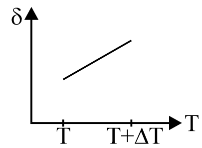
(D) 

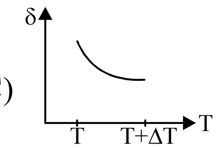
18. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways, the work done by the gas W_1 if the process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic, then : **[2000, 2M]**

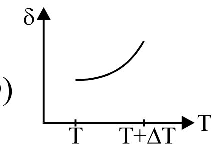
(A) $W_2 > W_1 > W_3$ (B) $W_2 > W_3 > W_1$
(C) $W_1 > W_2 > W_3$ (D) $W_1 > W_3 > W_2$

19. An ideal gas is initially at temperature T and volume V. Its volume is increased by ΔV due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \frac{\Delta V}{V\Delta T}$ varies with temperature as : **[2000, 2M]**

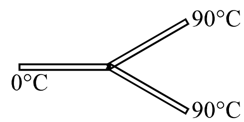
(A) 

(B) 

(C) 

(D) 

20. Three rods made of the 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 ºC and 90 ºC respectively. The temperature of junction of the three rods will be : **[2001, 2M]**

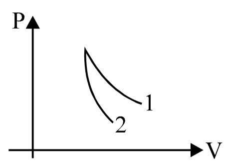


(A) 45 ºC (B) 60 ºC (C) 30 ºC (D) 20 ºC

21. In a given process of an ideal gas, $dW = 0$ and $dQ < 0$. Then for the gas : **[2001, 2M]**

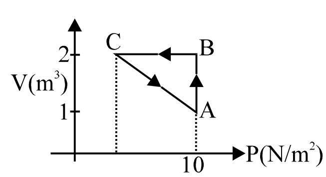
(A) the temperature will decrease (B) the volume will increase
(C) the pressure will remain constant (D) the temperature will increase

22. P-V plots for two gases during adiabatic processes are shown in the figure. Plots 1 and 2 should correspond respectively to : **[2001, 2M]**



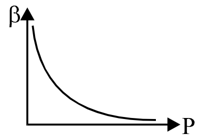
(A) He & O_2 (B) O_2 & He
(C) He & Ar (D) O_2 & N_2

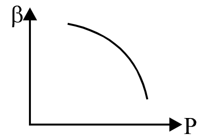
23. An ideal gas is taken through the cycle $A \to B \to C \to A$, as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, the work done by the gas in the process $C \to A$ is :

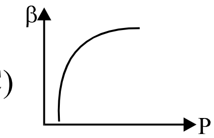


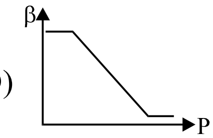
(A) – 5 J (B) – 10 J (C) – 15 J (D) – 20 J **[2002, 2M]**

24. Which of the following graphs correctly represent the variation of $\beta = -\frac{dV/dP}{V}$ with P for an ideal gas at constant temperature ? **[2002, 2M]**

(A) 

(B) 

(C) 

(D) 

25. An ideal black-body at room temperature is thrown into a furnace . It is observed that :

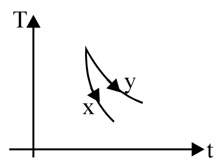
(A) initially it is the darkest body and at later times the brightest **[2002 , 2M]**

(B) it is the darkest body at all times

(C) it cannot be distinguished at all times

(D) initially it is the darkest body and at later times it cannot be distinguished

26. The graph , shown in the diagram, represents the variation of temperature (T) of the bodies , x and y having same surface area with time (t) due to the emission of radiation . Find the correct relation between the emissivity and absorptivity power of the two bodies .



(A) $E_x > E_y$ and $a_x < a_y$ (B) $E_x < E_y$ and $a_x > a_y$

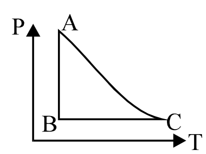
(C) $E_x > E_y$ and $a_x > a_y$ (D) $E_x < E_y$ and $a_x < a_y$ **[2003 , 2M]**

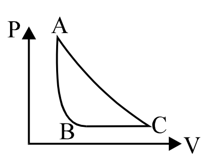
27. Two rods , one of aluminium and the other made of steel having initial length l_1 and l_2 are connected together to form a single rod of length $l_1 + l_2$. The co-efficients of linear expansion for aluminium and steel are α_a and α_s respectively . If the length of each rod increases by the same amount when their temperatures are raised by t ºC , then find the ratio $\dfrac{l_1}{l_1 + l_2}$:

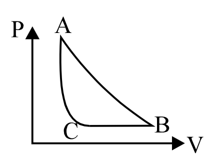
(A) $\dfrac{\alpha_s}{\alpha_a}$ (B) $\dfrac{\alpha_a}{\alpha_s}$ (C) $\dfrac{\alpha_s}{(\alpha_a + \alpha_s)}$ (D) $\dfrac{\alpha_a}{(\alpha_a + \alpha_s)}$

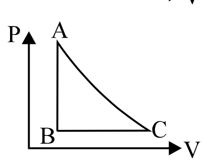
[2003 , 2M]

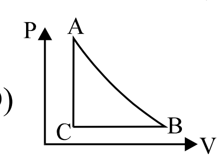
28. The P-T diagram for an ideal gas is shown in the figure , where AC is an adiabatic process, find the corresponding P-V diagram.



(A) 

(B) 

(C) 

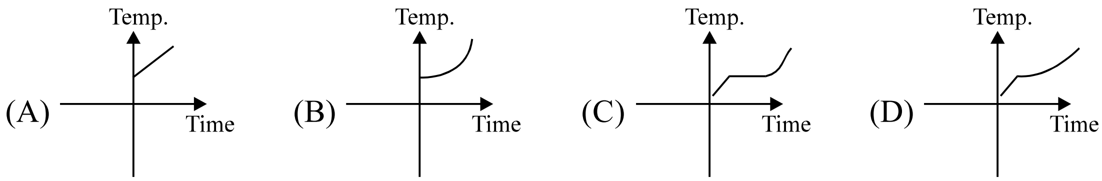
(D) 

[2003 , 2M]

29. 2 kg of ice at – 20 ºC is mixed with 5 kg of water at 20 ºC in an insulating vessel having a negligible heat capacity . Calculate the final mass of water remaining in the container . It is given that the specific heats of water and ice are 1 kcal/kg/ºC and 0.5 kcal/kg/ºC , while the latent heat of fusion of ice is 80 kcal/kg . **[2003 , 2M]**

(A) 7 kg (B) 6 kg (C) 4 kg (D) 2 kg

30. Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm . The rate of heating is constant . Which of the following graphs represent the variation of temperature with time ?



[2004 , 2M]

31. An ideal gas expands isothermally from a volume V_1 and 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 : **[2004 , 2M]**

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

32. Two identical conducting rods are first connected independently to two vessels, one containing water at 100 ºC and the other containing ice at 0 ºC . In the second case, the rods are joined end to end and connected to the same vessels . Let q_1 and q_2 be the rate of melting of ice in the two cases respectively . The ratio q_1/q_2 is : **[2004 , 2M]**

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

33. Three discs A , B and C having radii 2 m , 4 m and 6 m respectively are coated with carbon black on their outer surfaces . The wavelengths corresponding to maximum intensity are 300 nm , 400 nm and 500 nm respectively . The power radiated by them are Q_A , Q_B and Q_C respectively. **[2004 , 2M]**

(A) Q_A is maximum (B) Q_B is maximum (C) Q_C is maximum (D) $Q_A = Q_B = Q_C$

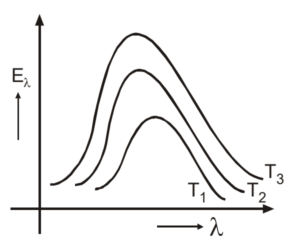
34. Water of volume 2 litre in a container is heated with a coil of 1 kW at 27 ºC . The lid of the container is open and energy dissipates at rate of 160 J/s . In how much time temperature will rise from 27 ºC to 77 ºC ? **[2005 , 2M]**

(A) 8 min 20 s (B) 6 min 2 s (C) 7 min (D) 14 min

35. In which of the following process, convection does not take place primarily ? **[2005 , 2M]**

(A) Sea and land breeze (B) boiling of water
(C) Warming of glass of bulb due to filament (D) Heating air around a furnace

36. Variation of radiant energy emitted by sun, filament of tungsten lamp and welding arc as a function of its wavelength is shown in figure . Which of the following option is the correct match ?



