PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

LAWS OF THERMODYNAMICS

Example

1. When a system goes from state A to state B, it is supplied with 400 J of heat and it does 100 J of work.

(a) For this transition, what is the system's change in internal energy?

(b) If the system moves from B to A, what is the change in internal energy?

(c) If in moving from A to B along a different path in which $W'_{AB} = 400J$ of work is done on the system, how much heat does it absorb?

2. Method 1 of Q

Temperature of two moles of a monoatomic gas is increased by 300 K in the process $p \propto V$.

(a) Find molar heat capacity of the gas in the given process.

(b) Find heat given to the gas in that.

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3. Method 2 of Q

In a given process work done on a gas is 40 J and increases in its internal energy is 10J. Find heat given or taken to/from the gas in this process.

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4. Method 1 of ΔU

Temperature of two moles of a monoatomic gas is increased by 600 K in a given process. Find change in internal energy of the gas.

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5. Method 2 of ΔU

Work done by a gas in a given process is $-20J$. Heat given to the gas is 60J. Find change in internal energy of the gas.

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6. Method 1 of W

By integration, make expressions of work done by gas in

(a) Isobaric process (p=constant)

(b) Isothermal process (pV=constant)

(c) Adiabatic process ($PV^{\gamma} = \text{ constant}$)

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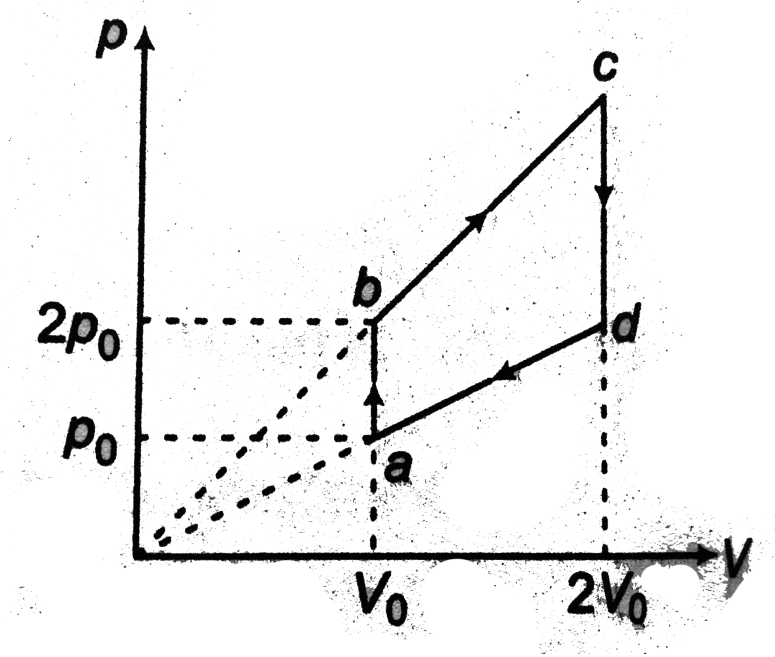
7. Method 2 of W

In the given p-V diagram, find



(a) pressures at c and d

(b) work done in different processes separately

(c) work done in complete cycle abcd.

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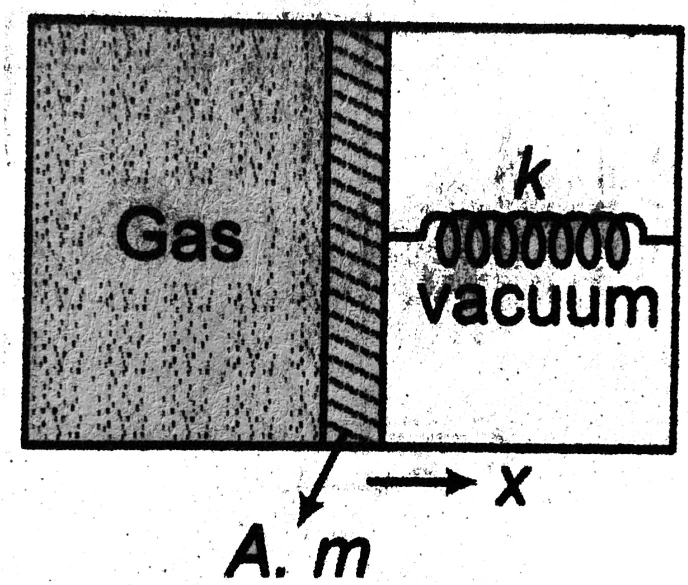
8. Method 3 of W

Mass of a piston shown in Fig. is m and area of cross-section is A. Initially spring is in its natural length. Find work done by the gas.



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9. Method 4 of W

The temperature of n-moles of an ideal gas is increased from T_0 to $2T_0$ through a process $p = \frac{\alpha}{T}$. Find work done in this process.

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10. Method 5 of W

Heat taken from a gas in a process is 80 J and increase in internal energy of the gas is 20J. Find work done by the gas in the given process.

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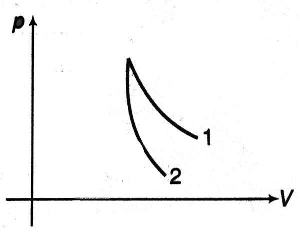
11. p-V plots for two gases during adiabatic processes are shown in the figure. Plots 1 and 2 should correspond respectively to



A. (a) H_e and O_2

B. (b) O_2 and H_e

C. (c) H_e and A_r

D. (d) O_2 and N_2

Answer: B

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

A. (a) $W_2 > W_1 > W_3$

B. (b) $W_2 > W_3 > W_1$

C. (c) $W_1 > W_2 > W_3$

D. (d) $W_1 > W_3 > W_2$

Answer: A

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13. When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied, which increases the internal energy of the gas, is

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

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

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

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

Answer: D

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14. What is the heat input needed to raise the temperature of 2 moles of helium gas from $0^\circ C$ to $100^\circ C$

$(a) atcons \tan tvolume, (b) atcons \tan tpressure? (c) w\hat{i} sthew$ or $kdo \neq by$

R`.

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15. An ideal monoatomic gas at 300K expands adiabatically to twice its volume. What is the final temperature?

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16. 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.

(a) Find the value of W_4.

(b) What are the efficiency of the cycle?

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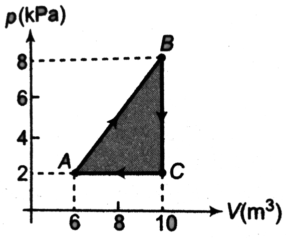
17. The density versus pressure graph of one mole of an ideal monatomic gas undergoing a cyclic process is shown in figure. The molecular mass of the gas is M.



(a) Find the work done in each process.

(b) Find heat rejected by gas in one complete cycle.

(c) Find the effiency of the cycle.

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18. Carnot engine takes one thousand kilo calories of heat from a reseervoir at $827^\circ C$ and exhausts it to a sink at $27^\circ C$. How, much work does it perform? What is the efficiency of the engine?

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19. In a refrigerator, heat from inside at 277K is transferred to a room at 300K. How many joules of heat shall be delivered to the room for each

joule of electrical energy consumed ideally?

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20. Calculate the least amount of work that must be done to freeze one gram of wate at $0^{\circ} C$ by means of a refrigerator. Temperature of surroundings is $27^{\circ} C$. How much heat is passed on the surroundings in this process? Latent heat of fusion $L = 80 cal / g$.

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Example Type 1

1. Boiling water: Suppose 1.0 g of water vaporizes isobarically at atmospheric pressure $(1.01 \times 10^{5} Pa)$. Its volume in the liquid state is $V_i = V_{liquid} = 1.0 cm^3$ and its volume in vapour state is $V_f = V_{vapour} = 1671 cm^3$. Find the work done in the expansion and the change in internal energy of the system. Ignore any mixing of the stream and the surrounding air. Take latent heat of vaporization $L_v = 2.26 \times 10^6 J / kg.$

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2. A metal of mass 1 kg at constant atmospheric pressure and at initial temperature $20^\circ C$ is given a heat of 20000J. Find the following

(a) change in temperature,

(b) work done and

(c) change in internal energy.

(Given, specific heat $= 400 J / kg - ^\circ C$, cofficient of cubical expansion, $\gamma = 9 \times 10^{-5} / ^\circ C$, density $\rho = 9000 kg / m^3$, atmospheric pressure $= 10^5 N / m^2$)

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Example Type 2

1. Make p-V equation for an adiabatic process.

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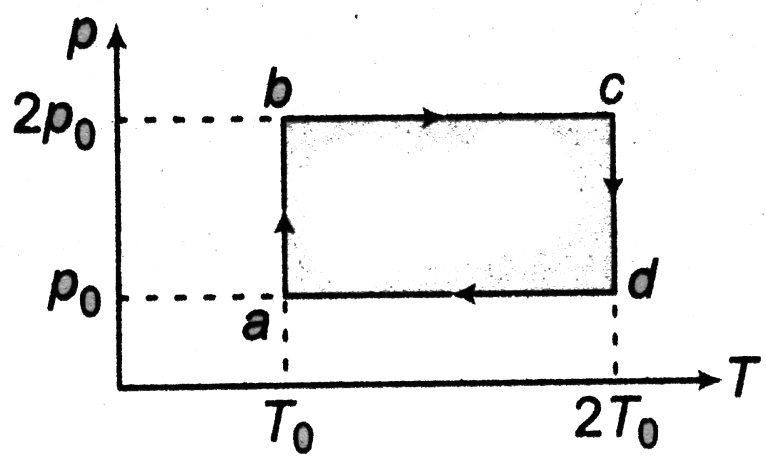
Example Type 3

1. A cyclic process abcd is given for a monoatomic gas ($C_V = \frac{3}{2}R$ and $C_p = \frac{5}{2}R$) as shown in figure. Find Q, W and ΔU in each of the four processes separately. Also find the effiecency of cycle.



