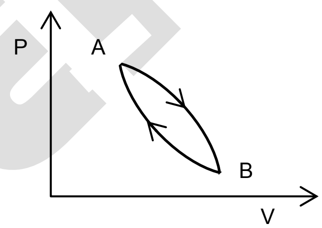
HEAT AND THERMODYNAMICS PROBLEMS

1. In a steady state, the temperature at the end A and B of 20 cm long rod AB are 100^0C and 0^0C. Find the temperature of a point 9 cm from A.

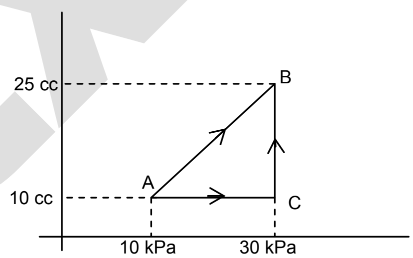
2. A thermally insulated vessel containing a gas whose molar mass is M and adiabatic exponent γ, moves with a velocity v. Prove that rise in temperature of the gas resulting from the stoppage of the vessel is $\frac{mv^2}{2R}(\gamma-1)$.

3. In a cyclic process shown in the figure an ideal gas is adiabatically taken from B to A, the work done on the gas during the process B $\rightarrow$ A is 30 J,when the gas is taken from A $\rightarrow$ B the heat absorbed by the gas is 20J. Find out the work done by the gas in the process A $\rightarrow$ B.



4. The initial and final temperature of water as recorded by an observer are $(40.6 \pm 0.2)°$C and $(78.3 \pm 0.3)°$C. Calculate the rise in temperature with proper error limits.

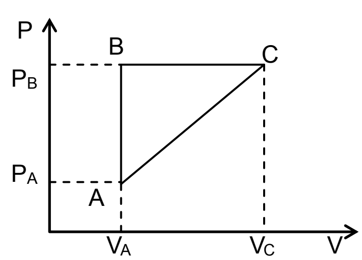
5. Figure shows two paths through a gas can be taken from the state A to the state B. Calculate the work done by the gas in each path.



6. In steady state, the temperature at the end A and B of 20 cm long rod AB are 100^0C and 0^0C. Find the temperature of a point 9 cm from A.

7. A gas is found to obey P^2V = constant. The initial temperature and volume of gas are T_0 & V_0. If the gas expands to volume $3V_0$. Find the final temperature of gas.

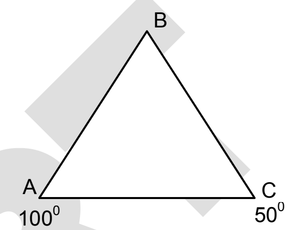
8. A thermodynamical process is a shown in the figure with $P_A = 3 \times 10^5$ Pa, $v_A = 2 \times 10^{-3}$ m^3, $P_B = 8 \times 10^4$ Pa, $v_C = 5 \times 10^{-3}$ m^3, in the process AB and BC 600 J and 200 J heat is added to the system, respectively. Find the change in internal energy of the system in the process AC.



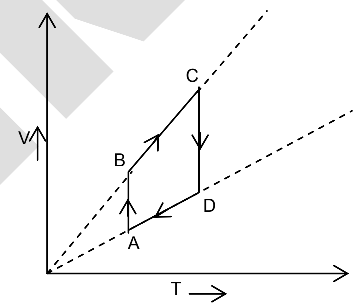
9. Find the specific heat capacity of mono-atomic ideal gas for thermodynamic process $P = \alpha v^2$. Where α is positive constant.

10. Find the molar specific heat (in terms of R) of a diatomic gas while undergoing the following process. $dQ = -\frac{1}{2}dU + \frac{1}{2}dW$

11. Three identical metallic rods are arranged as an equilateral triangle ABC as shown in the figure. Rod AB and BC have same thermal conductivity k. Ends A & C are maintained at constant temperature 100^0C and 50^0C. Find the temperature of junction B and conductivity of rod AC such that heat flowing is AB is same as in AC. (provided that only conduction is takes place)



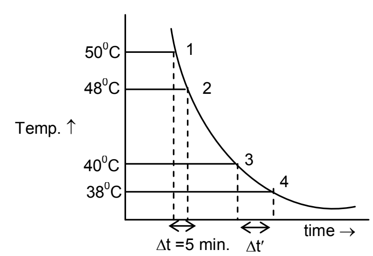
12. An ideal gas undergoes a cyclic process ABCD as shown in the figure. Draw the corresponding P-V diagram.