(A) Sun - T_1 , tungsten filament - T_2 , welding arc - T_3
(B) Sun - T_2 , tungsten filament - T_1 , welding arc - T_3
(C) Sun - T_3 , tungsten filament - T_2 , welding arc - T_1
(D) Sun - T_1 , tungsten filament T_3 , welding arc - T_2 **[2005 , 2M]**

37. Calorie is defined as the amount of heat required to raise temperature of 1 g of water by 1 ºC and it is defined under which of the following conditions ? **[2005 , 2M]**

(A) From 14.5 ºC to 15.5 ºC at 760 mm of Hg
(B) From 98.5 ºC to 99.5 ºC at 760 mm of Hg
(C) From 13.5 ºC to 14.5 ºC at 76 mm of Hg
(D) From 3.5 ºC to 4.5 ºC at 76 mm of Hg

38. A body with area A and temperature T and emissivity e = 0.6 is kept inside a spherical black body . What will be the maximum energy radiated ? **[2005 , 2M]**

(A) 0.60 eAT^4 (B) 0.80 eAT^4 (C) 1.00 eAT^4 (D) 0.40 eAT^4

39. An ideal gas is expanding such that PT^2 = constant. The coefficient of volume expansion of the gas is **[2008]**

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

OBJECTIVE PROBLEMS (More than one option may be correct)

40. For an ideal gas :

(A) the change in internal energy in a constant pressure process from temperature T_1 and T_2 is equal to $nC_V(T_2 - T_1)$, where C_V is the molar heat capacity at constant volume and n the number of moles of the gas .
(B) the change in internal energy of the gas and the work done by the gas are equal in magnitude in an adiabatic process
(C) the internal energy does not change in an isothermal process
(D) no heat is added or removed in an adiabatic process **[1989 , 2M]**

41. An ideal gas is taken from the state A (pressure P , volume V) to the state B (pressure P/2 , volume 2V) along a straight line path in the P-V diagram . Select the correct statements from the following .

(A) The work done by the gas in the process A to B exceeds the work that would be done by it if the system were taken from A to B along an isotherm
(B) In the T-V diagram, the path AB becomes a part of a parabola
(C) In the P-T diagram, the path AB becomes a part of a hyperbola
(D) In going from A to B, the temperature T of the gas first increases to a maximum value and then decreases **[1993 , 2M]**

42. Two bodies A and B have a thermal emissivities of 0.01 and 0.81 respectively . The outer surface areas of the two bodies are the same . The two bodies emit total radiant power at the same rate . The wavelength λ_B corresponding to maximum spectral radiancy in the radiation from B shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A by 1.00 μm . If the temperature of A is 5802 K : **[1994 , 2M]**

(A) the temperature of B is 1934 K (B) λ_B = 1.5 μm
(C) the temperature of B is 11604 K (D) the temperature of B is 2901 K

43. During the melting of a slab of ice at 273 K at atmospheric pressure :

(A) positive work is done by the ice-water system on the atmosphere
(B) positive work is done on the ice-water system by the atmosphere
(C) the internal energy of the ice-water system increases
(D) the internal energy of the ice-water system decreases **[1998 , 2M]**

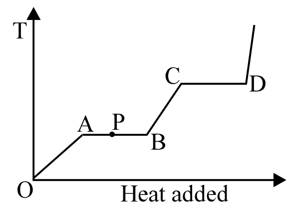
44. A bimetallic strip is formed out of two identical strips , one of copper and the other of brass . The coefficients of linear expansion of the two metals are α_C and α_B . On heating, the temperature of the strip goes up by ΔT and the strip bends to form an arc of radius of curvature R . Then R is : **[1999 , 3M]**

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

Fill in the Blanks

45. One mole of a monoatomic ideal gas is mixed with one mole of a diatomic ideal gas . The molar specific heat of the mixture at constant volume is ________ . **[1984, 2M]**

46. The variation of temperature of a material as heat is given to it at constant rate is shown in the figure . The material is in solid state at the point O . The state of the material at the point P is ________ . **[1985, 2M]**



47. During an experiment, an ideal gas is found to obey an additional law P^2V = constant . The gas is initially at a temperature T and volume V . When it expands to a volume 2V, the temperature becomes ________ . **[1987, 2M]**

48. 300 g of water at 25 °C is added to 100 g of ice at 0 °C . The final temperature of the mixture is ________ °C . **[1989, 2M]**

49. The earth receives at its surface radiation from the sun at the rate of 1400 Wm^{-2} . The distance of the centre of the sun from the surface of the earth is 1.5×10^{11} m and the radius of the sun is 7×10^8 m . Treating the sun as a black body , it follows from the above data that its surface temperature is ________ K . **[1989, 2M]**

50. A solid copper (density ρ and specific heat c) of radius r at an initial temperature 200 K is suspended inside a chamber whose walls are at almost 0 K . The time required for the temperature of the sphere to drop to 100 K is ________ . **[1991, 2M]**

51. A point source of heat of power P is placed at the centre of a spherical shell of mean radius R. The material of the shell has thermal conductivity K . If the temperature difference between the outer and inner surface of the shell is not to exceed T , the thickness of the shell should not be less than ________ . **[1991 , 1M]**

52. A substance of mass M kg requires a power input of P watts to remain in the molten state at its melting point . When the power source is turned off, the sample completely solidifies in time t seconds . The latent heat of fusion of the substance is ________ . **[1992 , 1M]**

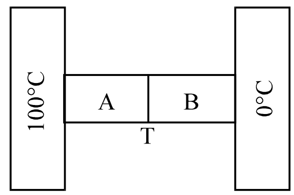
53. A container of volume 1 m^3 is divided into two equal parts by a partition . One part has an ideal gas at 300 K and the other part is vacuum . The whole system is thermally isolated from the surroundings . When the partition is removed , the gas expands to occupy the whole volume . Its temperature will now be ________ . **[1993 , 1M]**

54. An ideal gas with pressure P , volume V and temperature T is expanded isothermally to a volume 2V and a final pressure P_i . If the same gas is expanded adiabatically to a volume 2V, the final pressure is P_a . The ratio of the specific heats of the gas is 1.67 . The ratio $\frac{P_a}{P_i}$ is ________.

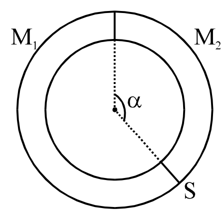
[1994 , 2M]

55. Two metal cubes A and B of same size are arranged as shown in figure . The extreme ends of the combination are maintained at the indicated temperatures . The arrangement is thermally insulated . The coefficients of thermal conductivity of A and B are 300 W/m °C and 200 W/m °C respectively . After steady state is reached the temperature t of the interface will be ________ .

[1996 , 2M]



56. A ring shaped tube contains two ideal gases with equal masses and relative molar masses $M_1 = 32$ and $M_2 = 28$. The gases are separated by one fixed partition and another movable stopper S which can move freely without friction inside the ring . The angle α as shown in the figure is ________ degree . **[1997 , 2M]**



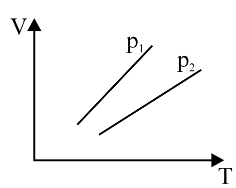
57. A gas thermometer is used as a standard thermometer for measurement of temperature . When the gas container of the thermometer is immersed in water at its triple point 273.16 K , the pressure in the gas thermometer reads 3.0×10^4 N/m^2 . When the gas container of the same thermometer is immersed in another system, the gas pressure reads 3.5×10^4 N/m^2 . The temperature of this system is therefore ________ °C . **[1997 , 1M]**

58. Earth receives 1400 W/m^2 of solar power . If all the solar energy falling on a lens of area 0.2 m^2 is focussed onto a block of ice of mass 280 g , the time taken to melt the ice will be ________ minutes . [Latent heat of fusion of ice = 3.3×10^5 J/kg] **[1997 , 2M]**

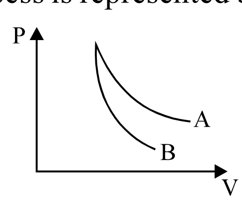
True/False

59. The volume V versus temperature T graphs for a certain amount of a perfect gas at two pressure p_1 and p_2 are as shown in figure . It follows from the graphs that p_1 is greater than p_2.

[1982 , 2M]



60. The curves A and B in the figure shows P-V graphs for an isothermal and an adiabatic process for an ideal gas . The isothermal process is represented by the curve A . **[1985 , 3M]**



61. At a given temperature, the specific heat of a gas at a constant pressure is always greater than its specific heat at constant volume. **[1987 , 2M]**

62. Two spheres of the same material have radii 1 m and 4 m temperature 4000 K and 2000 K respectively . The energy radiated per second by the first sphere is greater than that by the second. **[1988 , 2M]**

63. **STATEMENT - 1**

The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

because

STATEMENT - 2

The molecules of a gas collide with each other and the velocities of the molecules change due to the collision.

