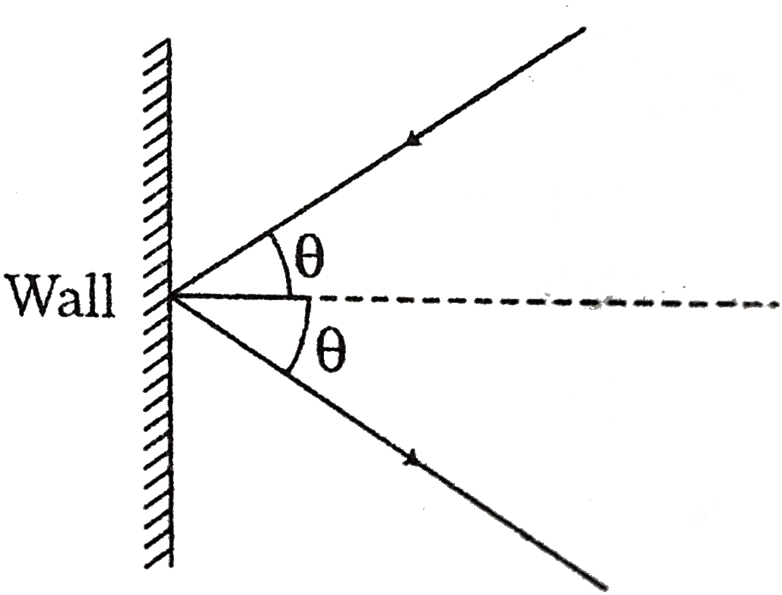
PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

KINETIC THEORY OF GASES

Illustration

1. The mass of hydrogen molecule is 3.32×10^{-27} kg. If 10^{23} hydrogen molecules strikes per second at 2 cm^2 area of a rigid wall at an angle of 45° from the normal and rebound back with a speed of 1000 ms^{-1}, then the pressure exerted on the wall is



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2. A parallel beam of particles of mass m moving with velocity v impinges on a wall at an angle θ to its normal. The number of particles per unit volume in the beam is n. If the collision of particles with the wall is elastic, then the pressure exerted by this beam on the wall is

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3. (a) Calculate (i) root-mean-square speed and (ii) the mean energy of 1 mol of hyderogen at STP given that density of hydrogen is $0.09 kg/m^3$. (b) Given that the mass of a molecule of hydergen is 3.34×10^{-27} kg, calculate Avogadro's number. (c) Calculate Boltmann's constant.

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4. Given molecular weight of hydrogen molecule is $M = 2.016 \times 10^{-3} kg/mol$. Calculate the root-mean-square speed of hydrogen molecules (H_2) at $373.15K(100^\circ C)$.

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5. One mole of oxygen occupies a volume of 24 L at $20^\circ C$ and 1 atm pressure. What is the rms speed of an oxygen? Find the total translational kinetic energy and the total momentum of the molecules.

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6. $1g$ mole of oxygen at $27^\circ C$ and 1 atmosphere pressure is enclosed in a vessel.

(a) 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.

(b) The vessel is next thermally insulated and moves with a constant speed v_0. It is then suddenly stoppes. The process results in a rise of temperature of the gas by $1^\circ C$. Calculate the speed v_0. $\left[k = 1.38 \times 10^{-23} J/K \text{ and } N_A = 6.02 \times 10^{23} /mol\right]$.

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7. A glass bulb of volume $400cm^3$ is connected to another bulb of volume $200cm^3$ by means of a tube of negligible volume. The bulbs contain dry air and are both at a common temperature and pressure of $20^\circ C$ and 1.000 atm, respectively. The larger bulb is immersed in steam at $100^\circ C$ and the smaller in melting ice at 0°. Find the final common pressure.

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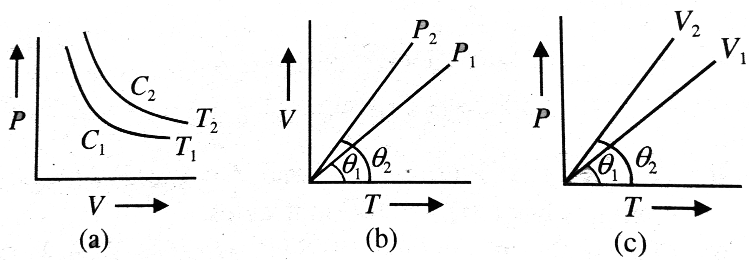
8. Explain whether (a) $T_2 > T_1$, (b) $P_2 > P_1$ and (c) $V_2 > V_1$ or otherwise in Fig., which represent in isothermal, isobaric, and isochoric processes for the same mass of an ideal gas, respectively.



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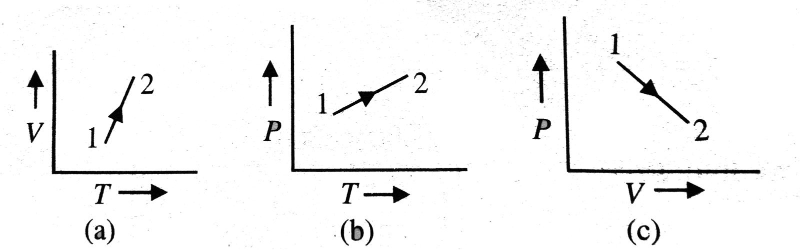
9. The three diagrams below depict three different processes for a given mass of an ideal gas. What information can be drawn regarding the change of (a) pressure, (b) volume and (c) temperature of the gas from the plots as shown in Fig., respectively.



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10. Draw the P-T and V-T diagrams of an isochoric process of n moles an ideal gas from pressure P_0 volume V_0 to pressure $4P_0$, indicating the pressures and temperatures of the gas in the initial and the final states.

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11. Draw the P-T and V-T diagrams for an isobabaric process of expansion, corresponding to n moles of an ideal gas at pressure P_0 from V_0 to $2V_0$

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12. 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 the T-axis.`

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13. Calculate (a) the average kinetic energy of translation of an oxygen molecule at $27^{\circ} C$ (b) the total kinetic energy of an oxygen molecule at $27^{\circ} C$ (c) the total kinetic energy in joule of one mole of oxygen at 27°. Given Avogadro's number $= 6.02 \times 10^{23}$ and Boltzmann's constant $= 1.38 \times 10^{-23} J/(mol-K)$.

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14. A light container having a diatomic gas enclosed with in is moving with velocity v. Mass of the gas is M and number of moles is n,

a. What is the kinetic energy of gas w.r.t. centre of mass of the system ?

b. What is K.E. of gas w.r.t. ground ?

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15. Two nonconducting containers having volume V_1 and V_2 contain monoatomic and dimatomic gases respectivley. They are connected as shown in figure. Pressure and temperature in the two containers are P_1, T_1 and P_2, T_2 respectively. Initially stop cock is closed, if the stop coc is opened find the final pressure and temperature.

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16. An ideal gas has a molar heat capacity at constant pressure of $Cp = 2.5R$. 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 x 10^(6) Nm^(-2). An amount 2.49 x 10^(4) J of heat energy is supplied to the gas. calculate the final temperature and pressure of the gas.

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17. A vessel of volume $0.2m^3$ contains hydrogen gas at temperature 300 K and pressure 1 bar. Find the heat required to raise the temperature to 400 K. The molar heat capacity of hydrogen at constant volume is $5cal/molK$.

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18. About 0.014 kg nitrogen is enclosed in a vessel at temperature of $27^\circ C$ How much heat has to be transferred to the gas to double the rms speed of its molecules ? $(R = 2cal/molK)$

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19. A gaseous mixture enclosed in a vessel contains 1 g mole of a gas A (why λ=5/3) and another gas B (with λ=7/5) at a temperature T. The gases

A and B do not react with each other and assumed to be ideal. The number of gram moles of B, if λ for the gaseous mixture is 19/13 is

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20. How much heat energy should be added to the gaseous mixture consisting of 1 g of hydrogen and 1g of helium to raise it s temperature from $0^{\circ} C$ to $100^{\circ} C$

(a) at constant volume,

b. at constant pressure $(R = 2cal / molK)$?

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21. Calculate the specific heat capacity C_r of a gaseous mixture consisting of v_1 moles of a gas of adiabatic exponent γ_1 and v_2 moles of another gas of adiaqbatic exponent γ_2.

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22. A vessel of volume $2 \times 10^{-2} m^3$ contains a mixture of hydrogen at $47^\circ C$ temperature and $4.15 \times 10^5 N/m^2$ Pressure. The mass of the mixture is $10^{-2} kg$. Calculate the masses of hydrogen and helium in the given mixture.

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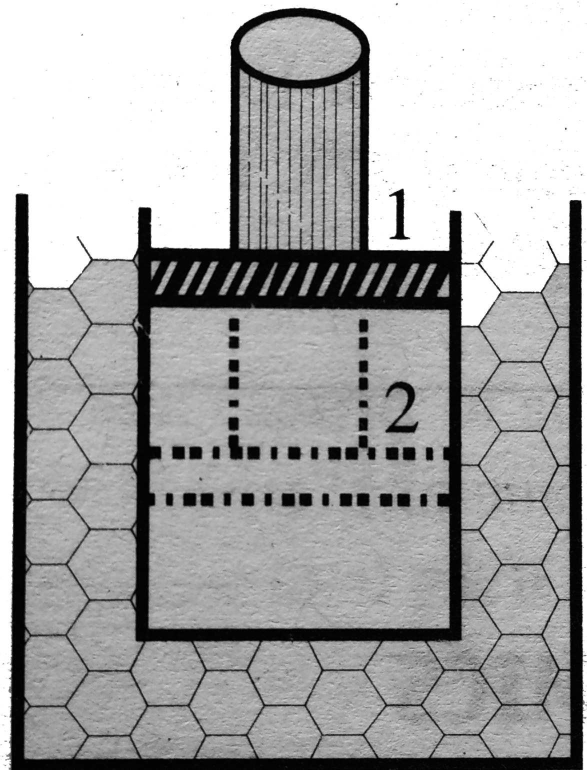
23. Figure shows a cylinder closed by a movable piston containing an ideal gas. The piston is quickly pushed down from position 2. The piston is held at position 2 until the gas is again at $0^\circ C$ and then is slowly raised back to position 1. Represent the whole operation on a P-V diagram. If 100 g of ice melts during the cycle, how much work is done on the gas?



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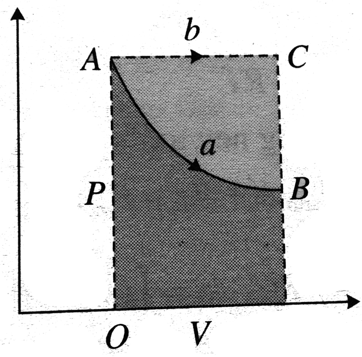
24. A quantity of gas occupies an initial volume V_0 at pressure p_0 and temperature T_0. It expands to a volume V (a) constant temperature and

(b) constant pressure. In which case does the gas do more work ?



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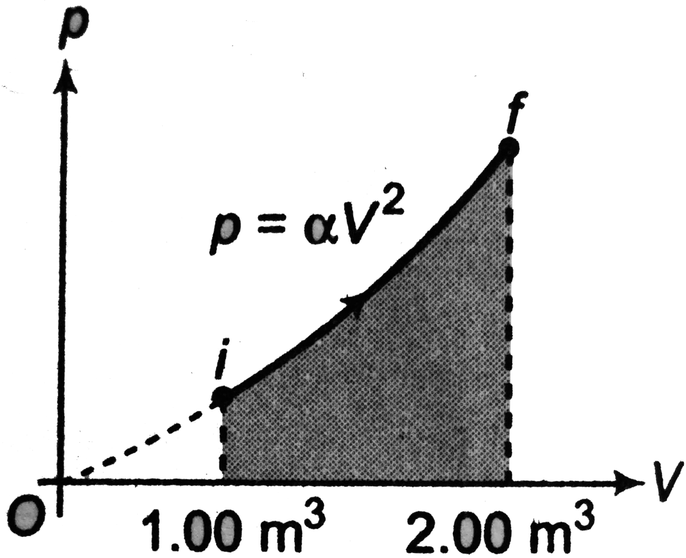
25. A sample of ideal gas is expanded to twice its original volume of $1.00m^3$ in a quasi-static process for which $p = \alpha V^2$, with $\alpha = 5.00atm/m^6$, as shown in Fig. How much work is done by the expanding gas?



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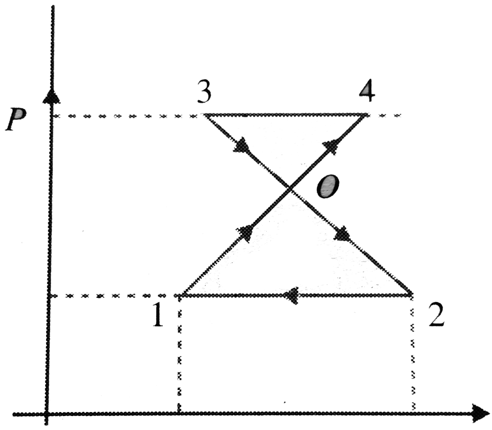
26. Determine the work done by an ideal gas doing $1 \to 4 \to 3 \to 2 \to 1$.

Given $P_1 = 10^5 Pa, P_0 = 3 \times 10^5 Pa, P_3 = 4 \times 10^5 Pa$ and

$V_2 - V_1 = 10L.$



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27. An ideal gas is enclosed in a cylinder with a movable piston on top of it. The piston has a mass of 800 g and an area of $5.00 cm^2$ and is free slide up and down, keeping the pressure of the gas constant. How much work is done on the gas as the temperature of 0.200 mol of the gas is raised from $20.0^\circ C$ to $300^\circ C$?

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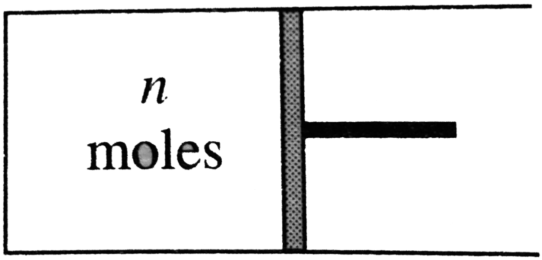
28. The cylinder shown in the figure has conducting walls and temperature of the surrounding is T, the pistonj is initially in equilibrium, the cylinder contains n moles of a gas, Now the piston is displaced slowly by an external agent to make the volume double of the initial. Find work done by external agent in term of n, R, T



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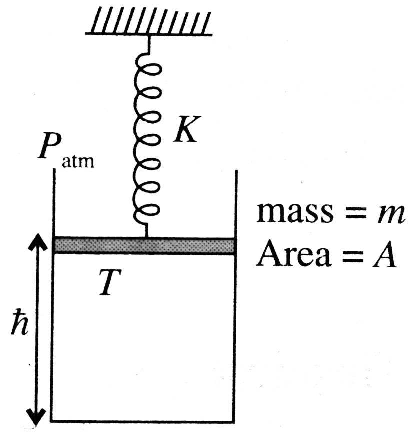
29. A non conducting piston of mass m and area of cross section A is placed on a non conducting cylinder as shown in figure. Temperature, spring constant, height of the piston are given by T,K,h respectively. Initially spring is relaxed and piston is at rest. Find

(a) Number of moles

(b) Work done by gas to displane the piston by distance d when the gas is heated slowly.

(c) Find the final temperature



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30. When a thermodynamic system is taken from an initial state I to a final state F along the path IAF, as shown in Fig. the heat energy absorbed by the system is $Q = 55J$ and work done by the system is $W = 25J$. If the same system is taken along the path IBF, the value of $Q = 35J$.

(a) If $W = -15J$ for the curved path FI, how much heat energy is lost by the system along this path ?

(b) If $U_1 = 10J$, what is U_F ?

(d) If $U_B = 20J$, what is Q for the process BF and IB ?

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31. How much work is done on the steam when 1.00 mol of water at $100^\circ C$ boils and becomes 1.00 mole of steam at $100^\circ C$ at 1.00 atm pressure? Assume the steam to behave as an ideal gas , determine the change in the internal energy of the material as it vapourizes.

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32. An ideal gas initially at 300 K undergoes an isobaric expansion at 2.50 k Pa. If the volume increases from $1.00m^2$ to $3.00m^3$ and 12.5 kJ is transferred to the gas by heat, what are (a) the change in its internal energy and (b) its final temperature ?

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33. The temperature of 3 kg of nitrogen is raised form $10^\circ C$ to $100^\circ C$, Compute the heat added, the work done, and the change in internal energy if (a) this is done at constant volume and (b) if the heating is at constant pressure. For nitrogen

$C_p = 1400 J kg^{-1} K^{-1}$ and $C_v = 740 J kg^{-1} K^{-1}$.

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34. Gaseous hydrogen contained initially under standard conditions in sealed vessel of volume $V = 5L$ was cooled by $\Delta T = 55K$. Find how much the internal energy of the gas will change and what amount of heat will be lost by the gas.

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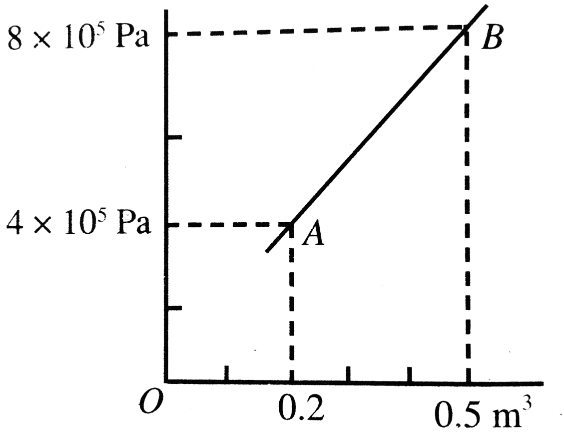
35. The volume of a monatomic ideal gas increases linearly with pressure, as shown in Fig. Calculate (a) increase in internal energy, (b) work done by the gas and (c) heat supplied to the gas.



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36. A Vessel contains helium, which expands at constant pressure when 15 kJ of heat is supplied to it. What will be the variation of the internal energy of the gas? What is the work performed in the expansion?

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37. The volume of one mode of an ideal gas with adiabatic exponent γ is varied according to the law $V = a/T$, where a is constant . Find the amount of heat obtained by the gas in this process, if the temperature is increased by ΔT.

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38. A 2.00 mol sample of helium gas initially at 300 K and 0.400 atm is compressed isothermally to 1.20 atm. Noting that the helium behaves as an ideal gas, find (a) the final volume of the gas, (b) the work done on the gas and (c) the energy transferred by heat.

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39. As a result of the Isobaric heating by $\Delta T = 72K$, one mole of a certain ideal gas receives heat Q = 1.6 kJ. Find the work performed by the increment of its intenal energy, and the value of its adiabatic exponent γ.

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40. Six grams of hydrogen gas at a temperature of 273 K isothoermally expanded to five times its initial volume and then isochorically heated so that the pressure in the final state becomes equal to that in the initial state. Find the total amount of heat absorbed by the gas during the entire process.

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41. Two moles of an ideal gas at $300K$ cooled at constant volume so that the pressure is reduced to half the initial value. Then as a result of heating at constant pressure. Find the total heat absorbed by the gas, if R is the gas constant.

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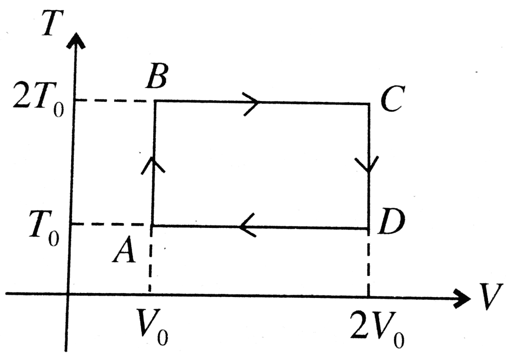
42. T-V curve of cyclic process is shown below, number of moles of the gas are n find the total work done during the cycle.



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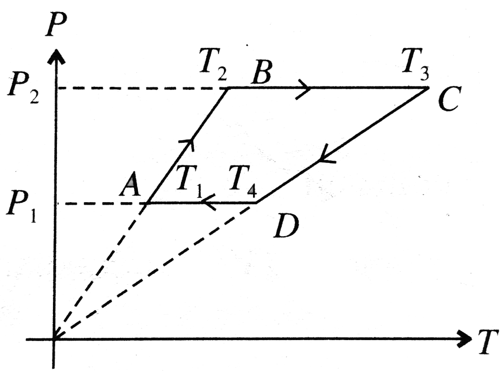
43. P-T curve of a cyclic process is shown. Find out the works done by the gas in the given proces if number of moles of the gas are n.



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44. In a cylinder, 2.0 moles of an ideal monatomic gas initially at 1.0×10^6 Pa and 300 K expands until its volume doulbles. Compute the work done if the expansion is (a) isothermal, (b) adiabatic and (c) isobaric.

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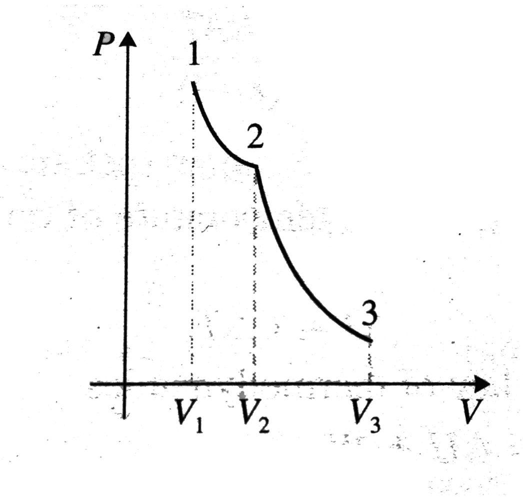
45. One mole of a perfect gas, initally at a pressure and temperature of $10^5 N/m^2$ and 300 K, respectively, expands isothermally unitl its volume is doubled and then adiabatically until its volume is again doubled. Find final pressure and temperature of the gas Find the total work done during the isothermal and adiabatic processes. Given $\gamma = 1.4$. Also draw the P-V diagram for the process.



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46. An ideal gas $(C_p / C_V = (\gamma)$ is taken through a process in which the pressure and the volume vary as $P = aV^b$. Find the values of (b) for which the specific heat capacity of the gas for the process is zero.

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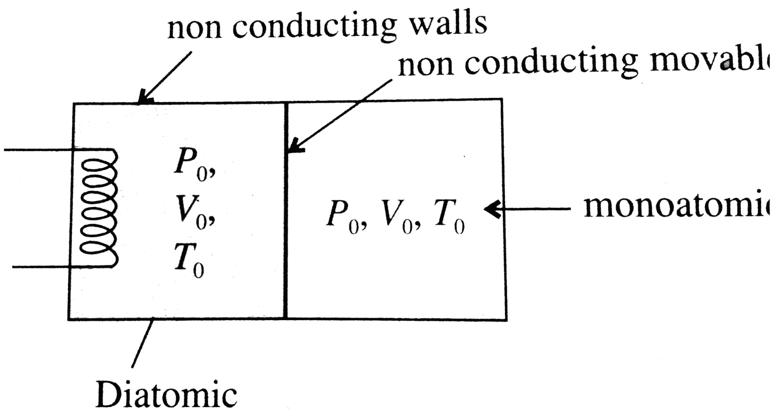
47. A cylindrical container having non-conducting walls is partitioned in two equal parts such that the volume of the each parts is eqaul to V_0 A

movable non-conducting piston is kept between the two parts. Gas on left is slowly heated so that the gas on right is compressed upto volume $V_0 / 8$. Find pressure and temperature on both sides if initial pressure and temperature, were P_0 and T_0 respectively. Also find heat given by the heater to the gas (number of moles in each parts is n)



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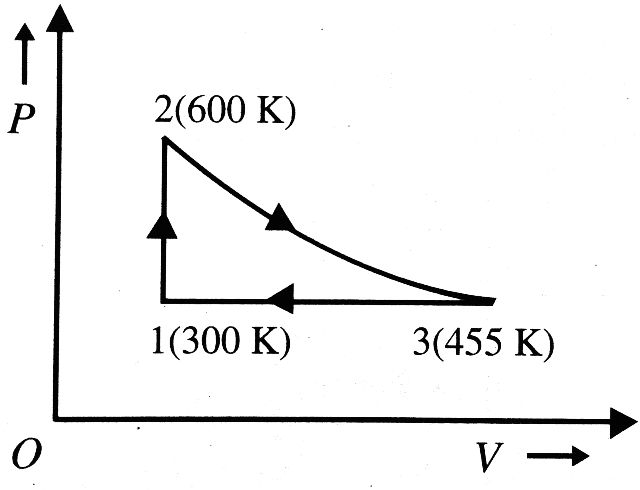
48. A reversible heat engine carries 1 mole of an ideal monatomic gas around the cycle 1-2-3-1. Process 1-2 takes place at constant volume, process 2-3 is adiabatic, and process 3-1 takes place at constant pressure. Complete the values for the heat ΔQ, the change in internal energy ΔU, and the work done Δ, for each of the three processes and for the cycle as a whole.



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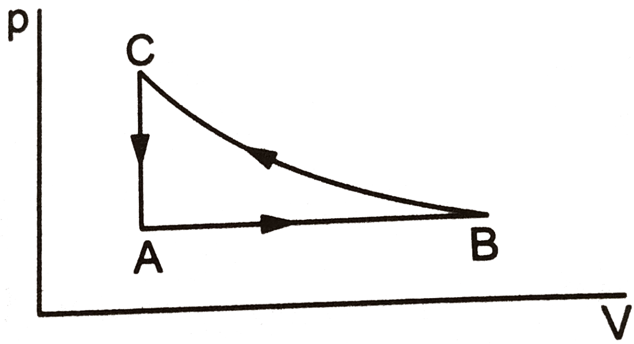
49. consider the cyclic process ABCA on a sample of 2.0 mol of an ideal gas as shown in the fig. temperature of the gas at A and B are 300 K and 500 k respectively. A total of 1200 J heat is withdrawn from the sample in the process. Find the work done by the gas in part BC. take

$R = 8.3 JK^{-1} mol^{-1}$



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50. A sample of an ideal gas has pressure p_0, volume V_0 and tempreture T_0. It is isothermally expanded to twice its original volume.It is then compressed at constant pressure to have the original volume V_0. Finally, the gas is heated at constant volume to get the original temperature.

(a) Show the process in a V-T diagram

(b) Calculate the heat absorbed in the process.

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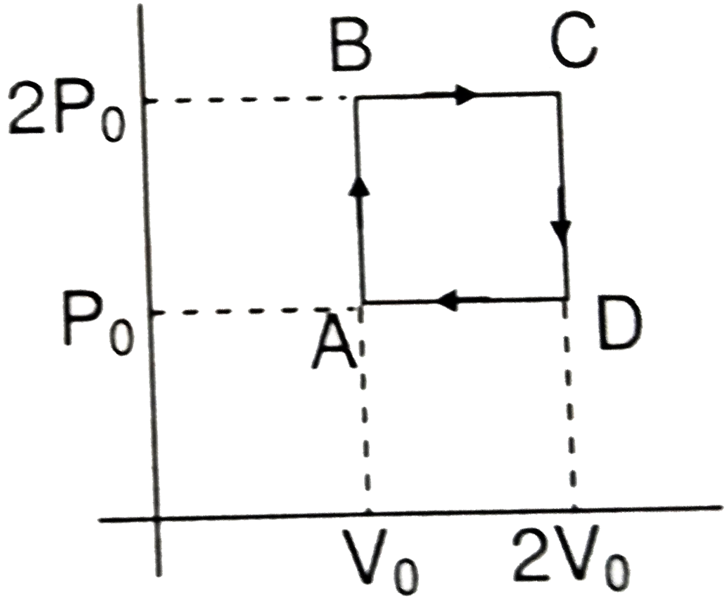
51. Helium gas goes through a cycle ABCDA (consisting of two isochoric and two isobaric lines) as shown in figure. Efficiency of this cycle is nearly :



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52. Three moles of an ideal gas at a 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

(a) Sketch the P-V and P-T 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.

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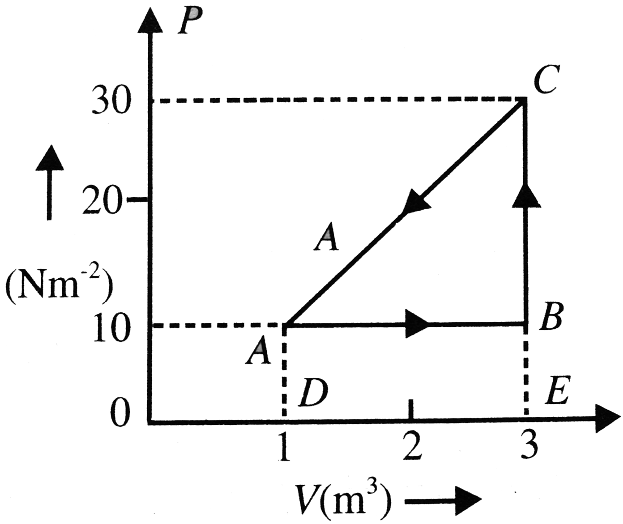
53. An ideal gas is taken round a cyclic thermodynamic process ABCA as shown if Fig. If the internal energy of the gas at point A is assumed zero while at B it is 50 J. The heat absorbed by the gas in the process BC is 90 J.

(a) What is the internal energy og the gas at point C ?

(b) How much heat energy is absorbed by the gas in the process AB?

(c) Find the heat energy rejected or absorbed by the gas in the process CA.

(d) What is the net work done by the gas in the complete cycle ABCA ?



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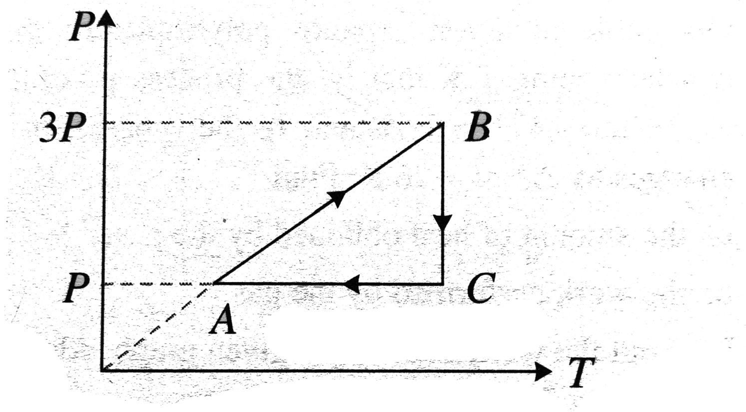
54. A fixed mass of oxygen gas performs a cyclic process ABCA as shown.

Find the efficiency of the process.



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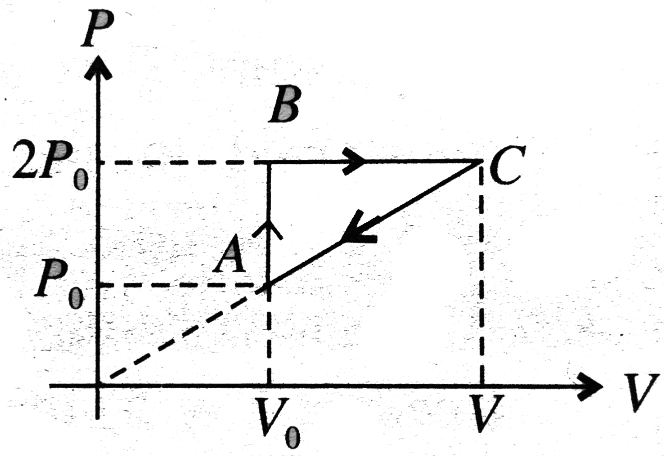
55. n moles of a diatomic gas has undergone a cyclic process ABC as shown in figure. Temperature at a is T_0. Find volume at C



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Solved Examples

1. A vessel containing 1 g of oxygen at a pressure of 10 atm a temperature of $47^\circ C$. It is found that because of a leak, the pressure drops to $5/8th$ of its original value and the temperature falls to $27^\circ C$. Find the volume of the vessel and the mass of oxygen that is leaked out.

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2. An ideal gas (2.0 moles) is carried round a cycle as shown. If the process $b \rightarrow c$ is isothermal and $C_V = 3cal/mol/K$. Determine

a. work done,

b. change in internal energy,

c. heat supplied to the system during processes $a \rightarrow b, b \rightarrow c$ and $c \rightarrow a$.

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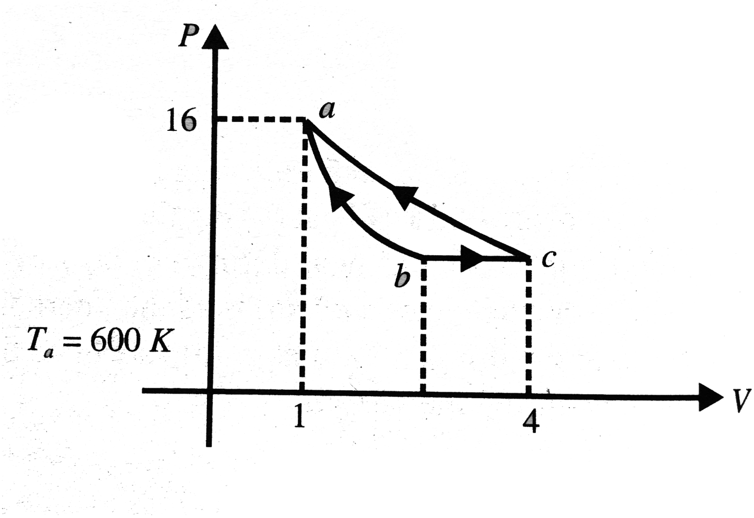
3. Figure. Shows three processes for an ideal gas. The temperature at 'a' is 600 K, pressure of 1 atm, and volume 1 L. The volume at 'b' is 4 L. Out of two processes, ab and ac, one is adiabatic and other is isothermal. The ratio of specific heats of the gas is 1.5.

a. Which of the processes ab and ac is adiabatic ? Why

b. Compute the pressure of the gas at b and c.

c. Compute the temperature at b and c.

d. Complete the volume at c.



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4. N molecules each of mass m of gas A and 2N molecules each of mass 2m of gas B are contained in the vessel which is maintained at a temperature T. The mean square of velocity of the molecules of B type is denoted by v^2 and the mean square of the x-component of the velocity of A type is denoted by w^2. The ratio of $w^2 : v^2$ is

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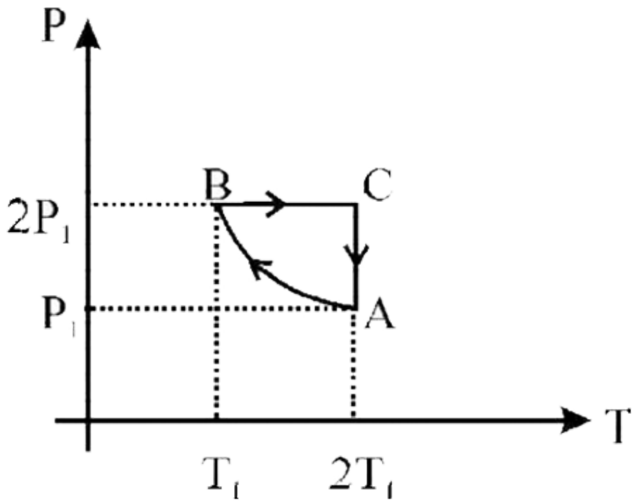
5. Two moles of an ideal monoatomic gas is taken through a cycle ABCA as shown in the P-T diagram. During the process AB , pressure and temperature of the gas very such that $PT = Cons\tan t$. It $T_1 = 300K$, calculate



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

(b) the heat absorbed or released by the gas in each of the processes. Give answer in terms of the gas constant R.

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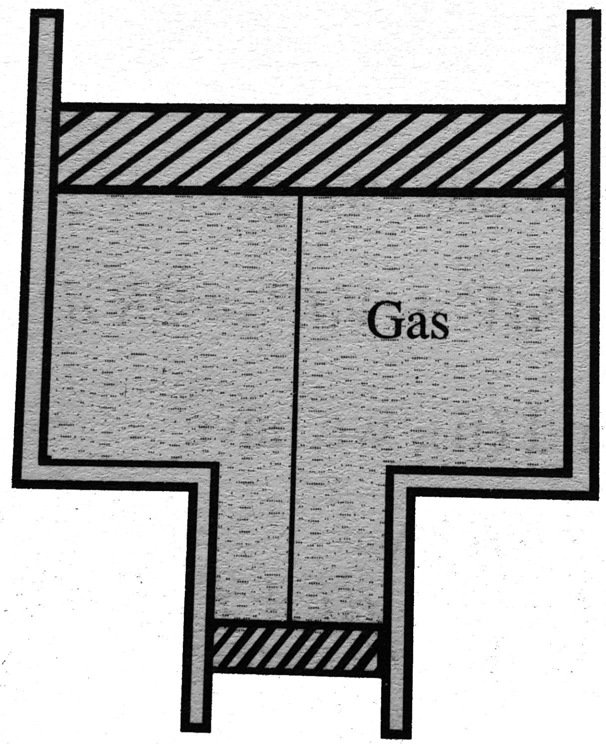
6. A smooth vertical tube having two different cross sections is open from both the ends but closed by two sliding pistions as shown in Fig. and tied with an inextensible string. One mole of an ideal gas is enclosed between the piston The difference in cross-sectional areas of the two pistons is given ΔS. The masses of piston are m_1 and m_2 for larger and smaller one, respectively. Find the temperature by which tube is raised so that the pistons will be displaced by a distance l. Take atmospheric pressure equal to P_0



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7. Two moles of helium gas$(\lambda = 5/3)$ are initially at temperature $27^\circ C$ 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 ?

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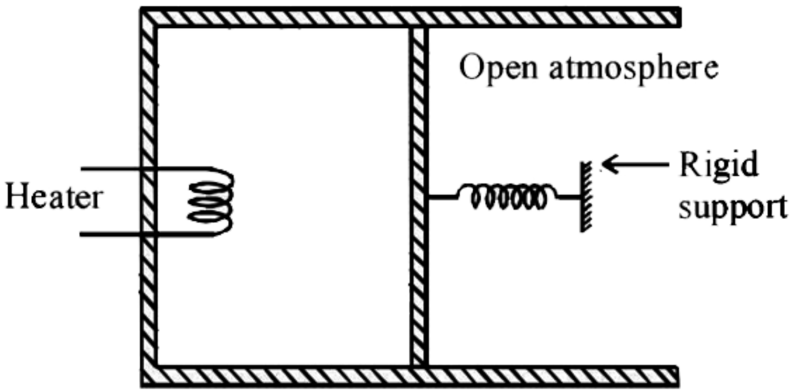
8. An ideal monoatomic gas is confined in a cylinder by a spring-loaded piston of cross-section $8.0 \times 10^{-3} m^2$. Initially the gas is at 300K and occupies a volume of $2.4 \times 10^{-3} m^3$ and the spring is in its relaxed (unstretched, unompressed) state, fig. The gas is heated by a small electric heater until the piston moves out slowly by 0.1m. Calculate the final temperature of the gas and the heat supplied (in joules) by the heater. The force constant of the spring is $8000 N/m$, atmospheric pressure is $1.0 \times 10^5 Nm^{-2}$. 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 lead wires of the heater. The heat capacity of the heater coil is negligible. Assume the spring to be massless.



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9. Three moles of an ideal gas at a 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

(a) Sketch the P-V and P-T 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.