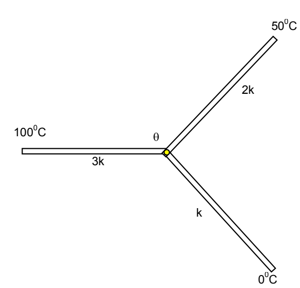
13. A vessel contains a mixture of one mole of CO_2 and two moles of nitrogen at 300 k. Find the ratio of the average rotational kinetic energy of CO_2 molecules to that of N_2 molecules.

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

15. Following graph shows variation of temperature with time of a cooling body. The surrounding temperature is 27^0 C. Find $\Delta t'$.



16. Find the temperature of junction of three rods of the same dimensions having thermal conductivity arranged as 3k, 2k, and k shown with their ends at 100^0C, 50^0C and 0^0C?



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

18. An ideal gas, whose adiabatic exponent is equal to γ is expended so that the amount of heat transferred to the gas is equal to the decrease of internal energy, find
(a) the molar heat capacity of the gas in this process.
(b) the equation of the process in the variables T, V.

19. A body cools from 62^0C to 50^0 in 10 min and 42^0 C in the next 10 minutes. Find the temperature of the surrounding.

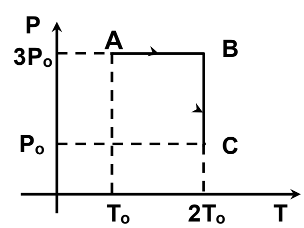
20. Two moles of Helium gases (γ = 5/3) are initially at temperature 27^0 C and occupy a volume of 20 litres. The gas is first expanded at constant pressure until the volume doubles. Then it undergoes an adiabatic change until the temperature return to its initial value.
(a) Sketch the process on P-V diagram.
(b) What are the final value and pressure of the gas.
(c) What is the work done by the gas.

21. Taking the composition of air to be 75% Nitrogen and 25% oxygen by weight, calculate the velocity of sound through air at STP.

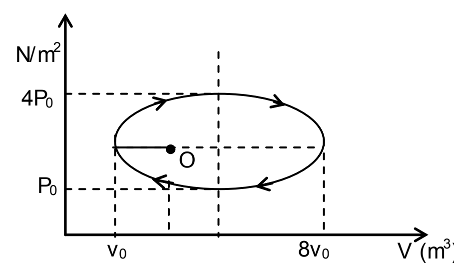
22. A heater wire boils water in a given electric kettle in 3 minutes. Another heater wire boils water in the same electric kettle in 7 minutes. Find the time taken when both heater wires are connected in series in the same electric kettle across the given mains.

23. A circular hole of radius 2 cm is made in an iron plate at O^oC. What will be its radius at 100^oC? α for iron = 11×10^{-6} /^{0}C.

24. One mole of an ideal monoatomic gas is taken through the thermodynamic process A→B→C as shown in figure. Find the total heat supplied to the gas.



25. P-V diagram of a cyclic process is given in the figure. This is elliptical process and O is the focus of the ellipse. Find the work done in the diagram.



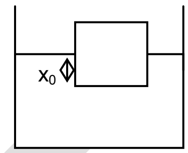
26. What is the heat input needed to raise the temperature of 2 mole of helium gas from 0^0C to 100^0C (take R = 8.31)
(a) at constant volume ?
(b) at constant pressure ?

27. A piece of ice of mass 100g and at temperature 0^0C is put in 200 g of water at 25^0C. Assuming that the heat is exchanged only between the ice and the water, find the final temperature of the mixture.

Latent heat of fusion of ice = 80 cal/g, specific heat capacity of water = 1 cal/g ^{0}C.

28. In steady state, the temperature at the end A and B of 20 cm long rod AB are 100^{0}C and 0^{0}C. Find the temperature of a point 9 cm from A.

29. A cubical block of coefficient of linear expansion α floats in liquid of coefficient of volume expansion γ. When temperature of block and liquid is raised by t^{0}C, it is found that immersed portion of cube in liquid remains same. Find the relation between γ and α.