(A) Statement- 1 is True, Statement-2 is True, Statement-2 **is** a correct explanation for Statement -1

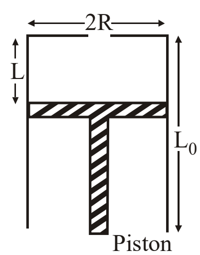
(B) Statement -1 is True, Statement -2 is True ; Statement -2 **is NOT** a correct explanation for Statement - 1

(C) Statement - 1 is True, Statement- 2 is False

(D) Statement -1 is False, Statement -2 is True **[2007, 3M]**

Passage

A fixed thermally conducting cylinder has a radius R and height L_0. The cylinder is open at its bottom and has a small hole at its top. A piston of mass M is held at a distance L from the top surface, as shown in the figure. The atmospheric pressure is P_0. **[2007, 12M]**



64. The piston is now pulled out slowly and held at a distance 2L from the top. The pressure in the cylinder between its top and the piston will then be

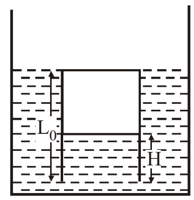
(A) P_0 (B) $\frac{P_0}{2}$ (C) $\frac{P_0}{2}+\frac{Mg}{\pi R^2}$ (D) $\frac{P_0}{2}-\frac{Mg}{\pi R^2}$

65. While the piston is at a distance 2L from the top, the hole at the top is sealed. The piston is then released, to a position where it can stay in equilibrium. In this condition, the distance of the piston from the top is

(A) $\left(\frac{2P_0\pi R^2}{\pi R^2 P_0+Mg}\right)(2L)$ (B) $\left(\frac{P_0\pi R^2-Mg}{\pi R^2 P_0}\right)(2L)$

(C) $\left(\frac{P_0\pi R^2+Mg}{\pi R^2 P_0}\right)(2L)$ (D) $\left(\frac{P_0\pi R^2}{\pi R^2 P_0-Mg}\right)(2L)$

66. The piston is taken completely out of the cylinder. The hole at the top is sealed. A water tank is brought below the cylinder and put in a position so that the water surface in the tank is at the same level as the top of the cylinder as shown in the figure. The density of the water is ρ. In equilibrium, the height H of the water column in the cylinder satisfies



(A) $\rho g (L_0 - H)^2 + P_0 (L_0 - H) + L_0 P_0 = 0$ (B) $\rho g (L_0 - H)^2 - P_0 (L_0 - H) - L_0 P_0 = 0$

(C) $\rho g (L_0 - H)^2 + P_0 (L_0 - H) - L_0 P_0 = 0$ (D) $\rho g (L_0 - H)^2 - P_0 (L_0 - H) + L_0 P_0 = 0$

67. **[2006, 6M]**

	Column I	**Column II**
(a)	JK process	(P) $\Delta W > 0$
(b)	KL process	(Q) $\Delta W < 0$
(c)	LM process	(R) $\Delta Q > 0$
(d)	MJ process	(S) $\Delta Q < 0$

68. **Column I** gives some devices and **Column II** gives some processes on which the functioning of these devices depend. Match the devices in **Column I** with the process in **Column II. [2007, 6M]**

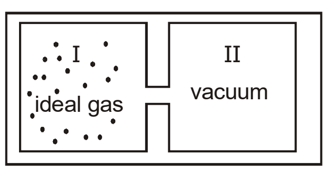
	Column I		**Column II**
(a)	Bimetallic strip	(P)	Radiation from a hot body
(b)	Steam engine	(Q)	Energy conversion
(c)	Incandescent lamp	(R)	Melting
(d)	Electric fuse	(S)	Thermal expansion of solids

69. **Column I** contains a list of processes involving expansion of an ideal gas. Match this with column II describing the thermodynamic change during this process. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS. **[2008]**

Column I **Column II**

(A) An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and the chamber. II has vacuum. The valve is opened.

(p) The temperature of the gas decreases



(B) An ideal monatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$, where V is the volume of the gas

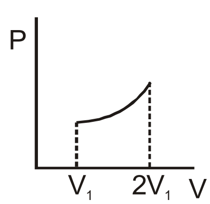
(q) The temperature of the gas increases or remains constant

(C) An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$, where V is its volume

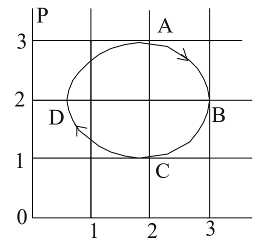
(r) The gas loses heat

(D) An ideal monoatomic gas expands such that its pressure P and volume V follows the behavior shown in the graph

(s) The gas gains heat



70. The figure shows the P-V plot of an ideal gas taken through a cycle ABCDA. The part ABC is semi-circle and CDA is half of an ellipse. Then, **[2009]**



(A) the process during the path $A \rightarrow B$ is isothermal
(B) heat flows out of the gas during the path $B \rightarrow C \rightarrow D$
(C) work done during the path $A \rightarrow B \rightarrow C$ is zero
(D) positive work is done by the gas is the cycle ABCDA

71. C_v and C_p denote the molar specific heat capacities of a gas at constant volume and constant pressure, respectively. Then **[IIT – 2009]**

(A) $C_p - C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

(B) $C_p + C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

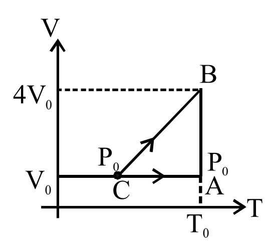
(C) C_p / C_v is larger for a diatomic ideal gas than for a monoatomic ideal gas

(D) $C_p \cdot C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

72. A metal rod AB of length 10x has its one end A is ice at 0ºC and the other end B in water at 100ºC. If a point P on the rod is maintained at 400ºC, 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.] **[2009]**

73. A real gas behaves like an ideal gas if its **[2010]**
(A) pressure and temperature are both high
(B) pressure and temperature are both low
(C) pressure is high and temperature is low
(D) pressure is low and temperature is high

74. One mole of an ideal gas in initial state A undergoes a cyclic process ABCA, as shown in the figure. Its pressure at A is P_-. Choose the correct options from the following) **[2010]**



(A) internal energies at A and B are the same
(B) work done by the gas in process AB is $P_0V_0 \, ln 4$

(C) pressure at C is $\frac{P_0}{4}$
(D) temperature at C is $\frac{P_0}{4}$

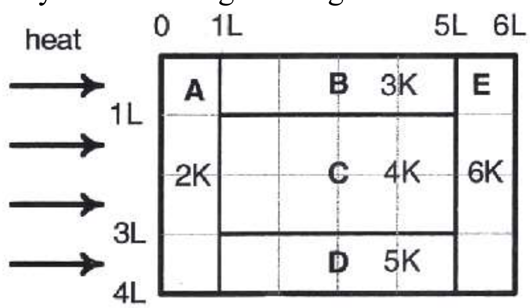
75. A piece of ice (heat capacity = $2100 Jkmg^{-1}C^{-1}$ and latent heat = 3.36×10^5 Jkg^{-1}) of mass m grams is at –5ºC at atmospheric pressure. It is given 420J of heat so that the ice starts melting. Finally when the ice-water mixture is in equilibrium, it is found that 1gm of ice has melted. Assuming there is no other heat exchange in the pressure, the value of m is **[2010]**

76. A diatomic ideal gas is compressed adiabatically to $\frac{1}{32}$ of its initial volume. In the initial temperature of the gas is T_i (in kelvin) and the final temperature is αT_i, the value of α is **[2010]**

77. 5.6 liter of helium gas at STP is adiabatically compressed to 0.7 litre. Taking the initial temperature to be T_1, the work done in the process is **[2011]**

(A) $\frac{9}{8}RT_1$ (B) $\frac{3}{2}RT_1$ (C) $\frac{15}{8}RT_1$ (D) $\frac{9}{2}RT_1$

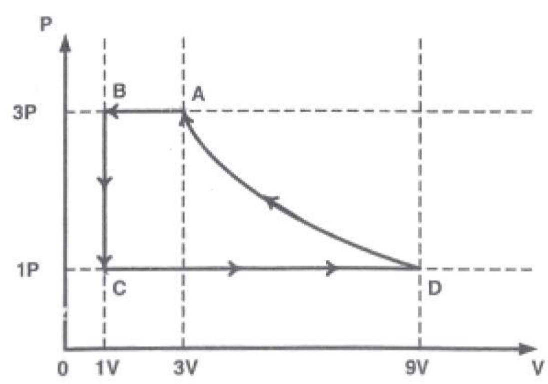
78. A composite block is made of slabs A, B, C, D and E of different thermal conductivities (given in terms of a constant K) and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat 'Q' flows only from left to right through the blocks. Then in steady state.**[2011]**



(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.

79. Steel wire of length 'L' at 40ºC is suspended from the ceiling and then a mass 'm' is hung from its free end. The wire is cooled down from 40ºC to 30ºC to region its original length 'L'. The coefficients of linear thermal expansion of the steel is 10^{-5} /ºC, Young's modulus of steel is 10^{11} N/m^2 and radius of the wire is 1mm. Assume that L >> diameter of the wire. Then the value of 'm' in kg is nearly.**[2011]**

80. One mole of a monoatomic ideal gas is taken through a cycle ABCDA as shown in the P-V diagram. Column-II gives the characteristics involved in the cycle. Match them with each of the processes given in Column-I. **[2011]**



Column-I		**Column-II**	
(A)	Process A $\to$ B	(p)	Internal energy decreases
(B)	Process B $\to$ C	(q)	Internal energy increases.
(C)	Process C $\to$ D	(r)	Heat is lost.
(D)	Process D $\to$ A	(s)	Heat is gained
		(t)	Work is done on the gas

81. 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 2T and 3T respectively. The temperature of the middle (i.e. second) plate under steady state condition is **[IIT-2012]**

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

82. A mixture of 2 moles of helium gas (atomic mass = 4 amu) and 1 mole of argon (Atomic mass = 40 amu) is kept at 300K in a container. The ratio of the rms speeds $\left(\frac{v_{rms}\,(\text{helium})}{v_{rms}\,(\text{argon})}\right)$ is **[IIT-2012]**

(A) 0.32 (B) 0.45 (C) 2.24 (D) 3.16

83. Two moles of ideal helium gas are in a rubber balloon at 30ºC. The balloon is fully expandable and can be assumed to require no energy in its expansion. The temperature of the gas in the balloon is slowly changed to 35ºC. The amount of heat required in raising the temperature is **[IIT-2012]**

(A) 62 J (B) 104 J (C) 124 J (D) 208 J

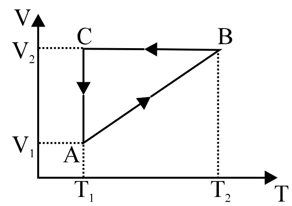
EXERCISE 10

1. A lead bullet just melts when stopped by an obstacle . Assuming that 25 per cent of heat is absorbed by the obstacle , find the velocity of the bullet if its initial temperature is 27 ºC.