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Miscellaneous Example

1. For a Carnot cycle (or engine) discussed in article 21.4, prove that efficiency of cycle is given by

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2. Find the molar specific heat of the process $p = \frac{a}{T}$ for a monoatomic gas, a being constant.

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3. At $27^{\circ} C$ two moles of an ideal monatomic gas occupy a volume V. The gas expands adiabatically to a volume $2V$. Calculate

(a) final temperature of the gas

(b) change in its internal energy and

(c) the work done by the gas during the process. [$R = 8.31 J / mol - K$]

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4. Two moles of a diatomic ideal gas is taken through $pT =$ constant. Its temperature is increased from T to 2T. Find the work done by the system?

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5. An ideal monoatomic gas at temperature $27^\circ C$ and pressure $10^6 N/m^2$ occupies 10L volume. 10,000 cal of heat is added to the system without changing the volume. Calculate the change in temperature of the gas. Given : $R = 8.31 J/mol - K$ and $J = 4.18 J/cal$.

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

$A \rightarrow B$ Adiabatic expansion

$B \rightarrow C$ Cooling at constant volume

$C \rightarrow D$ Adiabatic compression.

$D \rightarrow A$ Heating at constant volume

The pressure and temperature at A,B etc., are denoted by p_A, T_A, p_B, T_B etc. respectively.

Given, $T_A = 1000K, p_B = \left(\frac{2}{3}\right)p_A$ and $p_C = \left(\frac{1}{3}\right)p_A$. Calculate

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

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

Given, $\left(\frac{2}{3}\right)^{0.4} = 0.85$ and $R = 8.31J/mol - K$

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7. A gas undergoes a process such that $p \propto \frac{1}{T}$. If the molar heat capacity for this process is $C = 33.24J/mol - K$, find the degree of freedom of the molecules of the gas.

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

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

(b) Obtain the work done by the gas during the expansion as a function of the initial pressure p and volume V.

Given that $(5.66)^{0.4} = 2$

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Exercise 21 1

1. In a certain chemical process, a lab technician supplies 254 J of heat to a system. At the same time, 73 J of work are done on the system by its surroundings. What is the increase in the internal energy of the system?

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Exercise 21 2

1. A gas in a cylinder is held at a constant pressure of $1.7 \times 10^5 Pa$ and is cooled and compressed from $1.20m^3$ to $0.8m^3$. The internal energy of the gas decreases by $1.1 \times 10^5 J$.

(a) Find the work done by the gas.

(b) Find the magnitude of the heat flow into or out of the gas and state the direction of heat flow.

(c) Does it matter whether or not the gas is ideal?

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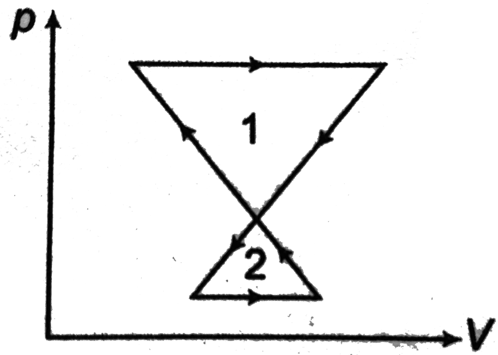
2. A thermodynamic system undergoes a cyclic process as shown in figure.



(a) over one complete cycle, does the system do positive or negative work.

(b) over one complete cycle, does heat flow into or out of the system.

(c) In each of the loops 1 and 2, does heat flow into or out of the system.

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3. How many moles of helium at temperature 300K and 1.00 atm pressure are needed to make the internal energy of the gas 100J?

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4. Temperature of four moles of a monoatomic gas is increased by 300K in isochoric process. Find W, Q and ΔU.

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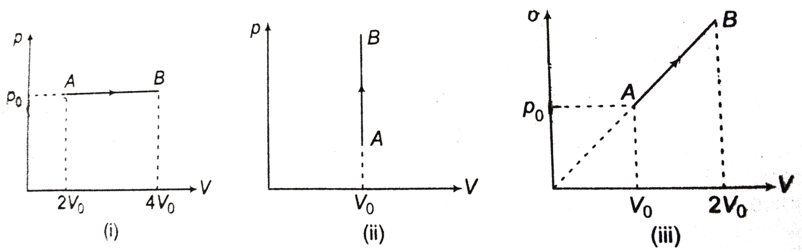
5. Find work done by the gas in the process AB shown in the following figures.



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6. Temperature of two moles of an ideal gas is increased by 300K in a process $V = \frac{a}{T}$, where a is positive constant. Find work done by the gas in the given process.

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7. Pressure and volume of a gas changes from (p_0V_0) to $\left(\frac{p_0}{4}, 2V_0\right)$ in a process $pV^2 =$ constant. Find work done by the gas in the given process.

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Exercise 21 3

1. One mole of an ideal monoatomic gas is initially at 300K. Find the final temperature if 200J of heat are added as follows:

(a) at constant volume (b) at constant pressure.

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2. An ideal gas expands while the pressure is kept constant. During the process, does heat flow into the gas or out of the gas? Justify you answer.

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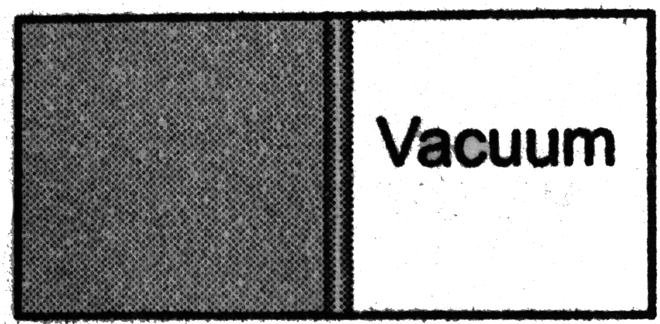
3. A well insulated box contains a partition dividing the box into two equal volumees as shown in figure. Initially, the left hand side contains an ideal monoatomic gas and the other half is a vacuum. The partition is suddenly removed so that the gas expands throughout the entire box.

(a) Does the temperature of gas change?

(b) Does the internal energy of the system change?

(c) Does the gas work?



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4. Find the ratio of $\frac{\Delta Q}{\Delta U}$ and $\frac{\Delta Q}{\Delta W}$ in an isobaric process. The ratio of molar heat capacities $\frac{C_p}{C_V} = \gamma$.

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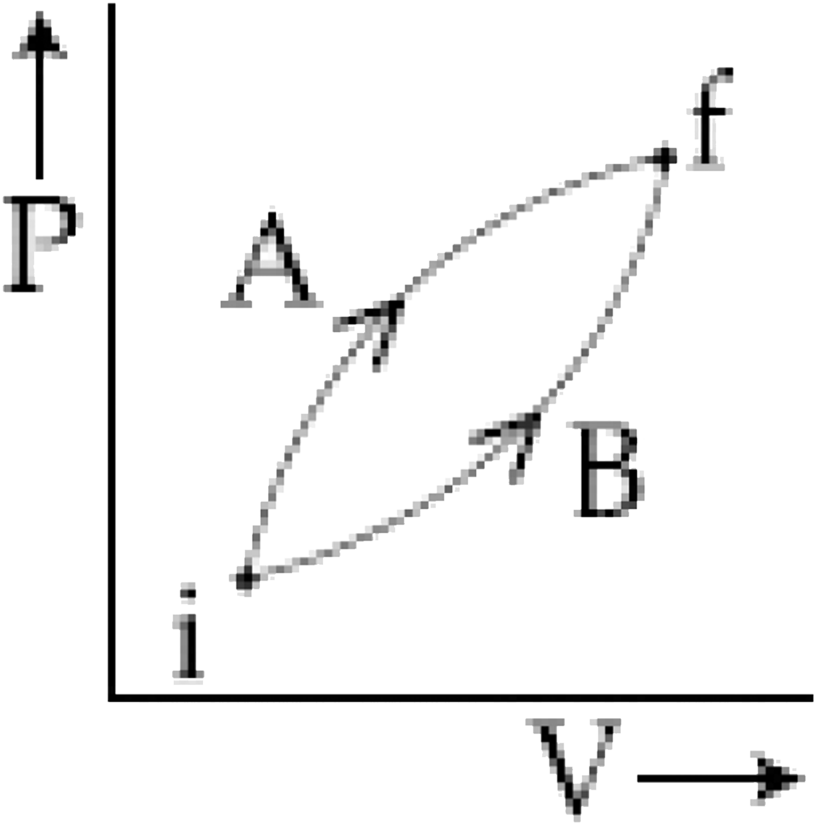
5. Following figure shows two process A and B for a gas. If ΔQ_A and ΔQ_B are the amount of heat absorbed by the system in two case, and ΔU_A and ΔU_B are changes in internal energies, respectively, then :