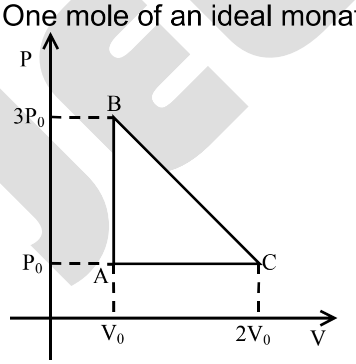
30. A hollow spherical ball of inner radius a and outer radius 2a is made of a uniform material of constant thermal conductivity k. The temperature within the ball is maintained at $2T_0$ and outside the ball is T_0.
Find
(a) the rate at which heat flows out of the ball in the steady state.
(b) the temperature at $r = \dfrac{3a}{2}$

31. Two bodies A and B have thermal emissivity of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are 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 is 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, calculate
(a) the temperature of B
(b) wavelength λ_B

32. The thickness of ice on a lake is 5.0 cm and the temperature of air is – 20^{0}C. Calculate how long will it take for the thickness of ice to be doubled. Thermal conductivity of ice = 0.005 cal/ cm sec. density of ice = 0.92 gm/cc. and latent heat of ice is 80 cal/g.

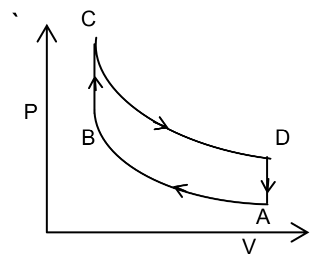
33. A cubical tank of water of volume 2m^3 is kept at a constant temperature of 65^{0}C by 2kW heater. At time t = 0 the heater is switched off. Find the time taken by the tank to cool down to 50^{0}C given the temperature of the room is steady at 15^{0}C. density of water = 10^{3}kg/m^3 and specific heat of water = 1 cal/gm-^{0}C(Assume the tank to behave like a black body and cool according to Newton's law of cooling) Take 1 Kw = 240 Cal/sec

34. One mole of an ideal monatomic gas is taken round the cyclic process ABCA as shown. Calculate



(i) work done by the gas
(ii) heat rejected by the gas in the path CA & heat absorbed by the gas in the path AB.
(iii) net heat absorbed by the gas in path BC
(iv) maximum temperature attained by the gas during the cycle.

35. One mole of an ideal monoatomic gas is taken along a cycle ABCDA where AB and CD are adiabatic process. BC and DA are isochoric process. If $v_A/v_B = 8$, then find efficiency of the cycle.

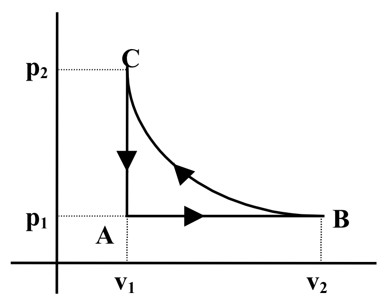


36. A gaseous mixture has the folowing volumetric composition per mole of the mixture.
He = 0.2, H_2 = 0.1, O_2 = 0.3, N_2 = 0.4
Assuming the mixture to be a perfect gas, determine
(a) the apparent molecular weight of the mixture
(b) c_v and c_p for the mixture
(c) gas constant per kg of the mixture.

37. At 27^0C two moles of an ideal monoatomic gas occupy a volume V. The gas expands a adiabatically to to a volume 2V. Calculate
(i) the final temperature of the gas.
(ii) change in its internal energy and
(iii) the work done by the gas during this process.

38. The speed of sound at N.T.P. in air is 332 m/sec. Calculate the speed of sound in hydrogen at (i) N.T.P. (ii) 819^0C temperature and 4 atmospheric pressure. (Air is 16 times heavier than hydrogen)

39. A cylinder with a piston holds a volume $V_1 = 1000\ cm^3$ of air at an initial pressure $p_1 = 1.1 \times 105$ Pa and temperature $T_1 = 300$ K. Assume that air behaves like ideal gas. The sequence of changes imposed on the air in the cylinder is shown in the figure.
(a) AB – the air heated to 375 K at constant pressure. Calculate the new volume, V_2.
(b) BC – the air is compressed isothermally to volume V_1. Calculate the new pressure p_2.
(c) CA – the air cools at constant volume to pressure p_1.
Find the net work done on the air.