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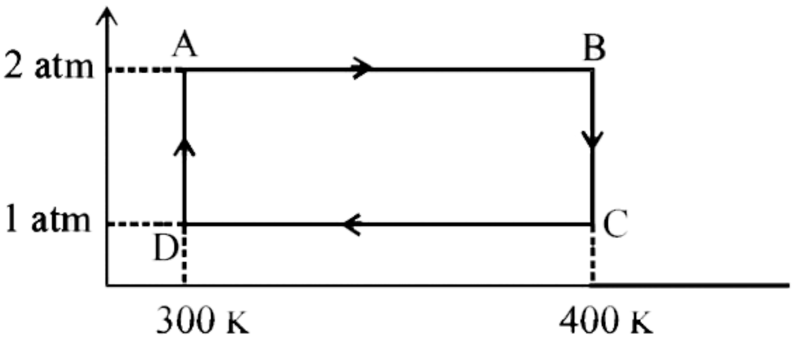
10. Two moles of helium gas undergo a cyclic process as shown in Fig. Assuming the gas to be ideal, calculate the following quantities in this process



(a) The net change in the heat energy

(b) The net work done

(c) The net change in internal energy

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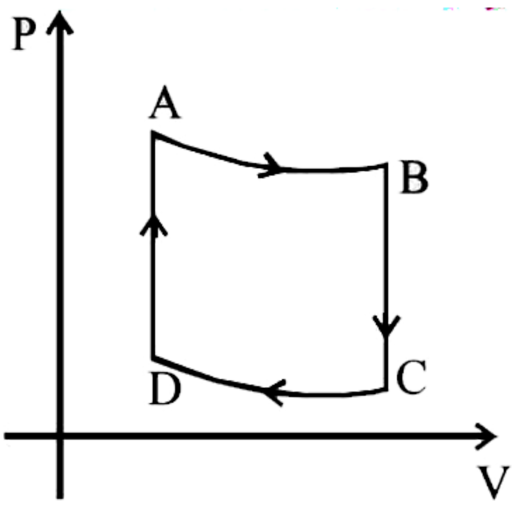
11. One mole of a monoatomic ideal gas is taken through the cycle shown in Fig:

$A \rightarrow B$: 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 $T_A = 1000K$, $P_B = (2/3)P_A$ and $P_C = (1/3)P_A$, calculate the following quantities:

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

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

(iii) The temperature T_D. [Given :$(2/3)^{2/5} = 0.85$]

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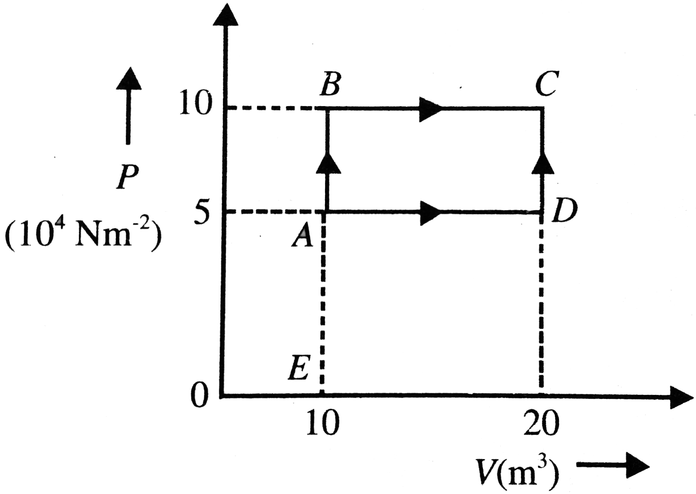
12. A sample of 2 kg of monatomic helium (assumed ideal) is taken through the process ABC another sample of 2 kg of the same gas is taken through the process ADC as shown in Fig. Given molecular mass of helium = 4.

a. What is the temperature of helium in each of the states A, B, C and D ?

b. 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.

How much is the heat involved in each of the process ABC and ADC ?



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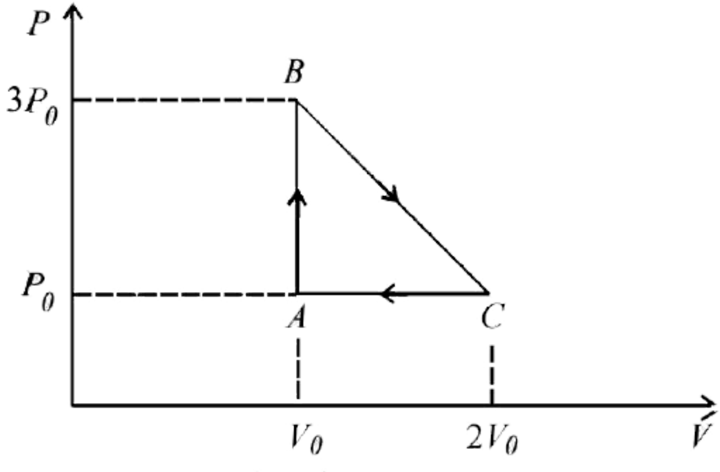
13. One mole of an ideal monatomic gas is taken round the cyclic process

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.

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14. A masslesss piston divides a closed thermallyy insulated cylinder into two equal parts. One part contains M = 28 g of nitrogen. At this temperature, one-third of molecules are dissociated into atoms and the other part is evacuated. The piston is released and the gas fills the whole volume of the cylinder at temperature T_0. Then, the piston is slowly displaced back to its initial position. calculate the increases in internal energy of the gas. Neglect further dissociation of molecules during, the motion of the piston.

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Exercise 2.1

1. The average kinetic energy per molecule of all monatomic gases is the same at the same temperature. Is this ture or false ?

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2. What happens to the random motion when an ideal gas undergoes free expansion (i.e., expansion into a vacuum) ?

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3. The highest vacuum attained so far is of the order of 10^{-11} mm of mercury. How many molecules are there in 1 cc of a vessel under such a high vacuum at $0^{\circ} C$?

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4. A thermally insulated vessel with gaseous nitrogen at a temperature of $27^{\circ} C$ moves with velocity $100 m / s^{-1}$. How much (in percentage) and in what way will the gas pressrue change if the vessel is brought to rest suddenly ?

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5. Find the molar mass and the number of degrees of freedom of molecules in a gas if its heat capacities are $C_v = 650 J kg^{-1} K^{-1}$ and $C_P = 910 J kg^{-1} K^{-1}$

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6. At $127^{\circ} C$ and 1.00×10^{-2} atm pressure, the density of a gas is $1.24 \times 10^{-2} kgm^{-3}$.

a. Find v_{rms} for the gas molecules.

b. Find the molecular weight of the gas and identify it.

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7. The mass of a gas molecule can be computed form the specific heat at constant volume. Take $C_V = 0.075 kcalkg^{-1}k^{-1}$ for argon and calculate

a. the mass of an argon atom

b. the atomic weight of argon.

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8. In a certain $\left(\frac{2}{5}\right)th$ of the energy of molecules is associated with the ratation of molecules and the rest of it is associated with the motion of the centre of mass.

(a) What is the average translational energy of one such molecule when the temperature id $27^{\circ}C$?

(b) How much energy must be supplied to one mole of thsi gas constant volume to raise the temperature by $1^{\circ}C$?

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9. If the water molecules in 1 g of water were distributed uniformaly over the surface of the earth, how many molecules would there be in $1m^2$ of the earth's surface (radius of the earth = 64 km)?

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10. How many degress of freedom have the gas molecules, if under standard conditions the gas density is $\rho = 1.3kg/m^3$ and velocity of sound propagation o it is $v = 330m/s$?

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11. The temperature of a gas consisting of rigid diatomic moleculoes is T = 300 K. Calculate the angular root-mean square velocity of a rotating molecules if its moment of inertia is $I = 2.0 \times 10^{-40} kgm^2$.

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12. The molar specific heat capacity of all monatomic gases is the same. Is this ture of false ? (Assumed ideal nature.)

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13. One mole of a monatomic ideal gas is mixed with one mole of a diatomic ideal gas. The molar specific heat of the mixture at constant volume is_________.

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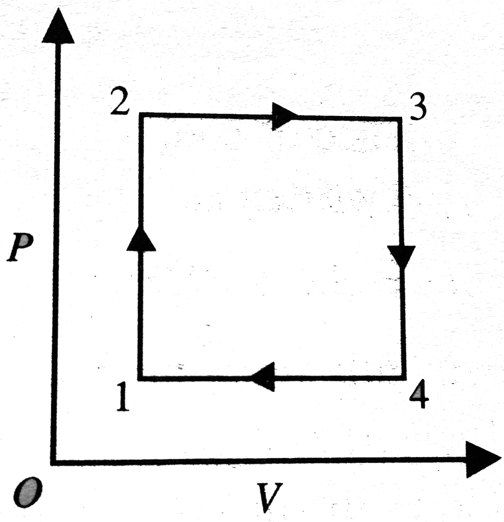
14. A gas has been subjected to isochoric-isobaric processes 1-2-3-4-1 see Fig. Plot this process on T - V and P - T diagrams.



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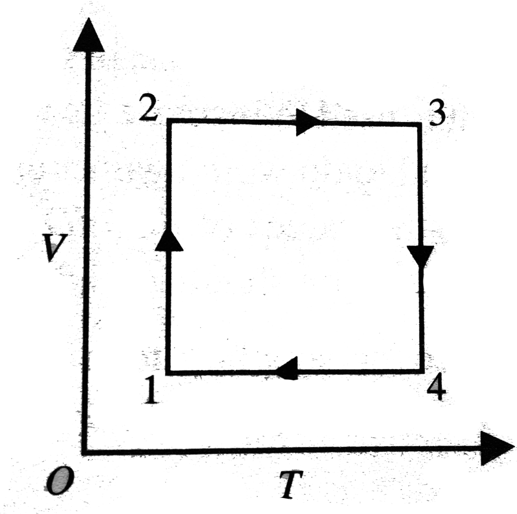
15. A gas has been subjected to an isothermal-isochromic cycle 1-2-3-4-1 see Fig. Represent the same cycle on P - V and P - T diagrams.



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16. Calculate γ of a gaseous mixture consisting of 3 moles of nitrogen and 2 moles of carbon dioxide.

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17. A closed container of volume $0.02m^3$ contains a mixture of neon and argon gases, at a temperature of $27^\circ C$ and pressure of $1 \times 10^5 Nm^{-2}$. The total mass of the mixture is 28g. If the molar masses of neon and argon are 20 and $40 g mol^{-1}$ respectively, find the masses of the individual gasses in the container assuming them to be ideal (Universal gas constant $R = 8.314 J/mol - K$).

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18. Equal masses of air are sealed in two vessels, one of volume V_0 and the other of volume $2V_0$. If the first vessel is maintained at a temperature $300K$ and the other at $600K$, find the ratio of the pressures in the two vessels.

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19. A glass container encloses a gas a pressure of 8×10^5 pa and 300 K temperature. The container walls can bear a maximum pressure of 10^6 Pa. If the temperature of container is gradually increased, find the temperature at which the container will break.

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20. Calculate the number of molecules in 1 cc of an ideal gas at $27^\circ C$ a pressure of 10 mm of mercury. Mean kinetic energy of molecule at $27^\circ C$ is 4×10^{-14} erg, the density of mercury is 13.6 $g/$.

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Exercise 2.2

1. Explain why the temperature of a gas drops in an adiabatic expansion, on basis of the kinetic theory of gases,

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2. Explain why a gas cools on sudden expansion on the basis of the principles of thermodynamics.

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3. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature 27°C. Amount of heat transferred to the gas, so that rms velocity of molecules is doubled, is about :

[Take $R = 8.3J/K$ mole]

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4. A gas consisting of a rigid diatomic molecules was initially under standard condition.Then,gas was compressed adiabatically to one fifth of its intitial volume What will be the mean kinetic energy of a rotating molecule in the final state?

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5. Can one distinguish between the internal energy of a body acquired by het transfer and that acquired by the performance of work on it by an etenal agent ?

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6. A theoms flask contains coffee. It is vigorously sheken, considering the coffee as the system. (a) Does its temperature rise ? (b) Has heat been added to it ? (c) Has work been done on it ?

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7. Does a gas do any work when it expands adiabatically ? If so, what is the source of the energy needed to do this work ?

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8. A block returns to its initial position after dissipating mechanical energy in the from of heat through frictionn. Is this process reversibe or irreversible ?

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9. Explain why the temperature of a gas drops in an adiabatic expansion, on basis of the kinetic theory of gases,

Watch Video Solution

10. In what process is the heat added entirely converted into internal energy of the system ?

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11. When a gas is compressed adiabaticlly, it becomes more elasitc. Is this ture ?

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12. A cylinder contains 3 moles of oxygen at a temperature of $27^\circ C$. The cylinder is provided with a frictionless piston which maintains a constant pressure of 1 atm on the gas. The gas is heated until its temperature rises to $127^\circ C$.

a. How much work is done by the gas in the process ?

b. What is the change in the internal energy of the gas ?

c. How much heat was supplied to the gas ?

For oxygen $C_P = 7.03 cal mol^{-1} . ^\circ C^{-1}$.

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13. What amount of heat is to be transferred to nitrogen in an isobaric heating process so that the gas may perform 2 J work?

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14. As a result of the isobaric heating by $\Delta T = 72K$, one mole of a certain ideal gas obtain an amount of heat $Q = 1.6 kJ$. Find the work performed by the gas, the increment of its internal energy and γ.

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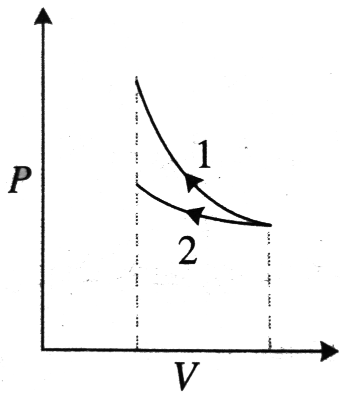
15. A certain mass of a gas is compressed first adiabatically, and then isothermally. In both cases, the initial state of the gas is the same. Is the work done W_1 in the first case greater than the work done W_2 in the second case ? Explain.



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16. A cylindrical vessel of 28 cm diameter contains 20 g of nitrogen compressed by a piston supporting a weight of 75 kg. The temperature of the gas is $17^\circ C$. What work will the gas do if it is heated to a temperature of $250^\circ C$? What amount of heat should be supplied ? To what distance will the weight be raised? The process should be assumed to be isobaric, the heating of the vessel as well as the external pressure is negligible.

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17. One mole of oxygen is heated at constant pressure starting at $0^\circ C$. How much heat energy must be added to the gas to double its volume ?

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18. An ideal gas expands adiabatically from an initial temperature T_1 to a final temperature T_2. Prove that the work done by the gas is $C_V(T_1 - T_2)$.

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19. An ideal gas whose adiabatic exponent equals γ expands so that the amount of heat transferred to it is equal to the decrease of its internal energy. Find

a. the molar heat capacity of the gas, and

b. the T -V equation for the process.

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20. On mole of argon expands polytropically, the polytropic constant being 1.5, that is, the process proceeds according to the law $pV^{1.5}$ = constant. In the process, its temperature change by $\Delta T = -26K$. Find

a. the amount of heat obtained by the gas.

b. the work performed by the gas.

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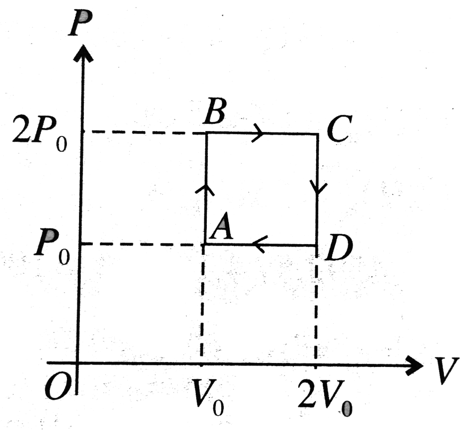
21. Find out the work done in the given graph. Also draw the corresponding T -V curve and P-T curve.



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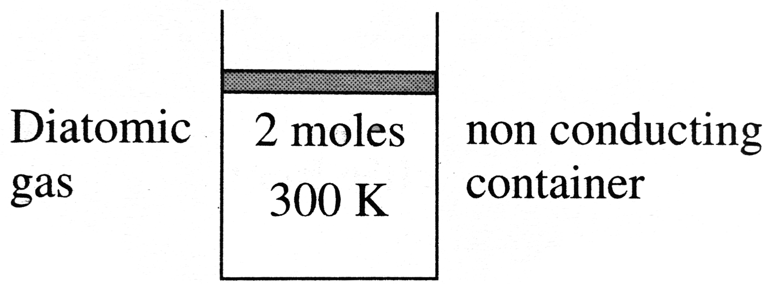
22. Two moles of a diatomic gas at 300 K are kept in a nonconducting container enclosed by a piston . Gas is now compressed to increase the temperature from 300 K to 400 K. Find word done by the gas



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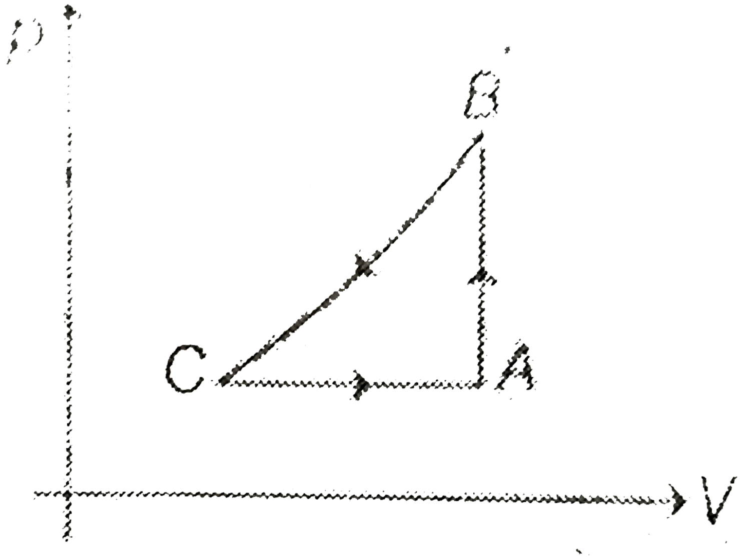
23. A sample of an ideal gas is taken through a cycle as shown in figure. If absorbs 50 J of energy during the process AB, no heat during BC, rejects 70 J during CA. 40 J of work is done on the gas during BC. Internal energy of gas at A is 1500 J, the internal energy at C would be



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24. The internal energy of a monatomic ideal gas is 1.5 nRT. One mole of helium is kept in a cylinder of cross section $8.5 cm^2$. The cylinder is closed by a light frictionless piston. The gas is heated slowly in a process during which a total of 42J heat is given to the gas. if the temperature rise through $2^{o}C$, find the distance moved by the piston. atmoshphere pressure `=100 kPa.

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25. A sample of ideal gas $(\gamma = 1.4)$ is heated at constant pressure. If $140J$ of heat is supplied to gas, find ΔU and ΔW.

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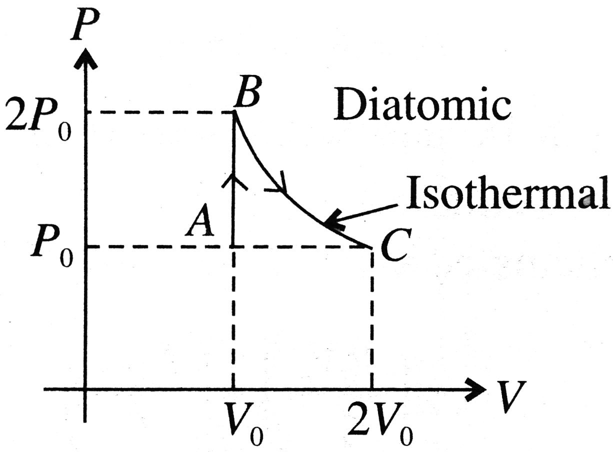
26. P-V curve of a diatomic gas is shown in the Fig. Find the total heat given to the gas in the process $A \rightarrow B \rightarrow C$



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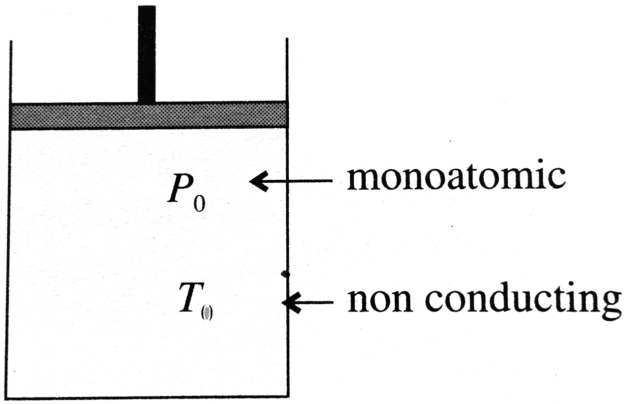
27. A monoatomic gas is enclosed in a non-conducting cylinder having a piston which can move freely. Suddenly gas is compressed to $1/8$ of its initial volume. Find the final pressure and temperature if initial pressure and temperature are P_0 and T_0 respectively.



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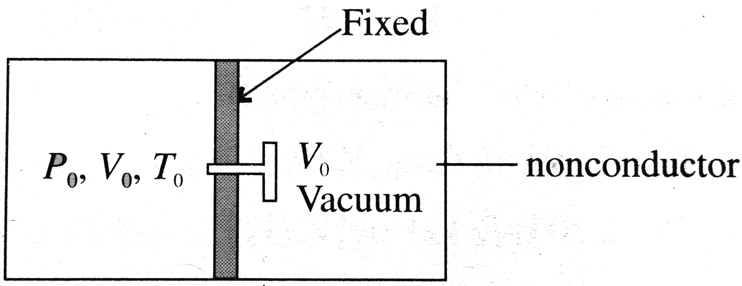
28. A non-conducting cylinder having volume $2V_0$ is partitioned by a fixed non conducting wall in two equal part. Partition is attached with a valve. Right side of the partition is a vacuum and left part is filled with a gas having pressure and temperature P_0 and T_0 respectively. If valve is opened find the final pressure and temperature of the two parts.



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Subjective

1. Five grams of helium having rms speed of molecules $1000 m/s$ and $24 g$ of oxygen having rms speed of $1000 m/s$ are introduced into a thermally isolated vessel. Find the rms speeds of helium and oxygen individually when thermal equilibrium is attained. Neglect the heat capacity of vessel.

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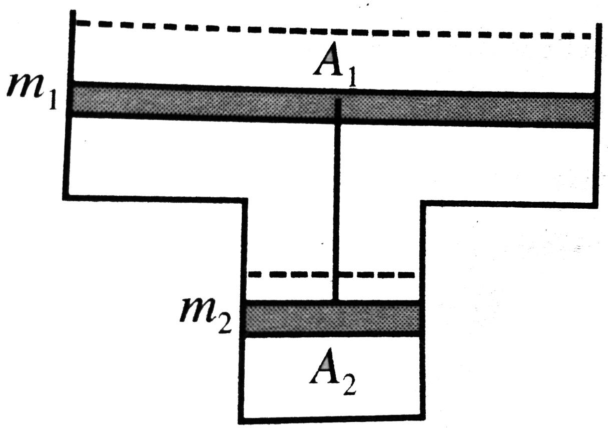
2. Consider a vertical tube open at both ends. The tube consistss of two parts, each of different cross sections and each part having a piston which can move smoothly in respective tubes. The two piston which can move smoothly in respective tube wire. The piston are joined together by an inextensible wire. The combined mass of the two piston is $5kg$and area of cross section of the upper piston is $10cm^2$ greater than that of the lower piston. Amount of gas enclosed by the pistons is $1mol$. When the gas is heated slowly, pistons move by $50cm$. Find the rise in the temperature of the gas in the form X/RK, where R is universal gas constant. Use $g = 10m/s^2$ and outside pressure $= 10^5 N/m^2$).



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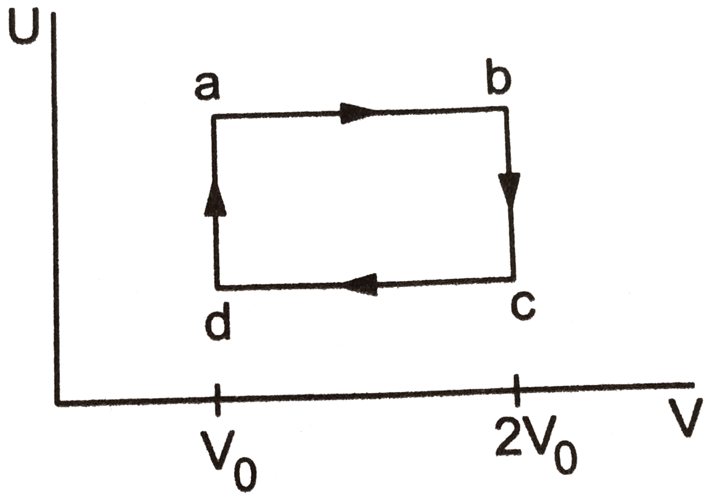
3. Fig shows the variation in the internal energy U with the volume V of 2.0 mol of an ideal gas in a cyclic process abcda. The temperatures of the gas at b and c are 500 K and 300 K respectively. Calculate the heat absorbed by the gas during the process.



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4. Two moles a monatomic gas in state A having critical pressure P_0 and temperature $3T_0$ is taken to a state B having pressure $3P_0$ and temperature $T_0/3$ by the process of equation P^2T = constant. Then state B is taken to state C keeping the volume constant and it comes back to initial state A keeping temperature constant.

a. Plot a P and T graph. (P on the y-axis and T on the x-axis).

Find the net work done and heat supplied to the gas during the complete cycle.

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5. A gaseous mixture enclosed in a vessel consists of one gram mole of a gas A with $\gamma = \left(\frac{5}{3}\right)$ and some amount of gas B with $\gamma = \frac{7}{5}$ at a temperature T.

The gases A and B do not react with each other and are assumed to be ideal. Find the number of gram moles of the gas B if γ for the gaseous mixture is $\left(\frac{19}{13}\right)$.

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6. A gas expands in a piston-cylinder device from volume V_1 to V_2, the process being described by $P = a/V + b$, a and b are constants. Find the work done in the process.

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7. find the minimum attainable pressure of an ideal gs in the process $T = t_0 + \propto V^2$, where $T_0 n$ and α are positive constants and (V) is the volume of one mole of gas.

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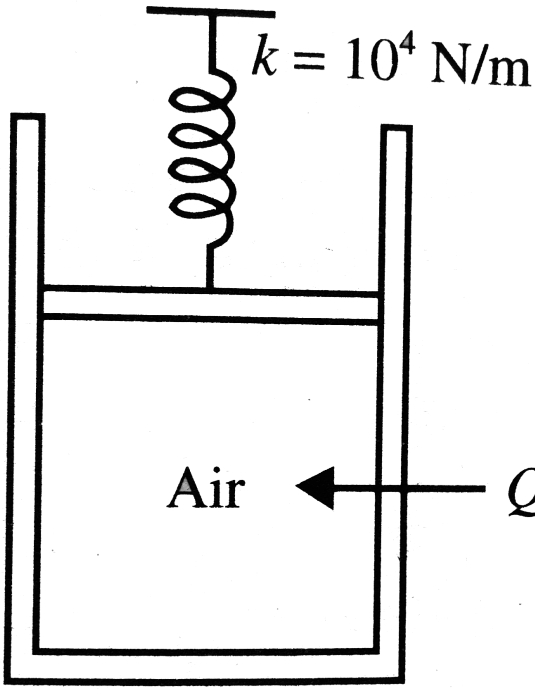
8. Air is contained in a piston-cylinder arrangement as shown in Fig. with a cross-sectional area of $4cm^2$ and an initial volume of $20cm^3$. The air is initially at a pressure of 1 atm and temperature of $20^\circ C$. The piston is connected to a spring whose spring constant is $k = 10^4 N/m$, and the spring is initially underformed. How much heat must be added to the air inside cylinder to increase the pressure to 3 atm (for air,

$CV = 718J/kg.^{\circ}C$, molecular of air 28.97)?



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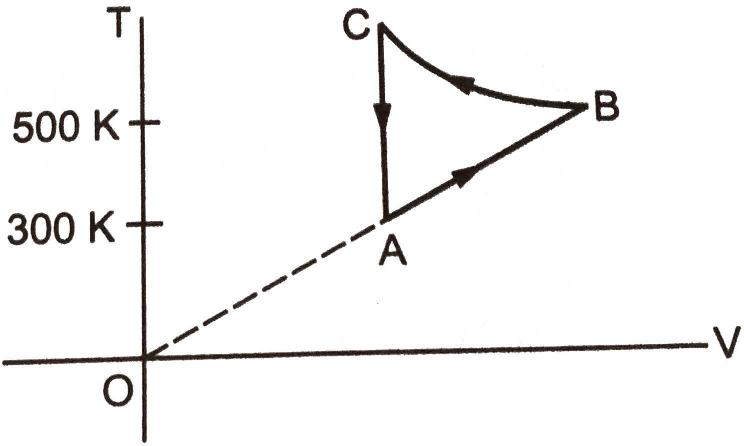
9. Consider the cyclic process ABCA, shown in fig, performed on a sample of 2.0 mol if an ideal gas. A total of 1200 J if heat is withdrawn from the sample in the process. Find the work done by the gas during the part BC.



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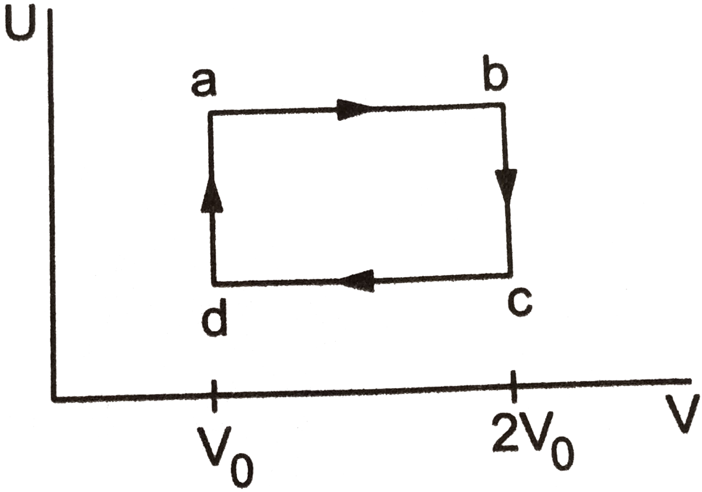
10. Fig shows the variation in the internal energy U with the volume V of 2.0 mol of an ideal gas in a cyclic process abcda. The temperatures of the gas at b and c are 500 K and 300 K respectively. Calculate the heat absorbed by the gas during the process.



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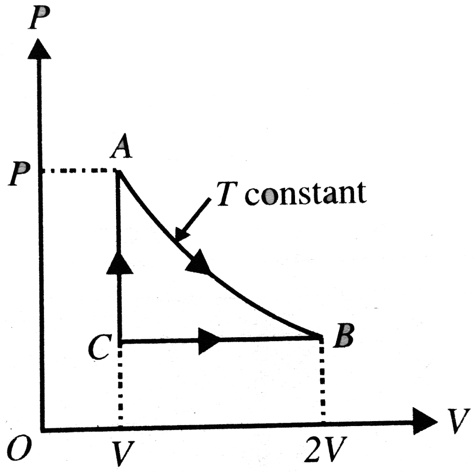
11. One mole of a gas is carried through the cycle shown in Fig. The gas expands at constant temperature T from volume V to $2V$. It is them compressed to the initial volume at constant pressure and is finally brought back to its original state by heating at constant volume.

Calculate the work done by the gas in complete cycle.



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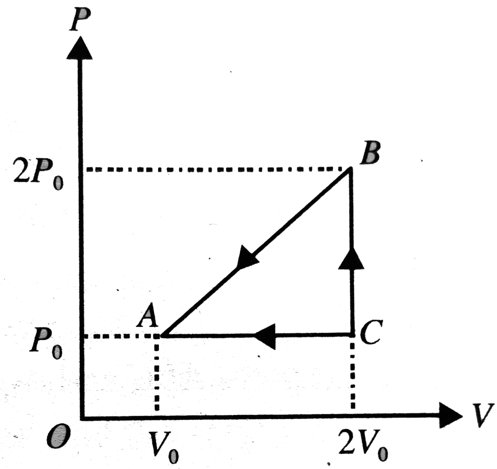
12. One mole of a monatomic gas is taken from a point A to another point B along the path ACB. The initial temperature at A is T_0.

Calculate the heat abosrbed by the gas in the process $A \to C \to B$.



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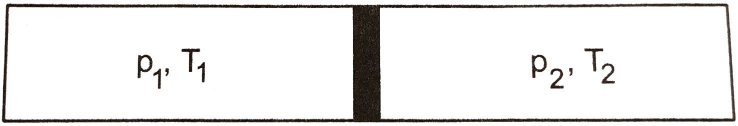
13. Figure shows an adiabatic cylindrical tube of volume (V_0) divided in two parts by a frictionless adiabatic separator . Initially, the separator is kept in the middle, an ideal gas at pressure (P_1) and the temperatures (T_1) is injected into the left part and the another ideal gas at pressures (P_2) and temperature (T_2) is injected into the right part. $\left(\frac{C_p}{C_v} = \gamma\right)$ is the same for both the gases. The separator is slid slowly and is released at a position where it can stay in equilibrium. Find

(a) the volumes of the parts,

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

(c) the final common pressure of the gases.



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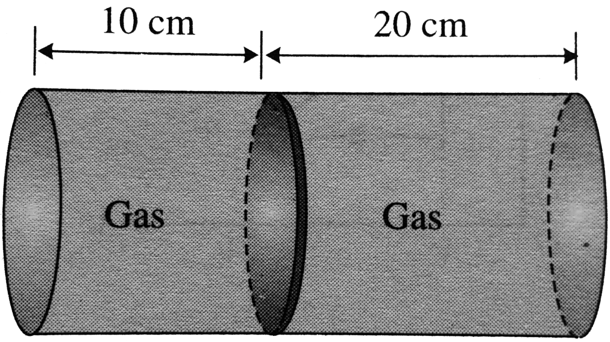
14. Fig. shows a horzontal cylindrical container of length $30cm$, which is partitioned by a tight-fiting separator. The separator is diathermic but conductws heat very slowly. Initially the separator is the state shown in the figure. The temperature of left part of cylinder is $100K$ and that on right part is $400K$. Initially the separator is in equilibrium. As heat is conducted from right to left part, of separator after a long when gases on the two displacement of separator after a long when gases on the two parts of cylinder are in thermal equilibrium.



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15. As adiabatic vessel contains $n_1 = 3$ mole of diatomic gas. Moment of inertia of each molecule is $I = 2.76 \times 10^{-46} kgm^2$ and root-mean-square angular velocity is $\omega_0 = 5 \times 10^{12} rad/s$. Another adiabatic vessel contains $n_2 = 5$ mole of a monatomic gas at a temperature $470K$. Assume gases to be ideal, calculate root-mean-square angular velocity of diatomic molecules when the two vessels are connected by a thin tube of negligible volume. Boltzmann constant $k = 1.38 \times 10^{-23} J/ : \text{molecule}$.

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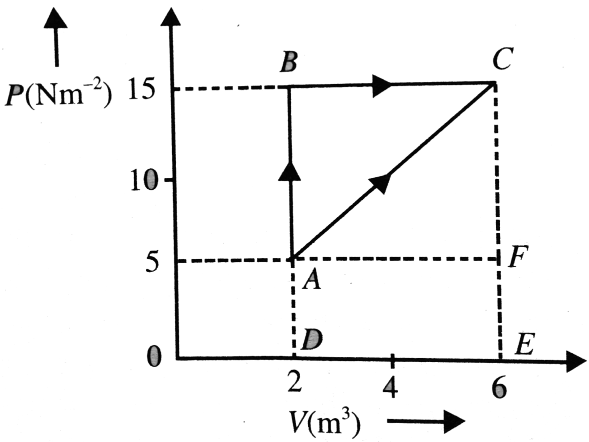
16. Figure shows an ideal gas changing its state A to state C by two different path ABC and AC. The internal energy of the gas at A is $10J$ and the amount of heat supplied to change its state to C through the path AC is $200J$. Find the internal energy at C.



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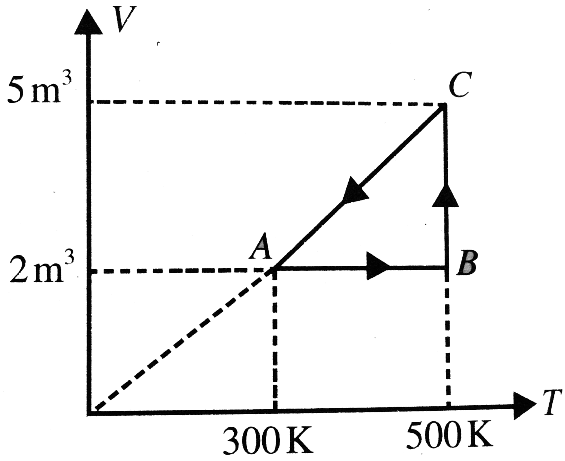
17. Fig. shows a process $ABCA$ performed on 1 mole of an ideal gas. Find the net heat supplied to the gaseous system during the process.



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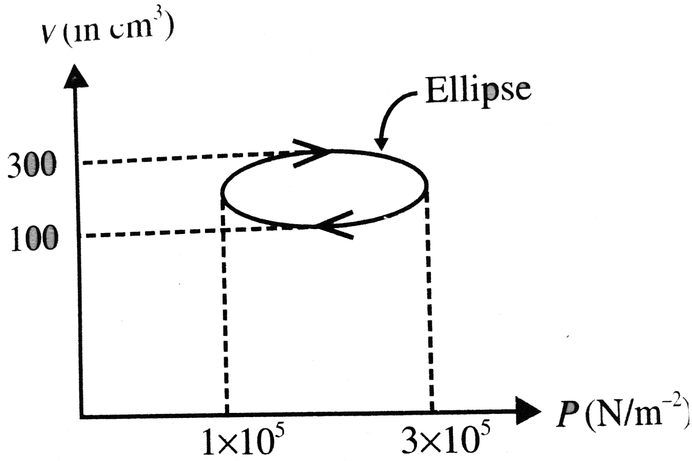
18. Calculate the heat abosrbed by a system in going through the cyclic process show in Fig.



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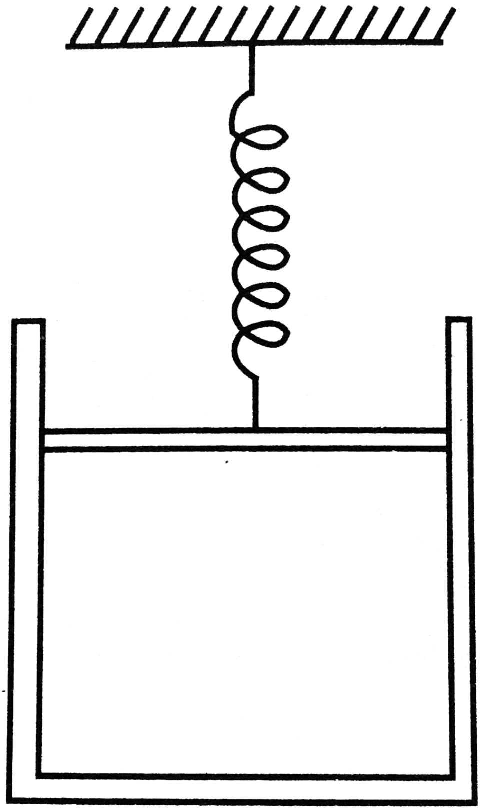
19. An ideal gas has a volume $0.3m^3$ at $150kPa$. It is confined by a spring-loaded piston in a vertical cylinder. Initially, the spring is in relaxed state. If the gas is heated to a final state of $0.5m^3$ and pressure $600kPa$ find the work done on the spring (atmospheric pressure,

$P_0 = 1 \times 10^5 N/m^2)$.



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20. One mole of an ideal monatomic gas undergoes the process $p = \alpha T^{1/2}$, where α is a constant.

(a) Find the work done by the gas if its temperature increases by 50K.

(b) Also, find the molar specific heat of the gas.

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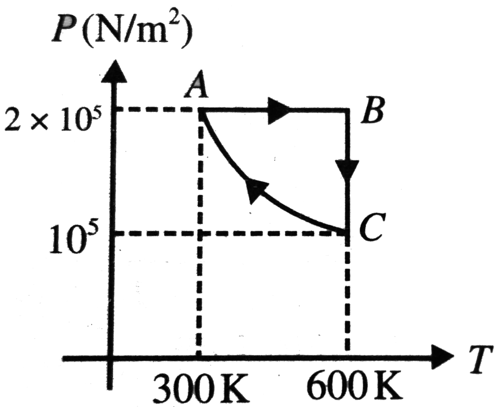
21. Two moles of monatomic ideal gas is taken through a cyclic process shown on $P - T$ diagram in Fig. Process CA is represented as PT = constant. If efficiency of given cyclic process is

$$1 - \frac{x}{121n2 + 15}$$

then find x,



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22. One mole of a gas is enclosed in a cylinde in a cyclinder and occupies a volume of $1.5L$ at a pressure 1.5 atm. It is subjected to strong heating due to which temperature of the gas increase according to the relation $T = \alpha V^2$, where α is a positive constant and V is volume of the gas.

a. Find the work done by air in increasing the volume of gas to $9L$.

b. Draw the $P - V$ diagram of the process.

c. Determine the heat supplied to the gas (assuming $\gamma = 1.5$).

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Single Correct

1. The temperature of a gas is raised while its volume remains constant, the pressure exerted by the gas on the walls of the container increases because its molecules

A. lose more kinetic energy to the wall

B. are in contact with the wall for a shorter time

C. strike the wall more often with higher velocities

D. collide with each other with less frequency

Answer: C

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2. A cylinder of capacity 20 litre is filled with H_2 gas. The total average kinetic energy of translatory motion of its molecules is 1.5×10^5J. The pressure of hydrogen in the cylinder is ....