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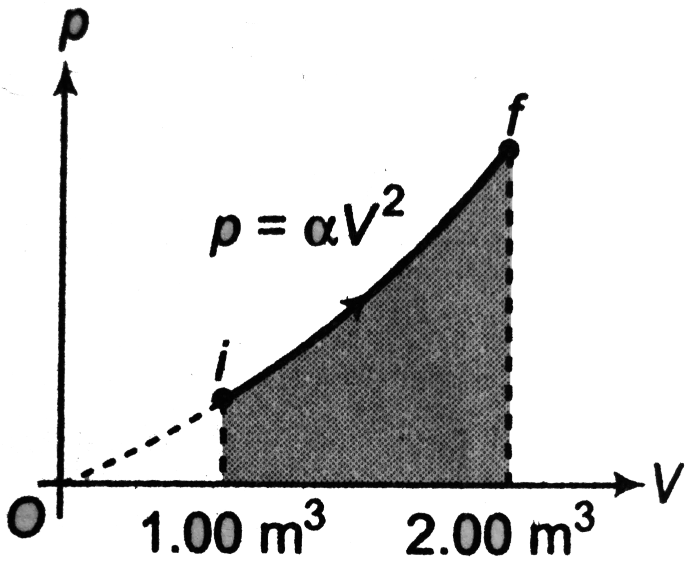
6. A sample of ideal gas is expanded to twice its original volume of $1.00m^3$ in a quasi-static process for which $p = \alpha V^2$, with $\alpha = 5.00 atm / m^6$, as shown in Fig. How much work is done by the expanding gas?



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

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Exercise 21 4

1. Carnot engine takes one thousand kilo calories of heat from a reseervoir at $827^\circ C$ and exhausts it to a sink at $27^\circ C$. How, much work does it perform? What is the efficiency of the engine?

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2. One of the most efficient engines ever developed operated between 2100K and 700K. Its actual efficiency is 40%. What percentage of its maximum possible efficiency is this?

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3. In a heat engine, the temperature of the source and sink are 500 K and 375 K. If the engine consumes $25 \times 10^5 J$ per cycle, find(a) the efficiency of the engine, (b) work done per cycle, and (c) heat rejected to the sink per cycle.

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4. A Carnot engine takes $3 \times 10^6 cal.$ of heat from a reservoir at $62^\circ C$, and gives it to a sink at $27^\circ C$. The work done by the engine is

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5. The efficiency of a Carnot cycle is $1/6$. If on reducing the temperature of the sink by $65^\circ C$, the efficiency becomes $1/3$, find the source and sink temperatures between which the cycle is working.

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6. Refrigerator A works between $-10^\circ C$ and $27^\circ C$, while refrigerator B works between $-27^\circ C$ and $17^\circ C$, both removing heat equal to 2000J from the freezer. Which of the two is the better refrigerator?

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7. A refrigerator has to transfer an average of 263J of heat per second from temperature $-10^{\circ} C$ to $25^{\circ} C$. Calculate the average power consumed, assuming no enegy losses in the process.

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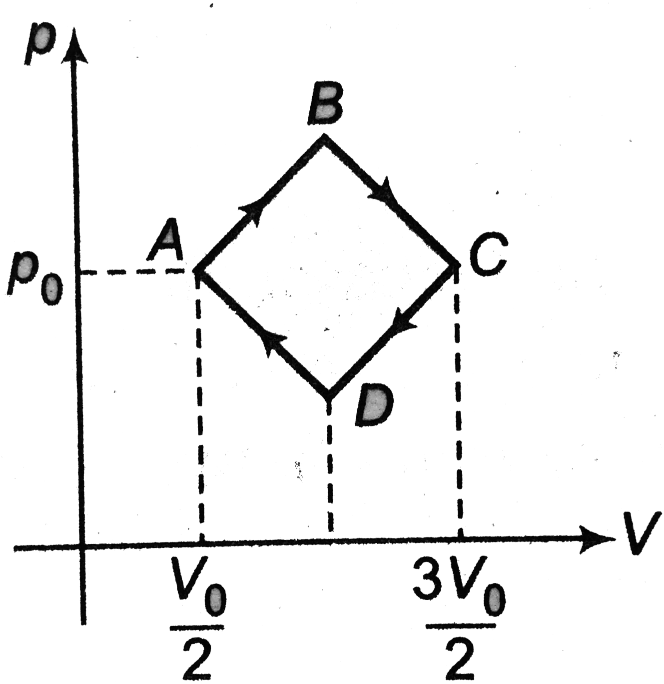
8. n moles of a monoatomic gas are taken around in a cyclic process consisting of four processes along ABCDA as shown. All the lines on the p-V diagram have slope of magnitude p_0 / V_0. The pressure at A and C is p_0 and $the volumes at A$ and $C are$V_0//2 and 3V_0//2`, respectively.

Calculate the percentage efficiency of the cycle.



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Level 1 Assertion And Reason

1. Assertion: In adiabatic expansion, temperature of gas always decreases.

Reason: In adiabatic process exchange of heat is zero.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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2. Assertion: In a thermodynamic process, initial volume of gas is equal to final volume of gas. Work done by gas in this process should be zero

Reason: Work done by gas in isochoric process is zero.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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3. Assertion: First law of thermodynamics can be applied for ideal gases only.

Reason: First law is simply, law of consevation of energy.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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4. Assertion: When ice melts, work is done by atmosphere on (ice+water) system.

Reason: On melting of ice volume of (ice+water) system decreases.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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5. Assertion: Between two thermodynamic states, the value of (Q-W) is constant for any process.

Reason: Q and W are path functions.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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6. Assertion: Efficiency of a heat engine can't be greater than efficiency of Carnot engine.

Reason: Efficiency of any engine is never 100%

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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7. Assertion: In the process pT=constant, if temperature of gas is increased work done by the gas is positive.

Reason: For the given process, $V \propto T$.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: C

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8. Assertion: In free expansion of a gas inside an aidabatic chamber Q, W and ΔU all are zero.

Reason: In such an expansion $p \propto \frac{1}{V}$.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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9. Assertion: For an ideal gas in a cyclic process and in an isothermal process change in internal energy is zero.

Reason: In both processes there is no change in temperature.

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: A

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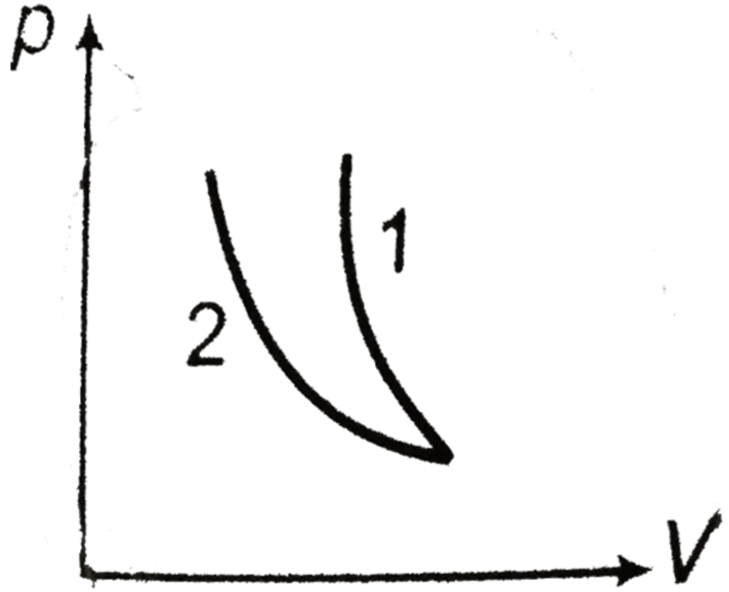
10. Assertion: Isothermal and adiabatic, two processes are shown on p-V diagram. Process-1 is aidabatic and process-2 is isothermal.

Reason: At a given point, slope of adiabatic process $= \gamma \times$ slope of isothermal process.



A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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Level 1 Objective

1. In a process, the pressure of an ideal gas is proportional to square of the volume of the gas. If the temperature of the gas increases in this process, then work done by this gas

A. (a) is positive

B. (b) is negative

C. (c) is zero

D. (d) may be positive or negative

Answer: A

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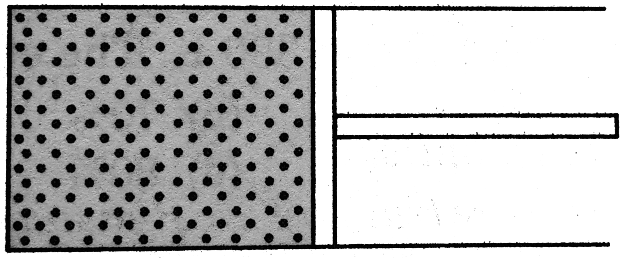
2. n moles of a gas are filled in a container at temperature T. If the gas is slowly and isothermally compressed to half its initial volume, the work done by the atmosphere on the gas is



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

B. $-\frac{nRT}{2}$

C. $nRTIn2$

D. $-nRTIn2$

Answer: C

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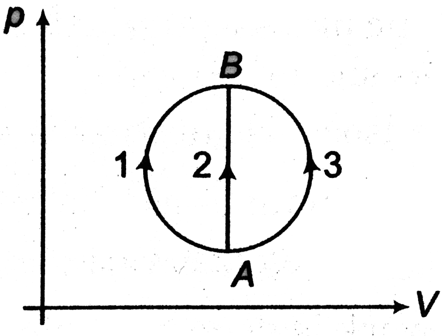
3. A gas undergoes A to B through three different processes 1,2 and 3 as shown in the figure. The heat supplied to the gas is Q_1, Q_2 and Q_3 respectively, then