[Melting point of lead = 327 ºC , specific heat of lead = 0.03 cal/g ºC, latent heat of fusion of lead = 6 cal/g , J = 4.2 J/cal] **[1981, 3M]**

2. A cyclic process ABCA shown in the V-T diagram is performed with a constant mass of an ideal gas . Show the same process on a P-V diagram .

[In the figure , CA is parallel to the V-axis and BC is parallel to T-axis] **[1981 , 4M]**



3. Calculate the work done when one mole of a perfect gas is compressed adiabatically . The initial pressure and volume of the gas are 10^5 N/m^2 and 6 litres respectively. The final volume of the gas is 2 litres, molar specific heat of the gas at constant volume is 3 R/2 . **[1982, 8M]**

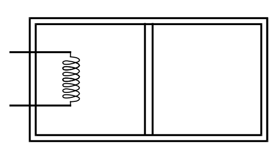
4. A solid sphere of copper of radius R and a hollow sphere of the same material of inner radius r and outer radius A are heated to the same temperature and allowed to cool in the same environment . Which of them starts cooling faster ? **[1982, 2M]**

5. One gram mole of oxygen at 27 ºC and one atmospheric pressure is enclosed in a vessel .

(i) Assuming the molecules to be moving with v_{rms} , find the number of collisions per second which the molecules make with one square metre area of the vessel wall .

(ii) The vessel is next thermally insulated and moved with a constant speed v_0 . It is then suddenly stopped . The process results in a rise of the temperature of the gas by 1ºC. Calculate the speed v_0 . **[1982, 8M]**

6. The rectangular box shown in figure has a partition which can slide without friction along the length of the box . Initially each of the two chambers of the box has one mole of a monoatomic ideal gas (γ = 5/3) at a pressure P_0, volume V_0 and temperature T_0 . The chamber on the left is slowly heated by an electric heater . The walls of the box and the partition are thermally insulated. Heat loss through the lead wires of the heater is negligible. The gas in the left chamber expands pushing the partition until the final pressure in both chambers becomes 243 P_0/32 . Determine :



(i) the final temperature of the gas in each chamber and
(ii) the work done by the gas in the right chamber **[1984 , 8M]**

7. Two glass bulbs of equal volume are connected by a narrow tube and are filled with a gas at 0 ºC and a pressure of 76 cm of mercury . One of the bulbs is then placed in melting ice and the other is placed in a water bath maintained at 62 ºC . What is the value of the pressure inside the bulbs ? The volume of the connecting tube is negligible . **[1985 , 6M]**

8. An electric heater is used in a room of total wall area 137 m^2 to maintain a temperature of $+20^\circ C$ inside it, when the outside temperature is $-10\ ^\circ C$. The walls have three different layers materials. The innermost layer is of wood of thickness 2.5 cm, the middle layer is of cement of thickness 1.0 cm and the outermost layer is of brick of thickness 25.0 cm. Find the power of the electric heater. Assume that there is no heat loss through the floor and the ceiling. The thermal conductivities of wood, cement and brick are 0.125, 1.5 and 1.0 watt/m/°C respectively. **[1986, 8M]**

9. A thin tube of uniform cross-section is sealed at both ends. It lies horizontally, the middle 5 cm containing mercury and the two equal ends containing air at the same pressure P. When the tube is held at an angle of 60° with the vertical direction, the length of the air column above and below the mercury column are 46 cm and 44.5 cm respectively. Calculate the pressure P in centimeters of mercury. [The temperature of the system is kept at 30 °C] **[1986, 6M]**

10. An ideal gas has a specific heat constant pressure $C_P = \frac{5R}{2}$. The gas is kept in a closed vessel of volume 0.0083 m^3, at a temperature of 300 K and a pressure of 1.6×10^6 N/m^2. An amount of 2.49×10^4 J of heat energy is supplied to the gas. Calculate the final temperature and pressure of the gas. **[1987, 7M]**

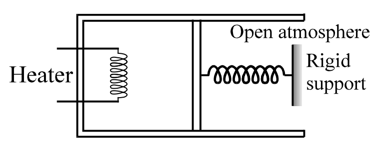
11. Two moles of helium gas ($\gamma = 5/3$) are initially at temperature 27 °C and occupy a volume of 20 litres. The gas is first expanded at constant pressure until the volume is doubled. Then it undergoes an adiabatic change until the temperature returns to its initial value.

(i) Sketch the process on a P-V diagram

(ii) What are the final volume and pressure of the gas ?

(iii) What is the work done by the gas ? **[1988, 6M]**

12. An ideal monoatomic gas is confined in a cylinder by a spring loaded position of cross-section 8×10^{-3} m^2. Initially the gas is at 300 K and occupies a volume of 2.4×10^{-3} m^3 and the spring is in its relaxed (unstretched, uncompressed) state. The gas is heated by a small electric heater until the piston moves out slowly by 0.1 m.



Calculate the final temperature of the gas and the heat supplied (in joules) by the heater. The force constant of the spring is 8000 N/m and the atmospheric pressure 10×10^5 Nm^{-2}. The cylinder and the piston are thermally insulated. The piston is massless and there is no friction between the piston and the cylinder. Neglect heat loss through the lead wires of the heater. The heat capacity of the heater coil is negligible. Assume the spring to be massless. **[1989, 8M]**

13. An ideal gas having initial pressure P, volume V and temperature T is allowed to expand adiabatically until its volume becomes 5.66 V while its temperature falls to T/2.

(i) How many degrees of freedom do gas molecules have ?

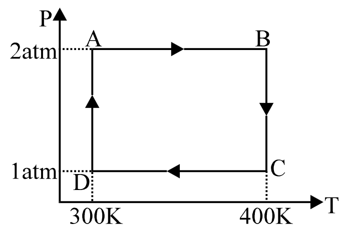
(ii) Obtain the work done by the gas during the expansion as a function of the initial pressure P and volume V. **[1990, 7M]**

14. Three moles of an ideal gas $\left(C_P = \frac{7}{2}R\right)$ at pressure P_A and temperature T_A is isothermally expanded to twice its initial volume . It is then compressed at constant pressure to its original volume . Finally gas is compressed at constant volume to its original pressure P_A .

(i) Sketch P-V and P-T diagrams for the complete process

(ii) Calculate the net work done by the gas and net heat supplied to the gas during the complete process . **[1991 , 4 + 4M]**

15. Two moles of helium gas undergo a cyclic process as shown in figure . Assuming the gas to be ideal, calculate the following quantities in this process .



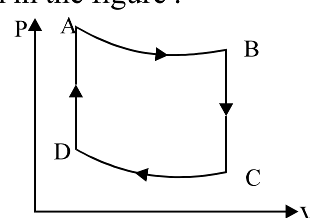
(a) The net change in the heat energy

(b) The net work done

(c) The net change in internal energy **[1992 , 8M]**

16. A cylindrical block of length 0.4 m and 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/mK and the specific heat capacity 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. **[1992 , 8M]**

17. One mole of a monoatomic ideal gas is taken through the cycle shown in the figure .



$A \rightarrow B$: adiabatic expansion

$B \rightarrow C$: cooling at constant volume

$C \rightarrow D$: adiabatic compression

$D \rightarrow A$: heating at constant volume

The pressure and temperature at A , B , etc are denoted by P_A , T_A , P_B , T_B etc respectively. Given that $T_A = 1000$ K , $P_B = (2/3)\,P_A$ and $P_C = (1/3)\,P_A$, calculate the following quantities:

(a) The work done by the gas in the process $A \rightarrow B$

(b) The heat lost by the gas in the process $B \rightarrow C$

(c) The temperature T_D .

[Given : $(2/3)^{2/5} = 0.85$] **[1993 , 4 + 4 +2M]**

18. An ideal gas is taken through a cyclic thermodynamic process through four steps . The amounts of heat involved in these steps are $Q_1 = 5960$ J , $Q_2 = -5585$ J , $Q_3 = -2980$ J and $Q_4 = 3645$ J respectively . The corresponding quantities of work involved are $W_1 = 2200$ J , $W_2 = -825$ J , $W_3 = -1100$ and W_4 respectively .