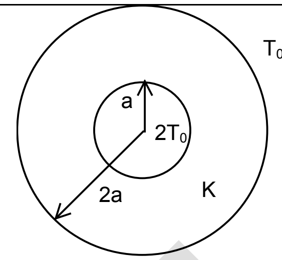


40. A wall is made of 7.5 cm thick magnesia, surfaced with 0.5 cm thick steel plate on one side & 2.5 cm thick asbestos on the other side. The thermal conductivities of steel, magnesia and asbestos are 52.3, 0.075 & 0.081 w/m-K respectively. If the outer surface temperature of steel plate is 150^0C and that of asbestos is 38^0C find
(a) rate of heat loss per square meter of surface area of wall &
(b) interface temperatures.

41. A hollow spherical ball of inner radius a and outer radius 2a is made of a uniform material of constant thermal conductivity K. The temperature within the ball is maintained at $2T_0$ and outside the ball it is T_0.Find,

(i) the rate at which heat flows out of the ball in the steady state,

(ii) the temperature at $r = \frac{3a}{2}$. Where r is radial distance from the centre of shell. Assume steady state condition.



42. A body cools down from 50^0C to 45^0C in5 minutes and to 40^0C in another 8 minutes. Find the temperature of the surrounding.

43. At 27^0C two moles of an ideal monoatomic gas occupy a volume V. The gas expands adiabatically to a volume 2V. Calculate

(i) the final temperature of the gas.

(ii) change in its internal energy and

44. A hot body of mass m, specific heat s is initially at temperature T_I and obeys Newton's law of cooling when placed in a surrounding of temperature T_0. Find

(a) the heat lost to the surroundings from t = 0 to the thermal equilibrium condition

(b) the time taken for losing 60 % of the total heat lost.

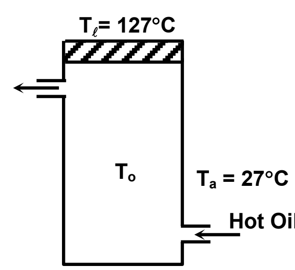
45. The temperature of a body falls from 40^0C to 36^0C in 5 minutes when placed in a surrounding of constant temperature 16^0 C. Find the time taken for the temperature of the body to fall from 36^0C to 32^0 C.

46. A solid copper sphere (density ρ and specific heat C) of radius r at an initial temperature 200k is suspended inside a chamber whose walls are at almost constant temperature at 0 K. Calculate the time required for the temperature of the sphere to drop to 100 K.

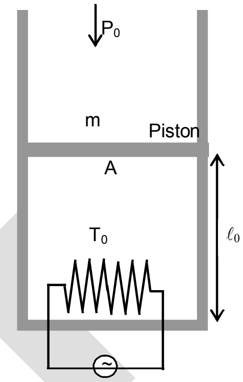
47. Hot oil is circulated through an insulated container with a wooden lid at the top whose conductivity K = 0.149 J/(m-°C-sec), thickness t = 5 mm, emissivity = 0.6. Temperature of the top of the lid is maintained at T_ℓ = 127°. If the ambient temperature T_a = 27°C. Calculate

(a) rate of heat loss per unit area due to radiation from the lid.

(b) temperature of the oil. (Given $\sigma = \frac{17}{3} \times 10^{-8}$)



48. An insulated vessel fitted with a frictionless movable piston of mass 'm' and area of cross section 'A' consists of certain amount of mono-atomic gas. When the temperature of the gas was T_0 the piston was at a height of 'l_0' from the bottom of the vessel. Now the gas is heated such that piston raises to a height of $2\ell_0$ from the bottom then (assume that atmospheric pressure is P_0)
(a) Identify the process?
(b) work done by the gas ?
(c) final temperature ? and
(d) heat absorbed by the gas ?

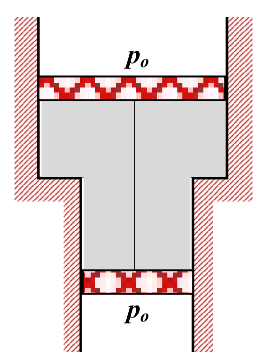


49. An ideal gas is enclosed in a vertical cylindrical container and supports a freely moving piston of mass M. The piston and the cylinder have equal cross-sectional area A. Atmospheric pressure is P_o and the volume of the gas is V_o when the piston is in equilibrium. The piston is slightly displaced from the equilibrium position. Assuming the process to be adiabatic, show that the piston executes SHM. Find the angular frequency of oscillation.