A. (a) $Q_1 = Q_2 = Q_3$

B. (b) $Q_1 < Q_2 < Q_3$

C. (c) $Q_1 > Q_2 > Q_3$

D. (d) $Q_1 = Q_3 > Q_2$

Answer: C

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4. For an adiabatic compression the quantity pV

A. (a) increases

B. (b) decreases

C. (c) remains constant

D. (d) depends on γ

Answer: A

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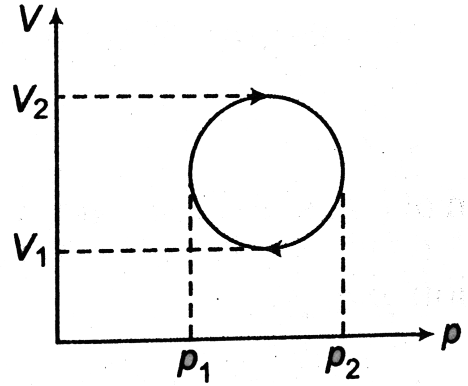
5. The cyclic process form a circle on a pV diagram as shown in figure. The work done by the gas is



A. (a) $\frac{\pi}{4}(p_2 - p_1)^2$

B. (b) $\frac{\pi}{4}(V_2 - V_1)^2$

C. (c) $\frac{\pi}{2}(p_2 - p_1)(V_2 - V_1)$

D. (d) $\frac{\pi}{4}(p_2 - p_1)(V_1 - V_2)$

Answer: D

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6. An ideal gas has initial volume V and pressure p. In doubling its volume the minimum work done will be in the process (of the given processes)

A. (a) isobaric process

B. (b) isothermal process

C. (c) adiabatic process

D. (d) same in all given processes

Answer: C

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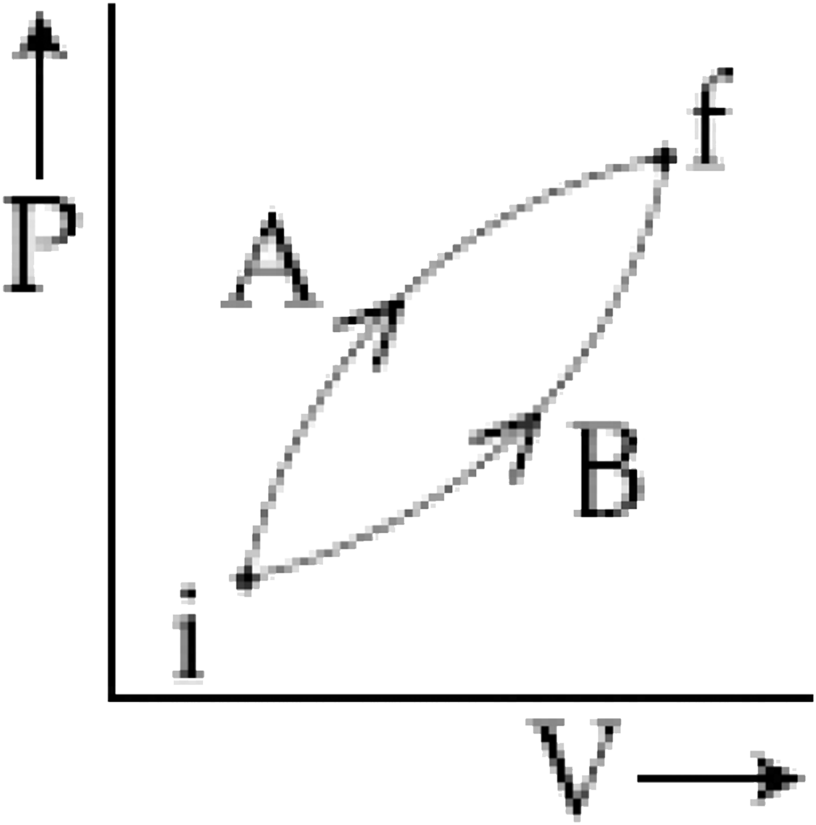
7. Following figure shows two process A and B for a gas. If ΔQ_A and ΔQ_B are the amount of heat absorbed by the system in two case, and ΔU_A

and ΔU_B are changes in internal energies, respectively, then :



A. (a) $\Delta Q_1 = \Delta_2, \Delta U_1 = \Delta U_2$

B. (b) $\Delta Q_1 > \Delta Q_2, \Delta U_1 > \Delta U_2$

C. (c) $\Delta Q_1 < \Delta Q_2, \Delta U_1 < \Delta U_2$

D. (d) $\Delta Q_1 > \Delta Q_2, \Delta U_1 = \Delta U_2$

Answer: D

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8. A Carnot engine works between 600K and 300K. The efficiency of the engine is

A. 50%

B. 70%

C. 20%

D. 80%

Answer: A

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9. A gas is contained in a metallic cylinder fitted with a piston.The piston is suddenly moved in to compress the gas and is maintained at this position. As time passes the pressure of the gas in the cylinder

A. (a) increaes

B. (b) decreases

C. (c) remains the same

D. (d) may increase or decrease depending on the nature of the gas

Answer: B

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10. A cycle pump becomes hot near the nozzle after a few quick strokes even if they are smooth because

A. the volume of air decreases

B. the number of air molecules increases

C. the compression is adiabatic

D. collision between air particles increases

Answer: C

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11. In an adiabatic change, the pressure p and temperature T of a diatomic gas are related by the relation $p \propto T^{\alpha}$, where α equals

A. (a) 1.67

B. (b) 0.4

C. (c) 0.6

D. (d) 3.5

Answer: D

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12. A diatomic gas obeys the law $pV^x =$ constant. For what value of x, it has negative molar specific heat?

A. (a) $x > 1.4$

B. (b) $x < 1.4$

C. (c) $1 < x < 1.4$

D. (d) 0ltxlt1

Answer: C

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13. The molar specific heat at constant volume of gas mixture is $\frac{13R}{6}$. The gas mixture consists of

A. 2 moles of O_2 and 4 moles of H_2

B. 2 moles of O_2 and 4 moles of argon

C. 2 moles of argon and 4 moles of O_2

D. 2 moles of CO_2 and 4 moles of argon

Answer: C

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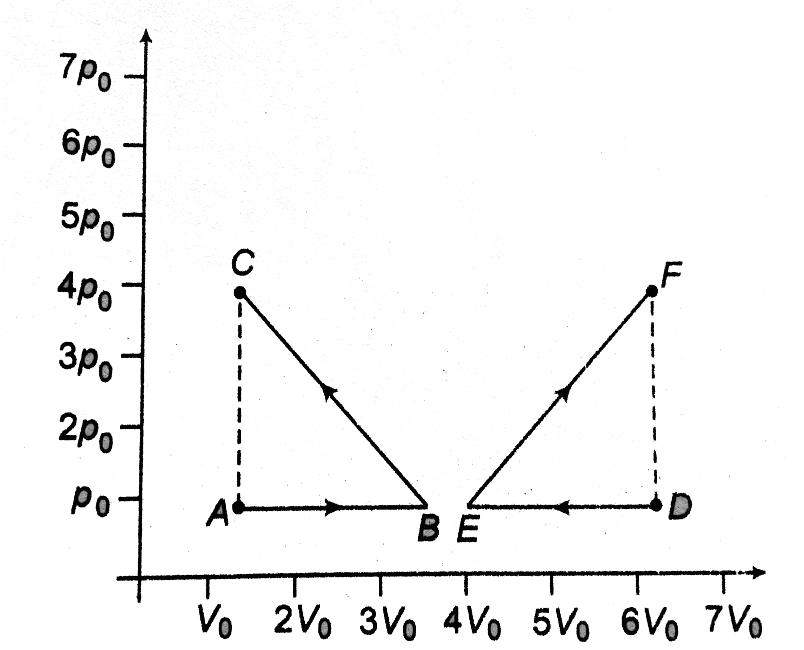
14. If W_{ABC} is the work done in process $A \rightarrow B \rightarrow C$ and W_{DEF} is work done in process $D \rightarrow E \rightarrow F$ as shown in the figure, then



A. (a) $|W_{DEF}| > |W_{ABC}|$

B. (b) $|W_{DEF}| < |W_{ABC}|$

C. (c) $|W_{DEF}| < |W_{ABC}|$

D. (d) $W_{DEF} = -W_{ABC}$

Answer: D

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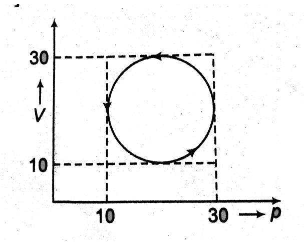
Level 1 Objective Questions

1. Heat energy absorbed by a system in going through a cyclic process as shown in figure [V in litre and p in kPa] is



A. (a) $10^{7}\pi J$

B. (b) $10^{4}\pi J$

C. (c) $10^{\pi} J$

D. (d) $10^{3}\pi J$

Answer: C

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Level 1 Subjective

1. How many moles of helium at temperature 300K and 1.00 atm pressure are needed to make the internal energy of the gas 100J?

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2. Show how internal energy U varies with T in isochoric, isobaric and adiabatic process?