(a) Find the value of W_4

(b) What is the efficiency of the cycle ? **[1994 , 6M]**

19. A closed container of volume 0.2 m^3 contains a mixture of neon and argon gases at a temperature of 27 °C and pressure of 1×10^5 Nm^{-2} . The total mass of the mixture is 28 g . If the molar masses of neon and argon are 20 and 40 g mol^{-1} respectively , find the masses of the individual gases in the container assuming them to be ideal . [Universal gas constant R = 8.314 J/mol-K] **[1994 , 6M]**

20. A gaseous mixture enclosed in a vessel of volume V consists of one gram mole of gas A with $\gamma = (C_P/C_V = 5/3)$ and another gas B with $\gamma = 7/5$ at a certain temperature T . The gram molecular weights of the gases A and B are 4 and 32 respectively . The gases A and B do not react with each other and are assumed to be ideal . The gaseous mixture follows the equation, $PV^{19/13}$ = constant in adiabatic process . **[1995 , 10M]**

(a) Find the number of gram moles of the gas B in the gaseous mixture

(b) Compute the speed of sound in the gaseous mixture at 300 K

(c) If T is raised by 1 K from 300 K , find the percentage change in the speed of sound in the gaseous mixture

(d) The mixture is compressed adiabatically to 1/5 of its initial volume V . Find the change in its adiabatic compressibility in terms of the given quantities .

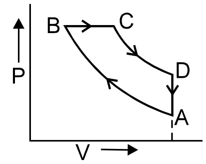
21. At 27 °C two moles of an ideal monoatomic gas occupy a volume V . Calculate :

(a) the final temperature of the gas **(b)** change in its internal energy

(c) the work done by the gas during this process **[1996 , 5M]**

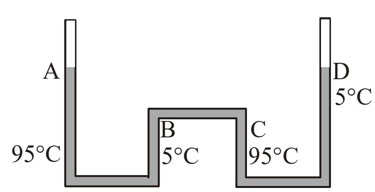
22. The temperature of 100 g of water is to be raised from 24 °C to 90 °C by adding steam to it. Calculate the mass of the steam required for this purpose . **[1996 , 2M]**

23. One mole of a diatomic ideal gas ($\gamma = 1.4$) is taken through a cyclic process starting from point A . The process A → B is an adiabatic compression . B → C is isobaric expansion , C → D an adiabatic expansion and D → A is isochoric . **[1997 , 5M]**



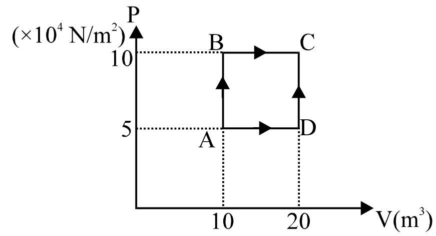
The volume ratio are V_A/V_B and $V_C/V_D = 2$ and the temperature at A is $T_A = 300$ K . Calculate the temperature of the gas at the points B and D and find the efficiency of the cycle .

24. The apparatus shown in figure consists of four glass columns connected by horizontal sections. The height of two central columns B and C are 49 cm each . The two outer columns A and D are open to the atmosphere . A and C are maintained at a temperature of 95 °C while the column B and D are maintained at 5 °C . The height of the liquid in A and D measured from the base line are 52.8 cm and 51 cm respectively . Determine the coefficient of thermal expansion of the liquid . **[1997 , 5M]**



25. A double-pane window used for insulating a room thermally from outside consists of two glass sheets each of area 1 m^2 and thickness 0.01 m separated by a 0.05 m thick stagnant air space . In the steady state , the room glass inter-face and the glass-outdoor interface are at constant temperatures of 27 °C and 0 °C respectively . Calculate the rate of heat flow through the window pane . Also find the temperatures of other interfaces . Given thermal conductivities of glass and air as 0.8 and 0.08 W m^{-1} K^{-1} respectively . **[1997 C, 5M]**

26. A sample of 2 kg monoatomic helium (assumed ideal) is taken through the process ABC and another sample of 2 kg of the same gas is taken through the process ADC (see figure) . Given molecular mass of helium = 4 .

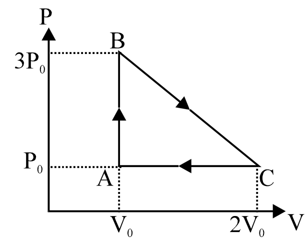


(i) What is the temperature of helium in each of the states A , B , C and D ?

(ii) Is there any way of telling afterwards which sample of helium went through the process ABC and which went through the process ADC ? Write Yes or No .

(iii) How much is the heat involved in the process ABC and ADC ? **[1997C, 5M]**

27. One mole of an ideal monoatomic gas is taken round the cyclic process ABCA as shown in figure. Calculate :



(a) the work done by the gas

(b) the heat rejected by the gas in the path CA and the heat absorbed by the gas in the path AB

(c) the net heat absorbed by the gas in the path BC

(d) the maximum temperature attained by the gas during the cycle . **[1998 , 8M]**

28. A solid body X of heat capacity C is kept in an atmosphere whose temperature is T_A = 300 K. At time t = 0 , the temperature of X is T_0 = 400 K . It cools according to Newton's law of cooling . At time t_1 its temperature is found to be 350 K .

At this time (t_1) the body X is connected to a large body Y at atmospheric temperature T_A through a conducting rod of length L , cross-sectional area A and thermal conductivity K . The heat capacity of Y is so large that any variation in its temperature may be neglected . The cross-sectional area A of the connecting rod is small compared to the surface area of X . Find the temperature of X at time $t = 3\ t_1$. **[1998 , 8M]**

29. Two moles of an ideal monoatomic gas initially at pressure P_1 and volume V_1 undergo an adiabatic compression until its volume is V_2. Then the gas is given heat Q at constant volume V_2.

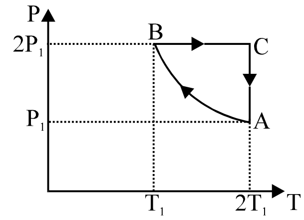
(a) Sketch the complete process on a P-V diagram

(b) Find the total work done by the gas , the total change in internal energy and the final temperature of the gas .

[Give your answer in terms of P_1 , V_1 , V_2 , Q and R] **[1999 , 10M]**

30. Two moles of an ideal monoatomic gas is taken through a cycle ABCA as shown in the P-T diagram. During the process AB , pressure and temperature of the gas vary such that

PT = constant . If T_1 = 300 K , calculate :



(a) the work done on the gas in the process AB

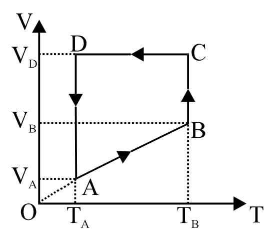
(b) the heat absorbed or released by the gas in each of the processes .

[Give answers in terms of the gas constant R] **[2000 , 10M]**

31. An ice cube of mass 0.1 kg at 0 ºC is placed in an isolated container which is at 227 ºC . The specific heat S of the container varies with temperature T according to the empirical relation $S = A + BT$, where $A = 100$ cal/kg-K and $B = 2 \times 10^{-2}$ cal/kg-K^2 . If the final temperature of the container is 27 ºC , determine the mass of the container . **[2001 , 5M]**

[Latent heat of fusion for water = 8×10^4 cal/kg , specific heat of water = 103 cal/kg-K]

32. A monoatomic ideal gas of two moles is taken through a cyclic process starting from A as shown in the figure . The volume ratios are $\dfrac{V_B}{V_A} = 2$ and $\dfrac{V_D}{V_A} = 4$. If the temperature T_A at A is 27 ºC, calculate :



(a) the temperature of the gas at point B

(b) heat absorbed or released by the gas in each process

(c) the total work done by the gas during the complete cycle

[Express your answer in terms of the gas constant R] **[2001 , 10M]**

33. A 5 m long cylindrical steel wire with radius 2×10^{-3} m is suspended vertically from a rigid support and carries a bob of mass 100 kg at the other end . If the bob gets snapped , calculate the change in temperature of the wire ignoring losses .

[For steel wire: Young's modulus = 2.1×10^{11} Pa ; Density = 7860 kg/m^3;
specific heat = 420 J/kg-K] **[2001 , 5M]**

34. A cubical box of side 1 m contains helium gas (atomic weight 4) at a pressure of 100 N/m^2 . During an observation time of 1 s , an atom travelling with the root mean square speed parallel to one of the edges of the cube , was found to make 500 hits with a particular wall without any collision with other atoms . Take R = 25/3 J/mol-K and $k = 1.38 \times 10^{-23}$ J/K]

(a) Evaluate the temperature of the gas

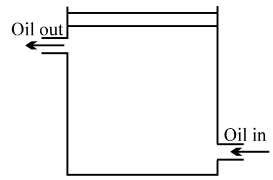
(b) Evaluate the average kinetic energy per atom

(c) Evaluate the total mass of helium gas in the box . **[2002 , 5M]**

35. An insulated box containing a monoatomic gas of molar mass M moving with a speed v_0 is suddenly stopped . Find the increment in gas temperature as a result of stopping the box .