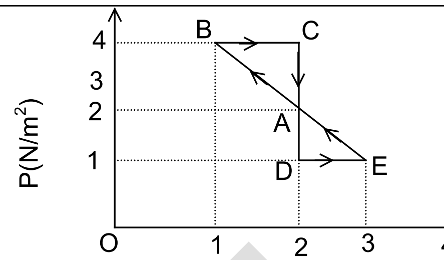
50. A copper and a tungsten plate having a thickness 2mm each are riveted together so that at 0^0C they form a flat bimetallic plate. Find the radius of curvature of the layer common to copper and a tungsten plates at 200^0C. The coefficients of linear expansion for copper and tungsten are 1.7×10^{-5} k^{-1} and 0.4×10^{-5} k^{-1} respectively.

51. Three moles of an ideal gas (c_p = 7/R) at pressure P_A and temperature T_A is isothermally expanded to twice is 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.
(a) Sketch P –V (P on X-axis, V on y-axis) and P–T (P on X-axis, T on y-axis) diagrams for the complete process.
(b) Calculate the net work done by the gas and net heat supplied to the gas during the complete process. (ln2 = 0.693).

52. A smooth vertical tube having two different sections is open from both ends and equipped with two pistons of different areas as shown. One mole of ideal gas is enclosed between the pistons tied with a non-stretchable thread. The cross-sectional S = 10cm□area of the upper piston is ^{2} greater than that of the lower one. The combined mass of the two pistons is equal to m = 5.0 kg. The outside air pressure is p_o = 1.0 atm. By how many kelvins must the gas between the pistons be heated to shift the pistons through l = 5.0 cm.
[Take g = 9.8 m/s^2]



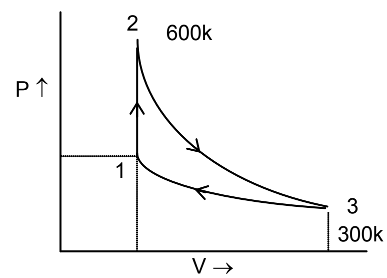
53. One mole of a monatomic gas is carried along process ABCDEA as shown in the diagram. Find the net work done by gas and heat given in the process.



54. 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.
(a) How many degrees of freedom do the gas molecules have ?
(b) Obtain the work done by the gas during the expansion as a function of initial pressure and volume.

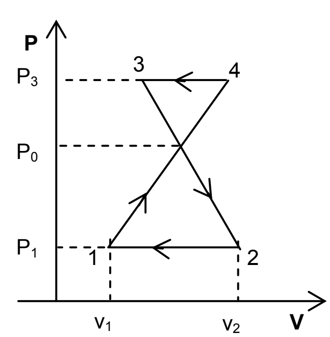
55. Two moles of an ideal monatomic gas, initially at pressure p_1 and volume V_1 undergo an adiabatic compression until its volume is V_2. Then the gas is given heat Q at constant volume V_2.
(a) Sketch the complete process on a p-V diagram.
(b) Find the total work done by the gas, the total change in its internal energy and the final change in its external energy and the final temperature of the gas.
[Give your answers in terms of p, V_1, V_2, Q and R]

56. A reversible heat engine carries 1 mole of an ideal monoatomic gas around the cycle as shown in the figure. Process $1\rightarrow2$ takes place at constant volume, process $2\rightarrow3$ is adiabatic and process $3\rightarrow1$ takes place at constant temperature.
(a) If the pressure at point (1) is one atmosphere find the pressures at points (2) and (3).
(b) Compute the heat exchanged, the change in internal energy and the work done for each of the three processes and for the cycle as a whole.
(c) Compute the efficiency of the cycle.
(Give all answers in terms of R) (ln2 = 0.693)

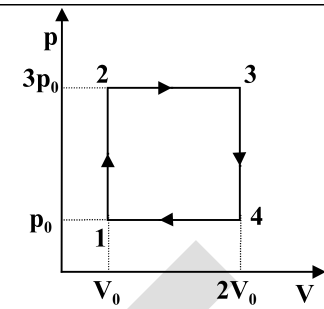


57. Heat flows radially outwards through a spherical shell of radius R_2 and R_1 ($R_2 > R_1$) and the temperature of inner and outer surfaces are θ_1 and θ_2 respectively. Find the radial distance from the centre of the shell at which the temperature is just halfway between θ_1 and θ_2.

58. Determine the work done by an ideal gas during $1 \rightarrow 4 \rightarrow 3 \rightarrow 2 \rightarrow 1$. Given $P_1 = 10^5$ Pa, $P_0 = 3 \times 10^5$ Pa, $P_3 = 4 \times 10^5$ Pa and $v_2 - v_1 = 10$ litres.