A. $2 \times 10^6 N/m^2$

B. $3 \times 10^6 N/m^2$

C. $4 \times 10^6 N/m^2$

D. $5 \times 10^6 N/m^2$

Answer: D

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3. A flask is filled with $13g$ of an ideal gas at $27^\circ C$ and its temperature is raised to $52^\circ C$. The mass of the gas that has to be released to maintain the temperature of the gas in the flask at $52^\circ C$, the pressure remaining the same is

A. $2.5g$

B. $2.0g$

C. $1.5g$

D. $1.0g$

Answer: D

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4. Air is filled at $60^\circ C$ in a vessel of open mouth. The vessle is heated to a temperature T so that $1/4th$ of air escapes. Assuming the volume of vessel remaining constant, the value of T is

A. $80^\circ C$

B. $440^\circ C$

C. $333^\circ C$

D. $171^\circ C$

Answer: D

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5. If the intermolecules forces vanish away, the volume occupied by the molecules contained in $4.5kg$ water at stantard temperature and pressure will be given by

A. $5.6m^3$

B. $4.5m^3$

C. $11.2L$

D. $11.2m^3$

Answer: A

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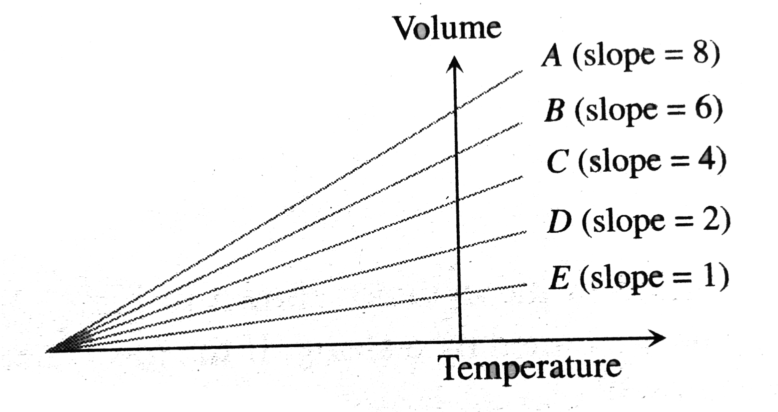
6. The expansion of an ideal gas of mass m at a constant pressure P is given by the straight line D. Then the expanison of the same ideal gas of mass $2m$ at a pressure $P/2$ is given by the straight line



A. E

B. C

C. B

D. A

Answer: D

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7. Two containers of equal volume contain the same gas at pressure P_1 and P_2 and absolute temperature T_1 and T_2, respectively. On joining the vessels, the gas reaches a common pressure P and common temperature T. The ratio P/T is equal to

A. $\frac{P_1}{T_1} + \frac{P_2}{T_2}$

B. $\frac{P_1T_1 + P_2T_2}{(T_1 + T_2)^2}$

C. $\frac{P_1T_2 + P_2T_2}{(T_1 + T_1)^2}$

D. $\frac{P_1}{2T_1} + \frac{P_2}{2T_2}$

Answer: D

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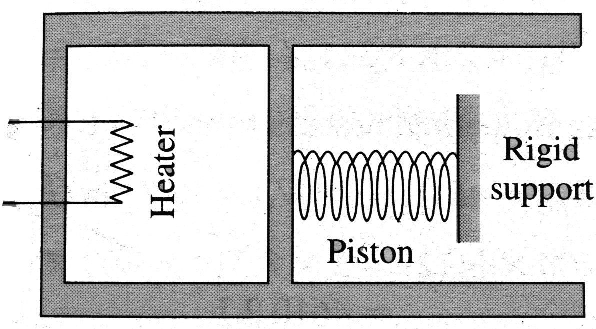
8. An ideal monatomic gas is confined in a cylinder by a spring-loaded piston of cross 8×10^{-3}. Initially, the gas is at 300 K and occupies a volume of $2.4 \times 10^{-3} m^3$ and the spring is in its relaxed (unstretched, uncompressed) state Fig. The gas is heated by a small electric heater until the piston moves out slowly by 0.1 m. Calculate the final temperature of the gas and the heat supplied (in joule) by the heater. The force constant of the spring is 8000 N/m, atmospheric pressure $1 \times 10^5 N/m^2$. 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 heart. The heat capacity of the heater coil is negligible. Assume the spring to be massless.



A. $400K$

B. $800K$

C. $1200K$

D. $300K$

Answer: B

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9. A box contains N molecules of a perfect gas at temperature T_1 and temperature P_1. The number of molecule in the box is double keeping the total kinetic energy of the gas same as before. If the new pressure is P_2 and temperature `T_(2), then

A. $P_2 = P_1, T_2 = T_1$

B. $P_2 = P_1, T_2 = \frac{T_1}{2}$

C. $P_2 = 2P_1, T_2 = T_1$

D. $P_2 = 2P_1, T_2 = \frac{T_1}{2}$

Answer: B

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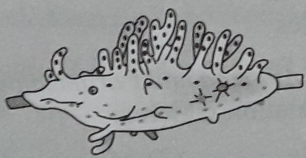
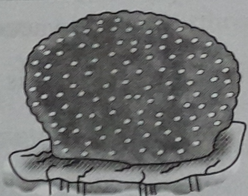
10. Match the column.

	Column-I		Column-II
(A)		(i)	Spongilla
(B)		(ii)	Euspongia
(C)		(iii)	Sycon
(D)		(iv)	Aurelia

A. move toward left

B. move toward right

C. remain stationary

D. none of these

Answer: B

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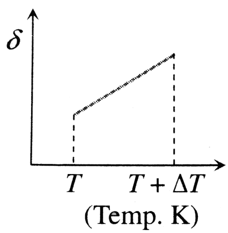
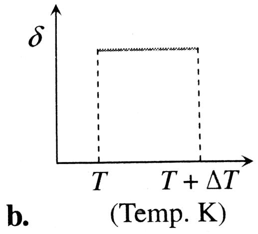
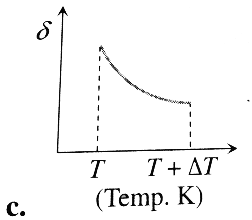
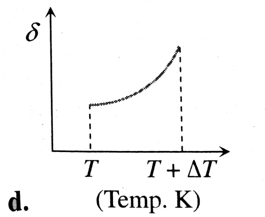
11. An ideal gas is initially at temperature T and volume V. ITS volume is increased by ΔV due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \Delta V / V\Delta T$ varies with temperature as

A. **a.** 

B. 

C. 

D. 

Answer: C

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12. The pressure of a gas filled in a closed vessel increase by 0.4% when temperature is increased by $1^{\circ} C$. Find the initial temperature of the gas.

A. $250K$

B. $250^{\circ} C$

C. $2500 K$

D. $25^{\circ} C$

Answer: A

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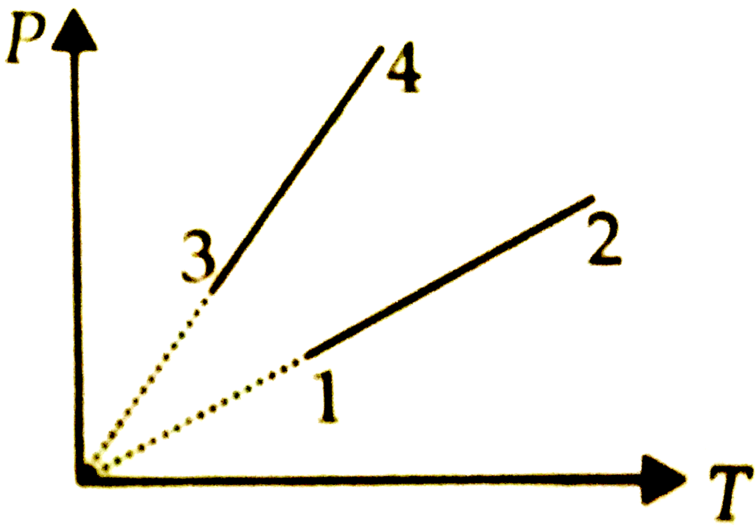
13. Pressure versus temperature graph of an ideal gas of equal number of an ideal gas of equal number of mole of defferent volumes are platted as shown in figure. Choose the correct alternative.



A. $V_1 = V_2, V_3 = V_4$ and $V_2 > V_3$

B. $V_1 = V_2, V_3 = V_4$ and $V_2 < V_3$

C. $V_1 = V_2, V_3 = V_4$

D. $V_4 = V_3 > V_2 > V_1$

Answer: A

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14. The capacity of a vessel is $3L$. It contains $6g$ oxygen, $8g$ nitrogen and $5gCO_2$ mixture at $27^\circ C$, If $R = 8.31J/molK$, then the pressure in the vessel in N/m^2 will be (approx.)

A. 5×10^5

B. 5×10^4

C. 10^6

D. 10^5

Answer: A

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15. Two gases occupy two containers A and B then gas in A, of volume $0.10m^3$, exerts a pressure of $1.40Mpa$ and that in B, of volume $0.15m^3$, exerts a pressure $0.7MPa$. The two containers are joined by a tube of negligible volume and the gases are allowed to intermingle. Then if the temperature remains constant, the final pressure in the container will be (in MPa)

A. 0.7

B. 0.98

C. 1.4

D. 2.1

Answer: B

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16. A closed vessel contains $8g$ of oxygen and $7g$ of nitrogen. The total pressure is 10 atm at a given temperature. If now oxygen is absorbed by introducting a suitable absorbent, the pressure of the remaining gas in atm will be

A. 2

B. 10

C. 4

D. 5

Answer: D

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17. Energy of all molecules of a monatomic gas having a volume V and pressure P is $3/2PV$. The total translational kinetic energy of all molecules of a diatomic gas at the same volume and pressure is

A. $1/2PV$

B. $3/2PV$

C. $5/2PV$

D. $3PV$

Answer: B

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18. Forty calories of heat is needed to raise the temperature of 1 mol of an ideal monatomic gas from $20^{\circ}C$ to $30^{\circ}C$ at a constant pressure. The amount of heat required to raise its temperature over the same interval at a constant volume $\left(R = 2 cal mol^{-1} K^{-1}\right)$ is

A. 20 cal

B. 40 cal

C. 60 cal

D. 80 cal

Answer: A

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19. For a gas the differce between the two specific heat is $4150J/kgK$. What is the specific heat at constant volume of gas if the ratio of sepcific heat is 1.4

A. $8475J/kg-K$

B. $5186J/kg-K$

C. $1660J/kg-K$

D. $10375J/kg-K$

Answer: D

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20. The specific heat at constant volume for the monatomic argon is $0.075 kcal / kg - K$, whereas its gram molecular specific heat is $C_V = 2.98 cal / mol / K$. The mass of the argon atom is (Avogadro's number $= 6.02 \times 10^{23} \text{molecules} / \text{mol}$)

A. $6.60 \times 10^{-23} g$

B. $3.30 \times 10^{-23} g$

C. $2.20 \times 10^{-23} g$

D. $13.20 \times 10^{-23} g$

Answer: A

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21. The temperature of $5 mol$ of gas which was held at constant volume was change from $100^\circ C$ to $120^\circ C$. The change in internal energy was found to have $80 J$. The total heat capacity of the gas at constant volume will be equal to

A. $8JK^{-1}$

B. $0.8JK^{-1}$

C. $4JK^{-1}$

D. $0.4JK^{-1}$

Answer: C

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22. A gas is heated at a constant pressure. The fraction of heat supplied used of external work is

A. $\frac{1}{\gamma}$

B. $\left(1 - \frac{1}{\gamma}\right)$

C. $\gamma - 1$

D. $\left(1 - \frac{1}{\gamma^2}\right)$

Answer: B

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23. A monatomic gas expands at constant pressure on heating. The percentage of heat supplied that increases the internal energy of the gas and that is involed in the expansion is

A. $75\ \%$, $25\ \%$

B. $25\ \%$, $75\ \%$

C. $60\ \%$, $40\ \%$

D. $40\ \%$, $60\ \%$

Answer: C

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24. The average degree of freedom per molecule for a gas is 6. The gas performs 25 J of work when it expands at constant pressure. The heat absorbed by the gas is

A. $75J$

B. $100J$

C. $150J$

D. $125J$

Answer: B

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25. Certain amount of an ideal gas is contained in a closed vessel. The vessel is moving with a constant velcity v. The molecular mass of gas is M. The rise in temperature of the gas when the vessel is suddenly stopped is $(\gamma C_P / C_V)$

A. $\dfrac{Mv^2(\gamma-1)}{2R(\gamma+1)}$

B. $\dfrac{Mv^2(\gamma-1)}{2R}$

C. $\dfrac{Mv^2}{2R(\gamma+1)}$

D. $\dfrac{Mv^2}{2R(\gamma-1)}$

Answer: B

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26. The density of a polyatomic gas in stantard conditions is $0.795kgm^{-3}$.

The specific heat of the gas at constant

A. $930J - kg^{-1}K^{-1}$

B. $1400J - kg^{-1}K^{-1}$

C. $1120J - kg^{-1}K^{-1}$

D. $1600J - kg^{-1}K^{-1}$

Answer: B

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27. The value of $C_P - C_v = 1.00R$ for a gas in state A and $C_P - C_v = 1.06R$ in another state. If P_A and P_B denote the pressure and T_A and T_B denote the temperature in the two states, then

A. $P_A = P_B, T_A > T_B$

B. $P_A < P_B, T_A = T_B$

C. $P_A < P_B, T_A > T_B$

D. $P_A = P_B, T_A < T_B$

Answer: C

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28. When 1 mole of monoatomic gas is mixed with 2 moles of diatomic gas, then find gamma` for the mixture of gases.

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29. Twenty-two grams of CO_2 at $27^\circ C$ is mixed with $16g$ of O_2 at $37^\circ C$. The temperature of the mixture is about

A. $31.5^\circ C$

B. $27^\circ C$

C. $37^\circ C$

D. $30.5^\circ C$

Answer: A

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30. A gas mixture coinsists of (2) moles of oxygen and (4) moles of argon at temperature (T). Neglecting all vibrational modes, the total internal energy of the system is (jee 1999)

(a) 4 RT (b) 15 RT (c) 9 RT (d) 11 RT.

A. $4RT$

B. $15RT$

C. $9RT$

D. $11RT$

Answer: D

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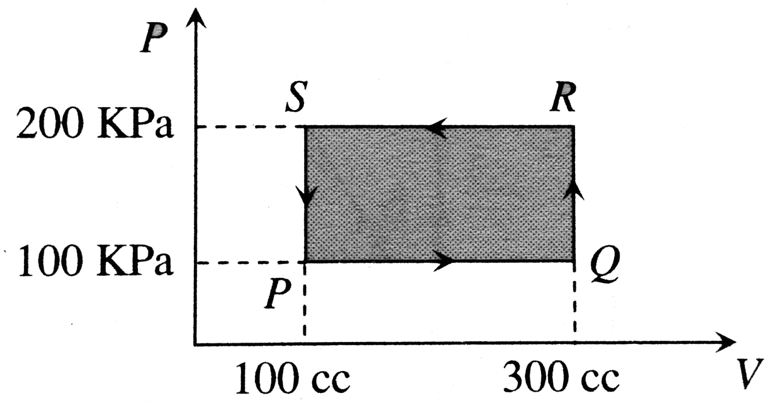
31. A thermodynamic system is taken through the cyclic $PQRSP$ process.

The net work done by the system is



A. $20J$

B. $-20J$

C. $400J$

D. $-374J$

Answer: B

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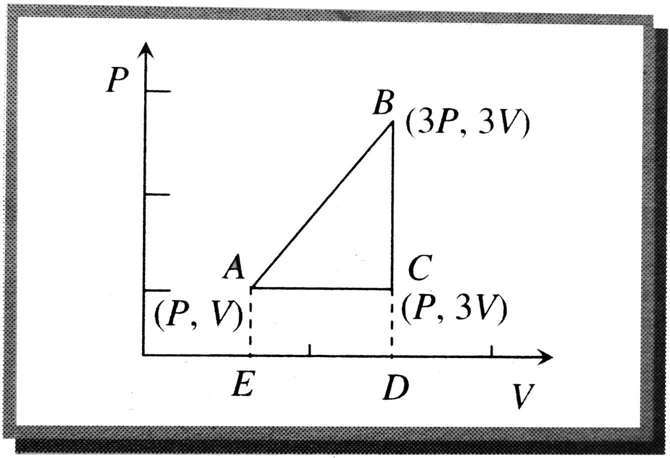
32. An ideal gas is taken around $ABCA$ as shown in the above $P-V$ diagram. The work done during a cycle is



A. $2PV$

B. PV

C. $1/2PV$

D. Zero

Answer: A

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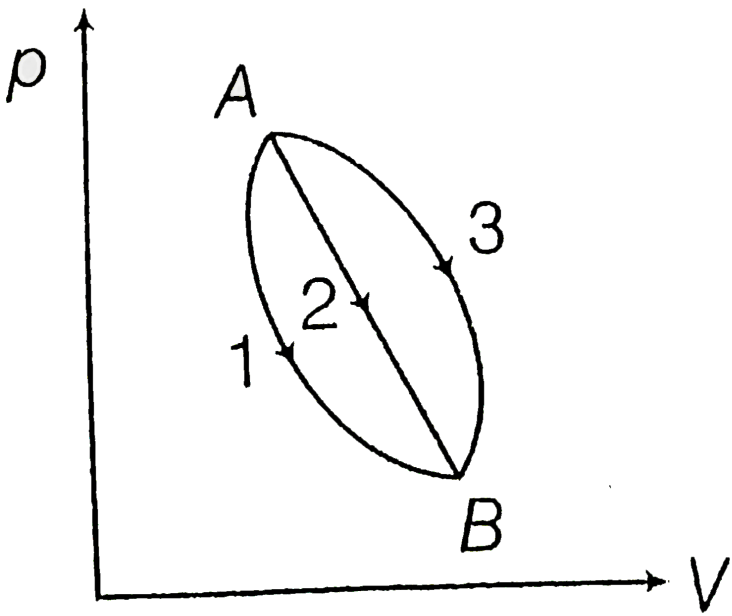
33. An ideal gas of mass m in a state A goes to another state B Via three different processes as shown in figure. If Q_1, Q_2 and Q_3 denote the heat absorbed by the gas along the three paths,then



A. $Q_1 < Q_2 < Q_3$

B. $Q_1 < Q_2 = Q_3$

C. $Q_1 = Q_2 > Q_3$

D. $Q_1 > Q_2 > Q_3$

Answer: A

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34. The relation between the internal energy U adiabatic constant γ is

A. $U = \dfrac{PV}{\gamma - 1}$

B. $U = \dfrac{PV^{\gamma}}{\gamma - 1}$

C. $U = \dfrac{PV}{\gamma}$

D. $U = \dfrac{\gamma}{PV}$

Answer: A

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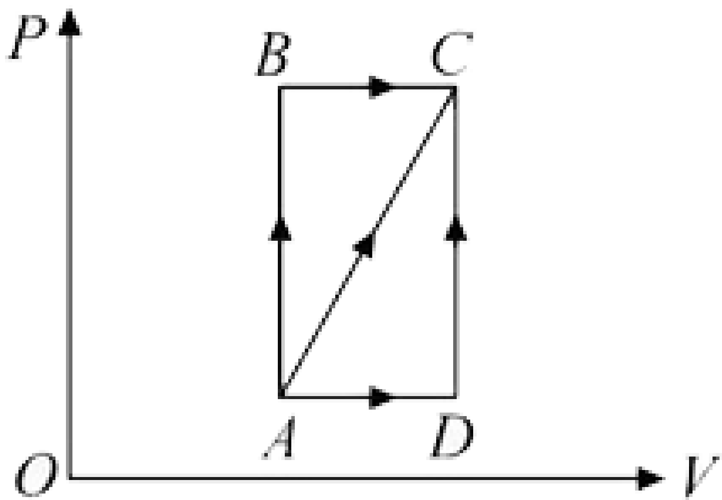
35. A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are: $P_A = 3 \times 10^4 Pa$, $P_B = 8 \times 10^4 Pa$ and $V_A = 2 \times 10^{-3} m^3$, $V_D = 5 \times 10^{-}$

. In process AB, 600 J of heat is added to the system and in process BC, 200 J of heat is added to the system. The change in internal energy of the system in process AC would be :



A. $560J$

B. $800J$

C. $600J$

D. $640J$

Answer: A

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36. If R is universal gas constant , the amount of heat needed to raise the temperature of 2 moles of an ideal monatomic gas from 273 K to 373 K when no work id done is

A. $100R$

B. $150R$

C. $300R$

D. $500R$

Answer: C

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37. During an adiabatic process, the pressure of gas is found to be proportional to the cube of its absolute temperature. The ratio of $(C_{p,m}/C_{v,m})$ for gas is :

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

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

C. 2

D. $\frac{5}{3}$

Answer: A

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38. An ideal gas at $27^{\circ}C$ is compressed adiabatically to $\frac{8}{27}$ of its original volume. The rise in temperature is $\left(\gamma = \frac{5}{3}\right)$

A. $450K$

B. $375K$

C. $225K$

D. $405K$

Answer: B

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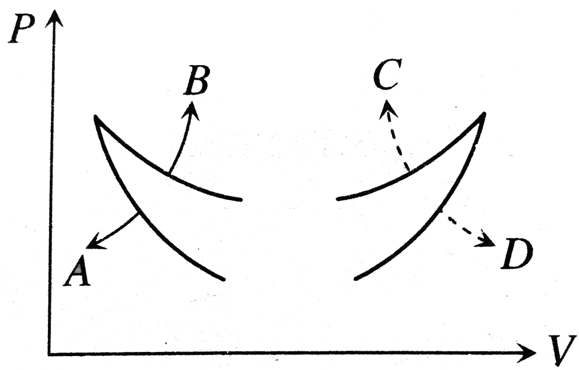
39. Four curves A, B, C and D are drawn in Fig. for a given amount of gas. The curves which represent adabatic and isothermal changes



A. C and D, respectively

B. D and$C$, respectively

C. A and B, respectively

D. B and A, respectively

Answer: C

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40. A thermal insulated container is divided into two parts by a screen, In one part the pressure and tempertature are P and T for an ideal gas filled. In the second part is vacuum. If now a small hole is created in the screen, then the temperatue of the gas will.....

A. decrease

B. increase

C. remain same

D. none of these

Answer: C

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41. Two samples, A and B of a gas at the same initial temperature and pressure are compressed from volume V to V/2, A isothermally and B adiabatically. The final pressure of A will be

A. greater than the final pressure of B

B. equal to the final pressure of B

C. less than final pressure of B

D. twice the final pressure of B

Answer: C

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42. 1 cm^3 of waterr at its boiling point absorbs 540 calories of heat to become steam with a volume of 1671 cm^3. If the atmospheric pressure $= 1.013 \times 10^5 N/m^2$ and the mechanical equivalent of heat $= 4.19$

J/calorie, the energy spent in this process in overcoming inter molecular forces is

A. $540 cal$

B. $40 cal$

C. $500 cal$

D. Zero

Answer: C

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43. Five moles of hydrogen gas are heated from $30^{\circ} C$ to $60^{\circ} C$ at constant pressure. Heat given to the gas is (given $R = 2 cal / mol$ degrees)

A. $750 cal$

B. $630 cal$

C. $1050 cal$

D. $1470cal$

Answer: C

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44. For a particular gas $\gamma = \frac{5}{3}$ and is heated at constant pressure. Calculate the percentage of total heat supplied, used for external work.

A. $40\ \%$

B. $30\ \%$

C. $60\ \%$

D. $20\ \%$

Answer: A

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45. At $100^{\circ} C$ the volume of $1kg$ of water is $10^{-3} m^3$ and volume of $1kg$ of steam at normal pressure is $1.671 m^3$. The latent heat of steam is $2.3 \times 10^6 J / kg$ and the normal pressure is $5 \times 10^5 N / m^2$. If $5kg$ of water at $100^{\circ} C$ is converted into steam, the increase in the internal energy of water in this process will be

A. $8.35 \times 10^5 J$

B. $10.66 \times 10^6 J$

C. $11.5 \times 10^5 J$

D. zero

Answer: B

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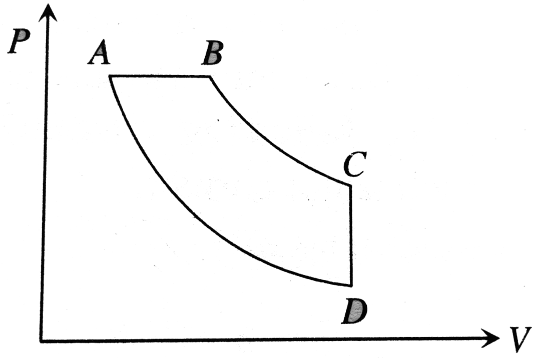
46. In the following pressure-volume diagram, the isochoric, isothermal and isobaric parts, respectively, are



A. BA, AD, DC

B. DC, CB, BA

C. AB, BC, CD

D. CD, DA, AB

Answer: D

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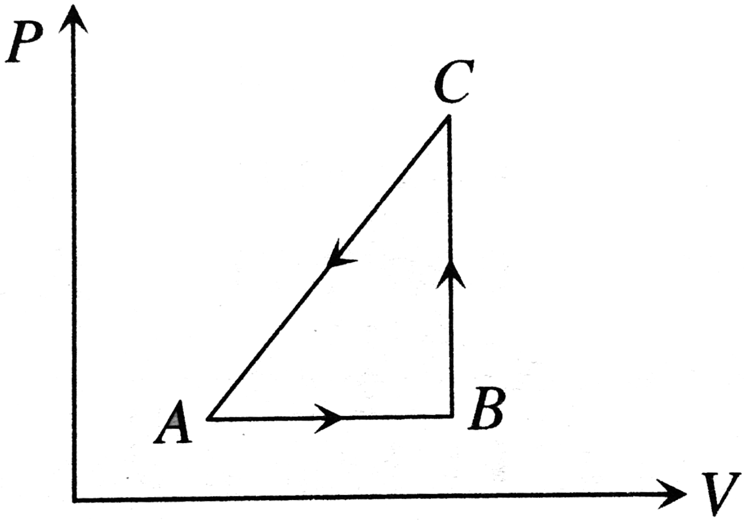
47. The $P-V$ diagram of a system undergoing thermodynnaic transformation is shown in Fig. The work done on the system in going from $A \rightarrow B \rightarrow C$ is $50J$ and $20cal$ heat is given to the system. The change in internal erergy between A and C is



A. $34J$

B. $70J$

C. $84J$

D. $134J$

Answer: D

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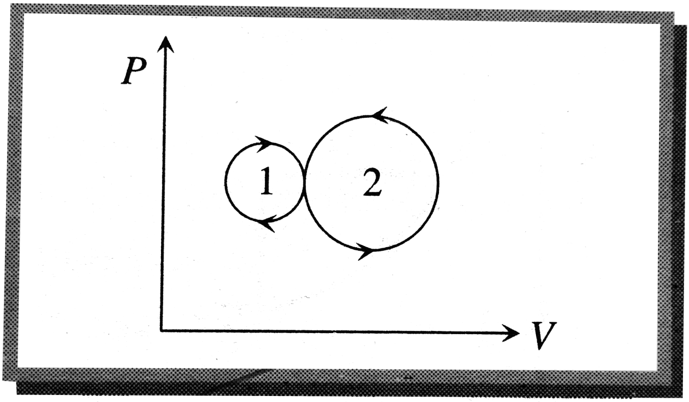
48. In the following indicator diagram, the net amount of work done will be



A. positive

B. negative

C. zero

D. infinity

Answer: B

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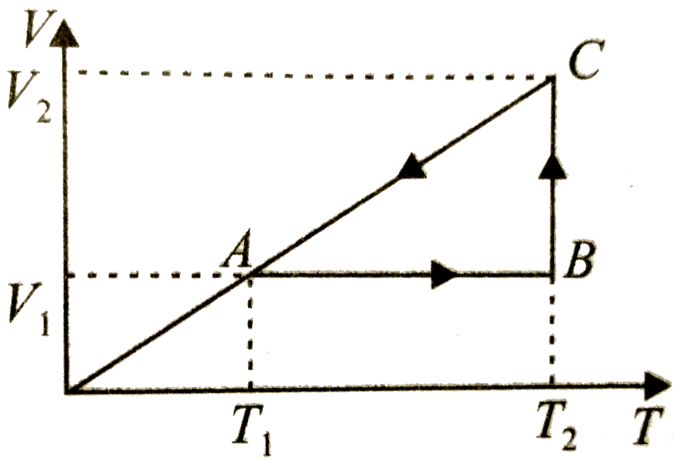
49. A cyclic process for one mole of an ideal gas is shown in the V-T diagram. The work done in AB, BC and CA repectively are



A. $0,\ RT_2 1n\left(\frac{V_1}{V_2}\right),\ R(T_1 - T_2)$

B. $R(T_1 - T_2),\ 0,\ RT_1 1n\left(\frac{V_1}{V_2}\right)$

C. $0,\ RT_2 1n\left(\frac{V_2}{V_1}\right),\ R(T_1 - T_2)$

D. $0,\ RT_2 1n\left(\frac{V_2}{V_1}\right),\ R(T_2 - T_1)$

Answer: C

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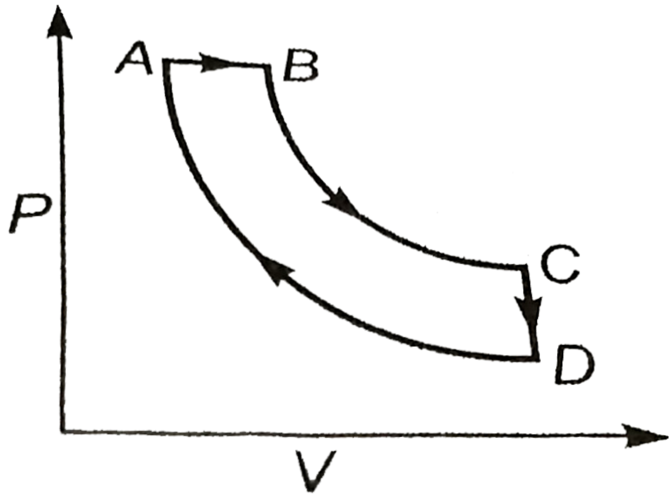
50. A cyclic process ABCD is shown in P-V diagram for an ideal gas. Which of the following diagram represents the same process?



A.

B.

C.

D.

Answer: A

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51. An ideal gas expands in such a manner that its pressure and volume can be related by equation $PV^2 =$ constant. During this process, the gas is

A. heated

B. cooled

C. neither heated nor cooled

D. first heated and then cooled

Answer: B

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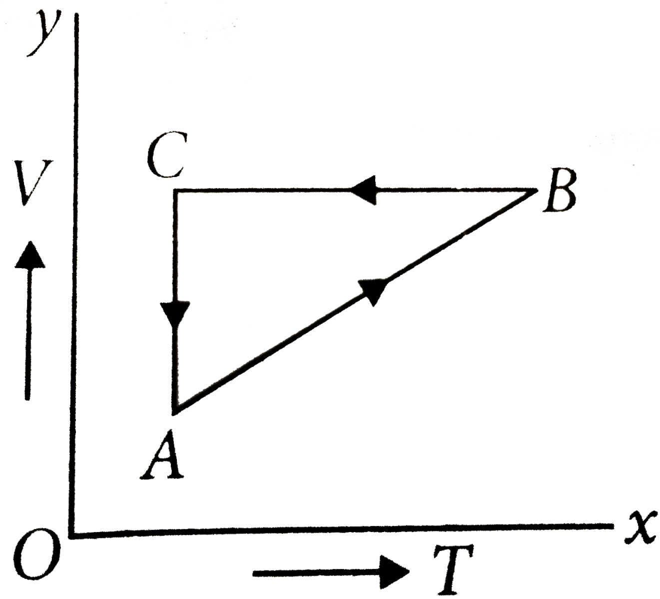
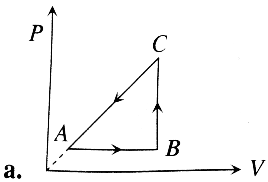
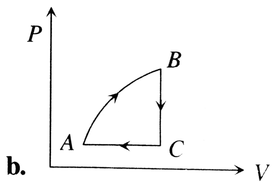
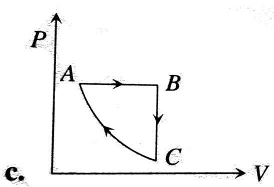
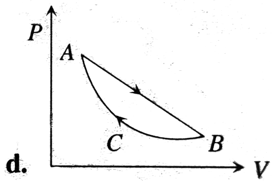
52. A cyclic process ABCA shown in V-T diagram, is performed with a constant mass of an ideal gas. Which of the following graphs in figure represents the corresponding process on a P-V diagram?



A. 

B. 

C. 

D. 

Answer: C

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53. One mole of a diatomic.gas undergoes a process $p = \frac{p_0}{1 + \left(\frac{V}{(V_0)^3}\right)}$,

where p_0 and V_0 are constants . The translational kinetic energy of the gas when V=V_0 is given by

A. $5P_0V_0/4$

B. $3P_0V_0/4$

C. $3P_0V_0/2$

D. $5P_0V_0/2$

Answer: B

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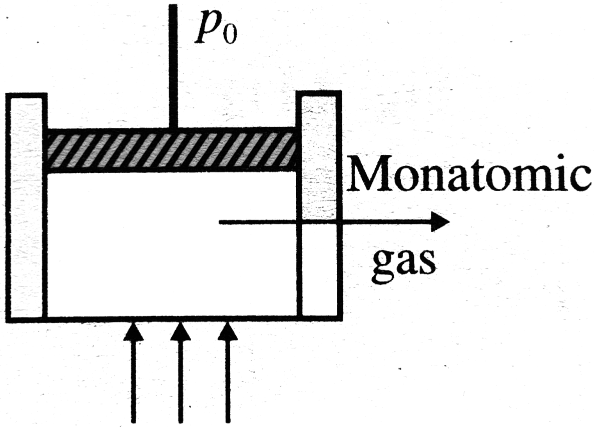
54. If $50cal$ of heat is supplied at constant pressure to the system containing $2mol$ of an ideal monatomic gas, the rise in temperature is $(R = 2cal/mol - K)$



A. $50K$

B. $5K$

C. $10K$

D. $20K$

Answer: B

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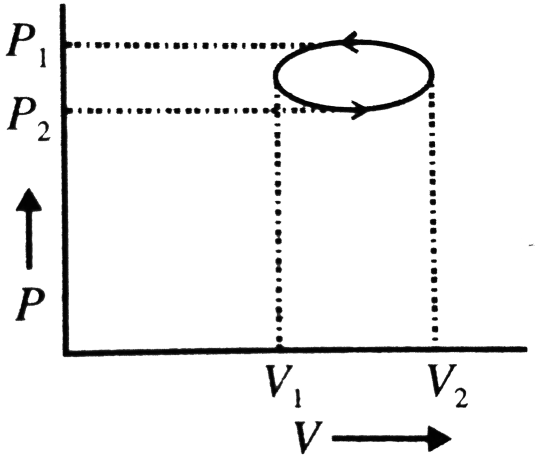
55. In the given elliptical $P-V$ diagram



A. the work done is positive

B. the change in internal energy is non-zero

C. the work done $=-(\pi/4)(P_2-P_1)(V_2-V_1)$

D. the work done $=\pi(V_1-V_2)^2-\pi(P_1-P_2)^2$

Answer: C

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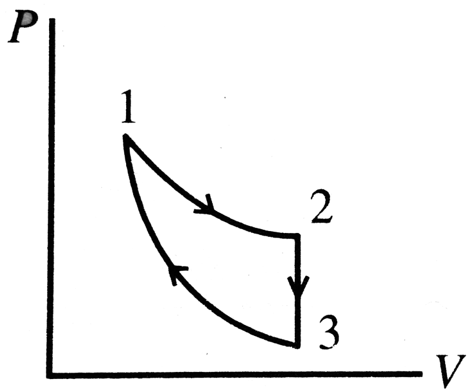
56. Three processes compose a thermodynamic cycle shown in the accompanying $P - V$, diagram of an ideal gas.

Process $1 \rightarrow 2$ take place at constant temperature, during this process $60J$ of heat enters the system.

Process $2 \rightarrow 3$ takes place at constant volume. During this process $40J$ of heat leaves the system.

Process $3 \rightarrow 1$ is adiabatic.

What is the change in internal energy of the during process $3 \rightarrow 1$?



A. $-40J$

B. $-20J$

C. $+20J$

D. $+40J$

Answer: D

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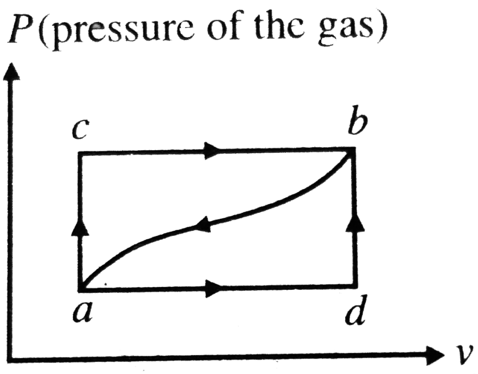
57. When an ideal gas is taken from state a to b, along a path acb, $84kJ$ of heat flows into the gas and the gas does $32kJ$ of work. The following conclusions are drawn. Mark the one which is not correct.



A. If the work done along the path adb is $10.5kJ$, the heat will flow into the gas is $62.5kJ$

B. When the gas is returned from b to a along the curved path, the work done on the gas is $21kJ$, and the system absorbs $73kJ$ of heat

C. If $U_a = 0, U_d = 42kJ$, and the work done along the path adb is $10.5kJ$ then the heat absorbed in the process ad is $52.5kJ$.

D. If $U_a = 0, U_d = 42kJ$, heat absorbed in the process db is $10kJ$.

Answer: B

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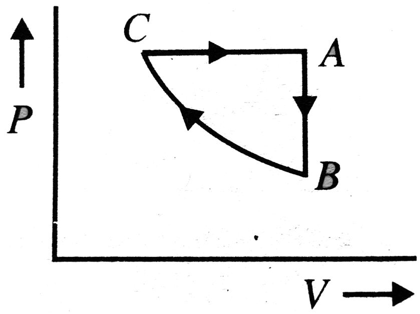
58. A sample of an ideal gas is taken through the cyclic-process $ABCA$ shown in Fig. It rejects $50J$ of heat during the part AB, doens not absorb or reject the heat during BC, and accepts $70J$ of heat during CA. Forty joules of works is done on the gas during the part BC. The internla energies at B and C, respectively, will be (Internal Energy at

A=1500Joules)



A. $1450J$ and $1410J$

B. $1550J$ and $1590J$

C. $1450J$ and $1490J$

D. $1550J$ and $1510J$

Answer: C

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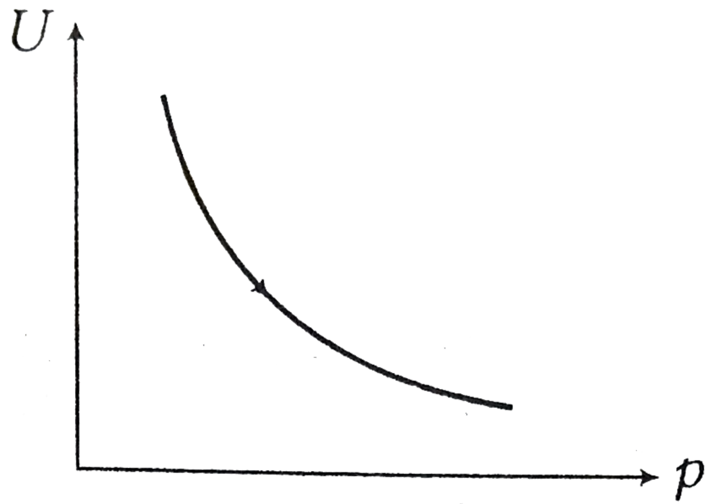
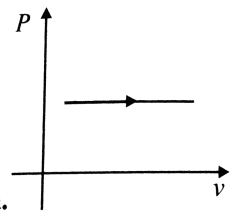
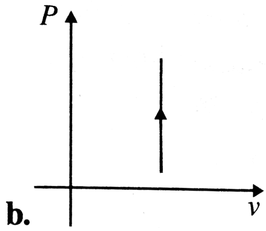
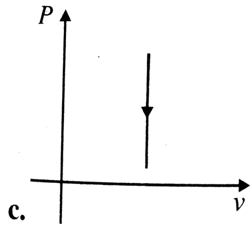
59. Vairation of internal energy with density of one mole of monoatomic gas is depicate in the adjoining figure. Correpsponding variation of pressure with volume can be depicted (Assuming the curve is rectangular hyperbola)

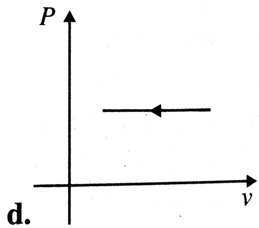


A. a.



B. 