[2003, 2M]

36. The top of an insulated cylindrical container is covered by a disc having emmissivity 0.6 and conductivity 0.167 W/km and thickness 1 cm . The temperature is maintained by circulating oil as shown .

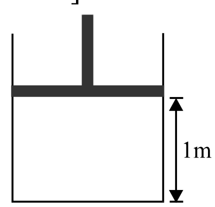


(a) Find the radiation loss to the surroundings in J/m^2 s if temperature of the upper surface of disc is 127 ºC and temperature of surroundings is 27 ºC

(b) Also find the temperature of the circulating oil . Neglect the heat loss due to convection.

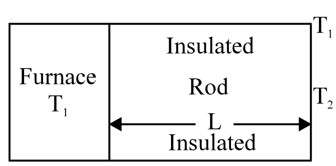
[Given : $\sigma = \frac{17}{3} \times 10^{8}$ W/m^{-2} K^{-4}] **[2003, 4M]**

37. The piston cylinder arrangement shown contains a diatomic gas at temperature 300 K . The cross-sectional area of the cylinder is 1 m^2 . Initially the height of the piston above the base of the cylinder is 1 m . The temperature is now raised to 400 K at constant pressure . Find the new height of the piston above the base of the cylinder . If the piston is now brought back to its original height without any heat loss , find the new equilibrium temperature of the gas . [You can leave the answer in fraction] **[2004, 2M]**



38. A cube of coefficient of linear expansion α_s is floating in a bath containing a liquid of coefficient of volume expansion γ_l . When the temperature is raised by ΔT , the depth upto which the cube is submerged in the liquid remains the same. Find the relation between α_s and γ_l showing all the steps . **[2004, 2M]**

39. One end of a rod of length L and cross-sectional area A is kept in a furnace of temperature T_1. The other end of the rod is kept at a temperature T_2 . The thermal conductivity of the material of the rod is K and emissivity of the rod is e . It is given that $T_2 = T_s + \Delta T$, where $\Delta T << T_s$, T_s being the temperature of the surroundings . If $\Delta T \propto (T_1 - T_s)$, find the proportionality constant . Consider that heat is lost only by radiation at the end where the temperature of the rod is T_2 .
[2004, 4M]



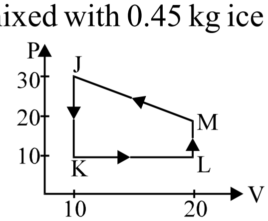
40. A metal of mass 1 kg at constant atmospheric pressure and at initial temperature 20 ºC is given a heat of 20000 J . Find the following : **[2005, 6M]**

(a) change in temperature **(b)** work done and

(c) change in internal energy

[Given : specific heat 400 J/kg/ºC , coefficient of cubical expansion , $\gamma = 9 \times 10^{-5}$ /ºC , density $\rho = 9000$ kg/m^3 , atmospheric pressure = 10^5 N/m^2]

41. If 0.05 kg steam at 373 K is mixed with 0.45 kg ice at –20°C then find the resultant temperature.



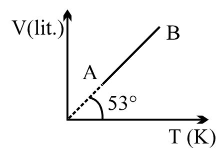
[2006, 6M]

EXERCISE 11

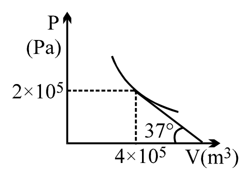
Q.1 The average degrees of freedom per molecules for a gas is 6. The gas performs 25 J of work when it expands at constant pressure. Find the heat absorbed (in joules) by the gas. (answer in multiple of 100)

Q.2 A vertical hollow cylinder contains an ideal gas. The gas is enclosed by a 5kg movable piston with an area of cross-section 5×10^{-3} m^2. Now, the gas is slowly heated from 300 K to 350K and the piston rises by 0.1 m. The piston is now clamped at this position and the gas is cooled back to 300 K. Find the difference between the heat energy added during heating process & energy lost during the cooling process. [1 atm pressure = 10^5 N m^{-2}] (answer in multiple of 11)

Q.3 V-T curve for 2 moles of a gas is straight line as shown in the graph here. Find the pressure (in N/m^2) of gas at A. (answer in multiple of 2.5×10^4). Find the value of N.



Q.4 P-V graph for an ideal gas undergoing polytropic process $PV^{m/2}$ = constant is shown here.Find the value of m.

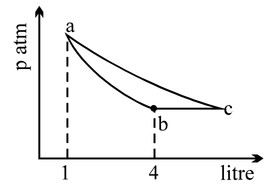


Q.5 An iron bar (Young's modulus = 10^{11} N/m^2, $\alpha = 10^{-6}$ /°C) 1 m long and 10^{-3} m^2 in area is heated from 0°C to 100°C without being allowed to bend or expand. Find the compressive force developed inside the bar. (answer in multiple of 10^4)

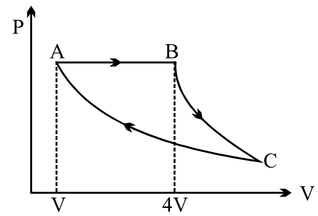
Q.6 One mole of an ideal gas is compressed from 0.5 lit to 0.25 lit. During the compression, 23.04×10^2 J of work is done on the gas and heat is removed to keep the temperature of the gas constant at all times. Find the temperature of the gas. (answer in multiple of 100K) (Take universal gas constant R = 8.31 J mol^{-1}K^{-1})

Q.7 70 calorie of heat is required to raise the temperature of 2 mole of an ideal gas at constant pressure from 40°C to 45°C. Find the amount of heat required to raise the temperature of the same gas through the same range at constant volume. (answer in multiple of 10calorie) (R = 2 cal/mol-K)

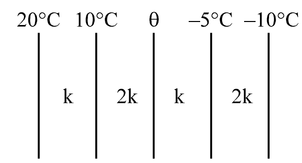
Q.8 Figure shows three processes for an ideal gas. The temperature at 'a' is 600 K, pressure 16 atm and volume 1 litre. The volume at 'b' is 4 litre. Out of the two process ab and ac, one is adiabatic and he other is isothermal. The ratio of specific heats of the gas is 1.5. find the volume at c. (in litre)



Q.9 A fixed mass of a gas is taken through a process $A \rightarrow B \rightarrow C \rightarrow A$. Here $A \rightarrow B$ is isobaric. $B \rightarrow C$ is adiabatic and $C \rightarrow A$ is isothermal. If the efficiency of the process is $\frac{X-2 \quad \ln 2}{X}$. Find the value of X. (take $\gamma = 1.5$)



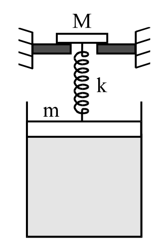
Q.10 The figure shows the face and interface temperature of a composite slab containing of four layers of two materials having identical thickness. Under steady state condition, find the value of temperature θ (in °C)?



k = thermal conductivity

Q.11 How many atoms do the molecules of a gas consist of if γ increases 1.20 times when the vibrational degrees of freedom are "frozen" ? Assume that molecules are non linear.

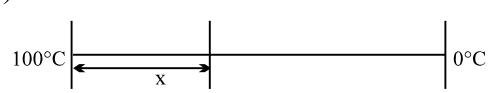
Q.12 0.01 moles of an ideal diatomic gas is enclosed in an adiabatic cylinder of cross-sectional area $A = 10^{-4} m^2$. In the arrangement shown, a block of mass $M = 0.8$ kg is placed on a horizontal support, and another block of mass $m = 1$ kg is suspended from a spring of stiffness constant $k = 16$ N/m. Initially, the spring is relaxed and the volume of the gas is $V = 1.4 \times 10^{-4} m^3$. Find the initial pressure of the gas. (answer in multiple of 10^5).



Q.13 A U-tube filled with a liquid of volumetric coefficient of 10^{-5}/°C lies in a vertical plane. The height of liquid column in the left vertical limb is 100 cm. The liquid in the left vertical limb is maintained at a temperature = 0°C while the liquid in the right limb is maintained at a temperature = 100°C. Find the difference in levels in the two limbs. (answer in multiple of 10^{-3}metre)

Q.14 A pan filled with hot food cools from 50.1 °C to 49.9 °C in 5 sec. How long will it take to cool from 40.1 °C to 39.9°C if room temperature is 30°C? (answer in multiple of 5sec)

Q.15 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 tempeature 100°C and 0°C. Specific heat capacity is 10 J/kg°C and linear mass density is 2 kg/m. Find ther total heat absorbed by the rod to reach steady state. (answer in multiple of 10^3)



PP- ANSWER KEY

PP-1

1. 26.00468 m
   (b) clock loses times
2. (a) 10 K, 1.1514ºC
3. $\theta = 75.6$ºC
4. Clock shows correct time at 25ºC.
5. R = 0.769 m.
6. $\alpha_g = \frac{\gamma_g}{3} = 1\times10^{-5}(^\circ C)^{-1}$
7. (a) 1.50 cm^3 (b) Water over flow = 1.455 cm^3
8. $\gamma = \left(\frac{W_2 - W_1}{W_0 - W_1}\right)\frac{1}{T_2 - T_1} + \left(\frac{W_0 - W_1}{W_0 - W_2}\right)\beta$
9. $\gamma_l = 1.84\times10^{-4}(^\circ C)^{-1}$
10. $\gamma_l = \frac{h_2 - h_1}{h_1(T_2 - T_1)}$

PP-2

1. (B)	2. (B)	3. (D)	4. (B)
5. (C)	6. (D)	7. (B)	8. (D)
9. (D)	10. 5815.6 cal.		