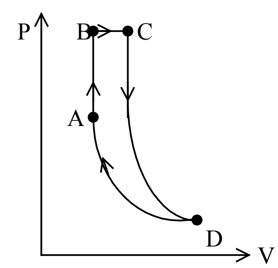
59. An ideal monoatomic gas is used to operate an engine. P-V diagram of the cyclic used is shown in the figure. Find the efficiency of the cycle.



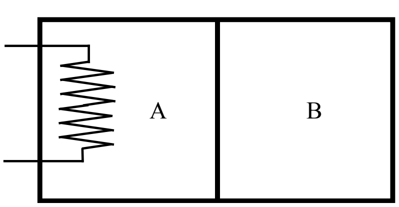
60. 2 moles of an ideal monatomic gas undergoes through the following changes in a cyclic process,
(i) Isothermal expansion from a volume 0.04 m^3 to 0.10 m^3 at 87^0 C
(ii) at constant volume, cooling to 27^0 C.
(iii) Isothermal compression at 27^0 to 0.04 m^3
(iv) at constant volume heating to original pressure volume and temperature
Then,
(a) draw P-V diagram of the complete cycle
(b) find the heat absorbed by the gas
(c) find the work done by the gas during the complete cycle
(d) find the efficiency of the cycle.
(e) find the change in internal energy of the gas during the complete cycle.

61. 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. If cools according to Newon'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 box 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 = $3t_1$.

62. One mole of an ideal monoatomic gas is taken along the cycle ABCDA where AB is isochoric, BC is isobaric, CD is adiabatic and DA is isothermal. Find the efficiency of the cycle. It is given that $\frac{T_C}{T_A} = 4$, $\frac{v_A}{v_D} = \frac{1}{16}$ and ln 2 = 0.693.



63. The insulated box shown in figure has an insulated 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 monatomic ideal gas (γ = 5/3) at a pressure P_o, volume V_o and temperature T_o. The chamber on the left is slowly heated by an electric heater so that its gas, pushing the partition, expands until the final pressure in both the chambers becomes $243P_o/32$. Determine :
(i) the final volume and temperature of the gas in B.



(ii) the heat given to the gas in A by the heater.

64. Find the molar specific heat (in terms of R) of a diatomic gas while undergoing each of the following processes :

(i) For any infinitesimal part of the first process, dQ = $-\frac{1}{2}dU + \frac{1}{2}dW$

(ii) For the second process : pV^2T = constant.

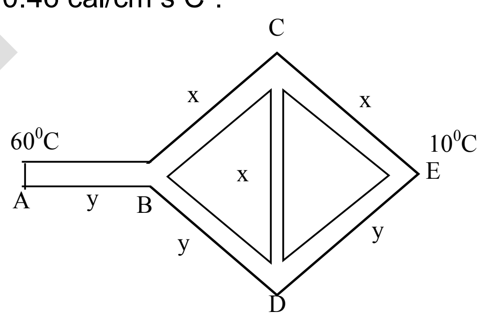
65. One mole of a gas is isothermally expanded at 27^0 C till the volume is doubled. Then it is adiabatically compressed to its original volume. Find the total work done. (γ = 1.4 and R = 8.4 J/mol -k).

66. 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.
(a) How many degrees of freedom do the gas molecules have ?
(b) Obtain the work done by the gas during the expansion as a function of initial pressure

67. An electrically heating coil was placed in a calorimeter containing 360 gm of water at 10^0 C. The coil consumes energy at the rate of 90 watt. The water equivalent of the calorimeter and the coil is 40 gm. Calculate what will be the temperature of the water after 10 minutes ?

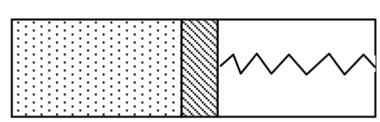
68. A double-pane window used for insulating a room thermally from outside, consists of two glass sheets each of area 1 m^2 and thickness 0.01 m separated by a 0.05 m thick stagnant air space. In the steady state the room-glass interface and the glass-outdoor interface are at constant temperature of 27^0C and 0^0C 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 $Wm^{-1} K^{-1}$ respectively.

69. Three rods of material x and three rods of material y are connected a shown in figure. All the rods are of identical length and cross-sectional area. If the end A is maintained at 60^0 C and the junction E at 10^0 C, calculate the temperature of junctions B, C and D. The thermal conductivity of x is 0.92 cal/cms C^0 and that of y is 0.46 cal/cm s C^0.