C. 

D. 

Answer: D

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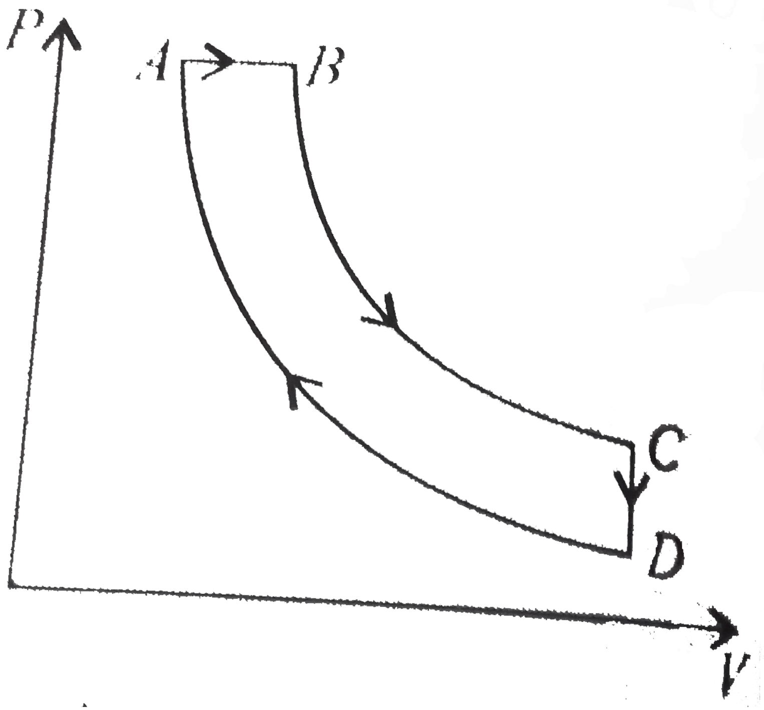
60. A cyclic process $ABCD$ is shown in the $P-V$ diagram. Which of the following curves represents the same process?



A. $\frac{5}{2}R, \frac{5}{2}$

B. $\frac{5}{2}R, \frac{5}{3}$

C. $\frac{7}{2}R, \frac{7}{2}$

D. $\frac{5}{2}R, \frac{7}{5}$

Answer: B

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61. A vessel of volume $20L$ contains a mixture o hydrogen and helium at temperature of $27^{\circ} C$ and pressure $2.0 atm$ The mass of the mixture is $5g$. Assuming the gases to be ideal, the ratio of the mass of hydrogen to heat of helium in the given mixture will be

A. (a)$1:2$

B. (b)$2:3$

C. (c)$2:1$

D. (d)$2:5$

Answer: D

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62. A cylinder of ideal gas is closed by an 8kg movable piston of area $60 cm^2$. The atmospheric pressure is 100kPa. When the gas is heated form $30^{\circ} C$ to $100^{\circ} C$, the piston rises 20 cm. The piston is then fastened in the place and the gas is cooled back to $30^{\circ} C$. If ΔQ_1 is the heat added to the gas during heating and ΔQ_2 is the heat lost during cooling, find the difference.

A. (a)zero

B. (b)$136J$

C. (c)$-136J$

D. (d)$-68J$

Answer: B

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63. A certain ideal gas undergoes a polytropic process PV^n = constant such that the molar specific heat during the process is negative. If the ratio of the specific heats of the gas be γ, then the range of values of n will be

A. (a)$0 < n < \gamma$

B. (b)$1 < n < \gamma$

C. (c)$n = \gamma$

D. (d)$n > \gamma$

Answer: B

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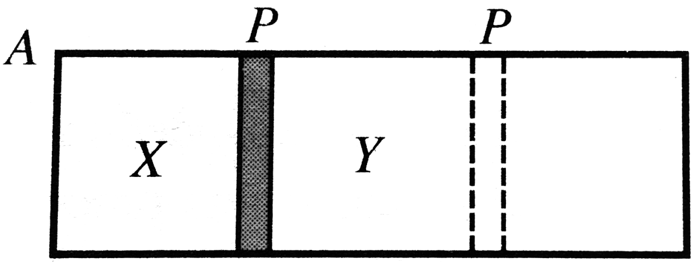
64. A cylindrical chamber A of uniform cross section is divided into two parts X and Y by a movalbe piston P which can slide without friction inside the chamber. Initially part X contains 1mol of a monochromatic gas and Y contains $2mol$ of a diatomic gas, and the volumes of X and Y are in the ratio $1:2$ with both parts X and Y being at the same temperature T. Assuming the gases to be ideal, the work W that will be done in moving the piston slowly to the position where the ratio of the volumes of X and Y is $2:1$ will be



A. $-5.8T$

B. $8.3T$

C. $12.3T$

D. zero

Answer: A

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65. An ideal gas (1 mol, monatomic) is in the intial state P (see Fig.) on an isothermal A at temperature T_0. It is brought under a constant volume $(2V_0)$ process to Q which lies on an adiabatic B intersecting the isothermal A at (P_0, V_0, T_0). The change in the internal energy of the gas during the process is (in terms of T_0) $\left(2^{2/3} = 1.587\right)$

A. (a)$2.3T_0$

B. (b)$-4.6T_0$

C. (c)$-2.3T_0$

D. (d)$4.6T_0$

Answer: B

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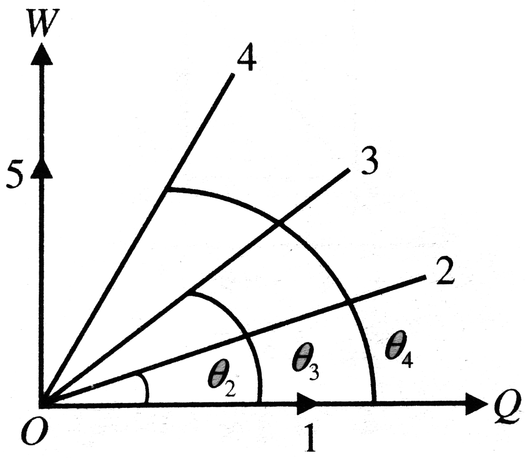
66. Figure shows an isochore, an isotherm, an adiabatic and two isobars of two gases on a work done versus heat supplied curve. The initial states of both gases are the same and the scales for the two axes are same.



A. Straight line 1 corresponds to an isochoric process.

B. Straight line 2 corresponds to an isobaric process for diatomic gas.

C. Straight line 4 corresponds to an isothermal process.

D. Straight line 5 corresponds to an isothermal process.

Answer: D

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67. A stationary cylinder of oxygent used in a hospital has the following characteristics at room temperature $300K$, gauge pressure 1.38×10^7 Pa. volume $16L$. If the flow area, measured at atmospheric pressure, is constant at $2.4L / \min$, the cylinder will last for nearly

A. $5h$

B. $10h$

C. $15h$

D. $20h$

Answer: C

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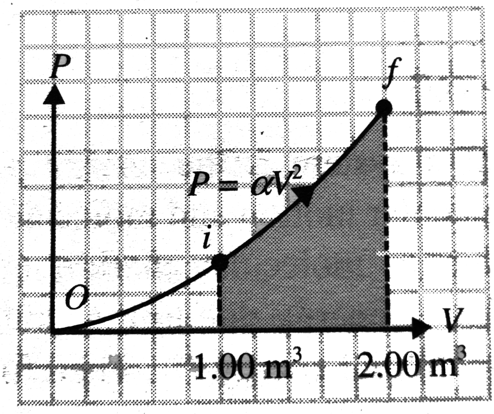
68. A sample of ideal gas is expanded to twice its original volume of $1.00m^3$ in a quasi-static process for which $P = \alpha V^2$, with $\alpha = 5.00atm / m^6$, as shown in Fig. How much wor is done on the expanding gas ?



A. $8 \times 10^5 J$

B. $7 \times 10^5 J$

C. $6 \times 10^5 J$

D. $3 \times 10^5 J$

Answer: B

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69. One mole of air $(C_V = 5R/2)$ is confined at atmospheric pressure in a cylinder with a piston at $0^\circ C$. The initial volume occupied by gas is V. After the equivalent of $13200 J$ of heat is transferred to it, the volume of gas V is nearly $\left(1 atm = 10^5 N/m^3\right)$

A. $37L$

B. $22L$

C. $60L$

D. $30L$

Answer: C

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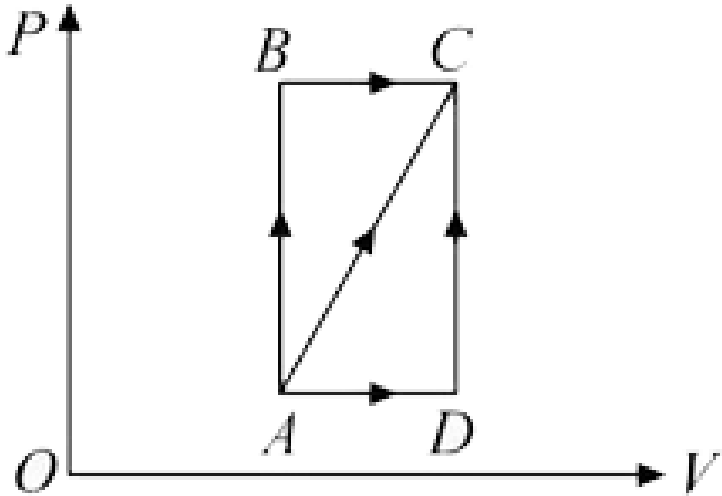
70. A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are: $P_A = 3 \times 10^4 Pa, P_B = 8 \times 10^4 Pa$ and $V_A = 2 \times 10^{-3} m^3, V_D = 5 \times 10^{-}$

. In process AB, 600 J of heat is added to the system and in process BC, 200 J of heat is added to the system. The change in internal energy of the system in process AC would be :



A. $560J$

B. $800J$

C. $60J$

D. $640J$

Answer: A

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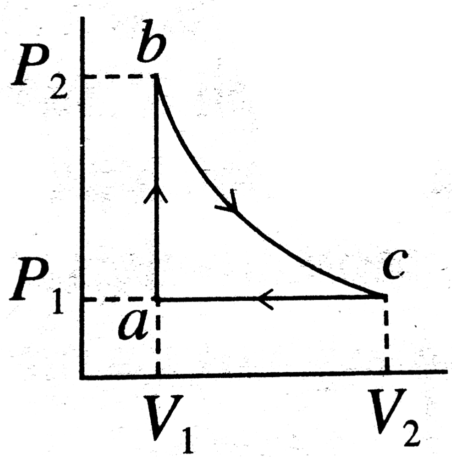
71. Carbon monoxide is carried around a closed cyclic processes abc, in which bc is an isothermal process, as shown in Fig. The gas absorbs $7000J$ of heat as its temperature is increased from $300K$ to $1000K$ in going from a to b. The quantity of heat ejected by the gas during the process ca is



A. $4200J$

B. $500J$

C. $9000J$

D. $9800J$

Answer: D

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

(1) Find the value of W_4.

(2) What is the efficiency of the cycle

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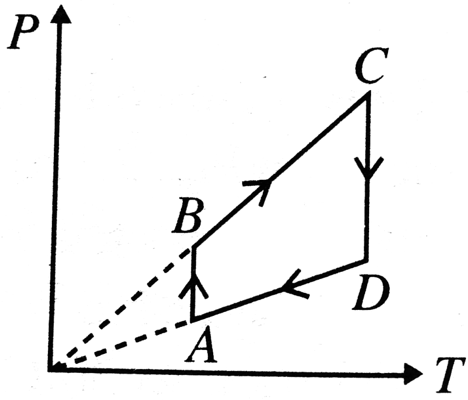
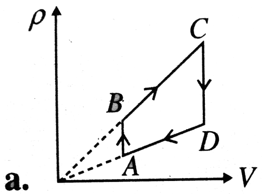
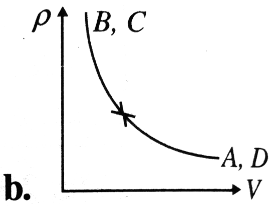
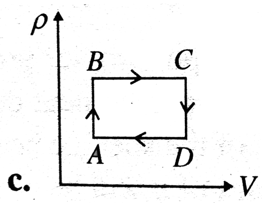
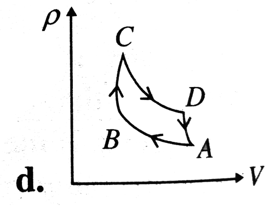
73. Pressure versus temperature graph of an ideal gas as shown in Fig. Corresponding density (ρ) versus volume (V) graph will be



A. 

B. 

C. 

D. 

Answer: B

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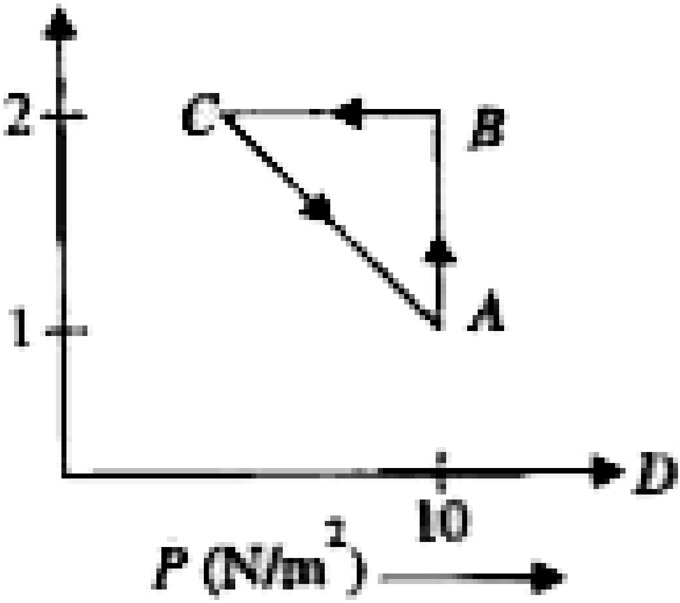
74. An ideal gas is taken through cycle $A \rightarrow B \rightarrow C - A$, as shown in Fig. IF the net heat supplied to the gas in the cycle is 5 J, the work done by the gas in the process $C \rightarrow A$ is



A. $-5J$

B. $-10J$

C. $-15J$

D. $-20J$

Answer: A

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75. Two identical cylinders A and B with frictionless pistons contain the same ideal gas at the same temperature and the same voluem V. The mass of gas $A is m_A$ and $tôf B is m_B$ .The gs in eah cylinder is notw allowed to expand isothermally to the same final volume 2V . The change in the pressure in A and B are found ot be ΔP and $1.5 \Delta P$ respecitvely Then

A. $4m_A = 9m_B$

B. $2m_A = 3m_B$

C. $3m_A = 2m_B$

D. $9m_A = 4m_B$

Answer: C

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76. Argon gas is adiabatically compressed to half its volume. If P, V and T represent the pressure, volume and temperature of the gasous, respectively, at any stage, then the correct equation representing the process is

A. $TV^{2/5}=$ constant

B. $TV^{5/3}=$ constant

C. $TP^{-2/5}=$ constant

D. $PT^{-2/5}=$ constant

Answer: C

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77. A fixed mass of helium gas is made to undergo a process in which its pressure varies linearly from $1kPa$ to $2kPa$, in relation to its volume as the latter varies from $0.2m^3$ to $0.4m^3$. The heat absorbed by the gas will be

A. $300J$

B. $900J$

C. $1200J$

D. $1500J$

Answer: C

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78. Oxygen gas is made to undergo a process in which its molar heat capacity C depends on its absolute temperature T as $C = \alpha T$. Work done by it when heated from an initial temperature T_0 to a final temperature $2T_0$, will be

A. $4\alpha T_0$

B. $(\alpha T_0 - R)\frac{3T_0}{2}$

C. $(3\alpha T_0 - 5R)\frac{T_0}{2}$

D. none of these

Answer: C

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79. If the ratio of specific heat of a gas at constant pressure to that at constant volume is γ, the change in internal energy of a mass of gas when the volume changes from V to 2V at constant pressure p is

A. $R/(\gamma - 1)$

B. pV

C. $pV/(\gamma - 1)$

D. $\gamma pV/(\gamma - 1)$

Answer: C

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80. A gas is at 1 atm pressure with a volume $800 cm^3$. When $100 J$ of heat is supplied to the gas, it expands to $1 L$ at constant pressure. The change in its internal energy is

A. $80J$

B. $-80J$

C. $20J$

D. $-20J$

Answer: A

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81. A fixed mass of a gas is first heated isobarically to double the volume and then cooled isochorically

A. (a)2

B. (b)$1/2$

C. (c)1n 2

D. (d)1n 3

Answer: C

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82. An ideal heat engine has an efficiency η. The cofficient of performance of the engine when driven backward will be

A. $1-(1/\eta)$

B. $\eta/(1-\eta)$

C. $(1/\eta)-1$

D. $1/(1-\eta)$

Answer: C

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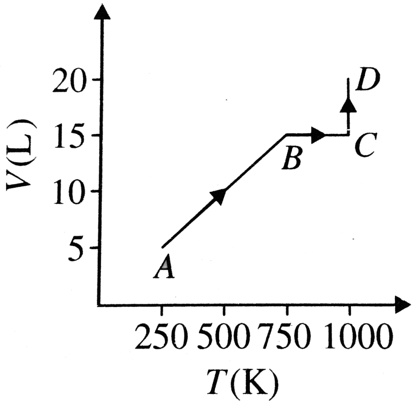
83. Two moles of helium gas are taken along the path $ABCD$ (as shown in Fig.) The work done by the gas is



A. $2000R\left(\frac{1}{2}+1n\frac{4}{3}\right)$

B. $500R(R+1n4)$

C. $500R\left(2+1n\frac{16}{9}\right)$

D. $1000R\left(1+1n\frac{16}{9}\right)$

Answer: A

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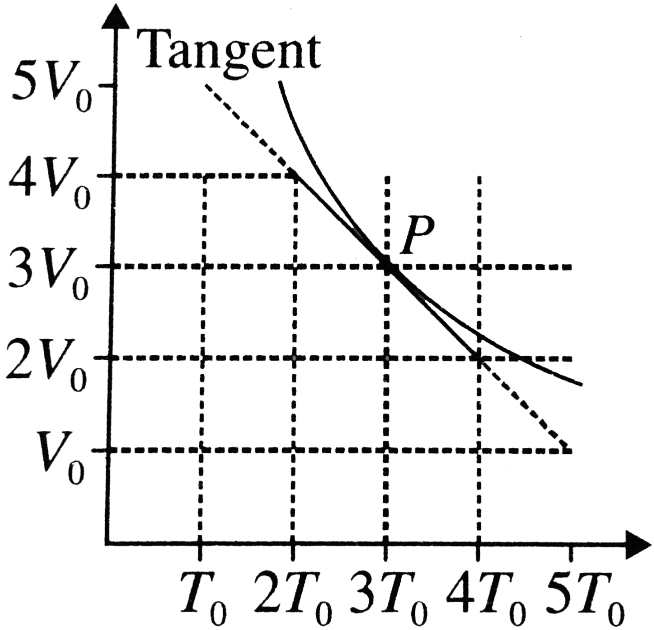
84. Figure shows the adiabatic curve for n moles of an ideal gas, the bulk modulus for the gas corresponding to the point P will be



A. $\frac{5nRT_0}{3V_0}$

B. $nR\left(2+\frac{T_0}{V_0}\right)$

C. $nR\left(1+\frac{T_0}{V_0}\right)$

D. $\frac{2nRT_0}{V_0}$

Answer: D

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85. Two moles of an ideal gas is contained in a cylinder fitted with a frictionless movable piston, exposed to the atmosphere, at an initial temperature T_0. The gas is slowly heated so that its volume becomes four times the initial value. The work done by gas is

A. zero

B. $2RT_0$

C. $4RT_0$

D. $6RT_0$

Answer: D

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86. The equation of state for a gas is given by $PV = \eta RT + \alpha V$, where η is the number of moles and α a positive constant. The intinal pressure and temperature of 1 mol of the gas contained in a cylinder is P_0 and T_0, respectively. The work done by the gas when its temperature doubles isobarically will be

A. $\dfrac{P_0T_0R}{P_0 - \alpha}$

B. $\dfrac{P_0T_0R}{P_0 + \alpha}$

C. P_0T_0R 1n 2

D. none of these

Answer: A

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87. A sound wave passing volume $1m^3$ is divided into two equal compartments by a partition. One of these compartments contains an ideal gas at $300K$. The other compartment is vacuum. The whole system is thermally isolated from its surroundings. The partition is removed and the gas expands to occupy the whole volume of the container. Its temperature now would be

A. $8.97 \times 10^{-4}K$

B. $8.97 \times 10^{-6}K$

C. $8.97 \times 10^{-8} K$

D. none of these

Answer: C

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88. A container of volume $1m^3$ is divided into two equal parts by a partition. One part has an ideal gas at 300K 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 ....

A. $300K$

B. $250K$

C. $200K$

D. $10K$

Answer: A

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89. The molar specific heat of oxygen at constant pressure $C_P = 7.03 cal / mol.^\circ C$ and $R = 8.31 J / mol.^\circ C$. The amount of heat taken by 5 mol of oxygen when heated at constant volume from $10^\circ C$ to $20^\circ C$ will be approximately.

A. 25 cal

B. 50 cal

C. 250 cal

D. 500 cal

Answer: C

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90. Four moles of hydrogen, 2 moles of helium and 1 mole of water form an ideal gas mixture. What is the molar specific heat at constant pressure of mixture ?

A. $\frac{16}{7}R$

B. $\frac{7R}{16}$

C. R

D. $\frac{23}{7}R$

Answer: D

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91. In a adiabatic process pressure is increased by $2/3\%$ if $C_P/C_V = 3/2$. Then the volume decreases by about

A. $\frac{4}{9}\%$

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

C. 4%

D. $\frac{9}{4}\%$

Answer: A

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92. Two cylinders A and B fitted with pistons contain equal amounts of an ideal diatomic gas at 300K. The piston of A is free to move, while that 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 30K, then the rise in temperature of the gas in B is

A. $30K$

B. $18K$

C. $50K$

D. $42K$

Answer: D

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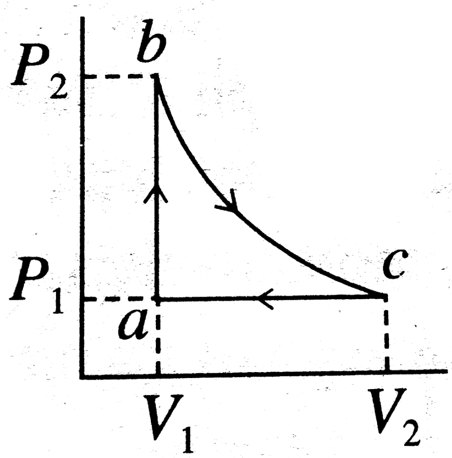
93. Carbon monoxide is carried around a closed cyclic processes abc, in which bc is an isothermal process, as shown in Fig. The gas absorbs $7000J$ of heat as its temperature is increased from $300K$ to $1000K$ in going from a to b. The quantity of heat ejected by the gas during the process ca is



A. 4200J

B. 500J

C. 9000J

D. 9800J

Answer: D

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94. If for hydrogen $C_P - C_V = m$ and for nitrogen $C_P - C_V = n$, where C_P and C_V refer to specific heats per unit mass respectively at constant pressure and constant volume, the relation between m and n is (molecular weight of hydrogen = 2 and molecular weight or nitrogen = 14)

A. $n = 14m$

B. $n = 7m$

C. $m = 7n$

D. $m = 14n$

Answer: C

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95. Five moles of hydrogen $(\gamma = 7/5)$, initially at STP, is compressed adiabatically so that its temperature becomes $400^\circ C$. The increase in the internal energy of the gas in kilojules is $(R = 8.30 J / mol - K)$

A. 21.55

B. 41.5

C. 65.55

D. 80.55

Answer: B

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96. One mole of gas having $\gamma = 7/5$ is mixed with 1 mole of a gas having $\gamma = 4/3$. What will be γ for the mixture ?

A. $\frac{15}{11}$

B. $\frac{5}{13}$

C. $\frac{5}{11}$

D. $\frac{15}{13}$

Answer: A

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97. The specific heats of an ideal gas at constant pressure and constant volume are $525 J/kg - .^{\circ} C$ and $315 J/kg - .^{\circ} C$ respectively. Its density at NTP is

A. $1.77 kg/m^3$

B. $0.77 kg/m^3$

C. $1.77 g/m^3$

D. $0.77 g/m^3$

Answer: A

Watch Video Solution

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

A. $P_3 > P_1, W > 0$

B. $P_3 < P_1, W < 0$

C. $P_3 > P_1, W < 0$

D. $P_3 = P_1, W = 0$

Answer: C

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99. Internal energy of n_1 mol of hydrogen of temperature T is equal to the internal energy of n_2 mol of helium at temperature $2T$. The ratio n_1 / n_2 is

A. $\frac{3}{5}$

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

C. $\frac{6}{5}$

D. $\frac{3}{7}$

Answer: C

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100. An ideal gas $(\gamma = 1.5)$ is expanded adiabatically. How many times has the gas to be expanded to reduce the root-mean-square velocity of molecules becomes half ?

A. 4 times

B. 16 times

C. 8 times

D. 2 times

Answer: B

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101. If 2 moles of an ideal monoatomic gas at temperature T_0 is mixed with 4 moles of another ideal monoatomic gas at temperature $2T_0$, then the temperature of the mixture is

A. $\frac{5}{3}T_0$

B. $\frac{3}{2}T_0$

C. $\frac{4}{3}T_0$

D. $\frac{5}{4}T_0$

Answer: A

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102. Three samples A, B and C of the same gas $(\gamma = 1.5)$ have equal volumes and temperatures. The volume of each sample is doubled, the process being isothermal for A, adiabatic for B and isobaric for C. If the final pressures are equal for the three samples, Find the ratio of the initial pressures.

A. $2\sqrt{2} : 2 : 1$

B. $2\sqrt{2} : 1 : 2$

C. $\sqrt{2} : 1 : 2$

D. $2 : 1\sqrt{2}$

Answer: B

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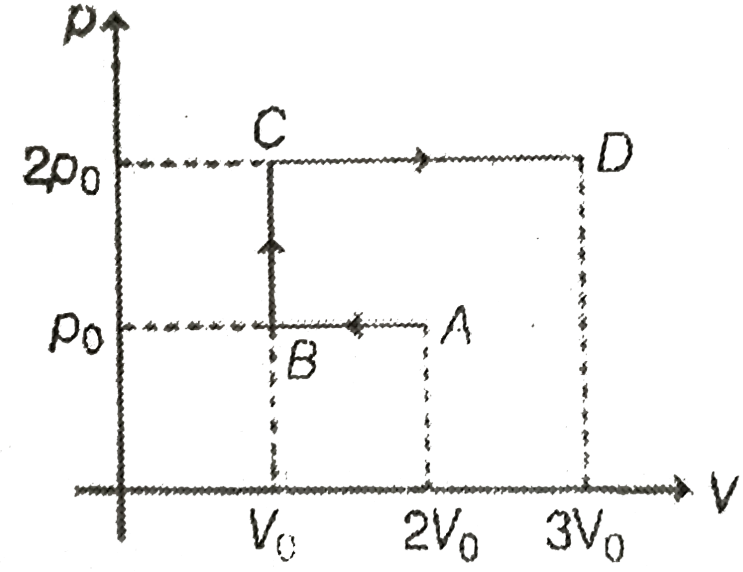
103. p-V diagram of an ideal gas is as shown in figure. Work done by the gas in the process ABCD is



A. $4P_0V_0$

B. $2P_0V_0$

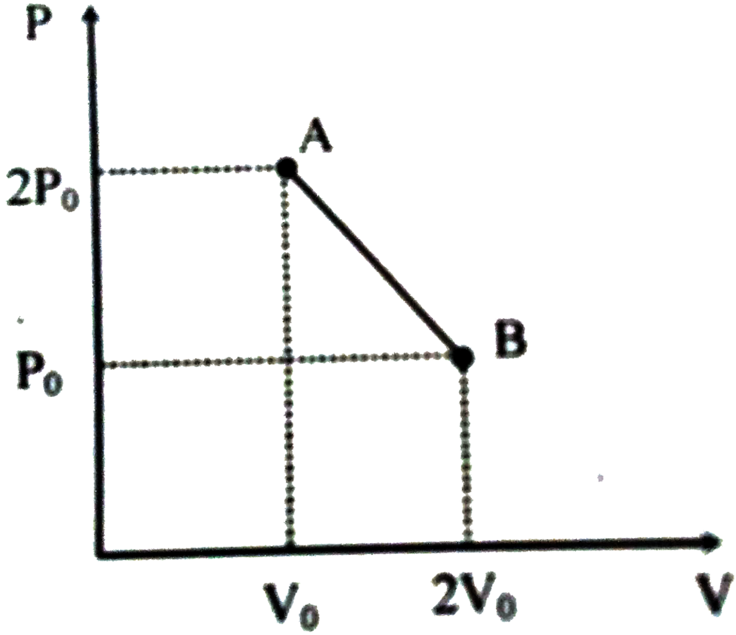
C. $3P_0V_0$

D. P_0V_0

Answer: C

Watch Video Solution

104. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be :



A. $\frac{3P_0V_0}{2nR}$

B. $\frac{9P_0V_0}{4nR}$

C. $\frac{9P_0V_0}{2nR}$

D. $\frac{9P_0V_0}{nR}$

Answer: B

Watch Video Solution

105. The relation between internal energy U, pressure P and volume V of a gas in an adiabatic process is U= a + bPV, where a and b are positive constants. What is the value of γ ?

A. $\frac{a}{b}$

B. $\frac{b+1}{b}$

C. $\frac{a+1}{a}$

D. $\frac{b}{a}$

Answer: B

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106. One mole of an ideal gas at temperature T_1 expands slowly according to the law $\frac{P}{V}$ = constant. Its final temperature is T_2. The work bone by the gas is

A. $R(T_2 - T_1)$

B. $(R/2)(T_2 - T_1)$

C. $(R/4)(T_2 - T_1)$

D. $PV(T_2 - T_1)$

Answer: B

Watch Video Solution

107. Two moles of an ideal gas at temperature $T_0 = 300K$ was cooled isochorically so that the pressure was reduced to half. Then, in an isobaric process, the gas expanded till its temperature got back to the initial value. Find the total amount of heat absorbed by the gas in the processs

A. $150RJ$

B. $300RJ$

C. $75RJ$

D. $100RJ$

Answer: B

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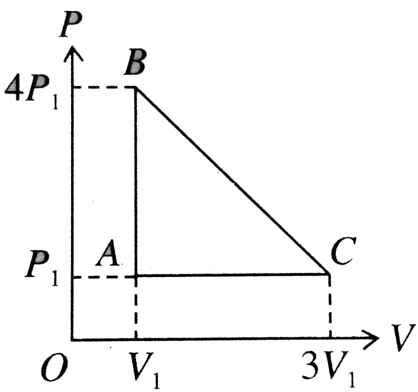
108. An ideal gas is taken around the cycle $ABCA$ shown in $P-V$ diagram. The net work done by the gas during the cycle is equal to



A. $12P_1V_1$

B. $6P_1V_1$

C. $3P_1V_1$

D. P_1V_1

Answer: C

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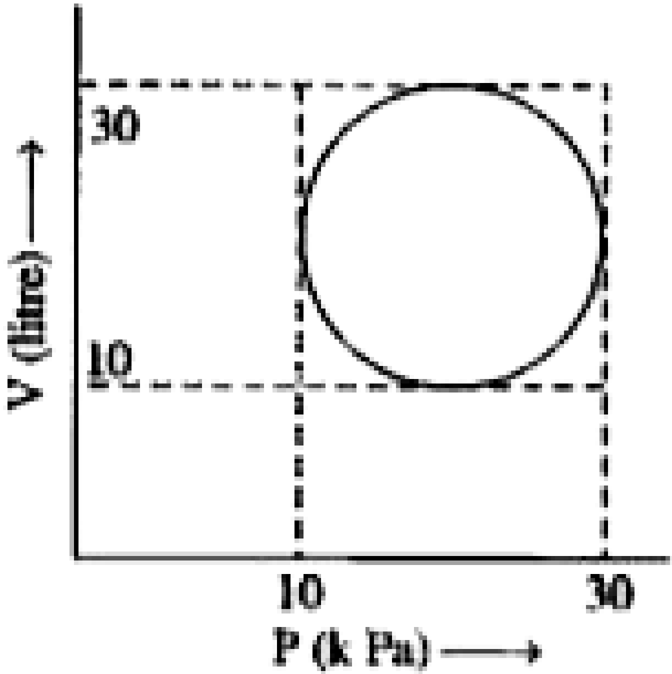
109. Heat energy absorbed by a system is going through a cyclic process shown is Fig. 15.9.3.



A. $10^7 \pi J$

B. $10^4 \pi J$

C. $10^2 \pi J$

D. $10^{-3} \pi J$

Answer: C

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110. A diatomic ideal gas is heated at constant volume until the pressure is doubled and again heated at constant pressure until the volume is doubled. The average molar heat capacity for the whole process is

A. $\frac{13R}{6}$

B. $\frac{19R}{6}$

C. $\frac{23R}{6}$

D. $\frac{17R}{6}$

Answer: B

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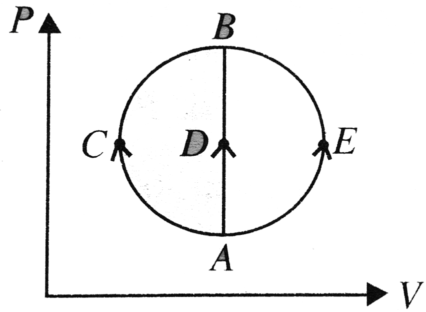
111. One mole of an ideal gas is taken from state A to state B by three different processes (a) ACB, (b) ADB and (c) AEB as shown in the

$P-V$ diagram. The heat absorbed by the gas is



A. greater in process (b) than in (a)

B. the least in process (b)

C. the same in (a) and (c)

D. less in (c) than in (b)

Answer: D

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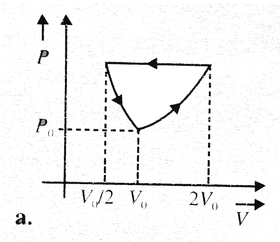
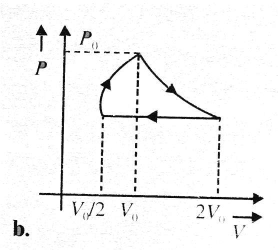
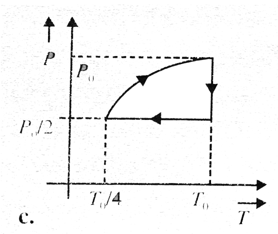
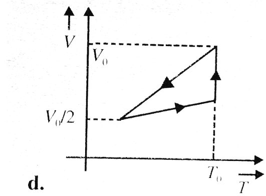
112. One mole of an ideal gas at pressure P_0 and temperature T_0 is expanded isothermally to twice its volume and then compressed at constant pressure to $(V_0/2)$ and the gas is brought bac to original state by a process in which $P \alpha V$ (pressure is directly proportional to volume). The correct temperature of the process is

A. 

B. 

C. 



D.

Answer: C

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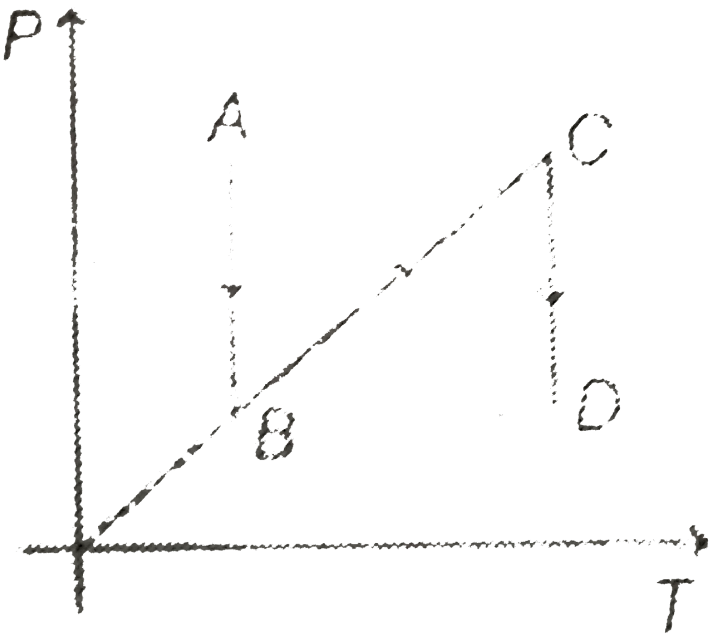
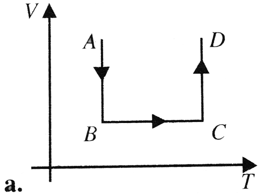
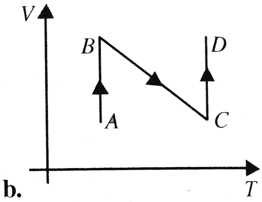
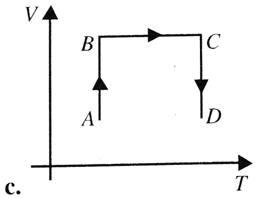
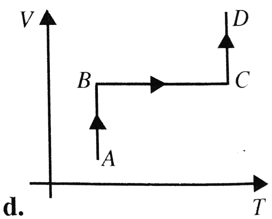
113. P-T diagram is shown below. Then choose the corresponding V-T diagram



A. 

B. 

C. 

D. 

Answer: D

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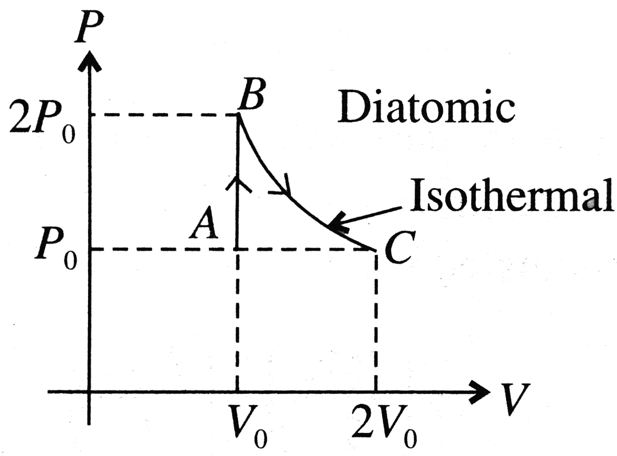
114. P-V curve of a diatomic gas is shown in the Fig. Find the total heat given to the gas in the process $A \to B \to C$



A. $2.5P_0V_0$

B. $1.4P_0V_0$

C. $3.9P_0V_0$

D. $1.1P_0V_0$

Answer: C

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115. A gas expands with temperature according to the relation $V = kT^{2/3}$. What is the work done when the temperature changes by $30^\circ C$?