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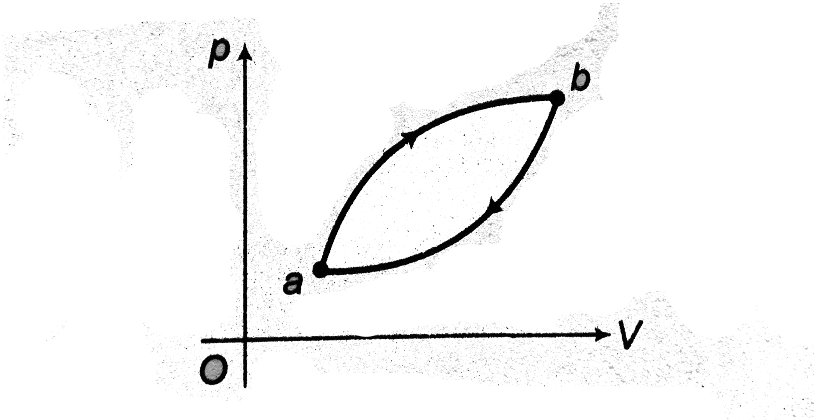
3. A system is taken around the cycle shown in figure from state a to state b and then back to state a. The absolute value of the heat transfer during one cyle is 7200J. (a) Does the system absorb or liberate heat when it goes around the cycle in the direction shown in figure? (b) What is the work W done by the system in one cycle? (c) If the system goes around the cycle in a counter-clock wise direction, does it absorb or liberate heat in one cycle? What is the magnitude of the heat absorbed or liberated in one counter-clockwise cycle?



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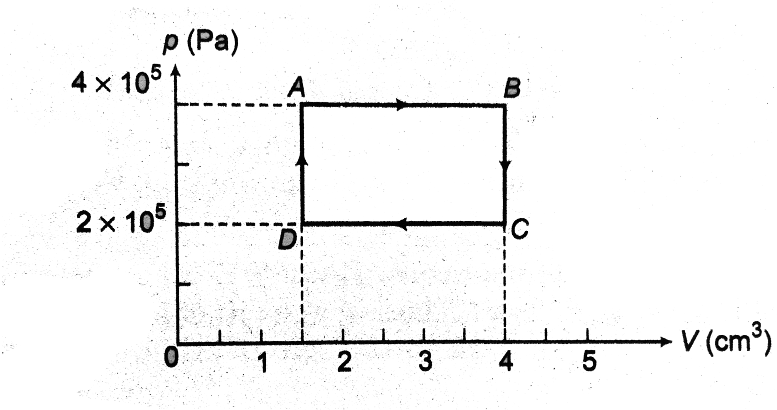
4. For the thermodynamic cycle shown in figure find (a) net output work of the gas during the cycle, (b) net heat flow into the gas per cycle.



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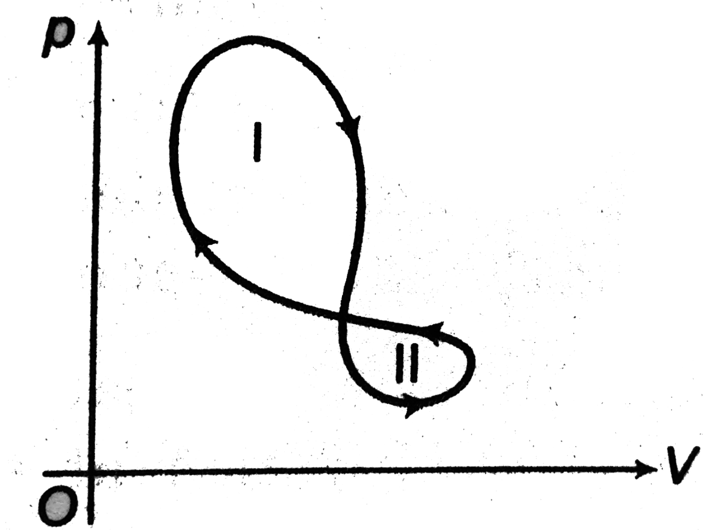
5. A thermodynamic system undergoes a cyclic process as shown in figure. The cycle consists of two closed loops, loop I and loop II. (a) Over one complete cycle, does the system do positive or negative work? (b) In each of loops I and II, is the net work done by the system positive or negative? (c) Over one complete cycle, does heat flow into or out of the system? (d) In each of loops I and II, does heat flow into or out of the system?



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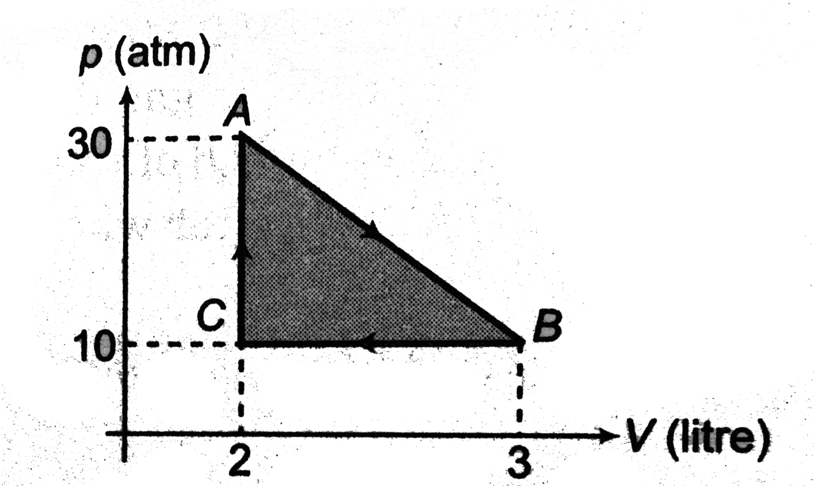
6. A gas undergoes the cycle shown in figure. The cycle is repeated 100 times per minute. Determine the power generated.



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7. One mole of an ideal monoatomic gas is initially at 300K. Find the final temperature if 200J of heat are added as follows:

(a) at constant volume (b) at constant pressure.

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8. A closed vessel 10L in volume contains a diatomic gas under a pressure of $10^5 N/m^2$. What amount of heat should be imparted to the gas to increase the pressure in the vessel five times?

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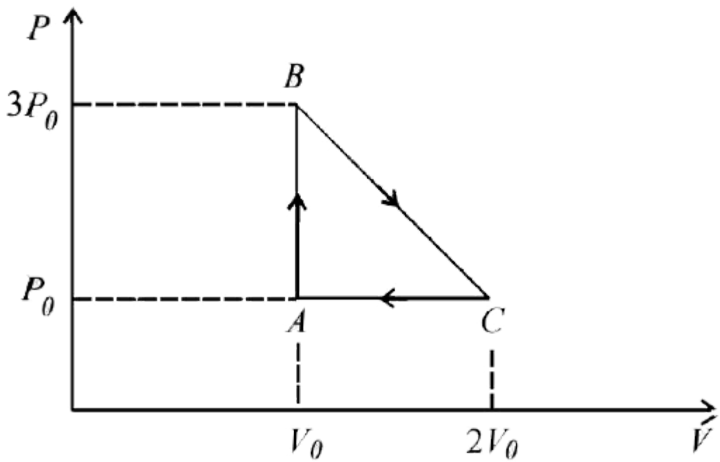
9. One mole of an ideal monatomic gas is taken round the cyclic process ABCA as shown in figure. Calculate



(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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10. A diatomic ideal gas is heated at constant volume until its pressure becomes three times. It is again heated at constant pressure until its volume is doubled. Find the molar heat capacity for the whole process.

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11. Two moles of a certain gas at a temperature $T_0 = 300K$ were cooled isochorically so that the pressure of the gas got reduced 2 times. Then as a result of isobaric process, the gas is allowed to expand till its temperature got back to the initial value. Find the total amount of heat absorbed by gas in this process.

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12. Five moles of an ideal monoatomic gas with an initial temperature of $127^{\circ} C$ expand and in the process absorb 1200J of heat and do 2100J of work. What is the final temperature of the gas?

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13. Find the change in the internal energy of $2kg$ of water as it heated from $0^{0} C \rightarrow 4^{0} C$. The specific heat capacity of water is $4200 J kg^{-1} K^{-1}$ and its densities at $0^{0} C$ and $4^{0} C$ are $999.9 kg m^{-3}$ and $1000 kg m^{-3}$ respectively. atmospheric pressure $= 10^{5}$ Pa.

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14. Calculate the increase in the internal energy of $10 g$ of water when it is heated from $0^{0} C \rightarrow 100^{0} C$ and converted into steam at $100 kPa$. The density of steam $= 0.6 kg m^{-3}$, specific heat capacity of water $= 4200 J kg^{-1^{0} C^{-3}}$,latent heat of vaporization of water $= 2.25 \times 106 J kg^{-1}$

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15. One gram of water $(1cm^3)$ becomes $1671cm^3$ of steam when boiled at a constant pressure of 1 atm $(1.013 \times 10^5 Pa)$. The heat of vaporization at this pressure is $L_v = 2.256 \times 10^6 J/kg$. Compute (a) the work done by the water when it vaporizes and (b) its increase in internal energy.