PP-3

1. (B)	2. (D)	3. (A)	4. (D)
5. (A)	6. (C)	7. (B)	8. (C)
9. (C)	10. (A)		

PP-4

1. 0.495kg
2. 429075 cal., t = 2hr 4 minutes
4. Final temperature = 100ºC, amount of water = 572.2 gram, amount of steam = 77.8 gm
5. Ice = 68.75 gm , water = 81.25 gm
6. Final temperature = 100ºC, Ice = 3.75 gm, Water = 6.25 gm
7. Mass = 31 gram
8. 49 gm of steam condense and the final temperature is 100ºC.
9. T > 0ºC
10. 266.75 gm of water at 0ºC

PP-5

1. (D)	2. (D)	3. (A)	4. (C)
5. (D)	6. (C)	7. (B)	8. (D)
9. (B)	10. (C)		

PP-6

1. (D)	2. (D)	3. (B)	4. (B)
5. (B)	6. (D)	7. (D)	
8. $RT[(\eta - 1) - n\log_e \eta]$	9. 2400 R = 20 kJ	10. 108 J	

1. (a) $(\Delta W)_{ABC} = 60$ J $(\Delta D)_{AC} = 40$ J

   (b) V_C =170J

   (c) $(\Delta Q)_{AB} = 10$ J, $(\Delta Q)_{BC} = 210$ J

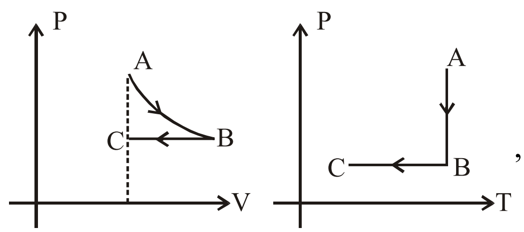
2. (a)

Process	Q	Q	ΔU
AB	$3P_0V_0 \ln(3)$	$P_0V_0 \ln(3)$	0
BC	$-\dfrac{9P_0V_0}{4}$	0	$-\dfrac{9P_0V_0}{4}$
CA	$\dfrac{9P_0V_0}{8}$	$-\dfrac{9P_0V_0}{8}$	$\dfrac{9P_0V_0}{4}$

   (b) C = 3/4 R

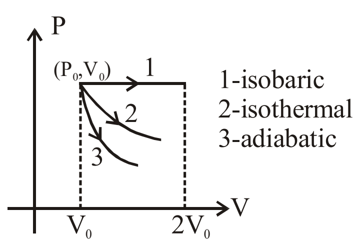
3. (a) $\alpha = \dfrac{2T_0kA}{5P_0V_0a}$ (b) $h = \left(\dfrac{T}{T_0}\right)h_0$

4. $T = 2\pi\sqrt{\dfrac{Ml_0}{2P_0A + kl_0}}$

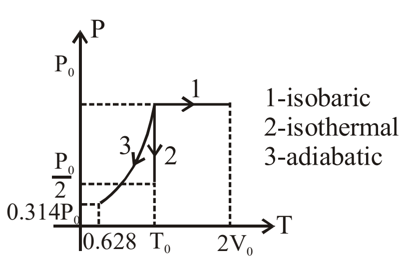
5. (a) 

,

   (b) $W_{total} = 3RT_0 \ln(2) - \dfrac{3}{2}RT_0$, (c) $Q_{total} = 3RT_0 \ln(2) - \dfrac{21}{4}RT_0$

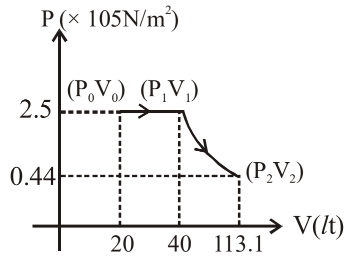
6. (a) 

Area under graph 3 is least. Therefore, work done is least in adiabatic process.

   (b) 

7. $T_0 = 369.3K$, $P_0 = 2.46 \times 10^5$ N/m^2

8. (a)



(b) $V_2 = 113.14 \times 10^{-3}$ m^3 , $P_2 = 0.44 \times 10^5$ N/m^2 (C) $W_{total} = 12470$ J

9. (a) $\frac{207}{16}T_0$ and $\frac{9}{4}T_0$, (b) $W = -\frac{15}{8}P_0V_0$

10. T_2 = 800 K, ΔQ = 600 + 120 = 720 J

PP-8

1.	(A)	2.	(D)	3.	(D)	4.	(B)
5.	(C)	6.	(A)	7.	(D)	8.	(A)
9.	(B)	10.	(D)				

PP-9

1.	(D)	2.	(A)	3.	(D)	4.	(D)
5.	(C)	6.	(C)	7.	(D)	8.	(C)
9.	(B)	10.	(B)				

PP-10

1. $\theta = 1.2 \times 10^{-3}\,{}^{o}C$
2. temperature gradient 0.87ºC cm^{-1}
3. (a) θ = 40ºC (b) 4.8 cal/sec
4. x = 10.34 cm
5. 48.457 ºC
6. 2019.8 watt
7. 6.4×10^7 W/ml, 5803 K
8. (a) 9/16 (b) 4/3
9. (a) 2 : 1 (b) 1.632/1
10. 51.28sec

ANSWER SHEET

Exercise - 02

1. C	2. D	3. C	4. B
5. A	6. B	7. A	8. B
9. C	10. B	11. B	12. B
13. B	14. A	15. C	16. C
17. A	18. B	19. C	20. B
21. A	22. C	23. B	24. B
25. B	26. A	27. A	28. B
29. B	30. C		

Exercise - 03

1. (a) readings that are too long (b)20.0048 cm 3. 99.6% 4. (a) –0.033% (b) + 0.011%

5. 1252.8 cm 6. 742 kJ 7. 2.13 gm 8. 3.78×10^5 J/kg

9. 52ºC 10. 100ºC, 7.74 g, 222.26 g 11. $(n-1)RT - RT\ln n$

12. $\dfrac{n_1T_1+n_2T_2}{n_1+n_2}$ 13. (a) 6 cal, (b) – 43 cal, (c) 40 cal, (d) 18 cal, 18 cal

14. $2^{\gamma+1}P_0$ (both cases) 15. 30 g 16. 0.10 atm 17. (a) 2 atm, (b) 36.7 g/mol

18. 0.42 kK 19. 0.9 K 20. 0.918 cm^2 21. 1.77 J/smK

22. 1.78 J/s 23. 25 cm from cold end 24. 0.33 25. 30°C

Exercise - 04

1. (B)	**2.** (A)	**3.** (A)	**4.** (B)
5. (A)	**6.** (A)	**7.** (C)	**8.** (B)
9. (C)	**10.** (D)	**11.** (C)	**12.** (A)
14. (B)	**15.** (B)	**16.** (C)	**17.** (B)
18. (A)	**19.** (A)	**20.** (C)	**21.** (C)
22. (D)	**23.** (A)	**24.** (C)	**25.** (B)
26. (B)	**27.** (C)	**28.** (B)	**29.** (C)
30. (B)			

Exercise - 05

1. 3.78×10^5 J/kg 2. $Q' = Q - 3nRT - \frac{5}{2}k\ell^2$ 3. C = 2R 4. $v = \frac{2}{5}\frac{q}{p_0S+Mg}$

5. 750 J 6. (a) $W_{12} = \frac{P_0M}{\rho_0}ln(2)$, $W_{23} = \frac{P_0M}{\rho_0}$, $W_{31} = 0$, (b) $\frac{P_0M}{\rho_0}\left[\frac{3}{2}+ln2\right]$, (c) $\frac{2}{5}(1-\ln 2)$

7. 395 K 8. $m = (1 - e^{-Mgh/RT})p_0 S / g$ 9. $\Delta U = -0.25 kJ, Q = -\Delta U$

10. 1.33 11. $C_V = 0.42 J/(g.K); C_P = 0.65 J/(g.K)$

12. $C_n = R(n-\gamma)/(n-1)(\gamma-1); C_n < 0$ for $1 < n < \gamma$

13. (a) $\Delta U = \alpha V_0^2(\eta^2 - 1)/(\gamma - 1)$, (b) $\frac{1}{2}\alpha V_0^2(\eta^2 - 1)$, (c) $C = \frac{1}{2}R(\gamma+1)/(\gamma-1)$

14. (a) $C = \gamma R/(\gamma - 1) + \alpha R / p_0 V$, (b) $\Delta U = p_0(V_2 - V_1)/(\gamma - 1)$;

$A = p_0(V_2 - V_1) + \alpha \ln(V_2/V_1); Q = \gamma p_0(V_2 - V_1)/(\gamma - 1) + \alpha \ln(V_2/V_1)$

15. (a) $Ve^{-\alpha T/R} = \text{const.}$, (b) $Te^{R/\beta V} = \text{const.}$, (c) $V - aT = \text{const.}$