(A)

70. 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 mono-atomic gas, and the right part is empty. The piston is connected to the right wall of the vessel through a



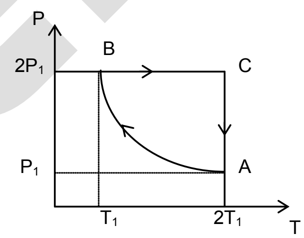
spring whose length in free state is equal to the length of the vessel. Determine the heat capacity C of the system, neglecting the heat capacities of the vessel, piston, and spring.

71. When a block of iron floats in mercury at 0^0C, a fraction K_1 of its volume is submerged, while at temperature 80^0C fraction K_2 is seen to be submerged. If the coefficient of volume expansion of iron is γ_{Fe} and that of mercury is γ_{Hg}. Find the ratio K_1 / K_2.

72. Two rods of different metals having the same area of cross-section A, are placed end to end between two massive walls. The first rod has a length ℓ_1, co-efficient of linear expansion α_1 and Young's modulus of elasticity Y_1. The corresponding quantities for second rod are ℓ_2, α_2 and Y_2 respectively. The temperature of both the rods is now raised by T degrees. Find the force which the rods exert on each other at the higher temperature in terms of the given quantities. Assume, there is no change in the area of cross-section of the rods, the rods do not bend and there is no deformation of the walls.

73. Two moles of an ideal monatomic 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.

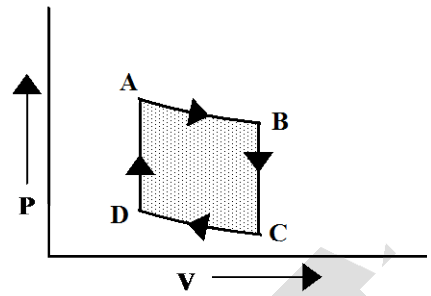


74. Two moles of a certain ideal gas at temperature T_0 = 300K were cooled at constant volume so that the gas pressure reduced η = 2 times. Then as a result of constant pressure process, gas expanded till its temperature got back to initial value. Find the total amount of heat absorbed by the gas in this process.

75. Two identical sphere with surface area A and emissivity e are connected by a metal rod of length ℓ, with high conductivity k and area of crossection a (a << A). Rod does not allow any loss of heat through It's side walls being coated with indulated cover. If initially temperatures of sphere is respectively T_1 and T_2 and temperature of surrounding is T_0 such that $T_1 > T_2 > T_0$. Temperature difference between sphere and surrounding is small enough to consider Newton's laws of cooling for heat loss through radiation. Find the temperature difference between spheres as function of time.

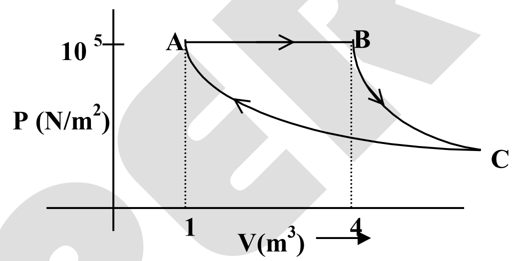
76. A polyatomic gas is initially taken at a pressure P_0 and temperature T_0 and volume V_1 = 500 ml. When the gas is compressed adiabatically to volume V_2 = 100 ml the temperature increases from T_0 to T_1 and the pressure from P_0 to P_1. Now the pressure increases from P_1 to P_2 isochorically and the temperature rises to T_2. The gas is expanded adiabatically from volume V_2 to V_1 such that the temperature drops to T_3. Finally the gas pressure drops to P_0 isochorically. Find efficiency of this cycle if γ = 1.33.

77. One mole of a mono atomic ideal gas is taken through the cycle shown in 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.



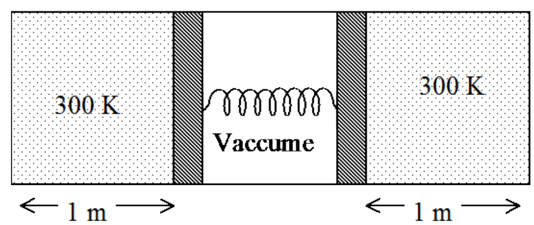
Given T_A = 1000K, $P_B = (2/3)P_A$ and $P_C = (1/3)P_A$. Calculate (a) The work done by the gas in the process $A \rightarrow B$ (b) the heat lost by the gas in the process $B \rightarrow C$ and (c) temperature T_D. Given $(2/3)^{2/5} = 0.85$ and R = 8.31 J/mol K.