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16. A gas in a cyclinder is held at a constant pressure of $2.30 \times 10^5 Pa$ and is cooled and compressed from $1.70m^3$ to $1.20m^3$. The internal energy of the gas decreases by $1.40 \times 10^5 J$. (a) Find the work done by the gas. (b) Find the absolute value $|Q|$ of the heat flow into or out of the gas and state the direction of the heat flow. (c) Does it matter whether or not the gas is ideal? Why or why not?

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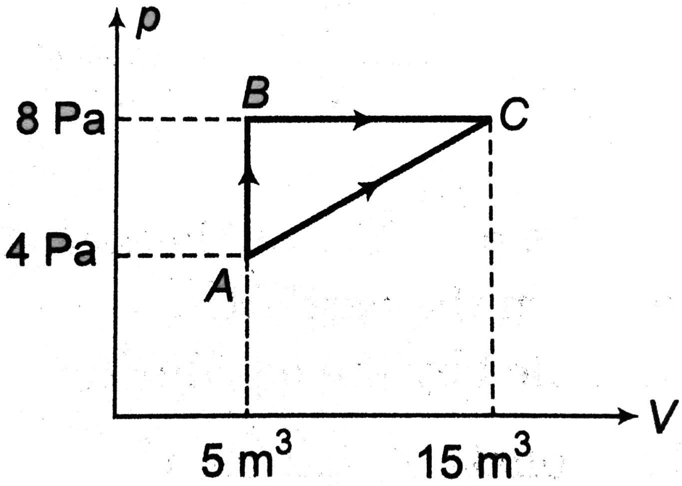
17. p-V diagram of an ideal gas for a process ABC is as shown in the figure.



(a) Find total heat absorbed or released by the gas during the process ABC.

(b) Change in internal energy of the gas during the process ABC.

(c) Plot pressure versus density graph of the gas for the process ABC.

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18. In the given graph, an ideal gas changes its state from A to C by two paths ABC and AC.

1

(a) Find the path along which work done is less.

(b) The intenal energy of gas at A is 10J and the amount of heat supplied in path AC is 200J. Calculate the internal energy of gas at C.

(c) The internal energy of gas at state B is 20J. Find the amount of heat supplied to the gas to go from A to B.

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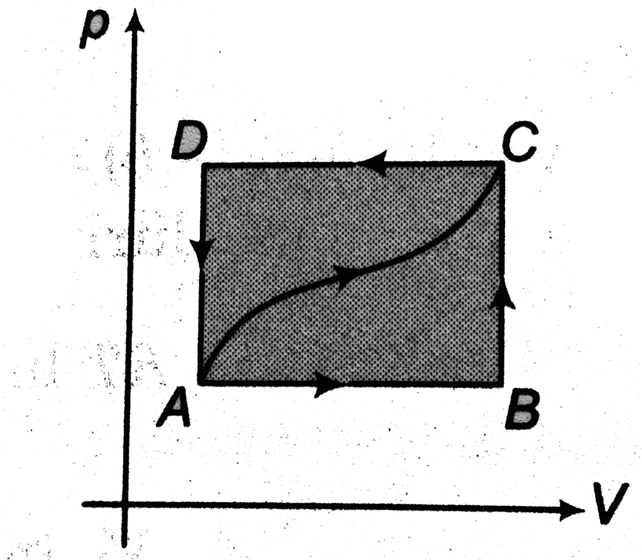
19. When a gas expands along AB, it does 500J of work and absorbs 250 J of heat. When the gas expands along AC, it does 700J of work and absorbs 300J of heat.



(a) How much heat does the gas exchange along Bc?

(b) When the gas makes the transition from C to A along CDA, 800J of work are done on it from C to D. How much heat does it exchange along CDA?

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20. A 1.0 kg bar of copper is heated at atmospheric pressure $(1.01 \times 10^5 N/m^2)$. If its temperature increases from $20^\circ C$ to $20^\circ C$, calculate the change in its internal energy. $\alpha = 7.0 \times 10^{-6} / ^\circ C$, $\rho = 8.92 \times 10^3 kg/m^3$ and $c = 387 J/kg - ^\circ C$.

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21. One mole of an ideal monoatomic gas occupies a volume of $1.0 \times 10^{-2} m^3$ at a pressure of $2.0 \times 10^5 N/m^2$.

(a) What is the temperature of tha gas?

(b) The gas undergoes an adiabatic compression until its volume is decreased to $5.0 \times 10^{-3} m^3$. What is the new gas temperature?

(c) How much work is done on the gas during the compression?

(d) What is the change in the intenal energy of the gas?

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22. A bullet of mass 10g travelling horizontally at $200 m/s$ strikes and embeds in a pendulum bob of mass 2.0 kg.

(a) How much mechanical energy is dissipated in the collision?

(b) Assuming that C_v for the bob plus bullet is 3R, calculate the temperature increase of the system due to the collision. Take the molecular mass of the system to be $200g/mol$.

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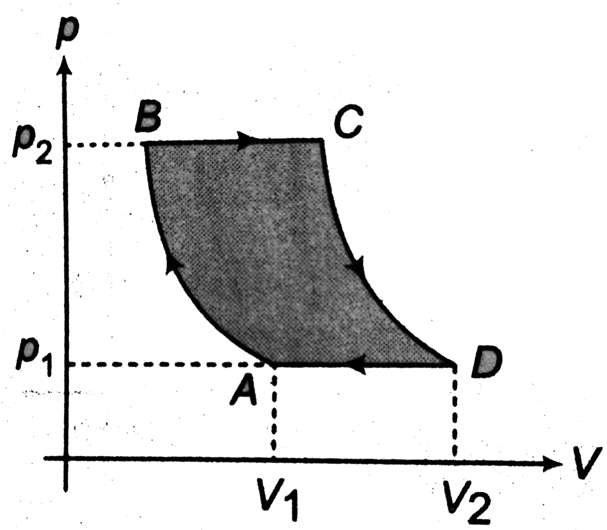
23. An ideal gas is carried through a thermodynamic cycle consisting of two isobaric and two isothermal processes as shown in figure. Show that the net work done in the entire cycle is given by the equation. $W_{net} = p_1(V_2 - V_1)In\frac{p_2}{p_1}$



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24. An ideal gas is enclosed in a cyclinder with a movable piston on top. The piston has mass of 8000g and an area of $5.00 cm^2$ and is free to slide up and down, keeping the pressure of the gas constant. How much work is done as the temperature of $0.200 mol$ of the gas is raised from $200^\circ C$ to $300^\circ C$?

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Level 2 Single Correct

1. The equation of a state of a gas is given by $p(V-b)=nRT$. If 1 mole of a gas is isothermally expanded from volume V and 2V, the work done during the process is

A. (a) $RT\ln\left|\frac{2V-b}{V-b}\right|$

B. (b) $RT\ln\left|\frac{V-b}{V}\right|$

C. (c) $RTIn\left|\frac{V-b}{2V-b}\right|$

D. (d) $RTIn\left|\frac{V}{V-b}\right|$

Answer: A

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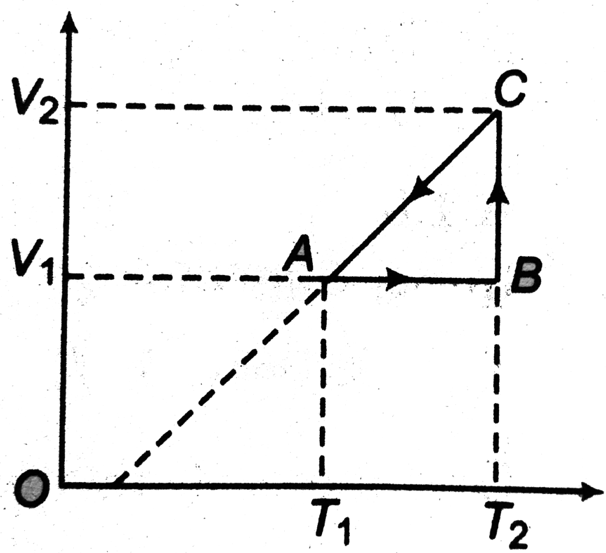
2. The cyclic process for 1 mole of an ideal gas is shown in the V-T diagram. The work done in AB, BC and CA respectively is



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

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

C. (c) 0, $RT_1 In\left|\frac{V_1}{V_2}\right|, R(T_1 - T_2)$

D. (d) 0,RT_(2)In|V_2/V_1|,R(T_2-T_1)`

Answer: A

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3. Ten moles of a diatomic perfect gas are allowed to expand at constant pressure. The initial volume and temperature are V_0 and T_0 respectively. If $\frac{7}{2}RT_0$ heat is transferred to the gas, then the final volume and temperature are

A. (a) $1.1V_0, 1.1T_0$

B. (b) $0.9V_0, 0.9T_0$

C. (c) $1.1V_0, \frac{10}{11}T_0$

D. (d) $0.9V_0, \frac{10}{9}T_0$

Answer: A

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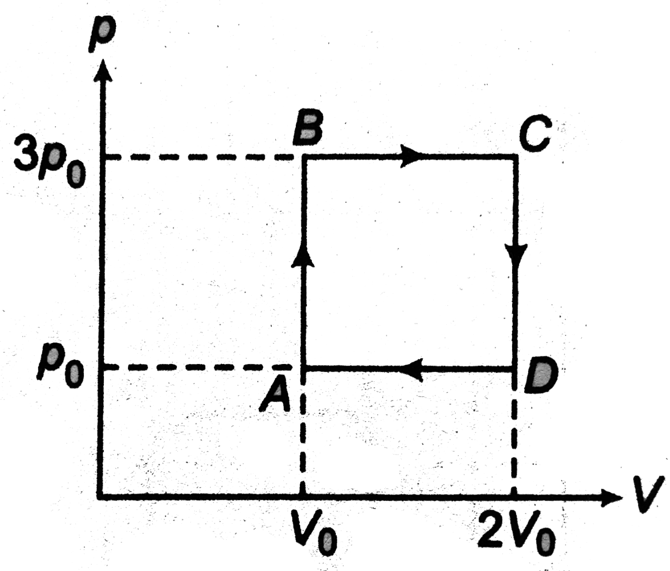
4. An ideal monoatomic gas is carried around the cycle ABCDA as shown in the figure. The efficiency of the gas cycle is