16. 5 m 17. $T_B = 30°C, T_C = T_D = 20°C$ 18. (a) $ms(\theta_1 - \theta_0)$, (b) $\frac{\ln 10}{k}$

Exercise - 06

1. (B) (C)	2. (A) (B) (C)	3. (B) (C)	4. (B) (C) (D)
5. (A) (B) (C)	6. (A) (B) (D)	7. (A) (B) (C)	8. (A) (B) (C) (D)
9. (C) (D)	10. (A) (C)	11. (A) (B)	12. (A) (B) (D)
13. (A) (B) (C) (D)	14. (D)	15. (A) (B) (D)	16. (B) (D)
17. (A) (C)	18. (A)	19. (A) (D)	20. (A) (C)
21. (A) (B) (C)	22. (C)	23. (C)	24. (B) (D)
25. (A) (D)	26. (D)	27. (E)	28. (D)
29. (D)	30. (A)	31. (A)	32. (A)
33. (D)	34. (B)	35. (A)	36. (D)
37. (C)	38. (D)	39. (A)	40. (C)
41. (B)	42. (A)	43. (A)	44. (B)
45. (D)	46. (C)	47. (C)	48. (B)
49. (D)	50. (D)	51. (A)	52. (B)
53. (A)	54. (B)	55. (D)	56. (B)
57. (C)	58. (A)	59. (A)	60. (A)
61. (B)	62. (D)	63. (B)	64. (A)
65. (A)	66. (C)	67. (B)	68. (B)
69. (B)	70. (D)	71. (A)	72. (B)
73. (A)	74. (B)	75. (D)	76. (B) 77. (B)

78. A-s, B-p, C-r,D-q
79. A–q, r, B–r, C–p,r
80. A-p,r, B-s,C-p,r D-q
81. A-r, B-p, C-p, D-r
82. A - p, B -q,C - s,D - r
83. A-s, B-p, C-r, D-q,s
84. A-p, B-r,s, C-p,q, D-p,q
85. A - p,s , B - s , C - r,s , D - p,q,r,s
86. A-r, B-p, C-q, D-s
87. A-r , B-s , C-p , D- q
88. A - r, B - s, C - p,s , D - q,s

Exercise - 08

1. (A)	2. (C)	3. (C)	4. (C)
5. (C)	6. (A)	7. (A)	8. (B)
9. (D)	10. (B)	11. (D)	12. (D)
13. (B)	14. (D)	15. (B)	16. (A)
17. (B)	18. (D)	19. (A)	20. (D)
21. (B)	22. (D)	23. (A)	24. (B)
25. (A)	26. (C)	27. (D)	28. (B)
29. (D)	30. (C)	31. (B)	32. (C)
33. (B)	34. (B)	35. (C)	36. (B)
37. (A)	38. (B)	39. (D)	40. (B)
41. (A)	42. (C)	43. (C)	

Exercise - 09

Objective Questions (Only one option)

1. (A)	2. (B)	3. (A)	4. (B)	5. (C)	6. (D)
7. (B)	8. (D)	9. (B)	10. (C)	11. (D)	12. (C)
13. (D)	14. (D)	15. (D)	16. (B)	17. (A)	18. (A)
19. (C)	20. (B)	21. (A)	22. (B)	23. (A)	24. (A)
25. (A)	26. (C)	27. (C)	28. (B)	29. (B)	30. (C)
31. (C)	32. (C)	33. (B)	34. (A)	35. (C)	36. (C)
37. (A)	38. (C)	39. (C)			

Objective Questions (More than one option)

40. (A, B, C, D) 41. (A, B, D) 42. (A, B) 43. (B, C)

44. (B, D)

Fill in the Blanks

45. 2R 46. Partly solid and partly liquid 47. $\sqrt{2}T$ 48. 0°C

49. 5803 50. 1.71 ρrc 51. $\frac{4\pi KTR^2}{P}$ 52. $\frac{Pt}{M}$ 53. temperature remains constant

54. 0.628 55. 60°C 56. 192° 57. 45.68°C 58. 5.5

True/False

59. F 60. T 61. T 62. F

63. B 64. A 65. D 66. C

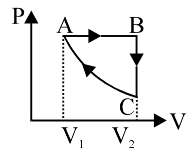
67. A-s, B-pr, C-r, D-qs 68. A-s, B-q, C-pr, D-pr 69. A-q, B-pr, C-ps, D-qs

70. BD 71. BD 72. 9 73. D 74. ABCD 75. 8

76. 4 77. A 78. ACD 79. 3 80. A-prt, B-pr, C-qs, D-rt

81. (C) 82. (D) 83. (D)

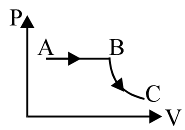
Exercise - 10

1. 12.96 m/s 2. 

3. –972 J 4. Hollow sphere

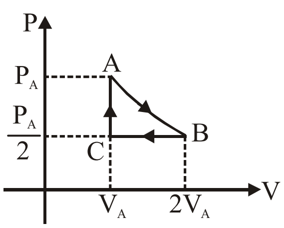
5. (i) 1.96×10^{27} per sec, (ii) 36 m/s 6. (i) $T_1 = 12.94\ T_0$, $T_2 = 2.25\ T_0$, (ii) $-1.875\ RT_0$

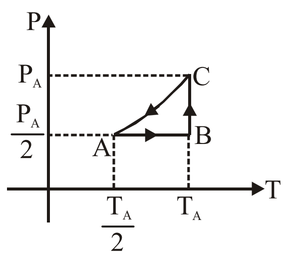
7. 83.83 cm of Hg 8. 9000 W 9. 75.4 cm of Hg

10. 675K, 3.6×10^6 N/m^2 11. (i) 

, (ii) 113L , 0.445×10^5 N/m^2, (iii) 12459 J

12. 800 K, 720 J 13. (i) f = 5, (ii) W = 1.23 PV

14. (i) 

, 

(ii) $0.58\ RT_A$, $0.58\ RT_A$

15. (a) 1152 J, (b) 1152 J, (c) zero 16. 166.32 s 17. (a) 1869.75 J, (b) –5297.6J, (c) 500K

18. (a) 765 J, (b) 10.82% 19. Mass of neon = 4.074 g, mass of argon = 23.926 g

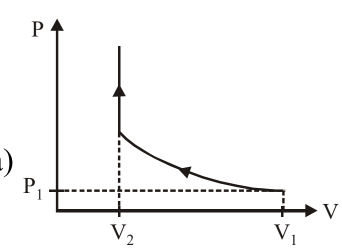
20. (a) 2 mol, (b) 401 m/s, (c) 0.167%, (d) -8.27×10^{-5} V 21. (a) 189K, (b) –2767 J, (c) 2767 J

22. 12 g 23. $T_B = 909K$, $T_D = 791.4K$, 61.4% 24. 6.7×10^{-5} per°C

25. 41.6 W, 26.48°C, 0.52°C

26. (i) $T_A = 120.34$ K, $T_B = 240.68K$, $T_C = 481.36$ K, $T_D = 240.68K$, (ii) No,

(iii) $Q_{ABC} = 3.25 \times 10^6$ J, $Q_{ADC} = 2.75 \times 10^6$ J 27. (a) P_0V_0, (b) $-\frac{5}{2}P_0V_0$, $3P_0V_0$, (c) $\frac{P_0V_0}{2}$, (d) $\frac{25}{8}\frac{P_0V_0}{R}$

28. $\left[300 + 12.5\ e^{-\frac{2KAt_1}{CL}}\right]$K 29. (a) 

(b) $W_{total} = -\frac{3}{2}P_1V_1\left[\left(\frac{V_1}{V_2}\right)^{2/3} - 1\right]$, $\Delta U_{total} = \frac{3}{2}P_1V_1\left[\left(\frac{V_1}{V_2}\right)^{2/3} - 1\right] + Q$ $T_{final} = \frac{Q}{3R} + \frac{P_1V_1}{2R}\left(\frac{V_1}{V_2}\right)^{2/3}$

30. (a) 1200 R, (b) $Q_{AB} = -2100R$, $Q_{BC} = 1500R$, $Q_{CA} = 831.6$ R

31. 0.495 kg   32. (a) 600 K, (b) 1500R, 831.6 R, –900R, –831.6R, (c) 600 R

33. 4.568×10^{-3} °C   34. (a) 160 K, (b) 3.312×10^{-21} J, (c) 0.3g   35. $\Delta T = \dfrac{Mv_0^2}{3R}$

36. (a)595 W/m^2, (b) 162.6°C   37. $\dfrac{4}{3}$m, 448.8K   38. $\gamma_1 = 2\alpha_s$

39. Proportionality constant $= \dfrac{K}{4e\sigma LT_s^3 + K}$ 40. (a) 50°C, (b) 0.05 J, (c) 19999.95 J   41. 0°C

Exercise - 11

Q.1	1	Q.2	5	Q.3	5	Q.4	3
Q.5	1	Q.6	4	Q.7	5	Q.8	8
Q.9	3	Q.10	5	Q.11	4	Q.12	2
Q.13	1	Q.14	2	Q.15	1		