A. $166.2J$

B. $136.2J$

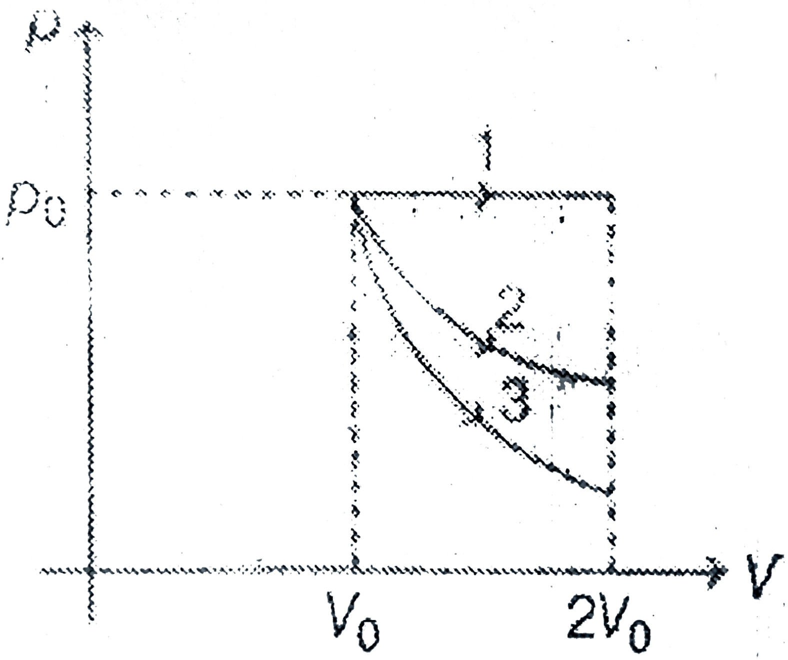
C. $126.2J$

D. none of these

Answer: A

Watch Video Solution

116. A gas is expanded from volume V_0 to $2V_0$ under three different processes. Process 1 is isobaric process 2 is isothermal and process 3 is adiabatic. Let ΔU_1, ΔU_2 and ΔU_3 be the change in internal energy of the gas in these three processes. Then



A. $\Delta U_1 > \Delta U_2 > \Delta U_3$

B. $\Delta U_1 < \Delta U_2 < \Delta U_3$

C. $\Delta U_2 < \Delta U_1 < \Delta U_3$

D. $\Delta U_2 < \Delta U_3 < \Delta U_1$

Answer: A

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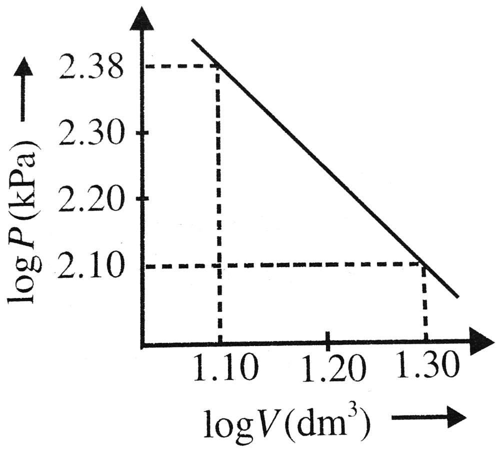
117. Logarithms of readings of pressure and volume for an ideal gas were plotted on a graph as shown in Fig. By measuring the gradient, it can be shwon that the gas may be



A. monatomic and undergoing an adiabatic change

B. monatomic and undergoing an isothermal change

C. diatomic and undergoing an adiabatic change

D. triatomic and undergoing an isothermal change

Answer: C

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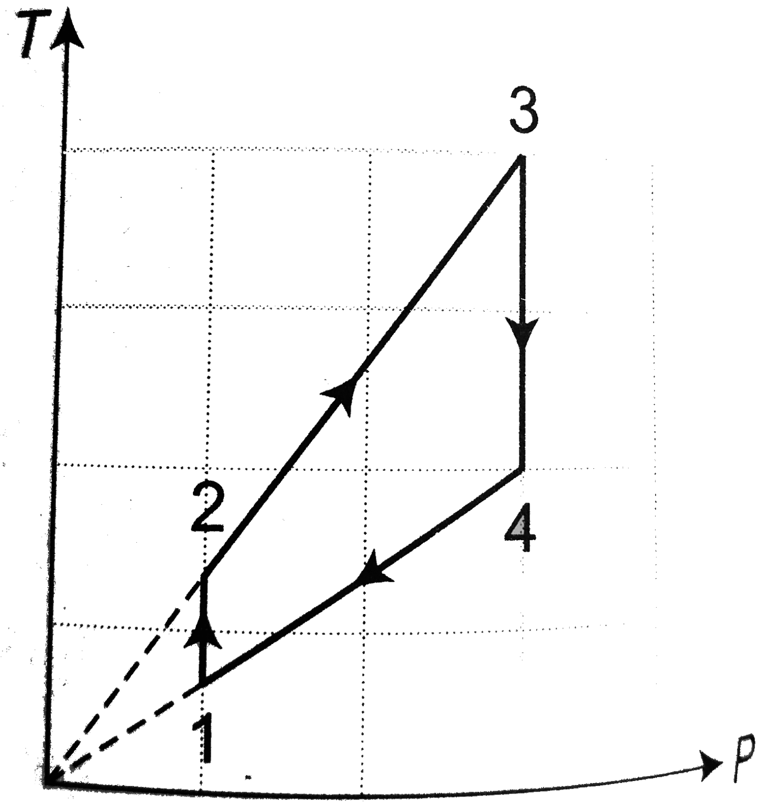
118. Two moles of an ideal mono-atomic gas undergo a cyclic process as shown in the figure. The temperatures in different states are given as $6T_1 = 3T_2 = 2T_4 = T_3 = 1800K$. Determine the work done by the gas during the cycle.



A. $-10kJ$

B. $-20kJ$

C. $-15kJ$

D. $-30kJ$

Answer: A

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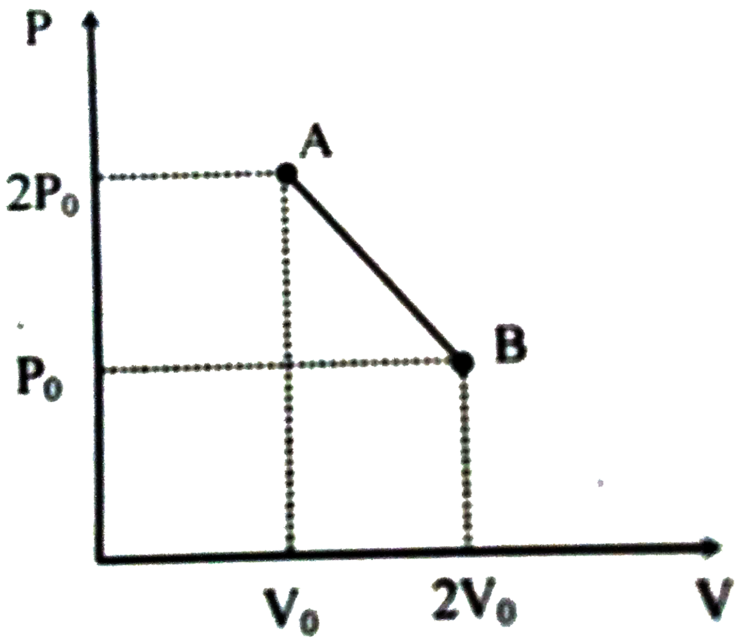
119. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be :



A. $\frac{P_0 V_0}{nR}$

B. $\frac{3P_0 V_0}{nR}$

C. $\frac{4P_0 V_0}{nR}$

D. $\frac{2P_0 V_0}{nR}$

Answer: C

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120. A vessel contains a mixture consisting of $m_1 = 7g$ of nitrogen ($M_1 = 28$) and $m_2 = 11g$ of carbon dioxide ($M_2 = 44$) at temperature T=300 K and pressure $P_0 = 1$ atm. The density of the mixture is

A. $0.72kg/m^3$

B. $1.44kg/m^3$

C. $2.88kg/m^3$

D. $5.16kg/m^3$

Answer: B

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121. The mass of a gas molecule can be computed form the specific heat at constant volume. Take $C_V = 0.075 kcal kg^{-1} k^{-1}$ for argon and calculate

a. the mass of an argon atom

b. the atomic weight of argon.

A. $40 kg$

B. $40 \times 10^{-3} kg$

C. $20 kg$

D. $20 \times 10^{-3} kg$

Answer: B

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122. A certain balloon maintains an internal gas pressure of $P_0 = 100 kPa$ until the volume reaches $V_0 = 20 m^3$. Beyond a volume of $20 m^3$, the internal pressure varies as $P = P_0 + 2k(V - V_0)^2$ where P is in kPa. V is in m^3 and k is a constant $\left(k = 1 kPa / m^3\right)$. Initially the balloon contains helium gas at $20^\circ C$, 100 kPa with a $15 m^3$ volume. The balloon is then heated until the volume becomes $25 m^3$ and the pressure is 150 kPa. Assume ideal gas behavior for helium. The work done by the balloon for the entire process in kJ is

A. 1256

B. 1414

C. 1083

D. 1512

Answer: C

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123. A spherical balloon contains air at temperature T_0 and pressure P_0. The balloon material is such that the instantaneous pressure inside is proportional to the square of the diameter. When the volume of the balloon doubles as a result of heat transfer, the expansion follows the law

A. $PV =$ constant

B. $PV^{2/5} =$ constant

C. $PV^{-1} =$ constant

D. $PV^{-2/3} =$ constant

Answer: D

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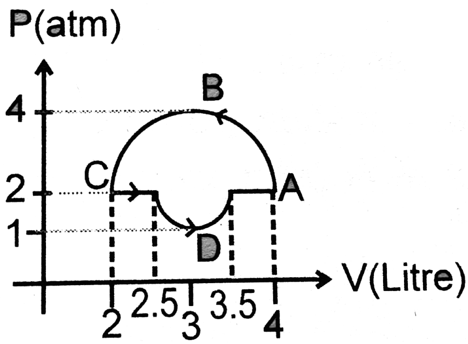
124. Find work done by the gas in the process shown in figure.



A. $\frac{5}{2}\pi atmL$

B. $\frac{5}{2}atmL$

C. $-\frac{3}{2}\pi atmL$

D. $-\frac{5}{4}\pi atmL$

Answer: D

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125. Two different ideal diatomic gases A and B are initially in the same state. A and B are then expanded to same final volume through adiabatic and isothermal process respectively. If P_A, P_B and T_A, T_B represents the final pressure and temperature of A and B respectively then.

A. $P_A < P_B$ and $T_A < T_B$

B. $P_A > P_B$ and $T_A > T_B$

C. $P_A > P_B$ and $T_A < T_B$

D. $P_A < P_B$ and $T_A > T_B$

Answer: A

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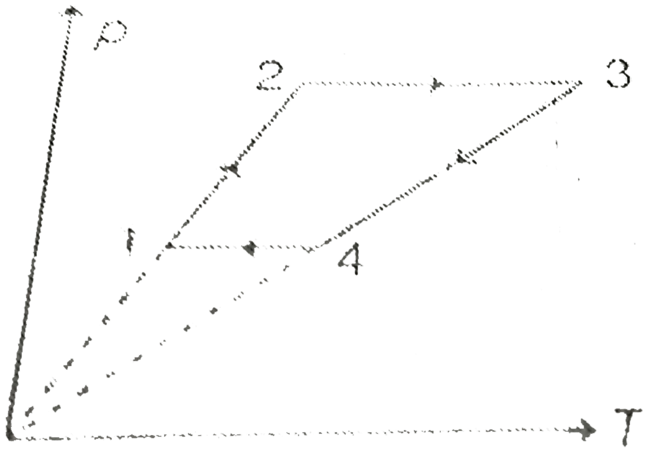
126. Three moles of an ideal monoatomic gas performs a cyclic process as shown in the figure. The temperatures in different states are $T_1 = 400K$, T_(2)=800K, T_(3)=2400K and T_(4)=1200K

. $Deter \min ethew$ or $kdo \neq bythegasdur \in gthecyc \leq$. ["Given

R"=8.31"J-mol"^(-1)K^(-1)]`



A. $5kJ$

B. $10kJ$

C. $15kJ$

D. $20kJ$

Answer: D

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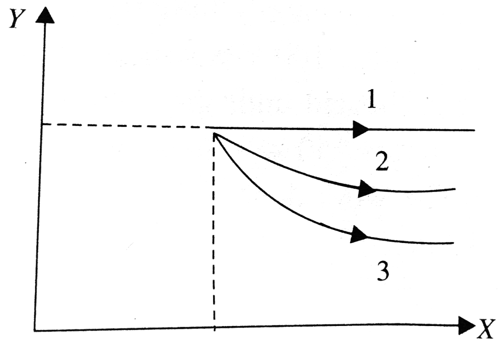
127. For process 1, ΔU is positive, for process 2, ΔU is zero and for process 3, ΔU is negative. Find the parameters indicating x and y axes.



A. Temperature and volume

B. Temperature and pressure

C. No. of moles and pressure

D. Volume and pressure

Answer: D

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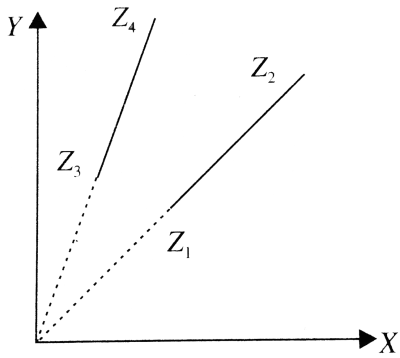
128. In the diagram as shown, find parameters representing x and y axes and also parameter Z, if $Z_1 = Z_2$, $Z_3 = Z_4$ and $Z_2 > Z_3$:



A. Volume, pressure and temperature

B. Temperature, volume and pressure, it is only possible option

C. Temperature, pressure and volume, it is only possible option.

D. Both (b) and (c)

Answer: D

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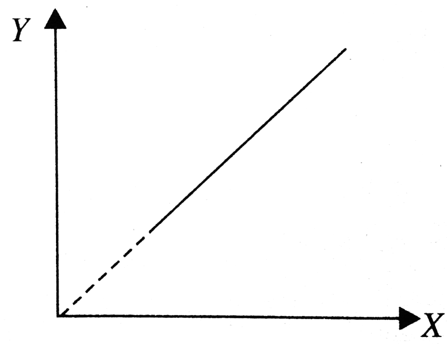
129. The ratio of heat absorbed and work done by the gas in the process, as shown is $5/2$. Find the parameters representing x and y axes :



A. Temperature and pressure

B. Temperature and volume

C. Volume and pressure

D. Volume and density

Answer: B

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130. In previous, Find the value of $\gamma = C_P / C_v$:

A. 1.6

B. 1.5

C. 1.6

D. 1.66

Answer: D

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131. In an adiabatic process, $R = \frac{2}{3}C_v$. The pressure of the gas will be proportional to:

A. $T^{5/3}$

B. $T^{5/2}$

C. $T^{5/4}$

D. $T^{5/6}$

Answer: B

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132. The ratio of pressure of the same gas in two containers is $\frac{n_1T_1}{n_2T_2}$ where n_1 & n_2 are the number of moles and T_1 & T_2 are respective temperatures. If the containers are now joined find the ratio of final pressure to the temperature :

A. $\dfrac{P_1T_2 + P_2T_1}{2T_1T_2}$

B. $\dfrac{P_1T_1 + P_2T_1}{T_1T_2}$

C. $\dfrac{P_1T_1 + P_2T_2}{2T_1T_2}$

D. none of these

Answer: A

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133. In an isobaric process, $\Delta Q = \dfrac{K\gamma}{\gamma - 1}$ where $\gamma = C_P / C_V$. What is K?

A. Pressure

B. Volume

C. ΔU

D. ΔW

Answer: D

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134. On an isothermal process, there are two POINTs A and B at which pressures and volumes are $(2P_0, V_0)$ and $(P_0, 2V_0)$ respectively. If A and B are connected by a straight line, find the pressure at a POINT on this straight line at which temperature is maximum

A. $\dfrac{4P_0}{3}$

B. $\dfrac{5}{4}P_0$

C. $\frac{3}{2}P_0$

D. $\frac{7}{5}P_0$

Answer: C

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135. On an isothermal process ,there are two points A and B at which pressures and volumes are (2P0,V0) and (P0,2V0) respectively. A and B are connected by a straight line then , the temperature of the isothemal process is how much lower the maximum temperature :

A. $\frac{P_0V_0}{nR}$

B. $\frac{P_0V_0}{2nR}$

C. $\frac{3P_0V_0}{2nR}$

D. $\frac{P_0V_0}{4nR}$

Answer: D

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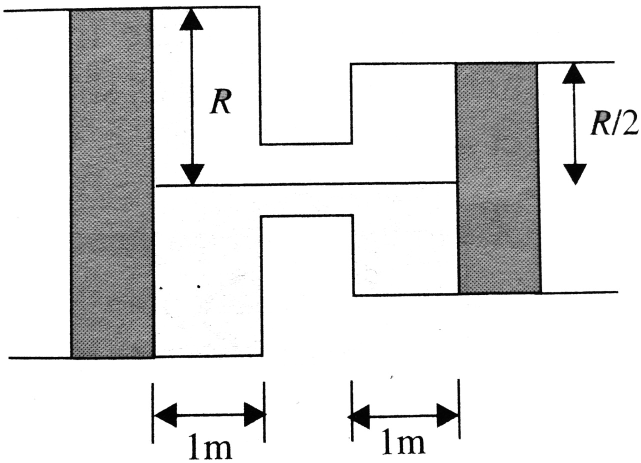
136. Two cyliendérs fitted with pistons and placed as shown, connected with string through a small tube of negligible volume, are filled with gas at pressure P_0 and temperature T_0. The radius of smaller cylinder is half of the other. If the temperature is increased to $2T_0$, find the pressure if the piston of bigger cylinder moves towards left by 1 metre ?



A. $\frac{4}{5}P_0$

B. $\frac{3}{5}P_0$

C. $\frac{2}{5}P_0$

D. $\frac{5}{4}P_0$

Answer: D

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137. If P is the atmospheric pressure in the last problems find the percentage increase in tension of the string after heating

A. $\frac{25}{(1 - P/P_0)}$

B. $\frac{25}{(1 - P/P_0)}$

C. $25(1 - P/P_0)$

D. $25(1 - P/P_0)$

Answer: A

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138. Two identical containers A and B having same volume of ideal gas at the same temperature have mass of the gas as m_A and m_B respectively.

$2m_A = 3m_B$. The gas in each cylinder expand isothermally to double its volume. If the change in pressure in A is Δp, find the change in pressure in B:

A. $2\Delta p$

B. $3\Delta p$

C. $\frac{2}{3}\Delta P$

D. $\frac{4}{3}\Delta P$

Answer: C

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139. There are two process ABC and DEF. In which of the process is the amount of work done by the gas is greater ?

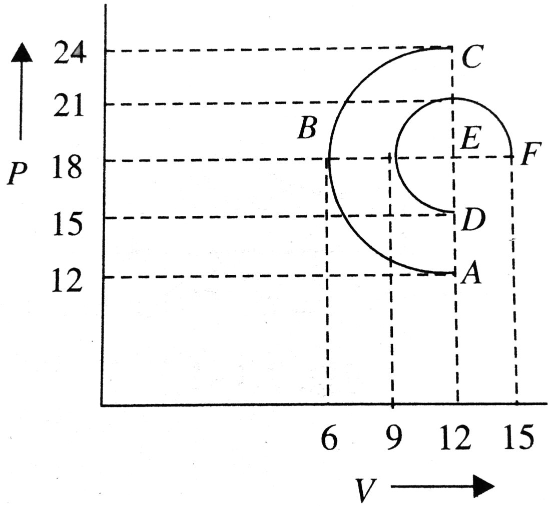

Fig. 2.149

A. ABC

B. DEF

C. Equal in both process

D. it cannot be predicted

Answer: B

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140. Find the pressure P , in the diagram as shown, of monoatomic gas of one mole in the process ABC if $\Delta U / \Delta W = 6/7$

A. $\frac{5}{2}P_0$

B. $\frac{3}{2}P_0$

C. $2P_0$

D. $\frac{7}{2}P_0$

Answer: A

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141. The pressure P, Volume V and temperature T of a gas in the jar A and the other gas in the jar B at pressure $2P$, volume $V/4$ and temperature $2T$, then the ratio of the number of molecules in the jar A and B will be

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: D

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142. At what temperature is the rms velocity of a hydrogen molecule equal to that of an oxygen molecule at $47^{\circ} C$? a) 10 K b) 20 K c) 30 K d) 40 K

A. 20K

B. 80K

C. $-73K$

D. $3K$

Answer: A

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143. A gas at pressure p_0 is contained in a vessel. If the masses of all the molecules are halved and their speeds doubled, the resulting pressure would be

A. $4P_0$

B. $2P_0$

C. P_0

D. $\frac{P_0}{2}$

Answer: B

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144. The root mean square speed of the molecules of a diatomic gas is v. When the temperature is doubled, the molecules dissociates into two atoms. The new root mean square speed of the atom is

A. $\sqrt{2}v$

B. y

C. 2v

D. 4v

Answer: C

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145. The molecules of a given mass of a gas have rms velocity of $200\frac{m}{s}at27^\circ C$ and $1.0 \times 10^5 N/m_2$ pressure. When the temperature and pressure of the gas are respectively $127^\circ C$ and $0.05 \times 10^5 Nm^{-2}$, the rms velocity of its molecules in ms^{-1} is

(a) $\frac{400}{\sqrt{3}}$ (b) $\frac{100\sqrt{2}}{3}$ (c) $\frac{100}{3}$ (d) $100\sqrt{2}$

A. $\frac{100\sqrt{2}}{3}$

B. $100\sqrt{2}$

C. $\frac{400}{\sqrt{3}}$

D. none of these

Answer: C

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146. Which of the following statement is true?

A. Absolute zero degree temperature is not zero enery temperature.

B. Two different gases at the same temperature pressure have equal root mean square velocities.

C. The rms speed of the molecules of different ideal gases, maintained at the same temperature are the same.

D. Given sample of 1cc of hydrogen and 1cc of oxygen both at N.T.P.,oxygen sample has a large number of molecules.

Answer: A

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147. At which of the following temperatures would the molecules of a gas have twice the average kinetic energy they have at $20^\circ C$?

A. $40^\circ C$

B. $80^\circ C$

C. $313^\circ C$

D. $586^\circ C$

Answer: C

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148. A vessel contains a mixture of one mole of Oxygen and two moles of Nitrogen at 300 K. The ratio of the average kinetic energy per O_2 molecule to that per N_2 molecule is :

A. $1:1$

B. $1:2$

C. $2:1$

D. Depend on the moments of inertia of the two molecules

Answer: A

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149. Three closed vessels (A),(B) and C are at the same temperature (T) and contain gases which obey Maxwell distribution law of velocities. Vessel (A) contains O_2, (B) only (N_2) and (C) mixture of equal quantities of O_2 and N_2. $Iftheavera \geq speedofthe$O_(2)$mo \leq ces \in vessel(A)is$ v_(1)$t\hat{o}f$N_(2)$mo \leq ces \in vessel(B)is$v_(2)

. $thentheavera \geq speedofthe$O_(2)` molecules in vessel (C) is.

A. $(V_1 + V_2)/2$

B. V_1

C. $(V_1 V_2)^{1/2}$

D. $\sqrt{kT/M}$

Answer: B

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150. Suppose ideal gas equation follows $VP^3 = con\tan t.$ Initial temperature and volume of the gas are T and V respectively. If gas expand to $27V$ temperature will become

A. T

B. 9T

C. 27T

D. T/9

Answer: B

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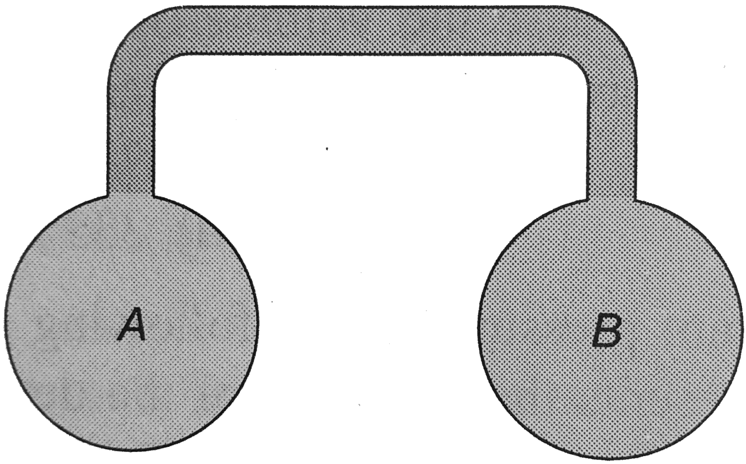
151. Two spherical vessel of equal volume are connected by a n arrow tube. The apparatus contains an ideal gas at one atmosphere and $300K$. Now if one vessel is immersed in a bath of constant temperature $600K$ and the other in a bath of constant temperature $300K$. then the common pressure will be



A. 1 atm

B. $\frac{4}{5}$ atm

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

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

Answer: C

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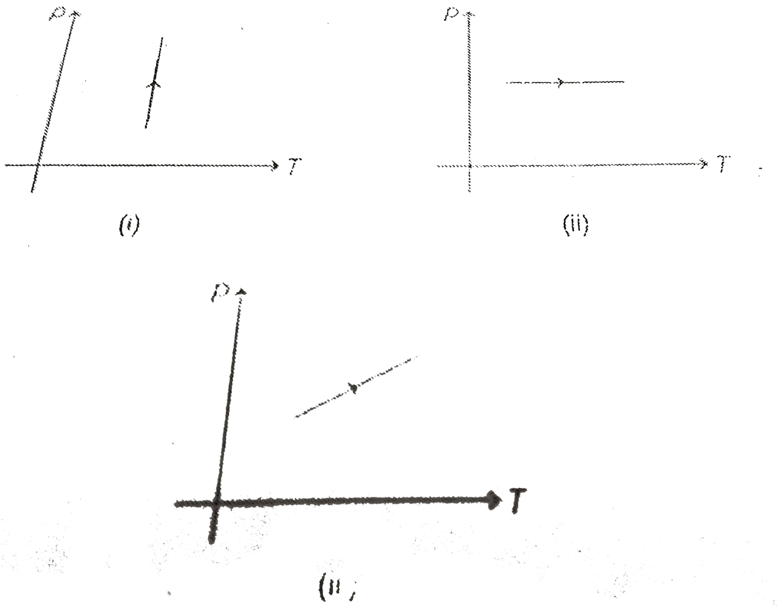
152. Pressure versus temperature graphs of an ideal gas are as shown in figure. Choose the wrong statement.



A. Density of gas is increasing in graph (i)

B. Density of gas is decreasing in graph (ii)

C. Density of gas is constant in graph (iii)

D. None of these

Answer: C

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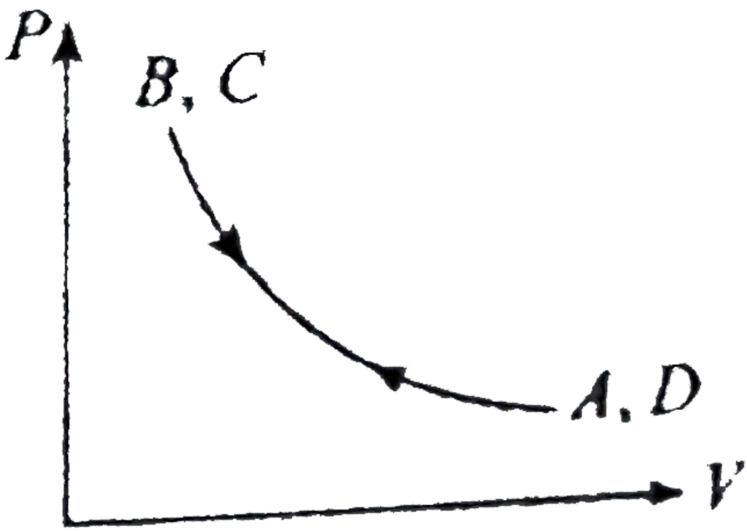
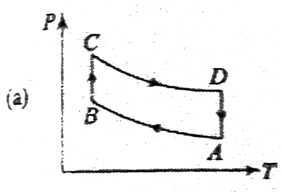
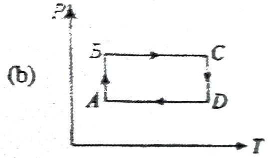
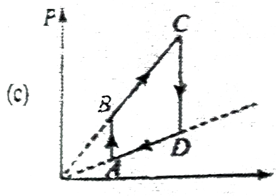
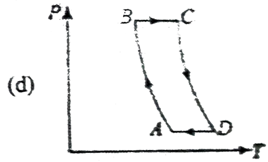
153. Pressure vs volume graph is shown in the figure . Find corresponding pressure vs temperature graph :



A. 

B. 

C. 

D. 

Answer: C

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154. A closed hollow insulated cylinder is filled with gas at $0^{\circ}C$ and also contains an insulated piston of negligible weight and negligible thickness at the middle point. The gas on one side of the piston is heated to $100^{\circ}C$. If the piston moves $5cm$ the length of the hollow cylinder is

A. 13.65 cm

B. 27.5 cm

C. 38.6 cm

D. 64.6 cm

Answer: D

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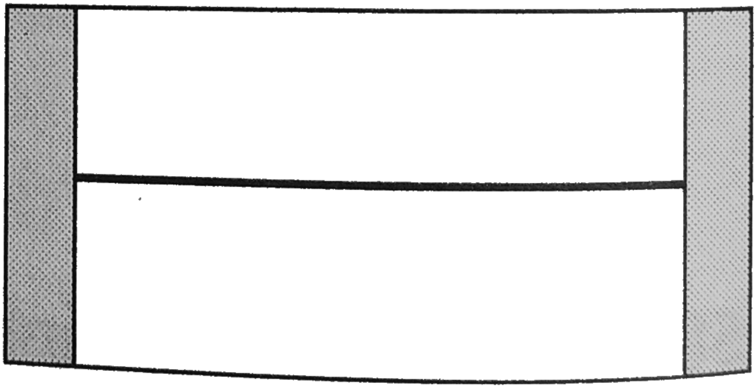
155. The air tight and smooth piston of a cylindrical vessel are connected with a string as shown. Initially pressure and temperature of the gas are P_0 and T_0. The atmospheric pressure is also P_0. At a later time, tension in the string is $\frac{3}{8}P_0A$ where A is the cross-sectional are of the cylinder. at this time, the temperature of the gas has become.



A. $\frac{3}{8}T_0$

B. $\frac{3}{4}T_0$

C. $\frac{11}{8}T_0$

D. $\frac{13}{8}T_0$

Answer: C

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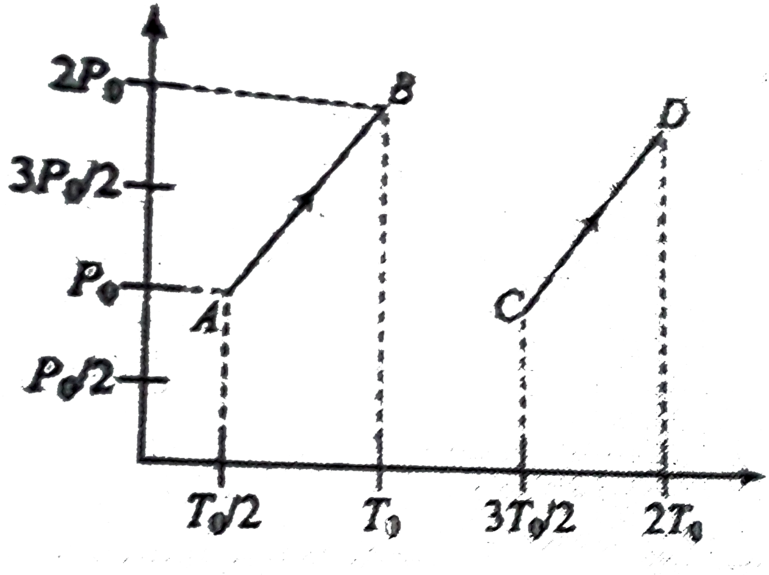
156. P-T graph for same number of moles of two ideal gases are shown .

Find the path along which volume decreases .



A. A to B

B. B to A

C. C to D

D. D to C

Answer: C

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157. A vessel of volume V = 30 litre is separated into three equal parts by stationary semi permeable membrane . The left , middle and right parts are filled with $m_H = 30$ gm of hydrogen , $m_{O_2} = 160$ gm of oxygen and $m_N = 70$ gm of nitrogen respectively . The left partition lets through only hydrogen while the right partition lets through hydrogen and nitrogen . If the temperature in all is 300K , the ratio of pressure in the three compartments will be :

A. $4:9:5$

B. $1.3:4.5:2$

C. $9:4:5$

D. $9:5:4$

Answer: B

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Multiple Corrects

1. For an ideal gas

A. The change in internal energy in a constant pressure process from trmperature T_1 to T_2 is equal to $nC_v(T_2 - T_1)$, where C_v is the molar specific heat 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 chagne in an isothermal process.

D. No heat is addes or removed in an adiabatic process.

Answer: A::B::C::D

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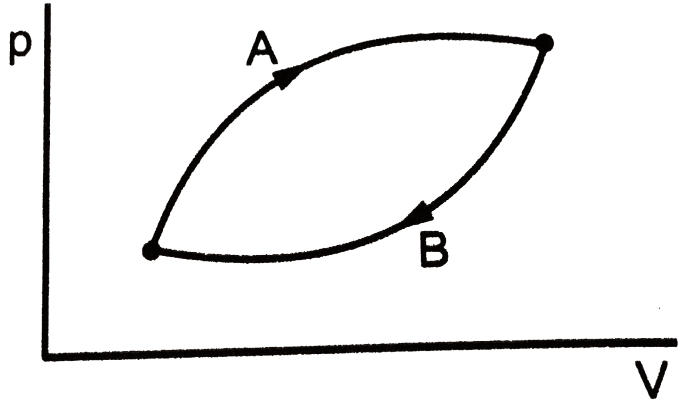
2. Refer to figure. Let ΔU_1 and ΔU_2 be the changes in internal energy in the system in process $A + B$ and ΔW be the net work done by the system in the process $A + B$,



A. $\Delta U_1 + \Delta U_2 = 0$

B. $\Delta U_1 - \Delta U_2 = 0$

C. $\Delta Q - \Delta W = 0$

D. $\Delta Q + \Delta W = 0$

Answer: A::C

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3. 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 from the following

A. The work done by the gas in the process A to B exceeds the work done 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 hyperboal.

D. In going from A to B, the temperature T of the gas first increase to a maximum value and then decreases

Answer: A::B::D

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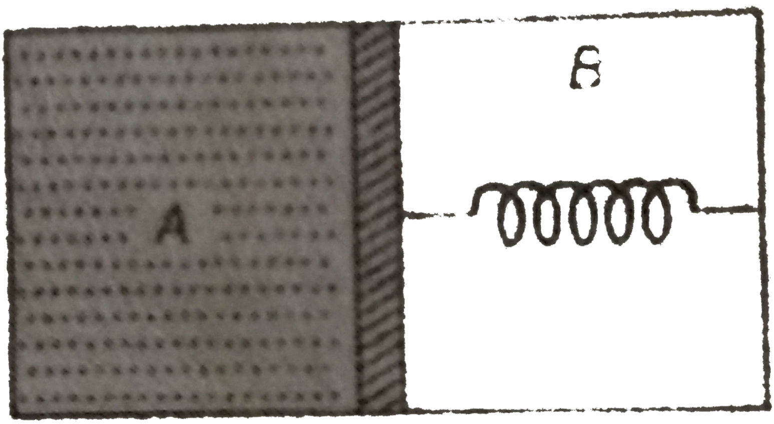
4. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area S into two equal parts A and B Part A has an ideal gas at pressure p_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant K is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber A is allowed to expand. Let in equilibrium spring is compressed by x_0. Then



A. final pressure of the gas is $\frac{Kx_0}{S}$

B. work done by the gas is $\frac{1}{2}Kx_0^2$

C. change in internal energy of the gas is $\frac{1}{2}Kx_0^2$

D. temperature of the gas is decreased

Answer: A::B::C::D

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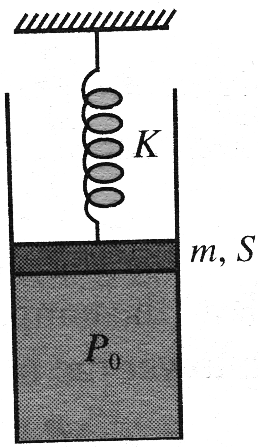
5. Choose the correct option:

In the arrangement shown in Fig. gas is thermally insulated. An ideal gas is filled in the cylinder having pressure P_0 (gt atmospheric pressure P_a). The spring of force constant K is initially un-stretched. The piston of mass m and area S is frictionless. In equilibrium, the piston rises up by distance x_0, then



A. final pressure of the gas is $P_0 + \frac{Kx_0}{S} + \frac{mg}{S}$

B. work done by the gas is $\frac{1}{2}Kx_0^2 + mgx_0$

C. decrease in internal energy of the gas is $\frac{1}{2}Kx_0^2 + mgx_0 + P_0Sx_0$

D. all of the above

Answer: A::C

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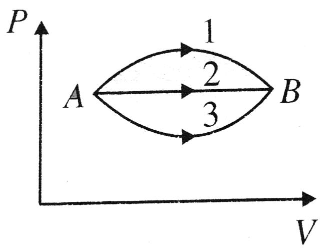
6. A gas undergoes change in its state from position A to position B via three different path as shown in Fig. Select the correct alternatives :



(A)Change in internal energy in all the three paths is equal

(B)In all the three paths heat is absorbed by the gas

(C)Heat absorbed/released by the gas is maximum in path 1

(D)Temperature of the gas first increases and then decreases in path 1

A. Change in internal energy in all the three paths is equal.

B. In all the three paths heat is absorbed by the gas .

C. Heat absorbed / released by the gas is maximum in path (1)

D. Temperature of the gas first increases and then decreases continuously in path (1)

Answer: A::B::C

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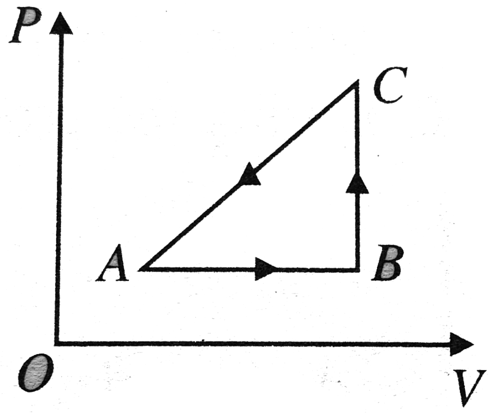
7. An ideal gas undergoes a thermodynamic cycle as shown in Fig. Which of the following statement are correct ?



A. Straight line AB cannot pass through O.

B. During process AB, temperature decreases while during process BC it increases.

C. During process BC, work is done by the gas against external pressure and temperature of the gas increases.

D. During process CA, work is done by the gas against external pressure and heat supplied to the gas is exactly equal to this work.

Answer: B::D

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8. 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 temperature

A. $C_V = \frac{3R}{2}$ for a monatomic gas

B. $C_V > \frac{3R}{2}$ for a monatomic gas

C. $C_V < \frac{3R}{2}$ for a diatomic gas

D. $C_V > \frac{3R}{2}$ for a diatomic gas

Answer: A::D

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9. The molar heat capacity for an ideal gas

A. cannot be negative

B. be equal to either C_V or C_P

C. lie in the range $C_V \leq C \leq C_P$

D. it may have any value between $-\infty$ and $+\infty$

Answer: A::B::C

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10. A closed vessel contains a mixture of two diatomic gases A and B. Molar mass of A is 16 times that of B and mass of gas A contained in the vessel is 2 times that of B. Which of the following statements are correct ?

A. Average kinetic energy per molecule of A is equal to that of B

B. Root mean square value of translational velocity of B is four time that of A

C. Pressure exerted by B is eight time of the exerted by A.

D. Number of moleucles of B, in the cylinder, is eight times that of A

Answer: A::B::C::D

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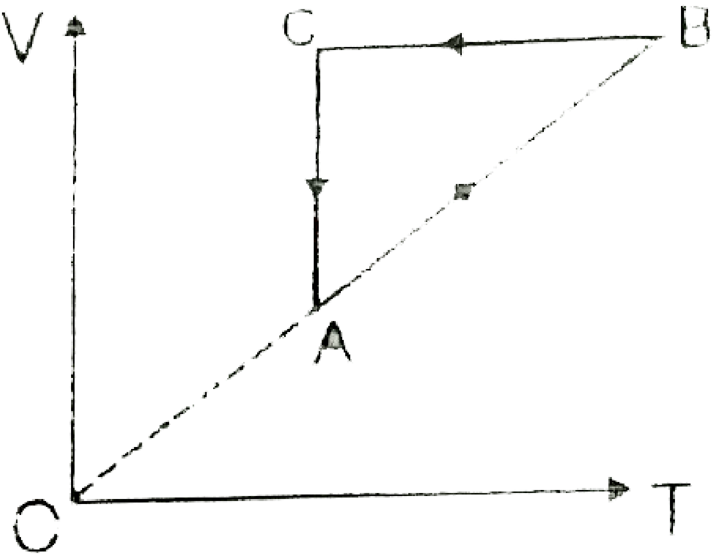
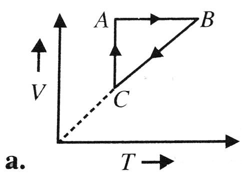
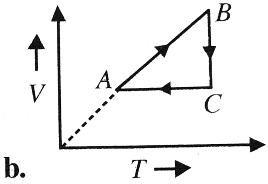
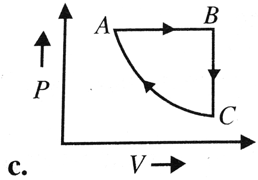
11. An ideal gas undergoes a thermodynamic cycle as shown in figure:

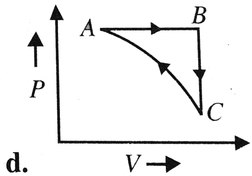


Which of the following graphs represents the same cycle?

A. 

B. 

C. 

D. 

Answer: A::C

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12. Which the following statements are correct ?

A. Two bodies at different temperature T_1 and T_2 are brought in thermal contact. When thermal equilibrium is attained, the temperature of each body is $(T_1 + T_2)/2$.