78. A fixed mass of 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. Find (a) Pressure and volume at C (b) work done in the process (take $\gamma = 1.5$)

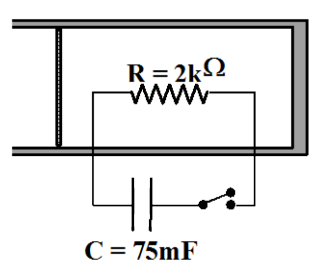


79. One mole of an ideal gas whose pressure changes with volume as $P = \alpha v$ where α is a constant, is expanded so that its volume becomes η times the original. Find the chage in internal energy and heat capacity of the gas.

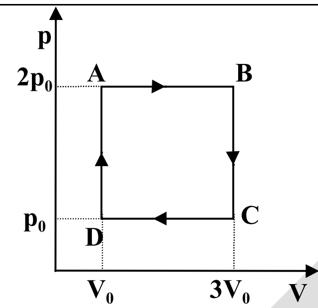
80. Consider the shown diagram where the two chambers separated by piston-spring arrangement contain equal amounts of certain ideal gas. Initially when the temperatures of the gas in both the chambers are kept at 300 K. The compression in the spring is 1 m. The temperature of the left and the right chambers are now raised to 400 K and 500 K respectively. If the pistons are free to slide, find the final compression in the spring.



81. One mole of a gas is taken in a cylinder with a movable piston. A resistor R connected to a capacitor through a key is immersed in the gas. Initial potential difference across the plates of the capacitor is equal to $213\frac{1}{3}$ V. When the key is closed for (2.5 ln 4) minutes , the gas expands isobarically and its temperature changes by 22 K .
(a) Find the work done by the gas
(b) Increment in the internal energy of the gas
(c) The value of γ



82. One mole of a monoatomic ideal gas has been subjected to an isochoric-isobaric cycle ABCDA. The temperature at D is T0 = 200 K.
Calculate
(i) the temperatures at the points A, B, C of the cycle.
(ii) the heat absorbed / released in each of the processes AB, BC, CD, DA.
(iii). the net work done in the process and the efficiency of the cycle.



83. Find the number of strokes that the piston of an air pump must make in order to pump a vessel of volume Vc.c from a pressure P_1 to P_2 if the change in volume corresponding to one stroke is $v_1$cc. Assume that the air in the vessel is in good thermal contact with the surroundings.

84. A pendulum clock consists of an iron rod connected to a small heavy bob. If it is designed to keep correct time at 20^0C, how fast or slow will it go in 24 hours at 40^0C.
($\alpha_{iron} = 12 \times 10^{-6}$ /^{0}C)

85. A vessel of volume 2000 cm^3 contains 0.1 mole of oxygen and 0.2 mole of carbon dioxide. If the temperature of the mixture is 300 K, find its pressure.

86. At the top of a mountain a thermometer reads 7^0C and a barometer reads 70 cm of Hg. At the bottom of the mountain they read 27^0C and 76 cm of Hg respectively. Compare the density of the air at the top with that at the bottom.

87. A body of mass 25kg is dragged on a horizontal rough road with a constant speed of 20km/hr. It the coefficient of friction is 0.5, find the heat generated in one hr. if 50% of the heat is absorbed by the body, find the rise in temperature. Specific heat of material of body is 0.1Cal/gm-^{0}C. (4.2 J = 1 Cal., g = 10m/s^2)

88. One mole of an ideal gas whose pressure changes with volume as P = αv where α is a constant, is expanded so that its volume becomes η times the original. Find the heat supplied to the gas.

89. A hot body placed in air cooled according to Newton's law of cooling, the rate of decrease of temperature being k times the temperature difference from the surrounding, starting from t = 0, find the time in which the body will loose 90 % of the maximum heat it can loose.

90. 1 mole of diatomic gas is kept in cylinder of volume V_0 at temperature T_0 and pressure P_0. Now gas is taken through three processes as shown in figure. Process 1 $\rightarrow$ 2 follows law P = V, Process 2$\rightarrow$ 3 is adiabatic while process 3$\rightarrow$ 1 is isothermal. Find
(a) temperature at state 2 in terms of T_0
(b) efficiency of cycle.