A. $\frac{4}{21}$

B. $\frac{2}{21}$

C. $\frac{4}{31}$

D. $\frac{2}{31}$

Answer: A

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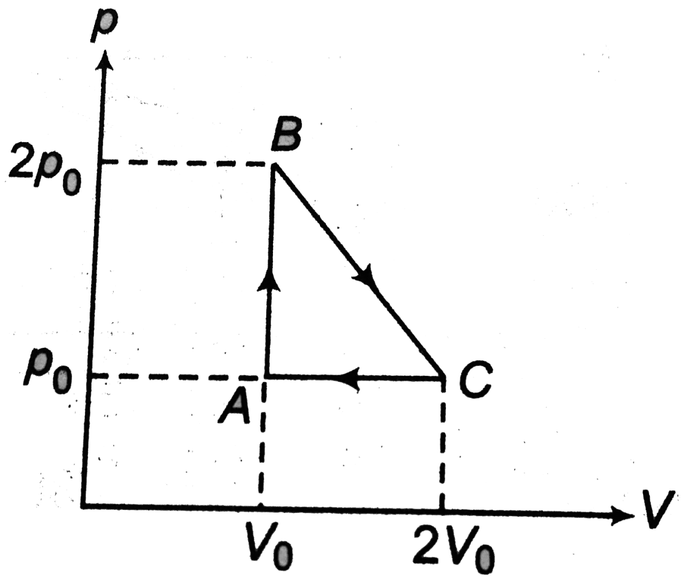
5. In the process shown in figure, the internal energy of and ideal gas decreases by $\frac{3p_0V_0}{2}$ in going from point C to A. Heat transfer along the process CA is



A. $(-3p_0V_0)$

B. $\left(-\frac{5}{2}p_0V_0\right)$

C. $\left(-\frac{3}{2}p_0V_0\right)$

D. zero

Answer: B

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6. One mole of an ideal monoatomic gas at temperature T_0 expands slowly according to the law $\frac{p}{V}$ = constant. If the final temperature is $2T_0$, heat supplied to the gas is

A. $2RT_0$

B. $\frac{3}{2}RT_0$

C. RT_0

D. $\frac{1}{2}RT_0$

Answer: A

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7. A mass of gas is first expanded isothermally and then compressed adiabatically to its original volume. What further simplest operation must be performed on the gas to restore it to its original state?

A. An isobaric cooling to bring its temperature to initial value

B. An isochoric cooling to bring its pressure to its initial value

C. An isothermal process to take its pressure to its initial value

D. An isochoric heating to bring its temperature to initial value

Answer: B

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8. A monoatomic ideal gas, initially at temperature T_1, is enclosed in a cylinder fitted with a friction less piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If L_1 and L_2 are the length of the gas column before expansion respectively, then $\frac{T_1}{T_2}$ is given by

A. (a) $\left(\frac{L_1}{L_2}\right)^{\frac{2}{3}}$

B. (b) $\frac{L_1}{L_2}$

C. (c) $\frac{L_2}{L_1}$

D. (d) $\left(\frac{L_2}{L_1}\right)^{\frac{2}{3}}$

Answer: D

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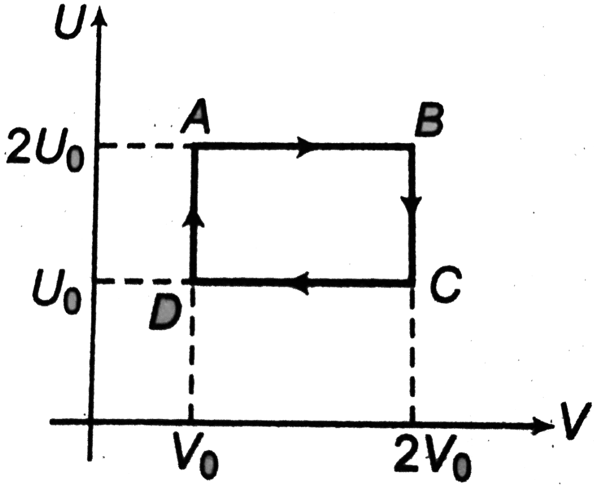
9. One mole of an ideal gas is taken through a cyclic process. The minimum temperature during the cycle is 300K. Then, net exchange of heat for complete cycle is



A. $600R\ln 2$

B. $300R\ln 2$

C. $-300R\ln 2$

D. $900R\ln 2$

Answer: B

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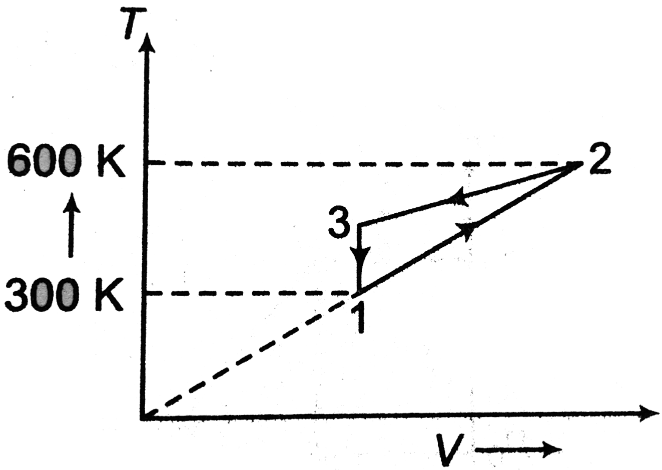
10. Two moles of an ideal gas are undergone a cyclic process 1-2-3-1. If net heat exchange in the process is 300J, the work done by the gas in the process 2-3 is



A. $-500J$

B. $-5000J$

C. $-3000J$

D. None of these

Answer: D

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11. 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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12. A gas follows a process $TV^{n-1} = constant$, where $T =$ absolute temperature of the gas and $V =$ volume of the gas. The bulk modulus of the gas in the process is given by

A. (a) $(n-1)p$

B. (b) $p/(n-1)$

C. (c) np

D. (d) p/n

Answer: C

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13. One mole of an ideal gas at temperature T expands slowly according to the law $\frac{p}{V}=$ constant.

Its final temperature is T_2. The work done by the gas is

A. (a) $R(T_2-T_1)$

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

C. (c) $\frac{R}{2}(T_2-T_1)$

D. (d) $\frac{2R}{3}(T_2 - T_1)$

Answer: C

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14. 600J of heat is added to a monoatomic gas in a process in which the gas performs a work of 150J. The molar heat capacity for the process is

A. 3R

B. 4R

C. 2R

D. 6R

Answer: C

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15. The internal energy of a gas is given by $U = 2pV$. It expands from V_0 to $2V_0$ against a constant pressure p_0. The heat absorbed by the gas in the process is

A. (a) $2p_0V_0$

B. (b) $4p_0V_0$

C. (c) $3p_0V_0$

D. (d) p_0V_0

Answer: C

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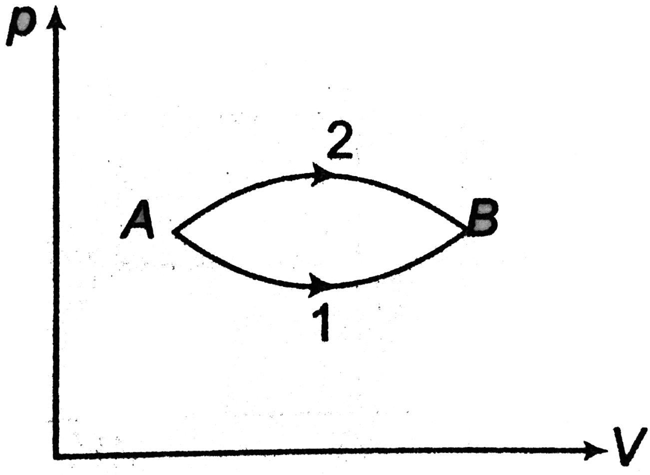
16. The figure shows two paths for the change of state of a gas from A to B. The ratio of molar heat capacities in path 1 and path 2 is is