B. The coolant used in a car or a chemical or nuclear plant should have high specific heat.

C. Vapour in equlibrium with its liquid at a constant temperature does not obey Boyle's law.

D. Two vessels A and B of equal capacity are connected to each other by a stop cock. Vessel A contains a gas at $0^\circ C$ and 1 atm pressure. Vessel B is completely evacuated. When the stop cock is opened, the final pressure of gas in each vessel will be 0.5 atm.

Answer: B::C::D

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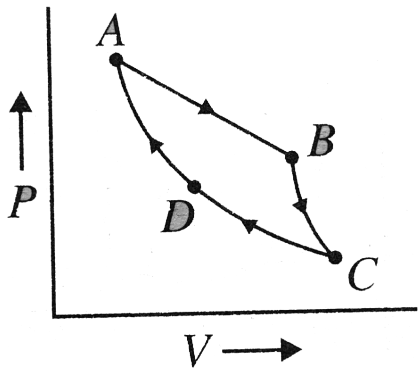
13. Figure. Shows the $P - V$ diagram for a Carnot cycle. In this diagram



A. curve AB represents isothemal process and BC adiabatic process

B. curve AB represents adiabatic process and BC isothermal process

C. curve CD represents isothermal process and DA adaibatic process

D. curve CD represent adiabatic process and DA isothermal process

Answer: A::C

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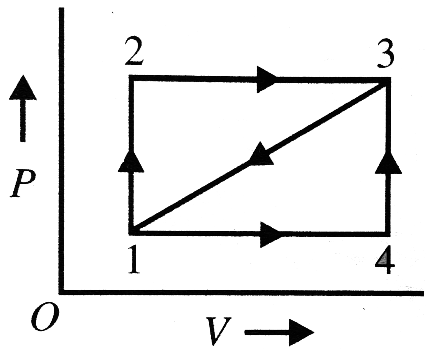
14. Figure shows an indicator diagram. During path 1-2-3, 100 cal is given to the system and 40 cal worth work is done. During pat 1-4-3, the work done is 10 cal . Then



A. heat given to the system during path 1-4-3 is 70 cal

B. if the systems is brought from 3 to 1 along straight line path 3-1, work done is worth 25 cal

C. along straight line path 3-1, the heat ejected by the system is $85J$

D. the internal energy of the system in state 3 is 140 cal above that in state 1

Answer: A::B::C

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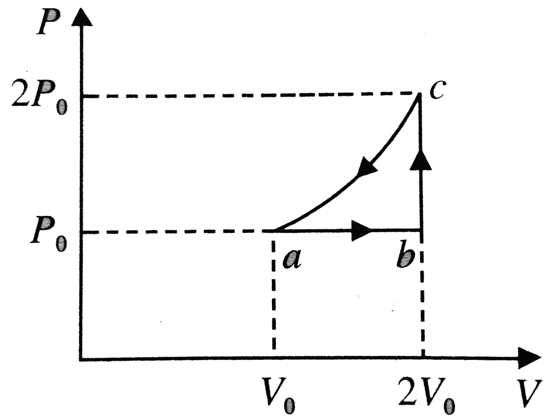
15. One mole of an ideal monatomic gas has initial temperature T_0, is made to go through the cycle abca shown in Fig. If U denotes the internal energy, then choose the correct alternative



A. $U_C > U_b > U_a$

B. $U_C - U_b = 3RT_0$

C. $U_c - U_a = \frac{9RT_0}{2}$

D. $U_b - U_a = \frac{3RT_0}{2}$

Answer: A::B::C::D

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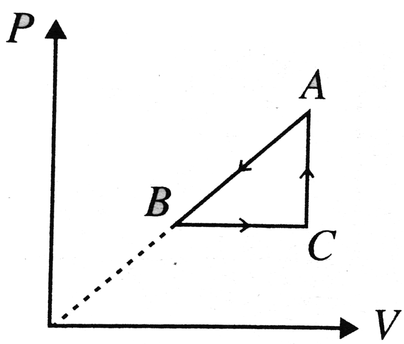
16. $P-V$ diagram of a cyclic process $ABCA$ is as shown in Fig. Choose the correct alternative



(A)$\Delta Q_{A \to B} =$ negative (B)$\Delta U_{B \to C} =$ positive (C)$\Delta U_{C \to A} =$ negative (D)$\Delta W_{CAB} =$ negative

A. $\Delta Q_A \to ._B$ is negative

B. $\Delta U_b \to ._c$ is negative

C. $\Delta U_c \to ._A$ is negative

D. ΔW_{CAB} is negative

Answer: A::B::D

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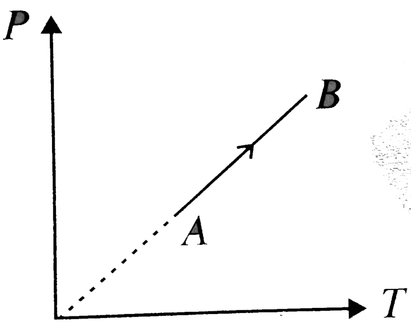
17. During the process AB of an ideal gas



A. work done on the gas is zero

B. density of the gas is constant

C. slope of line AB from the T-axis is inversely proportional to the number of moles of the gas

D. slope of line AB from the T-axis is directly proportional to the number of moles of the gas

Answer: A::B::D

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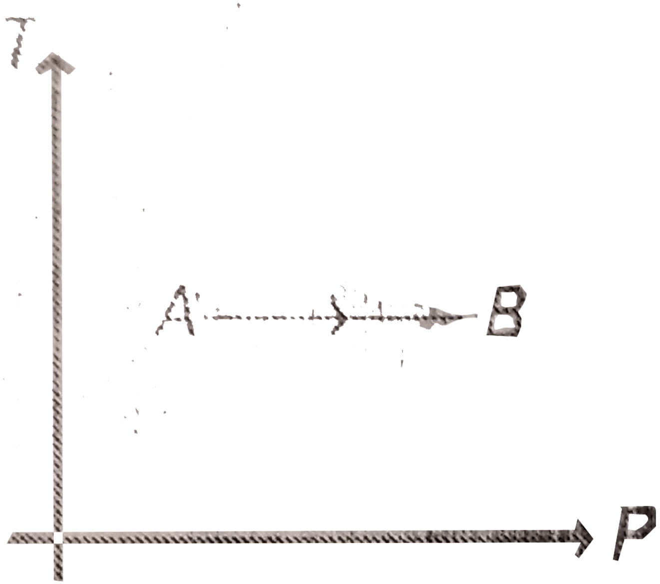
18. Temperature versus pressure graph of an ideal gas is shown in figure. During the process AB



A. internal energy of the gas remains constant

B. volume of the gas is increased

C. work done by the atmosphere on the gas is positive

D. pressure is inversely proportional to volume

Answer: A::C::D

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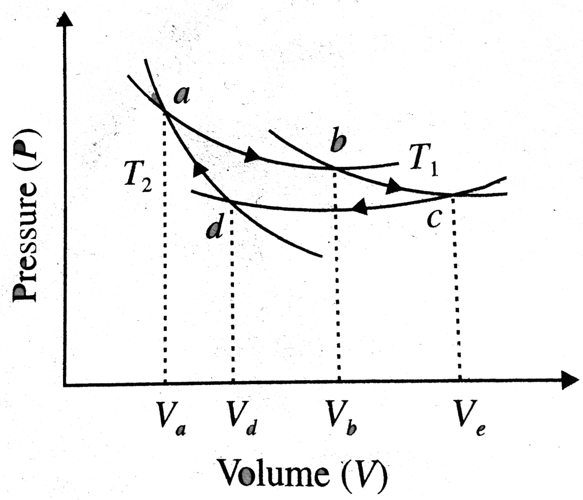
19. An ideal gas undergoes the cyclic process shown in a graph below :



A. $T_1 = T_2$

B. $T_1 > T_2$

C. $V_a V_c = V_b V_d$

D. $V_a V_b = V_c V_d$

Answer: B::C

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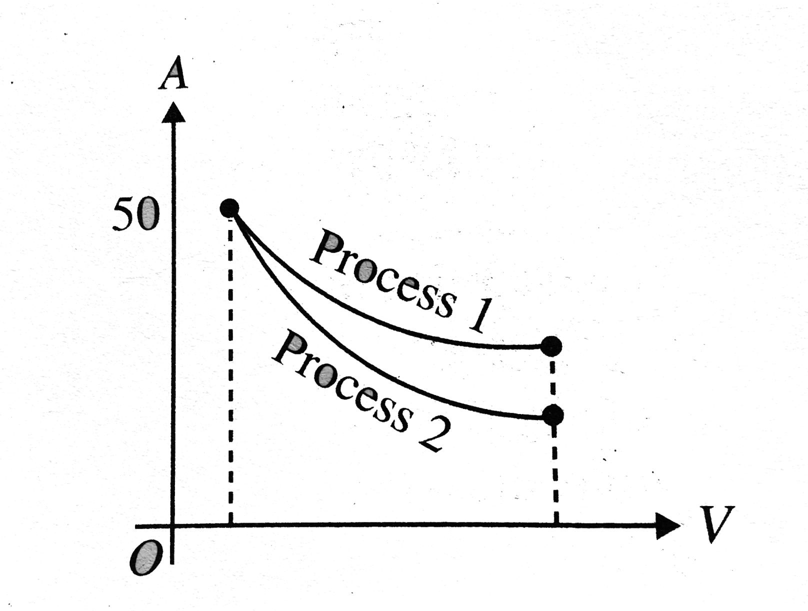
20. The indicator diagram for two processes 1(isothermal) and 2(adiabatic) carrying on an ideal gas is shown in Fig. If m_1 and m_2 be the slopes (dP/dV) for process 1 and process 2, respectively, then



A. $m_1 = m_2$

B. $m_1 > m_2$

C. $m_1 < m_2$

D. $m_2 C_V = m_1 C_P$

Answer: C::D

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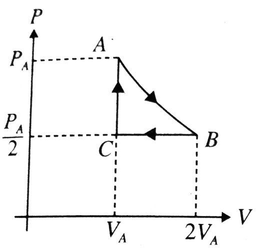
21. Three moles of an ideal gas $\left(C_p = \frac{7}{2}R\right)$ at pressure, P_A and temperature T_A is isothermally expanded to twice its initial volume. It is then compressed at constant pressure to its original volume. Finally gas is compressed at constant volume to its original pressure P_A.

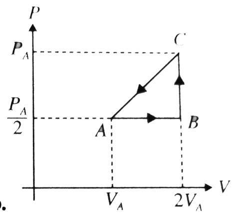
(a) Sketch P-V and P-T diagrams for the complete process.

(b) Calculate the net work done by the gas, and net heat supplied to the gas during the complete process.

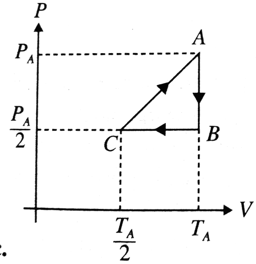
A. a.

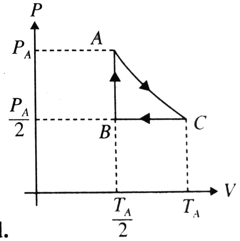


B. b.



C. c.



D. d. 

Answer: A::C

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22. An ideal gas is taken from the state A (pressure p, volume V) to the state B (pressure $\frac{p}{2}$, 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 process AB is greater than the work that would be done if the system were taken from A to B along the isotherm

B. In the $P-T$ diagram, the path AB becomes a part of parabola

C. In the $P-T$ diagram, the path AB becomes a part of hyperbola

D. In going from A to B, the temperature T of the gas first increase to a maximum value and then decreases

Answer: A::B::D

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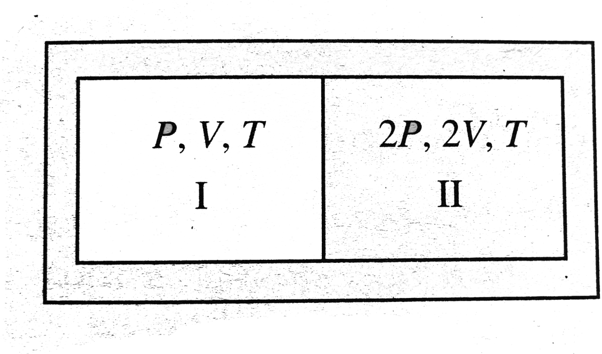
23. A partition divides a container having insulated walls into two compartments whose initial paraments are given. The partition is a conducting wall which can move freely without friction. Which of the following statements is/are correct, with reference to the final equilibrium position ?



A. The pressure in the two compartments are equal.

B. Volume of compartment I is $3V/5$

C. Volume of compartment II is $12V/5$

D. Final pressure in compartment I is $5P/3$

Answer: A::B::C::D

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24. During an experiment, an ideal gas is found to obey a condition $\frac{p^2}{\rho} = \text{constant}$. ($\rho$ = density of the gas). The gas is initially at temperature (T), pressure (p) and density ρ. The gas expands such that density changes to $\rho/2$.

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

B. The temperature of the gas change to $\sqrt{2}T$.

The graph of the above process on the $P-T$ diagram is parabola.

C. The graph of the above process on the $P - T$ diagram is hyperbola.

D.

Answer: B::D

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25. Pick the correct statement (s) :

A. The rms translational speed for all ideal gas molecules at the same temperature is not the same but it depends on the mass

B. Each particle in a gas has average transloational kinetic energy and the equation $1/2mv_{\max}^2 = 3/2kT$ establisehes the relationship between the average translational kinetic energy per particle and temperature of an ideal gas.

C. If the temperature of an ideal gas is doubled form $100^{\circ} C$ to $200^{\circ} C$, the average kinetic energy of each particle is also doubled.

D. It is possible for both pressure and volume of a monatomic ideal gas to change simultaneously without casuing the internal enregy of the gas to change

Answer: A::D

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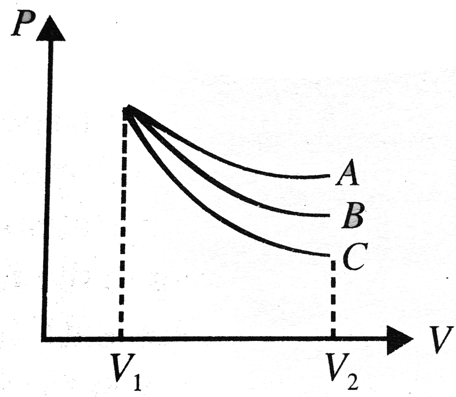
26. An ideal gas undergoes an expansion from a state with temperature T_1 and volume V_1 through three different polytropic processes A, B and C as shown in the $P-V$ diagram. If $|\Delta E_A|, |\Delta E_B|$ and $|\Delta E_C|$ be the magnitude of changes in internal energy along the three paths respectively, then :



A. $|\Delta E_A| < |\Delta E_B| < |\Delta E_C|$ if temperature in every process decreases

B. $|\Delta E_A| > |\Delta E_B| > |\Delta E_C|$ if temperature in every process decreases

C. $|\Delta E_A| > |\Delta E_B| > |\Delta E_C|$ if temperature in every process increases

D. $|\Delta E_B| < |\Delta E_A| < |\Delta E_C|$ if temperature in every process increases

Answer: A::C

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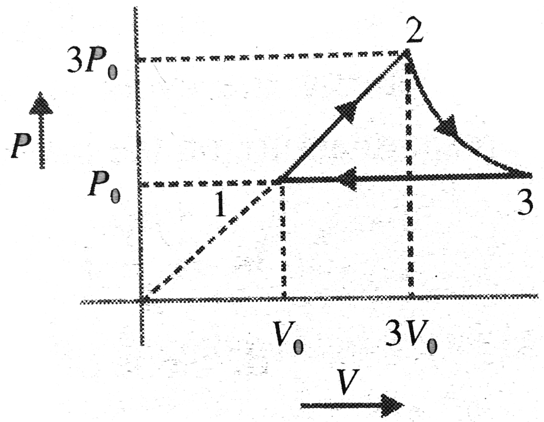
27. A system undergoes three quasi-static process sequentially as indicated in Fig. 1-2 is an isobaric process, 2-3 is a polytropic process with $\gamma = 4/3$ and 3-1 is a process in which PV = constant. $P_2 = P_1 = 4 \times 10^5 N/m^2$, $P_3 = 1 \times 10^5 N/m^2$ and $V_1 = 1m^3$.

The heat transfer for the cycle is ΔQ, the change in internal energy is ΔU and the work done is ΔW. Then



A. $\Delta W = 0$

B. $\Delta Q = 1.08 \times 10^5 J$

C. $\Delta U = 0$

D. $\Delta Q > \Delta W$

Answer: A::B::C

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28. An insulated $0.2m^3$ tank contains helium at $1200kPa$ and $47^\circ C$. A valve is now opened, allowing some helium to escaped. The valve is closed when one-half of the initial mass has escaped. The temperature of the gas is $\left(\sqrt[3]{4} = 16\right)$

A. $100K$

B. $200K$

C. $73^\circ C$

D. $-73^\circ C$

Answer: B::D

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29. A gas in container A is in thermal equilibrium with another gas in container B. Both contain equal masses of the two gases. Which of the following can be true ?

A. $P_A V_A = P_B V_B$

B. $P_A = P_B, V_A \neq V_B$

C. $P_A \neq P_B, V_A = V_B$

D. $\frac{P_A}{V_A} = \frac{P_B}{V_B}$

Answer: B::C

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Assertion-Reasoning

1. Statement I: A quasi -static process is so called bacause it is a sudden and large change of the system.

Statement II: An adiabatic process is not quasi- static because it is a sudden and large change of the system.

A. Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: B

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2. Statement I: The work done on an ideal gas in changing its volume from V_1 to V_2 under a polytropic porcess is given by the integral $\int_{v_1}^{v_2} P.\,Dv$ taken along the process

Statement II: No work is done under an isochroci process of the gas.

A. (a)Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. (b)Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. (c)Statement I is true, Statement II is false.

D. (d)Statement I is false, Statement II is fase.

Answer: C::D

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3. Statement I: When an ideal gas is taken from a given thermodynamics state A to another given thermodynamic state B by any polytropic process, the change in the internal energy of the system will be the same in all processes.

Statement II: Internal energy of the ideal gas depends only upon its absolute temperature.

A. Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: C

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4. Statement I: The specific heat of a gas in an adiabatic process is zwero but it is infinite in an isothermal process.

Statement II: Specific heat of a gas is directly proportional to heat exchanged with the system and inversely proportional to change in termperature.

A. Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: C

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5. StatementI: Work done by a gas in isothermal expansion is more than the work done by the gas in the same expansion adaibatically.

Statement II: Temperature remains constant in isothermal ecpansion but not in adiabatic expansion.

A. Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: A

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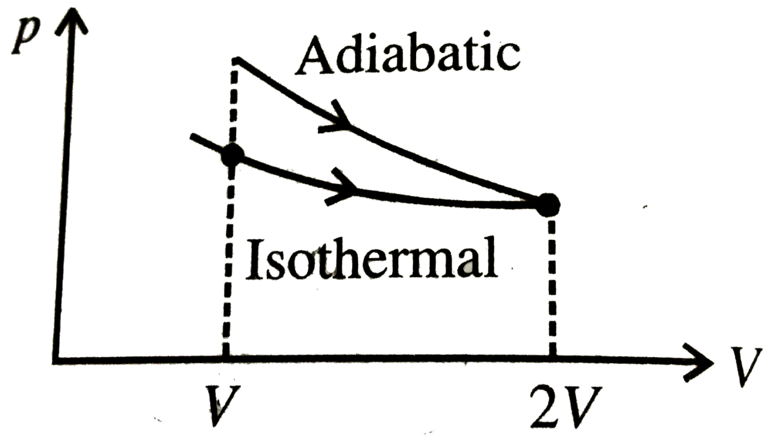
6. Statement I: A gas is expanded from a volume V to $2V$, first through adiabatic process then through isothermal process. Work done in isothermal process is more if final state $(i.e.$ pressure and volume $)$ in both the cases is same.

Statement II: Work done by the gas is equal to area under $p - V$ curve.



A. Statement I: is true, Statement II is true and Statement II is the correct explanation for Statement I.

B. Statement I: is true, Statement II is true and Statement II is NOT the correct explanation for Statement I.

C. Statement I is true, Statement II is false.

D. Statement I is false, Statement II is true.

Answer: A

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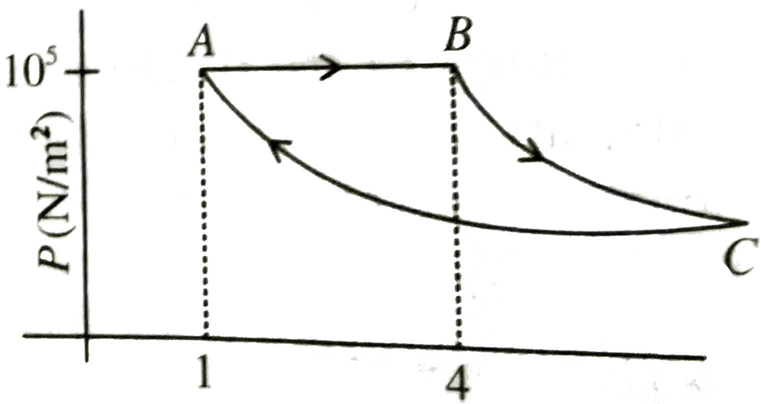
Comprehension

1. 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 pressure at C



.

A. $\frac{10^5}{64} N/m^2$

B. $\frac{10^5}{32} N/m^2$

C. $\frac{10^5}{12} N/m^2$

D. $\frac{10^5}{6} N/m^2$

Answer: A

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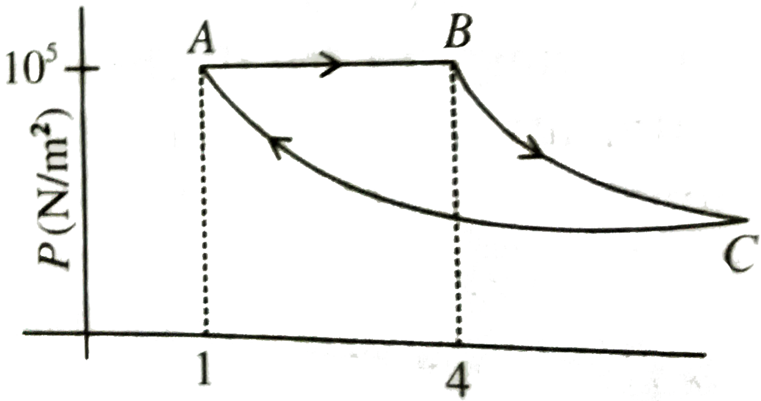
2. A fixed mass of gas is taken through a process $A \to B \to C \to A$. Here $A \to B$ is isobaric, $B \to C$ is adiabatic and $C \to A$is isothermal. Find volume at C.



A. $32m^3$

B. $100m^3$

C. $64m^3$

D. $25m^3$

Answer: C

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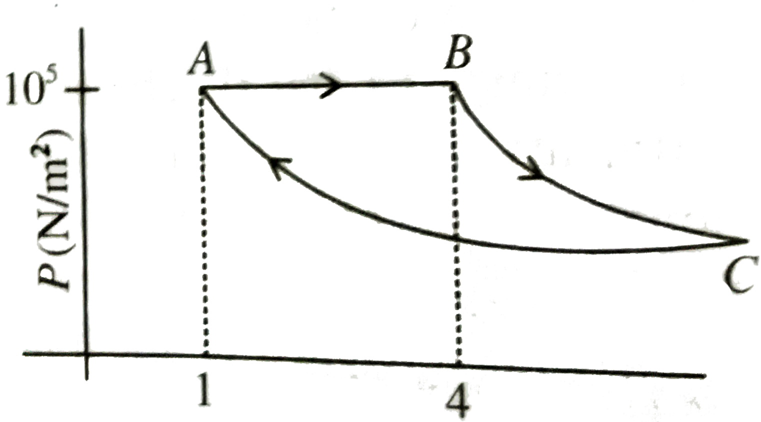
3. A fixed mass of gas is taken through a process $A \to B \to C \to A$. Here $A \to B$ is isobaric, $B \to C$ is adiabatic and $C \to A$is isothermal. Find work done is the process (take $\gamma = 1.5$).



A. $4.9 \times 10^5 J$

B. $3.2 \times 10^5 J$

C. $1.2 \times 10^5 J$

D. $7.2 \times 10^5 J$

Answer: A

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4. Four moles of an ideal gas is initially in a state A having pressure $2 \times 10^5 N/m^2$ and temperature 200 K . Keeping pressure constant the gas is taken to state B at temperature of 400K. The gas is then taken to a state C in such a way that its temperature increases and volume decreases. Also from B to C, the magnitude of $\frac{dT}{dV}$ increases. The volume of gas at state C is eaual to its volume at state A. Now gas is taken is initial state A keeping volume constant. A total of 1000 J heat is rejected from the sample in the cyclic process. Take $R = 8.3J/K/mol$.

Which graph between temperture T and volume V for the cyclic process is correct.

A. \` (##BMS_V06_C02_E01_249_O01.png" width="30%">

B. \` (##BMS_V06_C02_E01_249_O02.png" width="30%">

C. \` (##BMS_V06_C02_E01_249_O03.png" width="30%">

D. ` (##BMS_V06_C02_E01_249_O04.png" width="30%">

Answer: C

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5. Four moles of an ideal gas is initially in a state A having pressure $2 \times 10^5 N/m^2$ and temperature 200 K . Keeping pressure constant the gas is taken to state B at temperature of 400K. The gas is then taken to a state C in such a way that its temperature increases and volume decreases. Also from B to C, the magnitude of $\frac{dT}{dV}$ increases. The volume of gas at state C is eaual to its volume at state A. Now gas is taken is initial state A keeping volume constant. A total of 1000 J heat is rejected from the sample in the cyclic process. Take $R = 8.3 J/K/mol$.

The work done by the gas along path B to C is

A. $1000J$

B. $-1000J$

C. $-7640J$

D. $5640J$

Answer: C

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6. Four moles of an ideal gas is initially in state A having pressure $2 \times 10^5 N/m^2$ and temperature $200K$. Keeping the pressure constant the gas is taken to state B at temperature of $400K$. The gas is then taken to a state C in such a way that its temperature increases and volume decreases. Also from B to C , the magnitude of dT/dV increases. The volume of gas at state C is equal to its volume at state A. Now gas is taken to initial state A keeping volume constant. A total $1000J$ of heat is withdrawn from the sample of the cyclic process . Take $R = 8.3J/K/mol$. The volume of gas at state C is

A. $0.0332m^3$

B. $0.22m^3$

C. $0.332m^3$

D. $3.32m^3$

Answer: A

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7. A process in which work perfomed by an ideal gas is proportional to the corresponding increment of its internal energy is described as a polytropic process. If we represent work done by a ppolytropic process by W and increase in internal energy as ΔU then

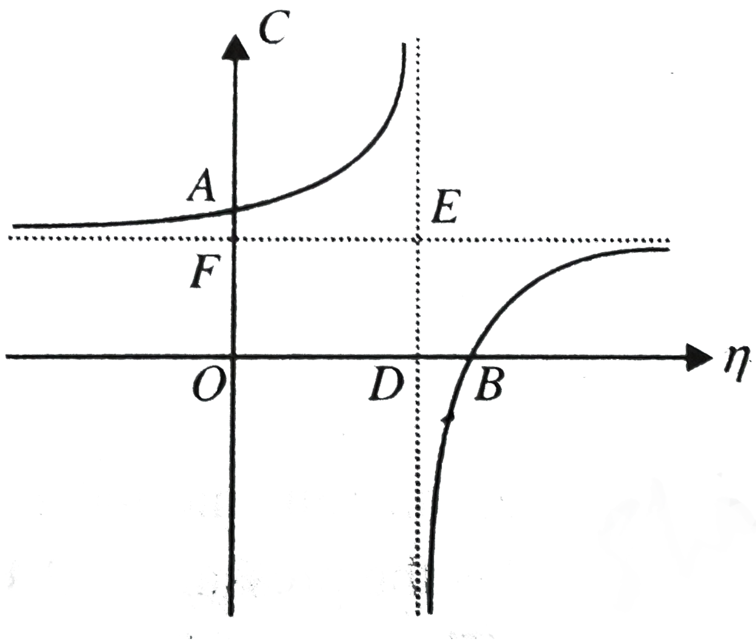
$W \propto \Delta U$

or $W = K_1 \Delta U$ ...(i)

For this process, it can be demonstrated that the relation between pressure and volume is given by the equation

$PV^{\eta} = K_2$ (constant) .....(ii)

We know that a gas can have various values for molar specific heats. The molar specific heat $'C'$ for an ideal gas in polytropic process can be calculated with the help of first law of thermodynamics. In polytropic process process the variation of molar specific heat $'C'$ with η for a monatomic gas is plotted as in the graph shown.



In the graph shown, the $y-$ coordinate of point A is (for monatomic gas)

A. $3R/2$

B. $5R/2$

C. $7R/2$

D. $4R$

Answer: B

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8. A process in which work perfomed by an ideal gas is proportional to the corresponding increment of its internal energy is described as a polytropic process. If we represent work done by a ppolytropic process by W and increase in internal energy as ΔU then

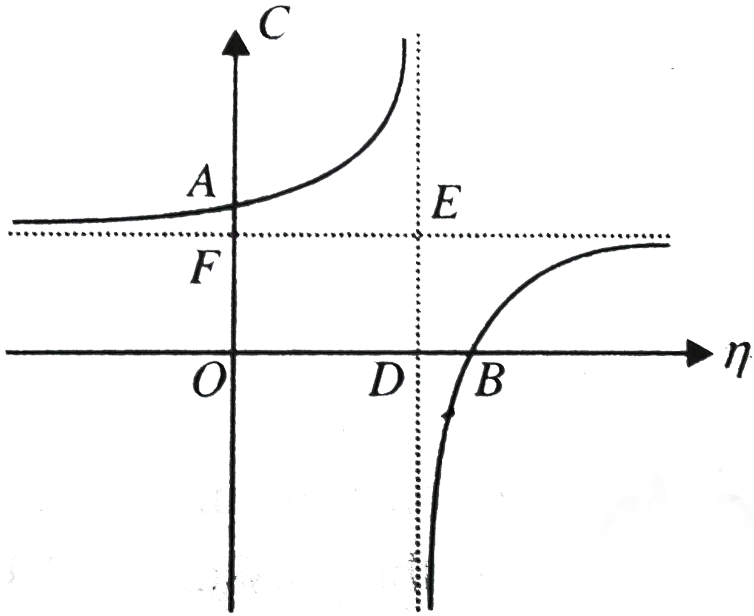
$W \propto \Delta U$

or $W = K_1 \Delta U$ ...(i)

For this process, it can be demonstrated that the relation between pressure and volume is given by the equation

$PV^{\eta} = K_2$ (constant) .....(ii)

We know that a gas can have various values for molar specific heats. The molar specific heat $'C'$ for an ideal gas in polytropic process can be calculated with the help of first law of thermodynamics. In polytropic process process the variation of molar specific heat $'C'$ with η for a monatomic gas is plotted as in the graph shown.



In the graph shown, the $y-$ coordinate of point A is (for monatomic gas)

A. $7/5$

B. $5/2$

C. $2/3$

D. $8/3$

Answer: B

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9. A process in which work perfomed by an ideal gas is proportional to the corresponding increment of its internal energy is described as a polytropic process. If we represent work done by a ppolytropic process by W and increase in internal energy as ΔU then

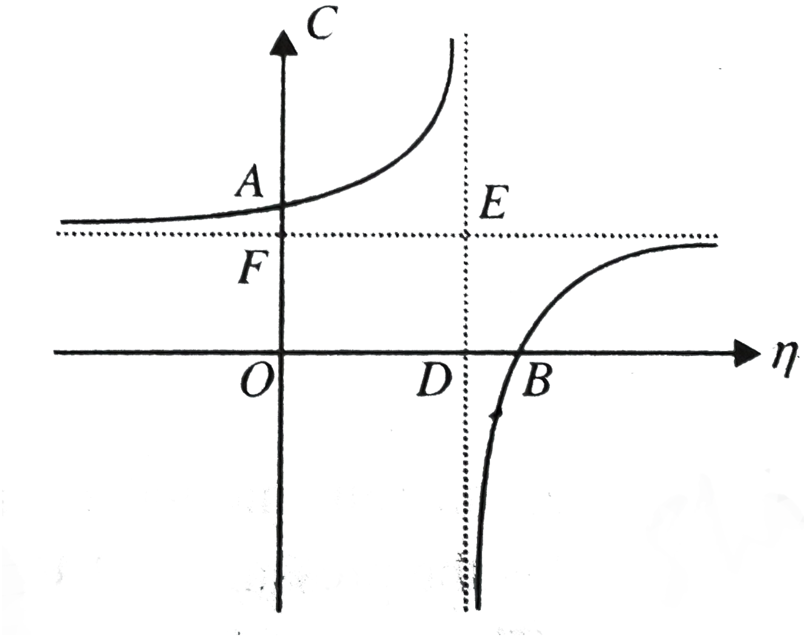
$W \propto \Delta U$

or $W = K_1 \Delta U$ ...(i)

For this process, it can be demonstrated that the relation between pressure and volume is given by the equation

$PV^{\eta} = K_2$ (constant) .....(ii)

We know that a gas can have various values for molar specific heats. The molar specific heat $'C'$ for an ideal gas in polytropic process can be calculated with the help of first law of thermodynamics. In polytropic process process the variation of molar specific heat $'C'$ with η for a monatomic gas is plotted as in the graph shown.



For a monoatomic gas, the values of polytropic constant η for which value specific heat is negative.

A. $1 < \eta < \frac{2}{3}$

B. $1 < \eta < \frac{8}{3}$

C. $1 < \eta < \frac{5}{3}$

D. $\frac{2}{3} < \eta < \frac{8}{3}$

Answer: C

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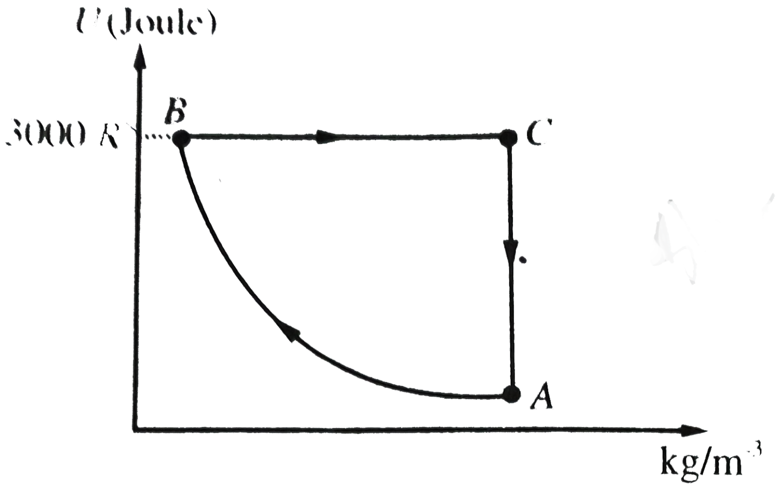
10. Figure, shows the variation of potential energy (U) of 2 mol of Argon gas with its density in a cyclic process $ABCA$. The gas was initiallly in the state A whose pressure and temperature are $P_A = 2atm, T_A = 300K$, respectively. It is also stated the path AB is a rectangular hyperbola and the internal energy of the gas at state C is $3000r$. Based on the above information answer the following question :



A. The process AB is isobaric, BC is adiabatic and CA is isochoric.

B. The pocess is AB is adiabatic, BC is isothermal and CA is isochoric.

C. The process AB is isochoric, BC is isothermal and CA is isobaric

D. The process AB is isochoric, BC is isothermal and CA is isochoric

Answer: D

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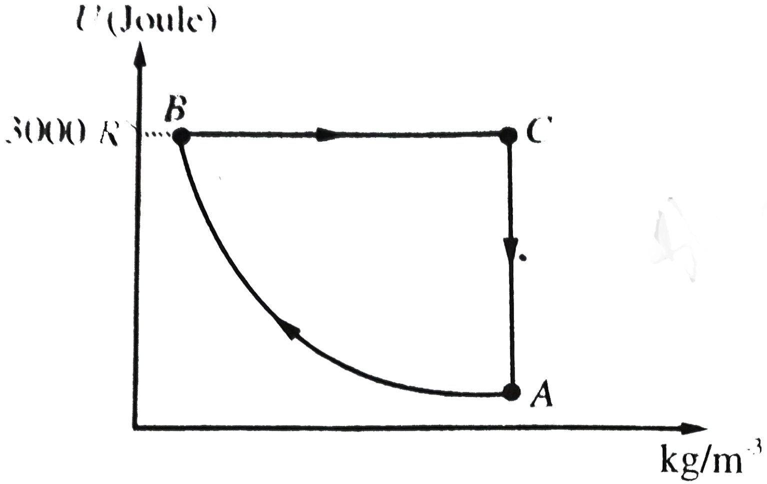
11. Figure, shows the variation of potential energy (U) of 2 mol of Argon gas with its density in a cyclic process $ABCA$. The gas was initiallly in the state A whose pressure and temperature are $P_A = 2atm, T_A = 300K$, respectively. It is also stated the path AB is a rectangular hyperbola and the internal energy of the gas at state C is $3000r$. Based on the above information answer the following question :



The heat supplied to the gas in the process AB is

A. (a)$700R$

B. (b)$3500R$

C. (c)$4400R$

D. (d)$1600R$

Answer: B

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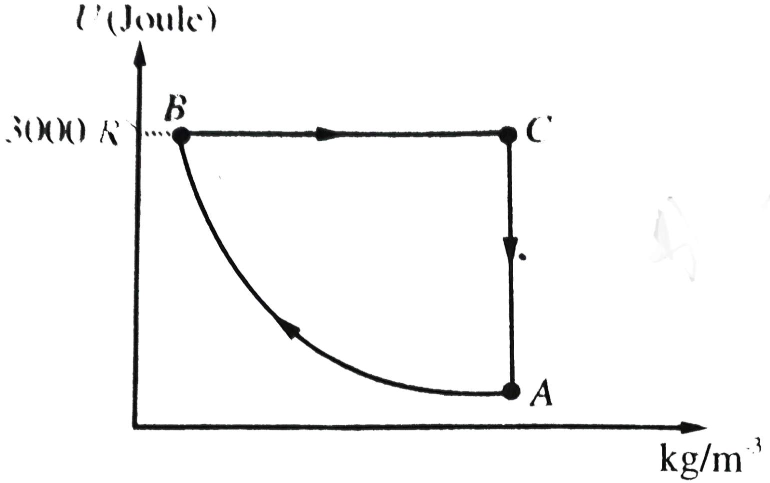
12. Figure, shows the variation of potential energy (U) of 2 mol of Argon gas with its density in a cyclic process $ABCA$. The gas was initiallly in the state A whose pressure and temperature are $P_A = 2atm, T_A = 300K$, respectively. It is also stated the path AB is a rectangular hyperbola and the internal energy of the gas at state C is $3000r$. Based on the above information answer the following question :



Heat supplied in the process CA is

A. $-1400R$

B. $1400R$

C. $2100R$

D. $-2100R$

Answer: D

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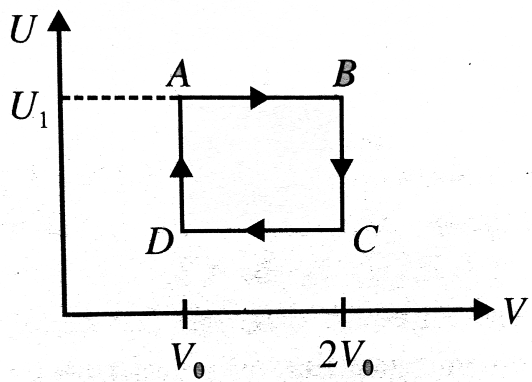
13. One mole of an ideal gas has an internal energy given by $U = U_0 + 2PV$, where P is the pressure and V the volume of the gas. U_0 is a constant. This gas undergoes the quasi $-$ static cyclic process $ABCD$ as shown in the $U - V$ diagram. The molar heat capacity of the gas at constant pressure is



A. $2R$

B. $3R$

C. $\frac{5}{2}R$

D. $4R$

Answer: B

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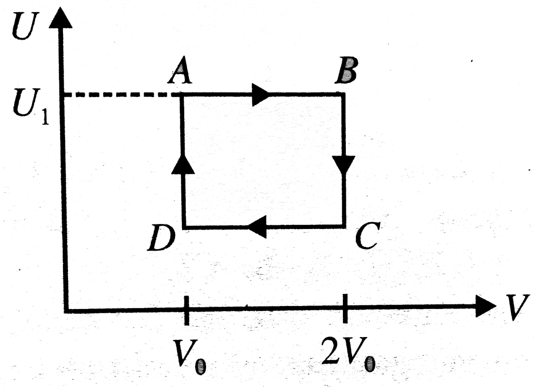
14. One mole of an ideal gas has an interal energy given by $U = U_0 + 2PV$, where P is the pressure and V the volume of the gas. U_0 is a constant. This gas undergoes the quasi $-$ static cyclic process $ABCD$ as shown in the $U - V$ diagram. The work done by the ideal gas in the process AB is



A. zero

B. $\frac{U_1 - U_0}{2}$

C. $\frac{U_0 - U_1}{2}$

D. $\frac{U_1 - U_0}{2}\log_e 2$

Answer: D

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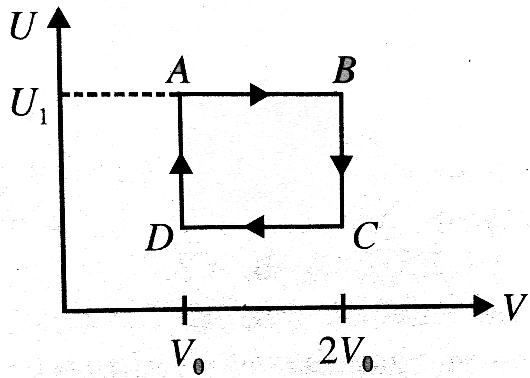
15. One mole of an ideal gas has an interal energy given by $U = U_0 + 2PV$, where P is the pressure and V the volume of the gas. U_0 is a constant. This gas undergoes the quasi $-$ static cyclic process $ABCD$ as shown in the $U - V$ diagram. The gas must be



A. monatomic

B. diatomic

C. a mixture of mono and diatomic gases

D. a mixture of di $-$ and tri $-$ atomic gases

Answer: C

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16. An ideal diatomic gas is expanded so that the amount of heat transferred to the gas is equal to the decrease in its internal energy. The molar specific heat of the gas in this process is given by C whose value is

A. $-\frac{5R}{2}$

B. $-\frac{3R}{2}$

C. $2R$

D. $\frac{5R}{2}$

Answer: A

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17. An ideal diatomic gas is expanded so that the amount of heat transferred to the gas is equal to the decrease in its internal energy.

The process can be represented by the equation $TV^n =$ constant, where the value of n is

A. $n = \frac{7}{5}$

B. $n = \frac{1}{5}$

C. $n = \frac{3}{2}$

D. $n = \frac{3}{5}$

Answer: B

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18. An ideal diatomic gas is expanded so that the amount of heat transferred to the gas is equal to the decrease in its internal energy. If in the process, the initial temperature of the gas be T_0 and the final volume by 32 times the initial volume, the work done (in Joules) by the gas during the process will be

A. RT_0

B. $\frac{5RT_0}{2}$

C. $2RT_0$

D. $\frac{RT_0}{2}$

Answer: B

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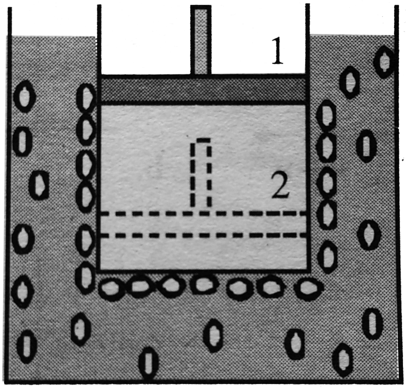
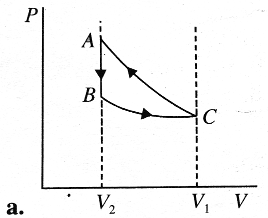
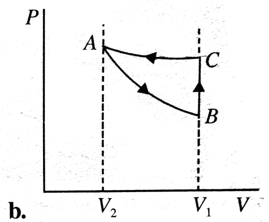
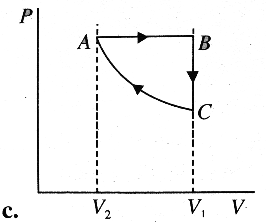
19. A cylinder containing an ideal gas (see figure) and closed by a movable pistong is submerged in an ice- water mixture. The pistone is quickly pushed down from position (1) to position (2)(process AB). The piston is held at position (2) until the gas is again at $0^\circ C$ (processs BC). Then the pistone is slowly raised back to position (1) (process CA)

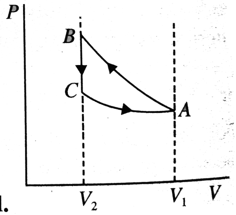


Which of the following $P-V$ diagram will correctly represent the processes AB, BC and CA and the cycle $ABCA$?

A. 

B. 

C. 

D. d. 

Answer: D

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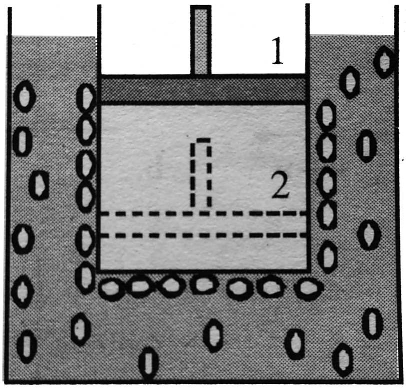
20. A cylinder containing an ideal gas (see figure) and closed by a movable pistong is submerged in an ice- water mixture. The pistone is quickly pushed down from position (1) to position (2)(process AB). The piston is held at position (2) until the gas is again at $0^\circ C$ (processs BC). Then the pistone is slowly raised back to position (1) (process CA)



Which of the following $P-V$ diagram will correctly represent the processes AB, BC and CA and the cycle $ABCA$?

A. (a)$8kcal$

B. (b)$5kcal$

C. (c)$2.1kJ$

D. (d)$4.2kJ$

Answer: A

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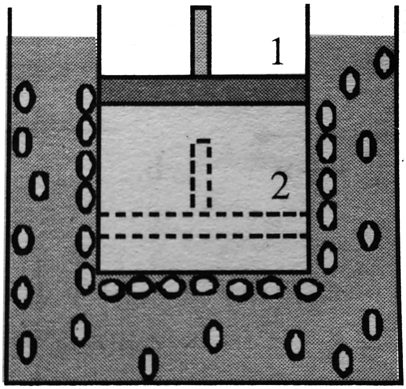
21. A cylinder containing an ideal gas (see figure) and closed by a movable pistong is submerged in an ice- water mixture. The pistone is quickly pushed down from position (1) to position (2)(process AB). The piston is held at position (2) until the gas is again at $0^\circ C$ (processs BC). Then the pistone is slowly raised back to position (1) (process CA)



Which of the following $P - V$ diagram will correctly represent the processes AB, BC and CA and the cycle $ABCA$?

A. $\frac{PV}{2} J$

B. $\frac{2PV}{3} J$

C. $PV J$

D. none of these

Answer: D

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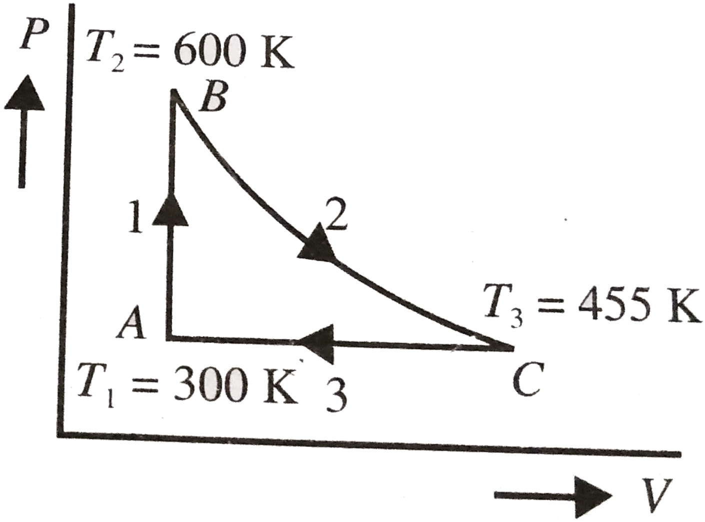
22. A reversible heat engine carries $1mol$ of an ideal monatomic gas around the cycle $ABCA$, as shown in the diagram. The process BC is adiabatic. Call the processes AB, BC and CA as $1, 2$ and 3 and the heat $(\Delta Q)_r$, change in internal energy (ΔU), and work done $(\Delta W)_r, r = 1, 2, 3$ respectively. The temperature at A, B, C are $T_1 = 300K, T_2 = 600K$ and $T_3 = 455K$. Indicate the pressure and volume at A, B and$C$ by P_r and $V_r, r = 1, 2, 3,$ respectively. Assume that intially pressure $P_1 = 1.00atm$.

Which of the following represents the correct values of the quantities indicated ?



A. $(\Delta Q) = 450RJ, (\Delta U)_1 = 450RJ, (\Delta W)_1 = 300RJ$

B. $(\Delta Q)_2 = 0, (\Delta U)_2 = 450RJ, (\Delta W)_2 = -217.5RJ$

C. $(\Delta Q)_3 = 0, (\Delta U)_3 = -232.5RJ, (\Delta W)_3 = 0$

D. $(\Delta Q)_1 = 450RJ, (\Delta U)_3 = -232.5RJ, (\Delta W)_2 = 217.5RJ$

Answer: D

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23. A reversible heat engine carries $1mol$ of an ideal monatomic gas around the cycle $ABCA$, as shown in the diagram. The process BC is adiabatic. Call the processes AB, BC and CA as $1, 2$ and 3 and the heat $(\Delta Q)_r$, change in internal energy (ΔU), and work done $(\Delta W)_r, r = 1, 2, 3$ respectively. The temperature at A, B, C are $T_1 = 300K, T_2 = 600K$ and $T_3 = 455K$. Indicate the pressure and volume at A, B and$C$ by P_r and $V_r, r = 1, 2, 3,$ respectively. Assume that intially pressure $P_1 = 1.00atm$.

Which of the following represents the correct values for the quantities indicated ?

A. $V_1 = 3 \times 10^{-3} Rm^3, P_2 = 0.5atm$

B. $V_2 = 3 \times 10^{-3} Rm^3, P_3 = 1.0atm$

C. $V_3 = 3 \times 10^{-3} Rm^3, P_2 = 2.0atm$

D. $V_2 = 3 \times 10^{-3} Rm^3, P_3 = 2.0atm$

Answer: B

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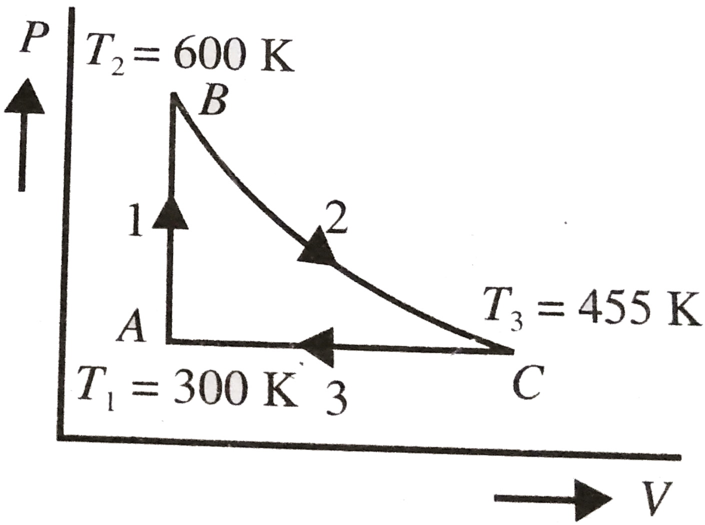
24. A reversible heat engine carries $1 mol$ of an ideal monatomic gas around the cycle $ABCA$, as shown in the diagram. The process BC is adiabatic. Call the processes AB, BC and CA as 1, 2 and 3 and the heat $(\Delta Q)_r$, change in internal energy (ΔU), and work done $(\Delta W)_r$, $r = 1, 2, 3$ respectively. The temperature at A, B, C are $T_1 = 300K, T_2 = 600K$ and $T_3 = 455K$. Indicate the pressure and volume at A, B and$C$ by P_r and V_r, $r = 1, 2, 3$, respectively. Assume that intially pressure $P_1 = 1.00 atm$.

Which of the following represents the correct values of the quantities indicated ?



A. $Q_i < Q_a$

B. $Q_i = Q_a$

C. $Q_i > Q_a$

D. Q_i will be greater or less than Q_a dependng upon the value of T_3

Answer: A

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25. A monatomic ideal gas undergoes the shown cyclic process in which path of the process $2 \rightarrow 3$ is a semicircle. If $2 mol$ of gas is taken, find

Heat given to the system in semicircular process

A. $\frac{P_0 V_0}{2}\left(7 - \frac{\pi}{4}\right)$

B. $\frac{P_0 V_0}{3}\left(7 + \frac{\pi}{4}\right)$

C. $\frac{P_0 V_0}{2}\left(7 + \frac{\pi}{4}\right)$

D. $\frac{P_0 V_0}{3}\left(7 - \frac{\pi}{4}\right)$

Answer: C

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26. A monatomic ideal gas undergoes the shown cyclic process in which path of the process $2 \rightarrow 3$ is a semicircle. If $2mol$ of gas is taken, find

Total heat rejected in one cycle

A. $\dfrac{P_0V_0(32-\pi)}{4}$

B. $\dfrac{P_0V_0(32+\pi)}{4}$

C. $\dfrac{P_0V_0(32+\pi)}{8}$

D. $\dfrac{P_0V_0(32-\pi)}{8}$

Answer: D

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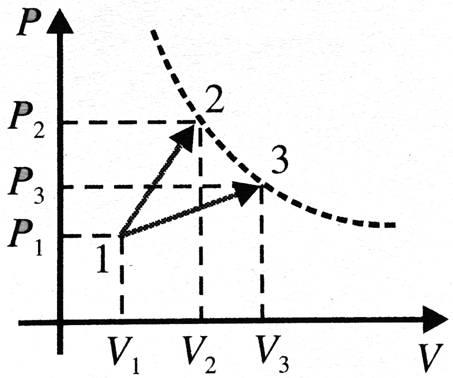
27. A gas take part in two thermal processes in which it is heated from the same initial state to the same final temperature. The processes are shown on the $P-V$ diagram by straight lines $1 \rightarrow 3$ and $1 \rightarrow 2$



A. $W_{13} > W_{12}$

B. $W_{12} > W_{13}$

C. $W_{13} = W_{12}$

D. None of above

Answer: A

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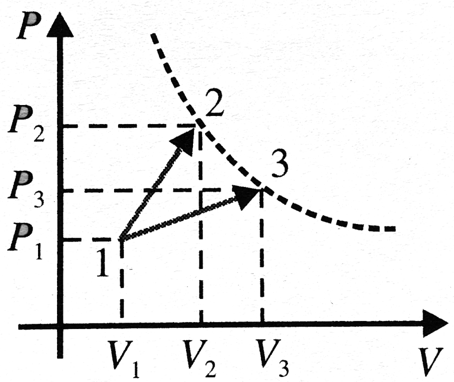
28. A gas take part in two thermal processes in which it is heated from the same initial state to the same final temperature. The processes are shown on the $P-V$ diagram by straight lines $1 \rightarrow 3$ and $1 \rightarrow 2$



A. $Q_{13} < Q_{12}$

B. $Q_{13} > Q_{12}$

C. $Q_{13} = Q_{12}$

D. None of above

Answer: B

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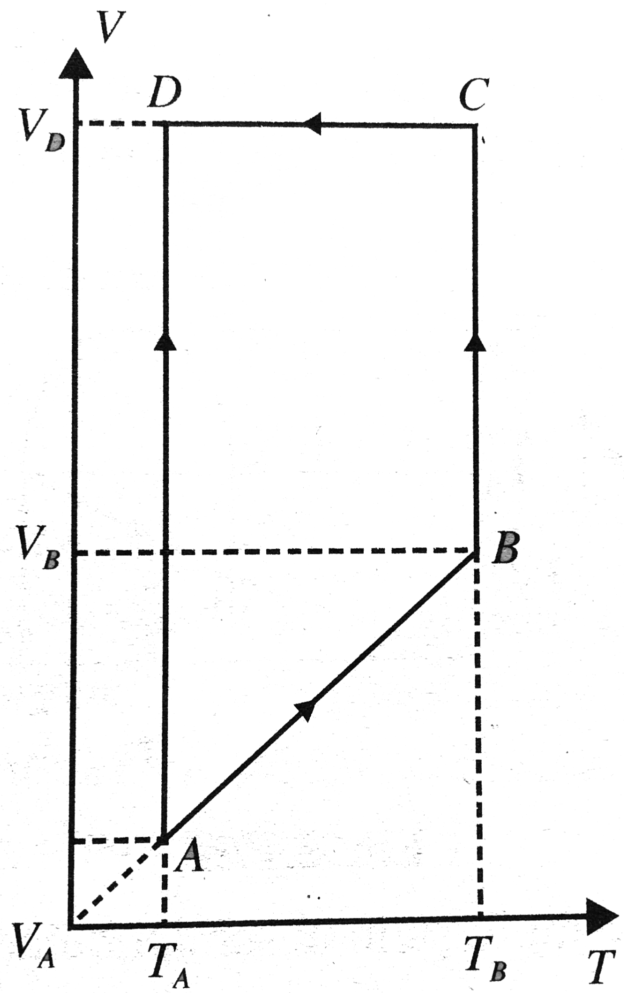
29. A monatomic idea gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B / V_A = 2$ and $V_D / V_A = 4$. If the temperature T_A at A is $27^{\circ} C$, and gas constant is R. Calculate the temperature of the gas at point B



A. $500K$

B. $700K$

C. $600K$

D. $300K$

Answer: C

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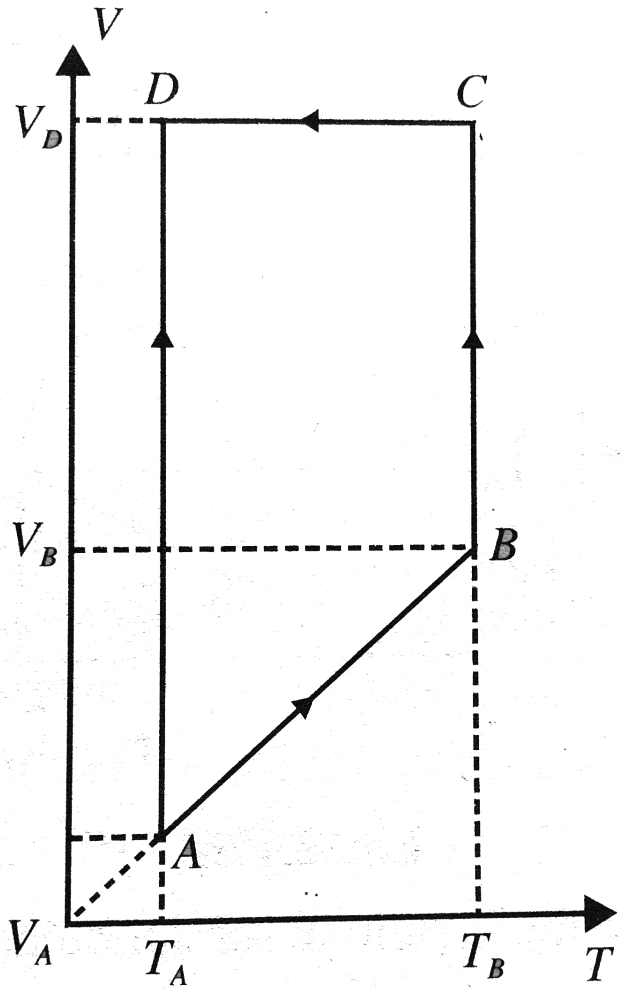
30. A monatomic ideal gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B / V_A = 2$ and $V_D / V_A = 4$. If the temperature T_A at A is $27^\circ C$, and gas constant is R.

Calculate heat absorbed or released by the gas in process $A \to B$



A. $1500R$, added

B. $1200R\ln(2)$, added

C. $900R$, rejected

D. $1200R\ln(2)$, rejected

Answer: A

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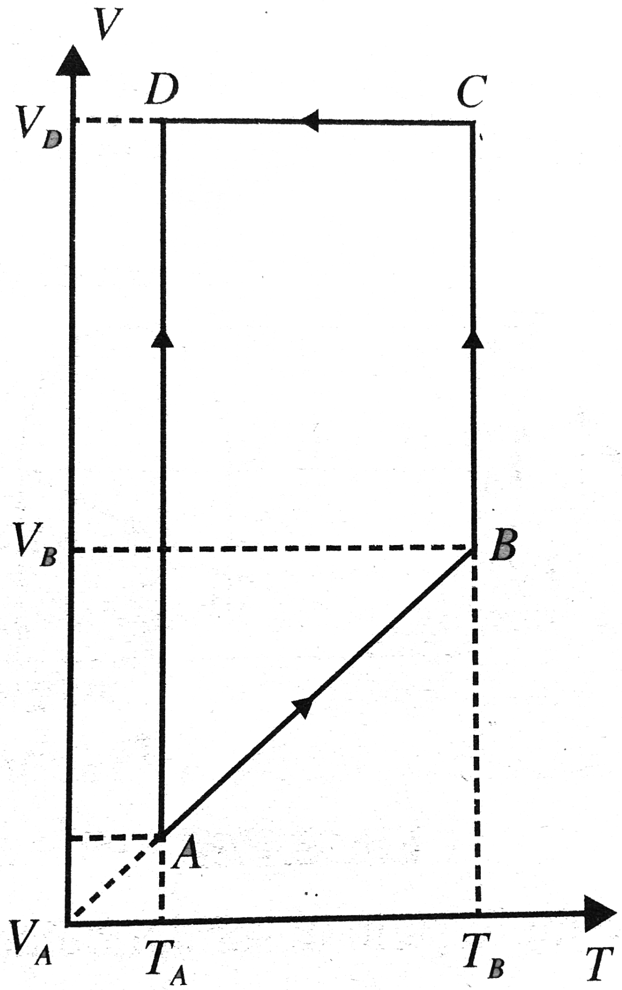
31. A monatomic ideal gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B / V_A = 2$ and $V_D / V_A = 4$. If the temperature T_A at A is $27^\circ C$, and gas constant is R.

Calculate heat absorbed or released by the gas in process $B \to C$



A. $1500,$ added

B. $1200R\ln(2),$ added

C. $900R,$ rejected

D. $1200R\ln(2)$, rejected

Answer: B

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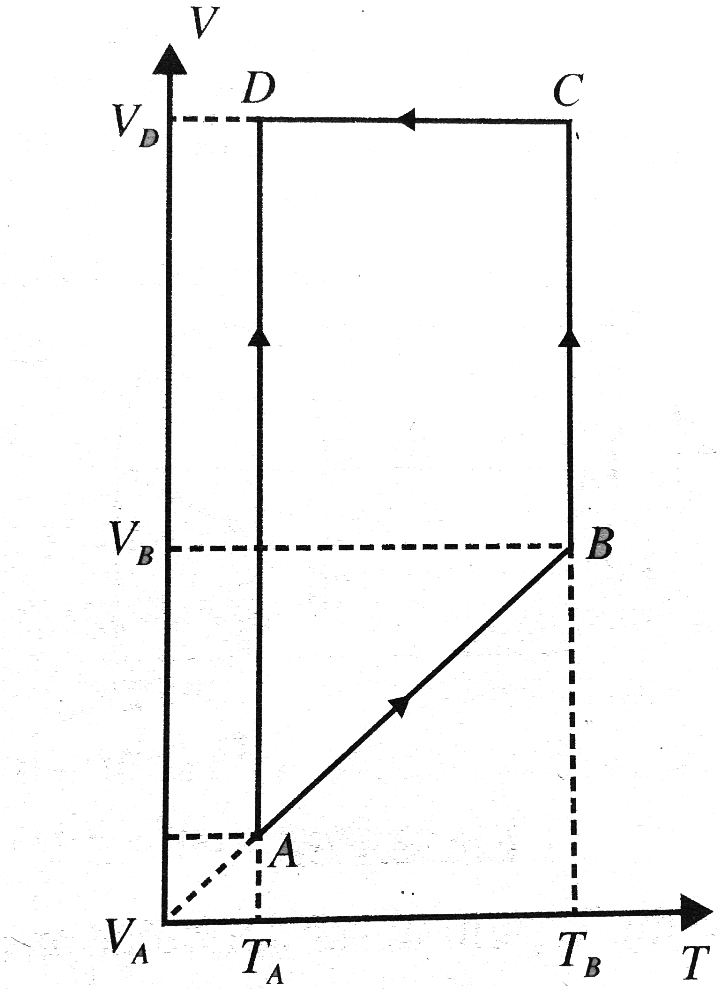
32. A monatomic ideal gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B / V_A = 2$ and $V_D / V_A = 4$. If the temperature T_A at A is $27^\circ C$, and gas constant is R. Calculate heat absorbed or released by the gas in process $C \to D$.



h

A. $1500,$ added

B. $1200R\ln(2)$, added

C. $900R,$ rejected

D. $1200R\ln(2)$, rejected

Answer: C

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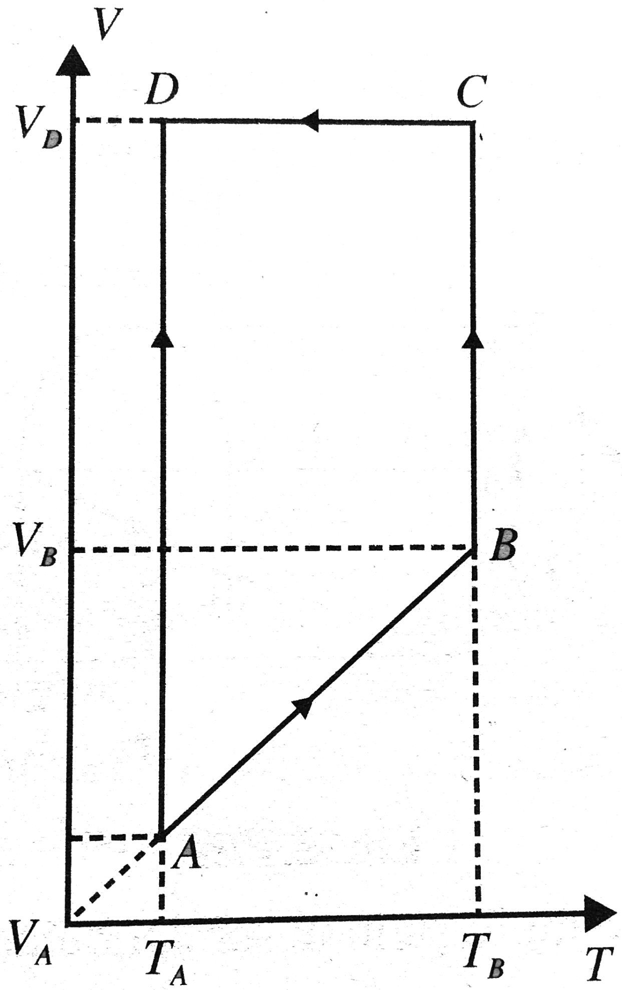
33. A monatomic idea gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B/V_A = 2$ and $V_D/V_A = 4$. If the temperature T_A at A is $27^\circ C$, and gas constant is R.

Calculate heat absorbed or released by the gas in process $D \to A$.



A. $1500,$ added

B. $1200R\ln(2)$, added

C. $900R,$ rejected

D. $1200R\ln(2)$, rejected

Answer: D

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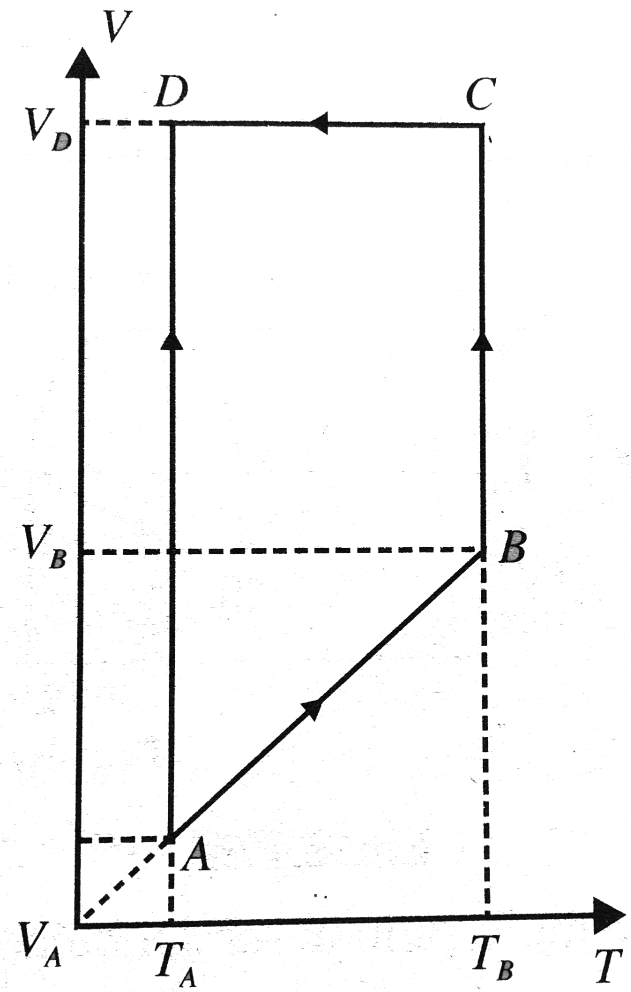
34. A monatomic idea gas of $2mol$ is taken through a cyclic process starting from A as shown in figure. The volume ratio are $V_B / V_A = 2$ and $V_D / V_A = 4$. If the temperature T_A at A is $27^\circ C$, and gas constant is R. Calculate.



The total work done by the gas during the complete cycle.

A. $500RJ$

B. $600RJ$

C. $700RJ$

D. $300RJ$

Answer: B

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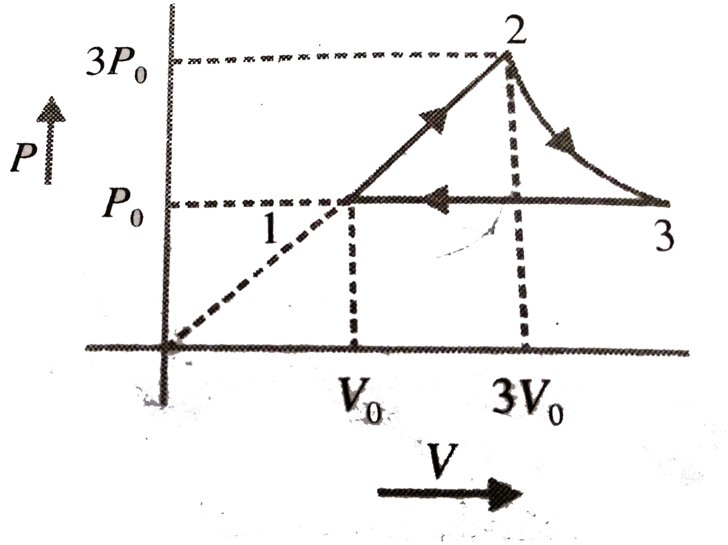
35. One mole of an ideal monatomic gas udnergoes thermodynamic cycle $1 \rightarrow 2 \rightarrow 3 \rightarrow 1$ as shown in figure. Initial temperature of gas in $T_0 = 300K$.

Process $1 \rightarrow 2: P = aV$

Process $2 \rightarrow 3: PV =$ Constant

Process $3 \rightarrow 1: P =$ Constant

(Take $1n|3| = 1.09$)



Find the net work done by the cycle.

A. $3.27RT_0$

B. $6.83RT_0$

C. $4.53RT_0$

D. $5.81RT_0$

Answer: D

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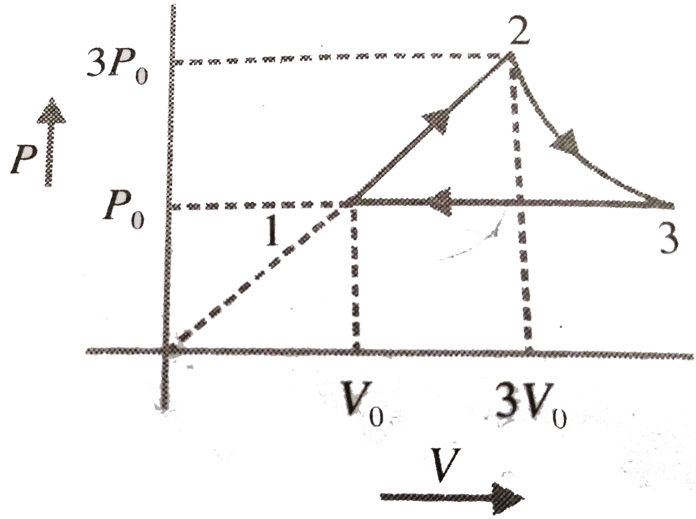
36. One mole of an ideal monatomic gas udnergoes thermodynamic cycle $1 \rightarrow 2 \rightarrow 3 \rightarrow 1$ as shown in figure. Initial temperature of gas in $T_0 = 300K$.

Process $1 \rightarrow 2$: $P = aV$

Process $2 \rightarrow 3$: $PV =$ Constant

Process $3 \rightarrow 1$: $P =$ Constant

(Take $1n|3| = 1.09$)



Determine the heat capacity of 3-1 process.

A. $20.75J\,/\,mol - K$

B. $10.\ 23J\,/\,molK$

C. $22.37J/mol - K$

D. $15.\ 96J/mol - K$

Answer: A

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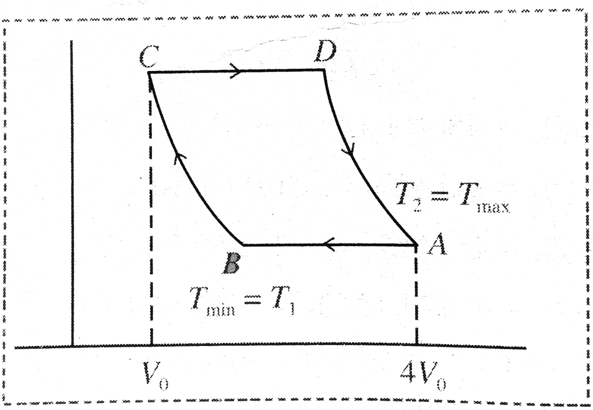
37. A monatomic gas undergoes a cycle consisting of two isothermals and two isobarics. The minimum and maximum temperatures of gas during the cycle are $T_1 = 400K$ and $T_2 = 800K$, respectively, and the ratio of maximum to minimum volume is 4. The volume at B is



A. $1.5V_0$

B. $2V_0$

C. $3V_0$

D. $2.5V_0$

Answer: B

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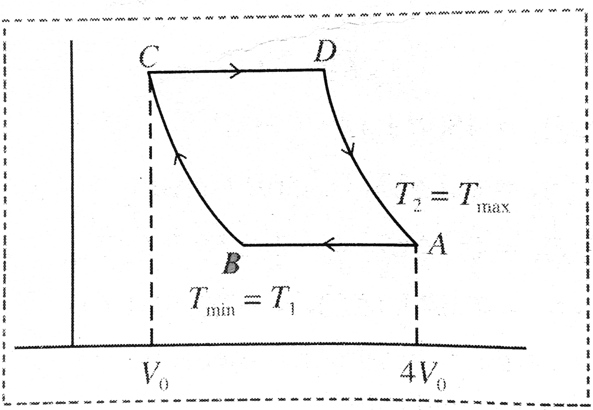
38. A monatomic gas undergoes a cycle consisting of two isothermals and two isobarics. The minimum and maximum temperatures of gas during the cycle are $T_1 = 400K$ and $T_2 = 800K$, respectively, and the ratio of maximum to minimum volume is 4.



The volume is D is

A. $1.5V_0$

B. $2V_0$

C. $3V_0$

D. $2.5V_0$

Answer: B

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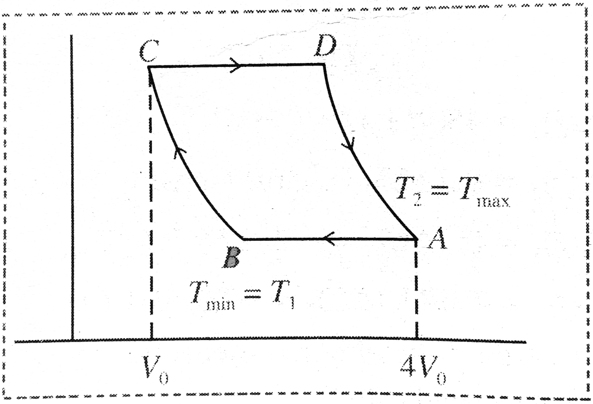
39. A monatomic gas undergoes a cycle consisting of two isothermals and two isobarics. The minimum and maximum temperatures of gas during the cycle are $T_1 = 400K$ and $T_2 = 800K$, respectively, and the ratio of maximum to minimum volume is 4.



The heat is extracted from the system in process

A. $A \to B, B \to C$

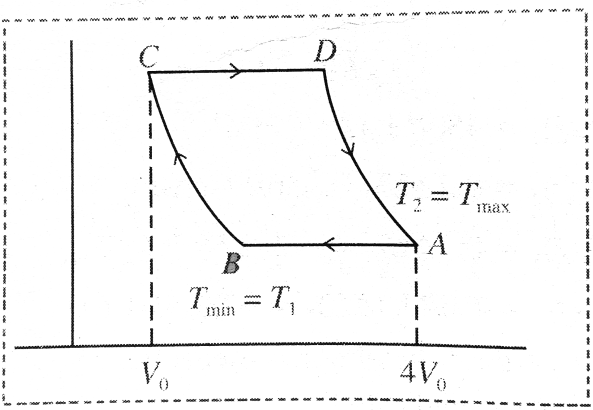
B. $C \to D, D \to A$

C. $A \to B, C \to D$

D. $B \to C, C \to D$

Answer: A

40. A monoatomic gas undergoes a cycle consisting of two isothermals and two isobarics. The minimum and maximum temperatures of gas during the cycle are $T_1 = 400K$ and $T_2 = 800K$, respectively, and the ratio of maximum to minimum volume is 4.



The efficiency of the cycle is

A. $\dfrac{31n2}{5+41n2} \times 100\,\%$

B. $\dfrac{21n2}{5+41n2} \times 100\,\%$

C. $\dfrac{31n3}{5+41n2} \times 100\,\%$

D. $\frac{21n}{3+41n2} \times 100\,\%$

Answer: B

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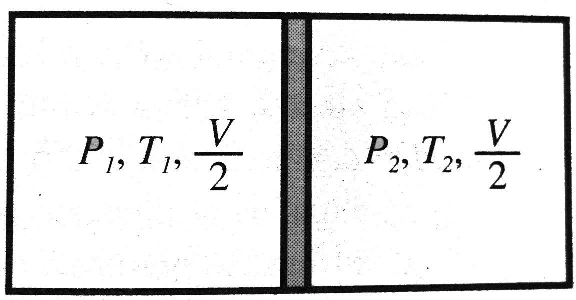
41. Figure shows an insulated cylinder of volume V containing monatomic gas in both the compartments. The pistone is diathermic. Initially the piston is kept fixed and the system is allowed to acquire a state of thermal equilibrium. The initial pressures and temperatures are as shown in the figure. Calculate



The final temperature

A. $\dfrac{(P_1 - P_2)T_1T_2}{P_1T_2 - P_2T_1}$

B. $\dfrac{(P_1 + P_2)T_1T_2}{P_1T_1 - P_2T_2}$

C. $\dfrac{(P_1 + P_2)T_1T_2}{P_1T_2 + P_2T_1}$

D. $\dfrac{(P_1 + P_2)T_1T_2}{P_1T_1 + P_2T_2}$

Answer: C

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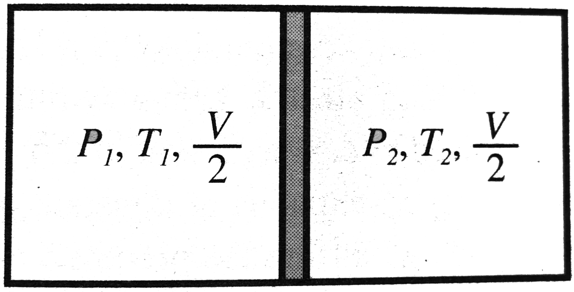
42. Figure shows an insulated cylinder of volume V containing monatomic gas in both the compartments. The pistone is diathermic. Initially the piston is kept fixed and the system is allowed to acquire a state of thermal equilibrium. The initial pressures and temperatures are as shown in the figure. Calculate



The final presssures of left and right compartment respectively are

A. $\frac{P_1(P_1+P_2)T_2}{P_1T_2+P_2T_1}, \frac{P_2(P_1+P_2)T_1}{(P_1T_2+P_2T_1)}$

B. $\frac{P_1(P_1+P_2)T_1}{P_1T_2+P_2T_2}, \frac{P_2(P_1+P_2)T_1}{(P_1T_2+P_2T_1)}$

C. $\frac{P_1(P_1+P_2)T_2}{P_1T_2-P_2T_1}, \frac{P_2(P_1-P_2)T_1}{(P_1T_2+P_2T_1)}$

D. $\frac{P_1(P_1+P_2)T_2}{P_1T_2+P_2T_1}, \frac{P_2(P_1-P_2)T_1}{(P_1T_2+P_2T_1)}$

Answer: A

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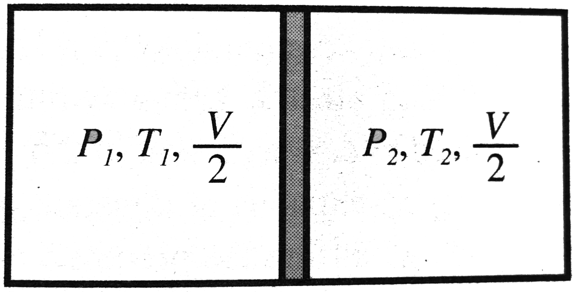
43. Figure shows an insulated cylinder of volume V containing monatomic gas in both the compartments. The pistone is diathermic. Initially the piston is kept fixed and the system is allowed to acquire a state of thermal equilibrium. The initial pressures and temperatures are as shown in the figure. Calculate



The heat that flows from RHS to LHS, Given $T_2 > T_1$.

Now, the pin which was keeping the piston fixed is removed. and the piston is set free to move. The piston is allowed to slide slowly, such that of mechanical equilibrium is also achieved and $T_1P_2 > P_1T_2$. Find.

A. $\frac{4}{3}P_1P_2V\frac{(T_2 - T_1)}{P_1T_2 + P_2T_1}$

B. $\frac{3}{4}P_1P_2V\frac{(T_2 - T_1)}{P_1T_2 + P_2T_1}$

C. $\frac{3}{4}P_1P_2V\frac{(T_2+T_1)}{P_1T_2+P_2T_1}$

D. $\frac{3}{4}P_1P_2V\frac{(T_2-T_1)}{P_1T_2-P_2T_1}$

Answer: B

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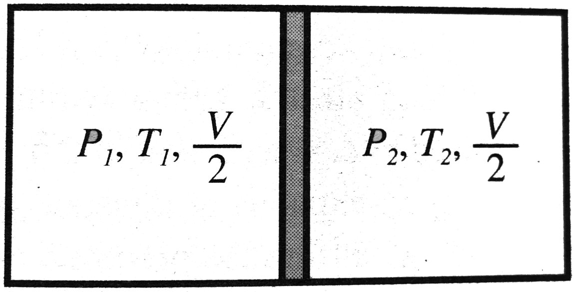
44. Figure shows an insulated cylinder of volume V containing monatomic gas in both the compartments. The pistone is diathermic. Initially the piston is kept fixed and the system is allowed to acquire a state of thermal equilibrium. The initial pressures and temperatures are as shown in the figure. Calculate



Final volume of the left compartment.

A. $\frac{V}{2}\left(\frac{P_1T_2}{P_2T_1 + P_1T_2}\right)$

B. $V\left(\frac{P_1T_2}{P_2T_1 - P_1T_2}\right)$

C. $V\left(\frac{P_1T_2}{P_2T_1 + P_1T_2}\right)$

D. $V\left(\frac{2P_1T_2}{P_2T_1 + P_1T_2}\right)$

Answer: C

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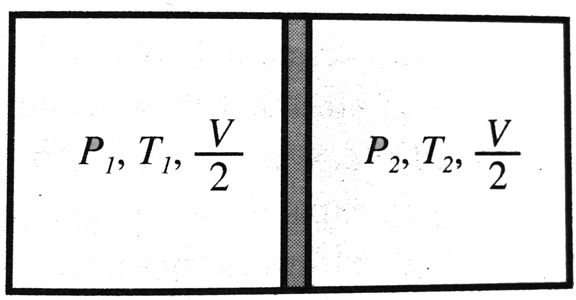
45. Figure shows an insulated cylinder of volume V containing monatomic gas in both the compartments. The pistone is diathermic. Initially the piston is kept fixed and the system is allowed to acquire a state of thermal equilibrium. The initial pressures and temperatures are as shown in the figure. Calculate



Final volume of the left compartment.

A. $\frac{V}{2}\left(\frac{P_2T_1}{P_2T_1+P_1T_2}\right)$

B. $V\left(\frac{P_2T_1}{P_2T_1-P_1T_2}\right)$

C. $V\left(\frac{P_2T_1}{P_2T_1+P_1T_2}\right)$

D. $V\left(\frac{2P_2T_2}{P_2T_1-P_1T_2}\right)$

Answer: C

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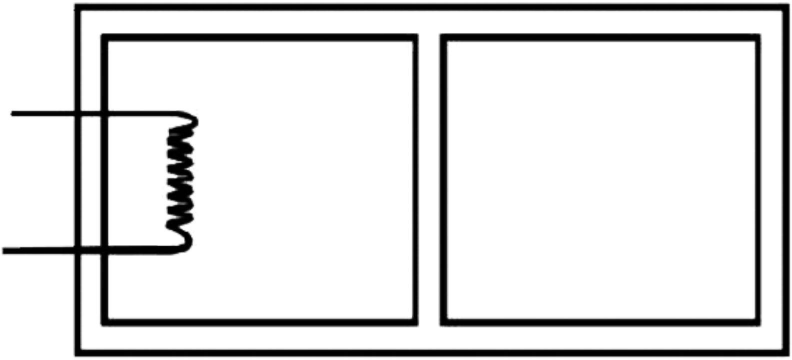
46. The rectangular box shown in Fig has partition which can slide without friction along the length of the box. Initially each of the two chambers of the box has one mole of a mono-atomic ideal gas $(\lambda = 5/3)$ at a pressure P_0, volume V_0 and temperature T_0. The chamber on the left is slowly heated by an electric heater. The walls of the box and the 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 $243P_0/32$. Determine (i) the final temperature of the gas in each chamber and (ii) the work done by the gas in the right chamber.



A. $4/9T_0$

B. $4/7T_0$

C. $1/5T_0$

D. $9/4T_0$

Answer: D

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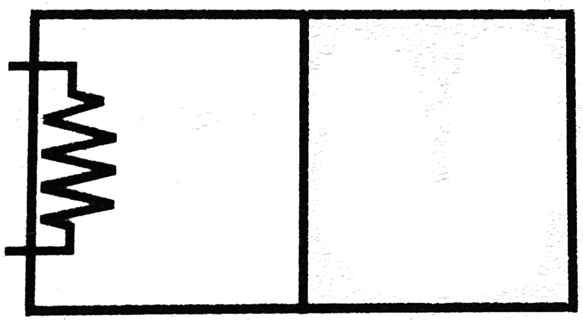
47. The insulated box shown in figure has an insulated partition which can slide without friction along the length of the box. Initially each of the two chambers of the box has $1mil$ of a monatomic ideal gas $(\gamma = 5/3)$ at a pressure P_0, volume V_0 and temperature T_0. The chamber of the left is slowly heated by an electric heater so that its gas, pushing the partition, expands until the final pressure in both the chambers becomes $243P_0/32$. Determine



Final temperature fo the gas in each chamber.

A. $\frac{15}{8}RT_0$

B. $-\frac{15}{8}RT_0$

C. $\frac{7}{4}RT_0$

D. $-\frac{7}{4}RT_0$

Answer: B

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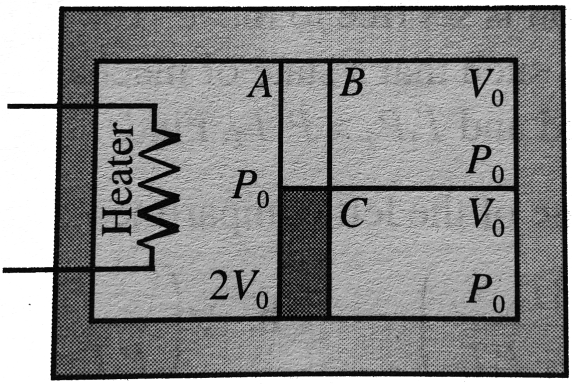
48. A container of volume $4V_0$ made of a perfectly non $-$ conducting material is divided into two equal parts by a fixed rigid wall whose lower half is non $-$ conducting and upper half is purely conducting. The right side of the wall is divided into equal parts (initially 0 by means of a massless non $-$ conducting piston free to move as shown . Section A constains $2mol$ of a gas while the section B and C contain $1mol$ each of the same gas $(\gamma = 15.)$ at pressure P_0 . The heater in left part is switched on till the final pressure in section C becomes $125/27P_0$. Calculate



The heat supplied by the heater.

A. $\frac{205P_0V_0}{27R}$

B. $\frac{P_0V_0}{R}$

C. $\frac{105P_0V_0}{13R}$

D. $\frac{12P_0V_0}{13R}$

Answer: A

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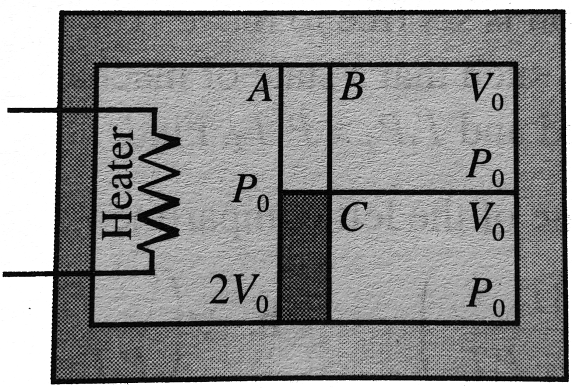
49. A container of volume $4V_0$ made of a perfectly non – conducting material is divided into two equal parts by a fixed rigid wall whose lower half is non $-$ conducting and upper half is purely conducting. The right side of the wall is divided into equal parts (initially 0 by means of a massless non $-$ conducting piston free to move as shown . Section A constains $2mol$ of a gas while the section B and C contain $1mol$ each of the same gas $(\gamma = 15.)$ at pressure P_0 . The heater in left part is switched on till the final pressure in section C becomes $125/27P_0$.

Calculate



Final temperature in part C.

A. $\dfrac{P_0V_0}{R}$

B. $\dfrac{5P_0V_0}{3R}$

C. $\dfrac{P_0V_0}{3R}$

D. $\dfrac{5P_0V_0}{R}$

Answer: B

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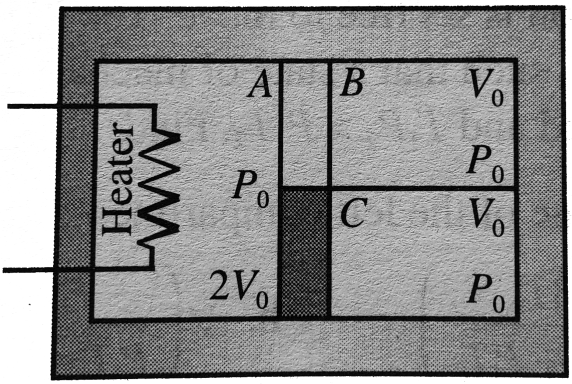
50. A container of volume $4V_0$ made of a perfectly non $-$ conducting material is divided into two equal parts by a fixed rigid wall whose lower half is non $-$ conducting and upper half is purely conducting. The right side of the wall is divided into equal parts (initially 0 by means of a massless non $-$ conducting piston free to move as shown . Section A constains $2mol$ of a gas while the section B and C contain $1mol$ each of the same gas $(\gamma = 15.)$ at pressure P_0 . The heater in left part is switched on till the final pressure in section C becomes $125/27P_0$. Calculate



The heat supplied by the heater.

A. $\frac{368}{9}P_0V_0$

B. $\frac{113}{5}P_0V_0$

C. $\frac{316}{9}P_0V_0$

D. $\frac{405}{8}P_0V_0$

Answer: A

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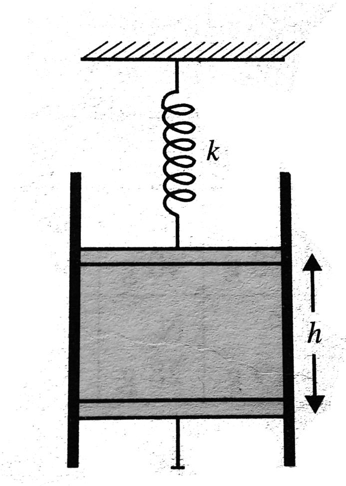
51. An ideal gas at NTP is enclosed in an adiabatic vertical cylinder havin an area of cross section $A = 27cm^2$ between two light movable pistons as shown in figure. Spring with force constant $K = 37 - - N/m$ is in a relaxed state initially. Now the lower position is moved upwards a distance $h/2$, h being the initial length of gas column . It is observed that the upper piston moves up by a distance $h/16$. Final temperature of gas $4/3 \times 273K$. Take γ for the gas to be $3/2$.



When the lower pistone is moved upwards a distance $h/2$, the compression.

A. leads to cooling

B. takes place isothermally

C. takes place adiabatically

D. leads to heating

Answer: C::D

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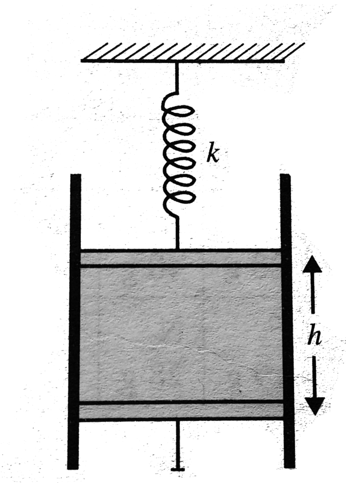
52. An ideal gas at NTP is enclosed in an adiabatic vertical cylinder havin an area of cross section $A = 27cm^2$ between two light movable pistons as shown in figure. Spring with force constant $K = 37 - \quad - N/m$ is in a relaxed state initially. Now the lower position is moved upwards a distance $h/2$, h being the initial length of gas column . It is observed that the upper piston moves up by a distance $h/16$. Final temperature of gas $4/3 \times 273K$. Take γ for the gas to be $3/2$.



Which of the following statements is correct ?

A. Heat given in compression is used to do work against elastic force only.

B. Heat given in compression is used to do work against elastic force and atmospheric force.

C. No work is done during compression.

D. There is no change in internal energy.

Answer: B

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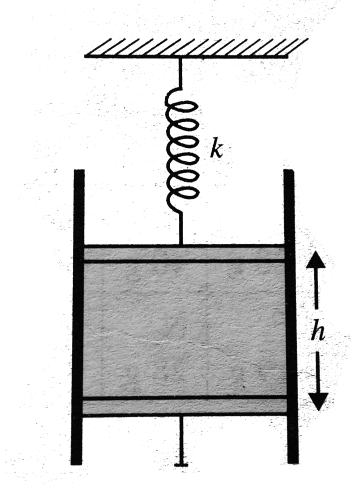
53. An ideal gas at NTP is enclosed in an adiabatic vertical cylinder havin an area of cross section $A = 27cm^2$ between two light movable pistons as shown in figure. Spring with force constant $K = 37 - - N/m$ is in a relaxed state initially. Now the lower position is moved upwards a distance $h/2$, h being the initial length of gas column . It is observed that the upper piston moves up by a distance $h/16$. Final temperature of gas $4/3 \times 273K$. Take γ for the gas to be $3/2$.



The value of h is

A. $1m$

B. $1.4m$

C. $1.6m$

D. $2m$

Answer: C

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54. Piston cylinder device initially contains $0.5m^3$ of nitrogen gas at $400kPa$ and $27^\circ C$. An electric heater within the device is turned on and is allowed to apss a current of $2A$ for $5min$ from a $120V$ source. Nitrogen expands at constant pressure and a heat loss of $2800J$ occurs during the process.

$R = 25/3kJ/kmol - K$

Electric work done on the nitrogen gas is

A. $72kJ$

B. $36kJ$

C. $118kJ$

D. $9kJ$

Answer: A

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55. Piston cylinder device initially contains $0.5m^3$ of nitrogen gas at $400kPa$ and $27^\circ C$. An electric heater within the device is turned on and is allowed to apss a current of $2A$ for $5min$ from a $120V$ source. Nitrogen expands at constant pressure and a heat loss of $2800J$ occurs during the process.

$R = 25/3kJ/kmol - K$

Number of moles of nitrogen gas is

A. $0.8kmol$

B. $0.08kmol$

C. $0.8mol$

D. $0.08mol$

Answer: B

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56. Piston cylinder device initially contains $0.5m^3$ of nitrogen gas at $400kPa$ and $27^\circ C$. An electric heater within the device is turned on and is allowed to apss a current of $2A$ for $5min$ from a $120V$ source. Nitrogen expands at constant pressure and a heat loss of $2800J$ occurs during the process.

$R = 25/3kJ/kmol - K$

Number of moles of nitrogen gas is

A. $2.6^\circ C$

B. $56.6^\circ C$

C. $29.6^\circ C$

D. $5.67^\circ C$

Answer: B

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Interger

1. 8g of oxygen, 14 g of nitrogen and 22 g carbon dioxide are mixed in an encloser of volume 10 litre and temperature $27^{\circ} C$. Calculate the pressure exerted by the mixture , $R = 8.3 J \text{mole}^{-1} K^{-1}$, Molecular weight of oxygen , nitrogen and carbon 32 , 28 and 44 respectively.

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2. 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

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3. p-V diagram of a diatomic gas is a straight line passing through origin. The molar heat capacity of the gas in the process will be

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

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5. A vessel A of volume 3V contains a gas at pressure $4p_0$ and a vessel of volume 2V contains that same gas at pressure $1.5p_0$. Temperature is same in both vessels. What is the equilibrium pressure if vessels A and B are connected by a tube of negligible volume.

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6. A vessel of volume $0.2m^3$ contains hydrogen gas at temperature 300 K and pressure 1 bar. Find the heat required to raise the temperature to 400 K. The molar heat capacity of hydrogen at constant volume is $5cal/molK$.

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7. A Vessel contains helium, which expands at constant pressure when 15 kJ of heat is supplied to it. What will be the variation of the internal energy of the gas? What is the work performed in the expansion?

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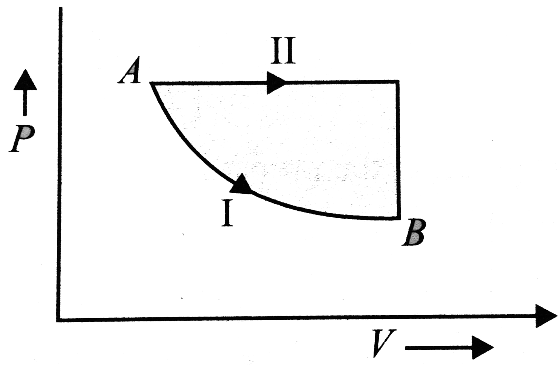
8. A certain mass of gas is taken from an initial thermodynamics state A to another state B by process I and II. In process I for the gas does $5J$ of work and absorbs $4J$ of heat energy. In process II, the gas absorbs $5J$ of heat. The work done by the gas in process II is



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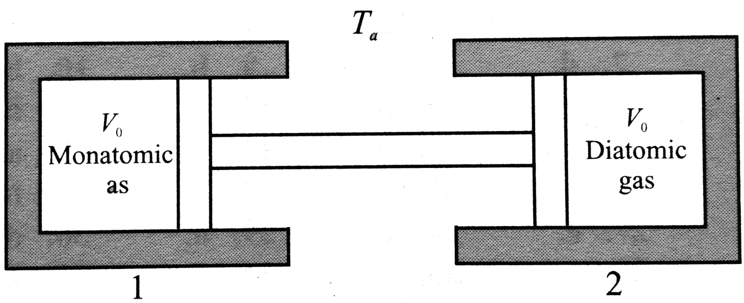
9. The two conducting cyliner-piston systems shows below are linked. Cyliner 1 is filled with a certain molar quantity of a monatomic ideal gas, and cylinder 2 is filled with an equal molar quantity of a diatomic ideal gas. The entire apparatus is situated inside an oven whose temperature is $T_a = 27^\circ C$. The cylinder volumes have the same initial value $V_0 = 100$. When the oven temperature is slowly raised to $T_b = 127^\circ C$. What is the volume change ΔV (in cc) of cylinder 1 ?



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10. A long container has air enclosed inside at room temperature and atmoshperic pressure $(10^5 Pa)$. It has a volume of 20000 c c. The area of cross section is $100cm^2$ and force constant of spring is $k_{\text{spring}} = 1000N/m$. We push the right piston isothermally and slowly till it reaches the origianl position of the left piston which is movalbe. Final length of air colume is found to be 25 h cm. Assume that spring is initially relaxed. Find h.

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11. The value of $\gamma = C_P/C_V$ is $4/3$ for an adaibatic process of an ideal gas for which internal energy $U = K + nPV$. Find the value of n (K is constant) :

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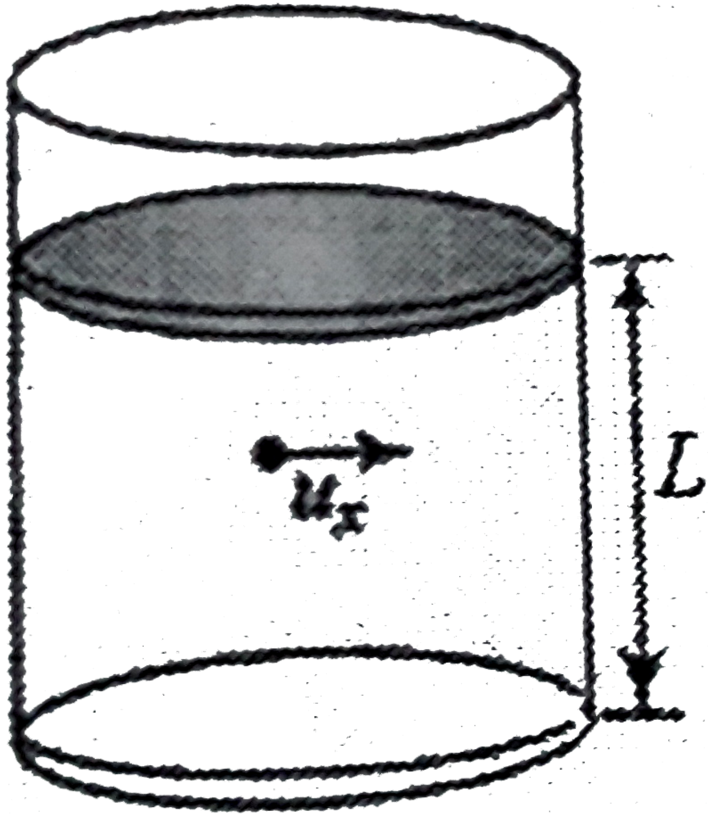
Comprehension Type

1. Suppose there are N molecules each of mass m, of an ideal gas in a container. The x component of velocity of a molecule is denoted by u_x.

The gas is enclosed using a horizontal piston of area A as shown.



The pressure of the gas is

A. $\frac{m\left(u_x^2\right)N}{AL}$

B. $\frac{m\left(u_x^2\right)N}{3AL}$

C. $\frac{3m\left(u_x^2\right)N}{AL}$

D. $\frac{3m\left(u_x^2\right)}{AL}$

Answer: A

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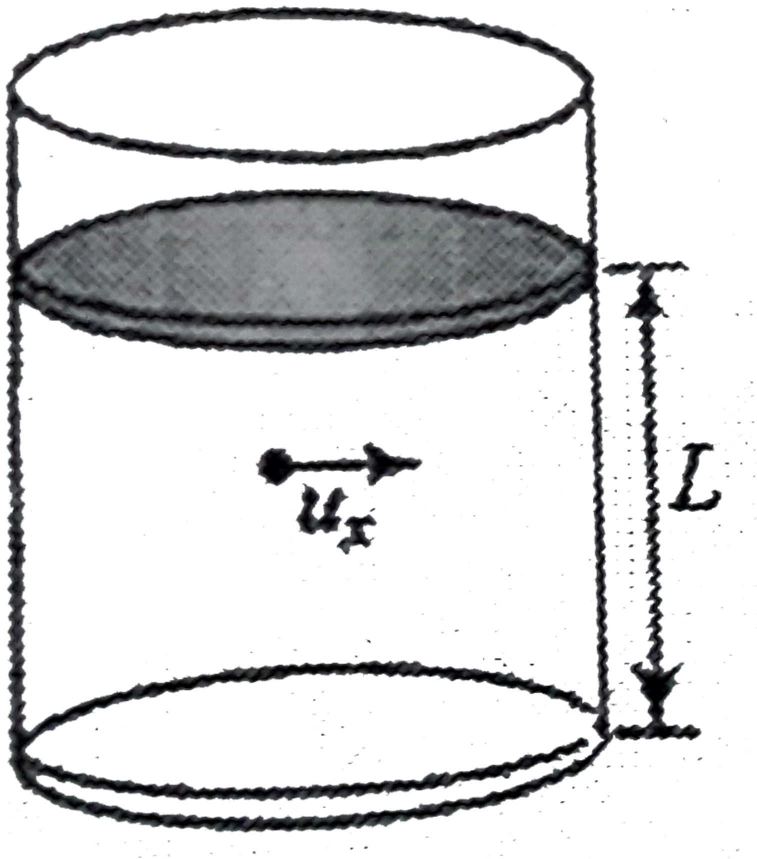
2. Suppose there are N molecules each of mass m, of an ideal gas in a container. The x component of velocity of a molecule is denoted by u_x. The gas is enclosed using a horizontal piston of area A as shown.



The pressure of the gas can also be written in terms of momentum transferred per collision (Δp) and collision frequency (f) on the wall of area A as

A. $\Delta p \times f$

B. $\frac{\Delta p}{A \times f}$

C. $\frac{\Delta p \times f}{A}$

D. none of these

Answer: C

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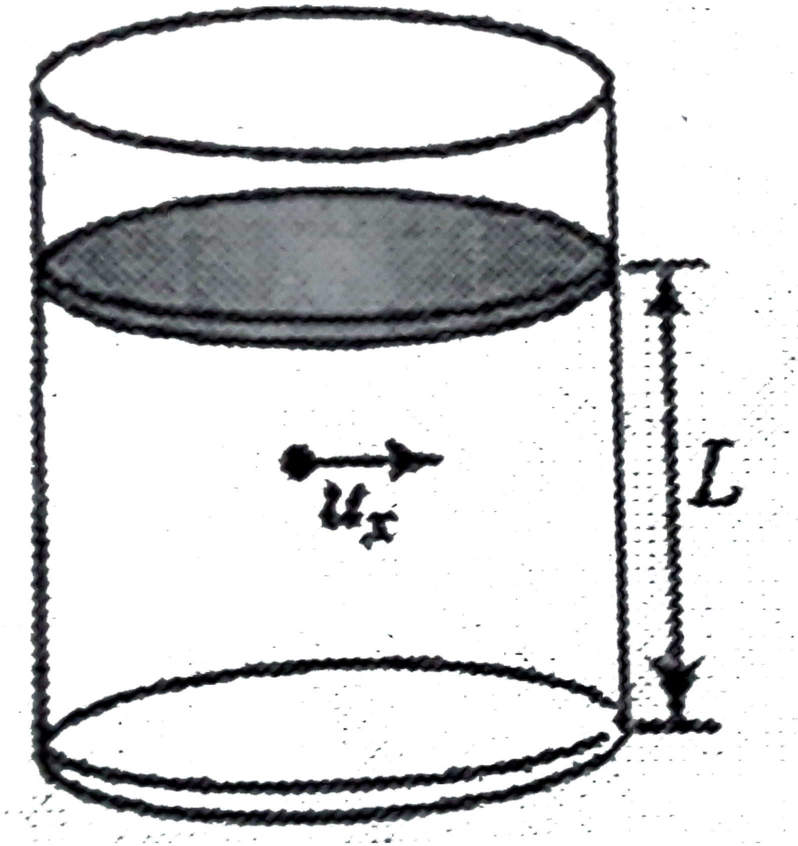
3. Suppose there are N molecules each of mass m, of an ideal gas in a container. The x component of velocity of a molecule is denoted by u_x. The gas is enclosed using a horizontal piston of area A as shown.



If the temperature of gas is doubled keeping volume constant, we know from the gas law that the pressure will be doubled. On microscopic level this increase in pressure is because

A. momentum change per collision is doubled while the frequency of collision remains constant

B. momentum change per collision remain constant while the frequency of collision is doubled

C. momentum change per collision and the frequency of collision both are increased

D. none of these two physical quantities are changed. It is due to some other reason.

Answer: C

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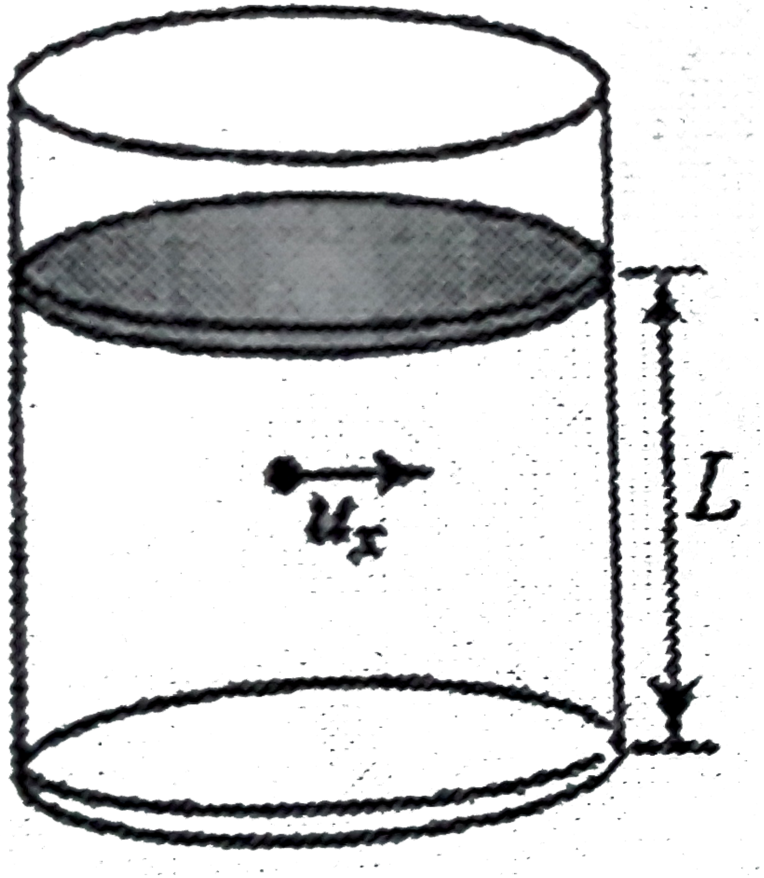
4. Suppose there are N molecules each of mass m, of an ideal gas in a container. The x component of velocity of a molecule is denoted by u_x. The gas is enclosed using a horizontal piston of area A as shown.



If the piston is moved so as to reduce the volume of gas by half, keeping the temperature of gas constant , we know from the gas law that the pressure will be doubled. On microscopic level the increase in pressure on the piston is because

A. (a)momentum change per collision is doubled while the frequency of collision remains constant

B. (b)momentum change per collision remain constant while the frequency of collision is doubled

C. (c)momentum change per (c)collision and the frequency of collision both are increased

D. (d)none of these two physical quantities are changed. It is due to some other reason.

Answer: B

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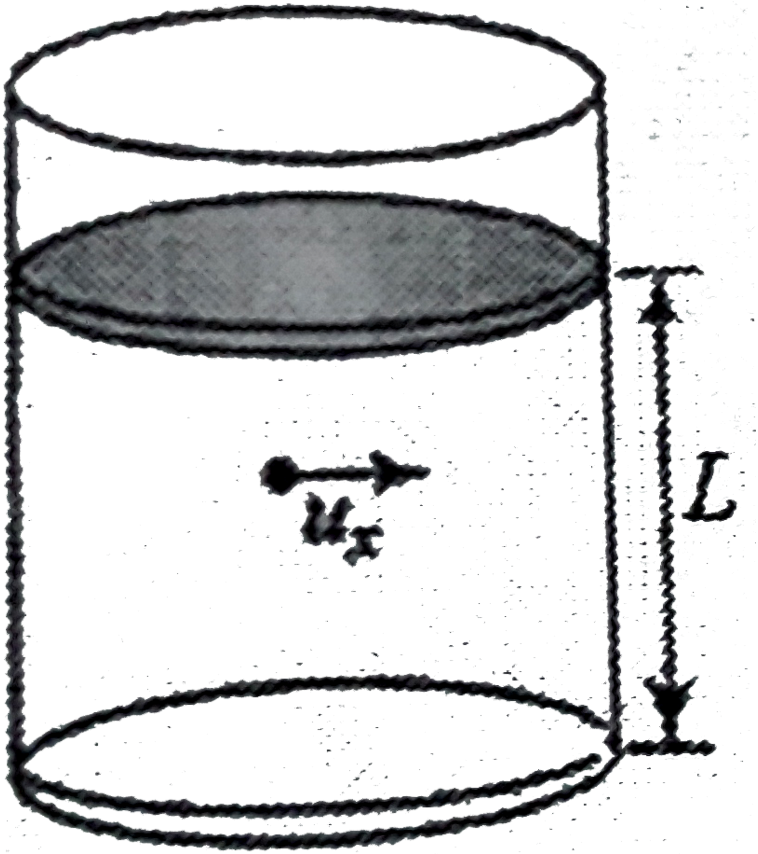
5. Suppose there are N molecules each of mass m, of an ideal gas in a container. The x component of velocity of a molecule is denoted by u_x. The gas is enclosed using a horizontal piston of area A as shown.



If the piston is moved so as to reduce the volume of gas by half, keeping the temperature of gas constant , we know from the gas law that the pressure will be doubled. On microscopic level the increase in pressure on the piston is because

A. momentum change per collision is doubled while the frequency of collision remains constant

B. momentum change per collision remain constant while the frequency of collision is doubled

C. momentum change per collision and the frequency of collision both are increased

D. none of these two physical quantities are changed. It is due to some other reason.

Answer: D

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Fill in the blanks

1. The root mean square speed of hydrogen molecules of an ideal hydrogen gas kept in a gas chamber at $0^\circ C$ is 3180 m/s. The pressure on the hydrogen gas is ....

(Density of hydrogen gas is $8.99 \times 10^{-2} kg/m^3$, 1 atmosphere= $1.01 \times 10^5 \frac{N}{m^2}$

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2. A cylinder of capacity $20L$ is filled with H_2 gas. The total average kinetic energy of translatory motion of its molecules is $1, 5 \times 10^5 J$. The pressure of hydrogen in the cylinder is

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3. A flask contains $10^{-3} m^3$ gas. At a temperature, the number of molecules of oxygen at 3.0×10^{22}. The mass of an oxygen molecule is 5.3×10^{-26} kg and at that temperature the rms velocity of molecules is 400m/s. The pressure in N/m^2 of the gas in the flask is ....

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4. When volume of system is increased two times and temperature is decreased half of its initial temperature, then pressure becomes ....

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5. Let A and B the two gases and given: $\frac{T_A}{M_A} = 4. \frac{T_B}{M_B}$, where T is the temperature and M is the molecular mass. If C_A and C_B are the rms speed, then the ratio $\frac{C_A}{C_B}$ will be equal to ....

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6. The rms speed of the molecules of a gas in a vessel is $400ms^{-1}$. If half of the gas leaks out at constant temperature, the rms speed of the ramaining molecules will be..............

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7. The root mean square speed of hydrogen molecule at 300 K is 1930m/s. Then the root mean square speed of oxygen molecules at 900K will be...........

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8. The speeds of 5 molecules of a gas (in arbitrary units) are as follows: 2, 3, 4, 5, 6. The root mean square speed for these molecules is ....

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Multiple correct

1. A steel tank contains 300 g of ammonia gas (NH_3) at a pressure of 1.35×10^6 Pa and a temperature of $77^\circ C$. Later the temperature is $22^\circ C$ and the pressure is 8.7×10^5 Pa .

A. the initial volume of the tank is 38 litre

B. finally 71 g grams of gas will leak out of the tank .

C. the number of moles of the remaining gas is 13.5 mol .

D. the number of moles of the remaining gas is 8.5 mol.

Answer: A::B::C

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2. Which of the following quantities is independent of the nature of the gas at same temperature ?

A. The number of molecules in 1 mole

B. The number of molecules in equal volume

C. The translational kinetic energy of 1 mole

D. The kinetic energy of unit mass

Answer: A::C

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3. Which of the following quantities depend on temperature only for a given ideal gas ?

A. Internal energy of the gas

B. Product PV of the gas

C. The ratio of pressure and density of the gas

D. Root mean square speed of the gas

Answer: C::D

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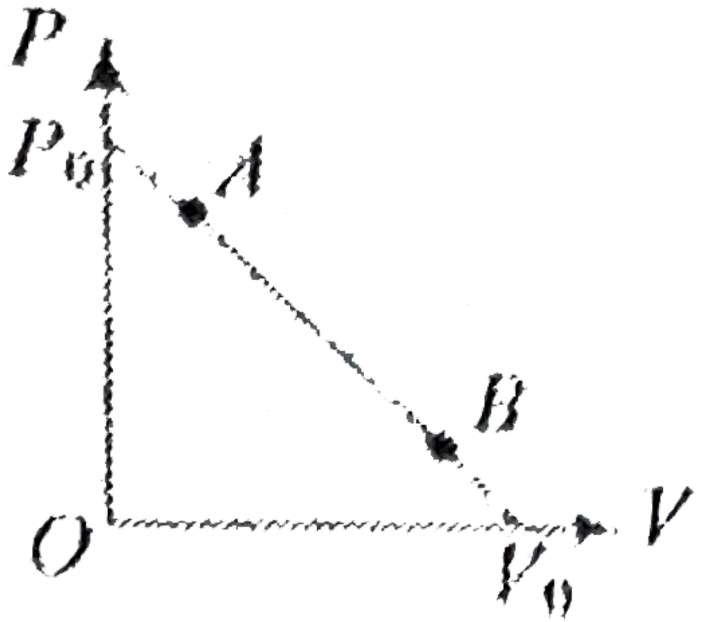
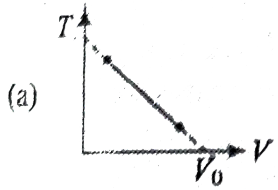
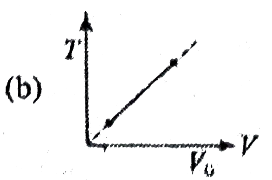
Compression

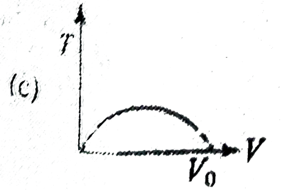
1. One mole of an ideal monatomic gas undergoes a linear process from A to B , in which is pressure P and its volume V change as shown in figure .

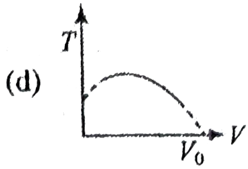


The absolute temperature T versus volume V for the given process is

A. 

B. 

C. 

D. 

Answer: C

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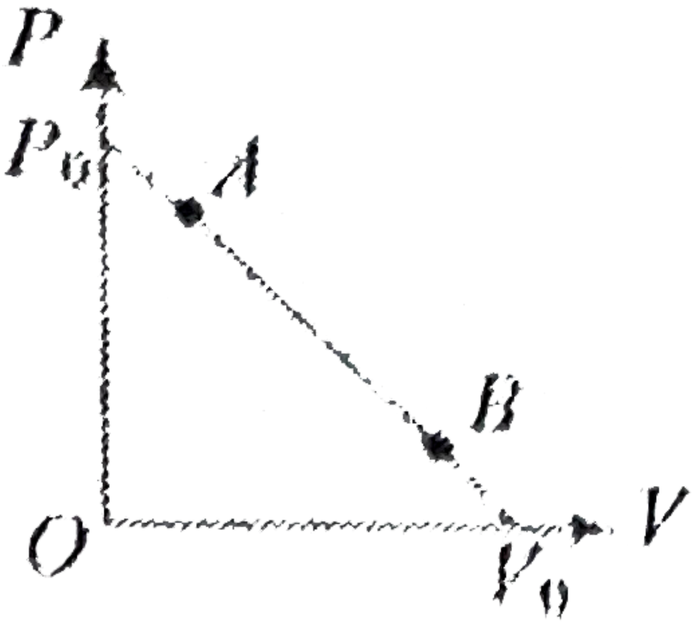
2. One mole of an ideal monatomic gas undergoes a linear process from A to B , in which is pressure P and its volume V change as shown in figure .



The absolute temperature T versus volume V for the given process is

A. $\frac{P_0V_0}{2R}$

B. $\frac{P_0V_0}{4R}$

C. $\frac{3P_0V_0}{4R}$

D. $\frac{3P_0V_0}{2R}$

Answer: B

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