A. < 1

B. < 1

C. 1

D. Data insufficient

Answer: A

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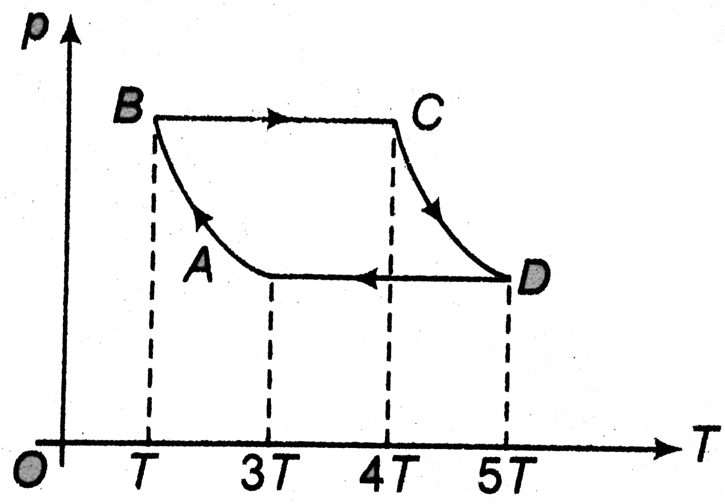
17. p-T diagram of one mole of an ideal monatomic gas is shown. Processes AB and CD are adiabatic. Work done in the complete cycle is



A. $2.5RT$

B. $-2RT$

C. $1.5RT$

D. $-3.5RT$

Answer: A

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18. An ideal monoatomic gas undergoes a process in which its internal energy U and density ρ vary as $U\rho$= constant. The ratio of change in internal energy and the work done by the gas is

A. (a) $\frac{3}{2}$

B. (b) $\frac{2}{3}$

C. (c) $\frac{1}{3}$

D. (d) $\frac{3}{5}$

Answer: A

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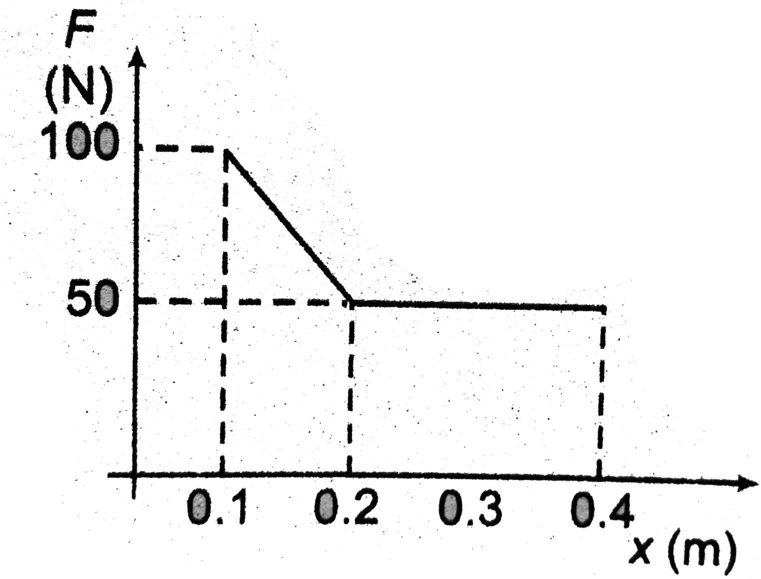
19. The given figure shows the variation of force applied by ideal gas on a piston which undergoes a process during which piston position changes from 0.1 to 0.4m. If the internal energy of the system at the end of the process is 2.5 J higher, then the heat (in joule) absorbed during the process is



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20. A gas can expand through two processes : (i) isobaric, (ii) $\frac{p}{V}$ =constant. Assuming that the initial volume is same in both processes and the final volume which is two times the initial volume is also same in both processes, which of the following is true?

A. (a) Work done by gas in process (i) is greater than the work done by the gas in process (ii)

B. (b) Work done by gas in process (i) is smaller than the work done by the gas in process (ii)

C. (c) Final pressure is greater in process (i)

D. (d) Final temperature is greater in process (i)

Answer: B

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21. An ideal gas of adiabatic exponent γ is expanded so that the amount of heat transferred to the gas is equal to the decrease of its internal energy. Then, the equation of the process in terms of the variables T and V is

A. $TV^{\frac{(\gamma-1)}{2}}=C$

B. $TV^{\frac{(\gamma-2)}{2}}=C$

C. $TV^{\frac{(\gamma-1)}{4}}=C$

D. $TV^{\frac{(\gamma-2)}{4}}=C$

Answer: A

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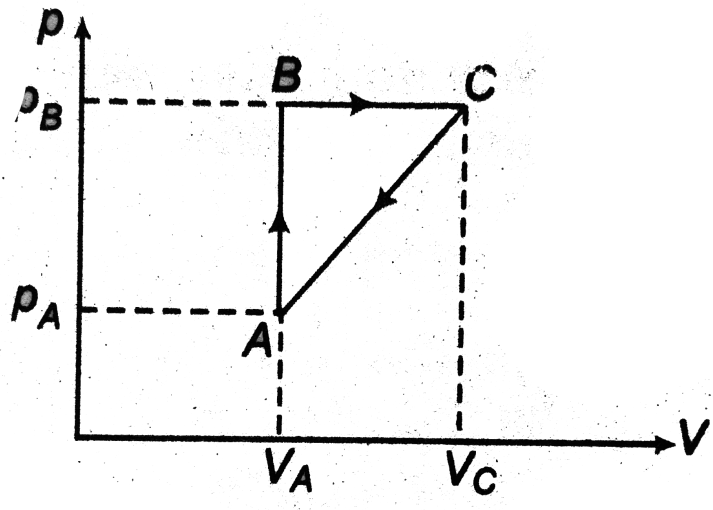
22. A thermodynamical process is shown in the figure with $p_A=3\times p_{atm}$, $V_A=2\times10^{-4}m^3$, $p_B=8\times p_{atm}$, $V_C=5\times10^{-4}m^3$. In the process AB and BC, 600J and 200J heat are added to the system. Find the change in internal energy of the system in the process CA. $\left[1p_{atm} = 10^5 N/m^2\right]$



A. (a) $560J$

B. (b) $-560J$

C. (c) $-240J$

D. (d) $+240J$

Answer: B

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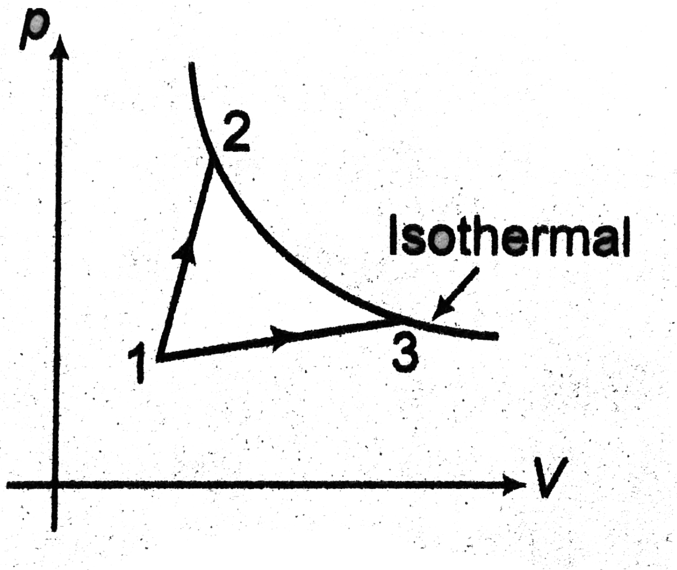
23. A gas takes part in two processes in which it is heated from the same initial state 1 to the same final temperature. The processes are shown on the p-V diagram by the straight lines 1-3 and 1-2. 2 and 3 are the points on the same isothermal curve. Q_1 and Q_2 are the heat transfer along the two processes. Then,



A. $Q_1 = Q_2$

B. $Q_1 < Q_2$

C. $Q_1 > Q_2$

D. Insufficient data

Answer: C

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24. A closed system receives 200kJ of heat at constant volume. It then rejects 100kJ of heat while it has 50kJ of work done on it at constant pressure. If an adiabatic process can be found which will restore the system to its initial state, the work done by the system during this process is

A. 100kJ

B. 50kJ

C. 150kJ

D. 200kJ

Answer: C

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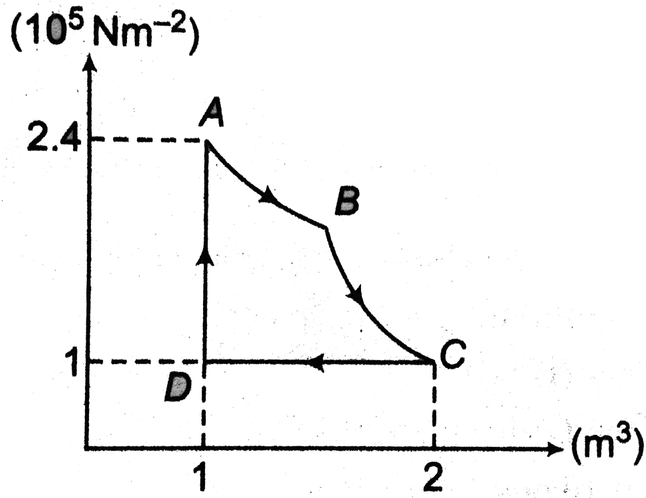
25. 100 moles of an ideal monatomic gas undergoes the thermodynamic process as shown in the figure



$A \to B$: isothermal expansion $B \to C$: adiabatic expansion

$C \to D$: isobaric compression $D \to A$: isochoric process The heat transfer along the process AB is $9 \times 10^4 J$. The net work done by the gas during the cycle is [Take $R = 8JK^{-1}mol^{-1}$]

A. $-0.5 \times 10^4 J$

B. $+0.5 \times 10^4 J$

C. $-5 \times 10^4 J$

D. $+5 \times 10^4 J$

Answer: D

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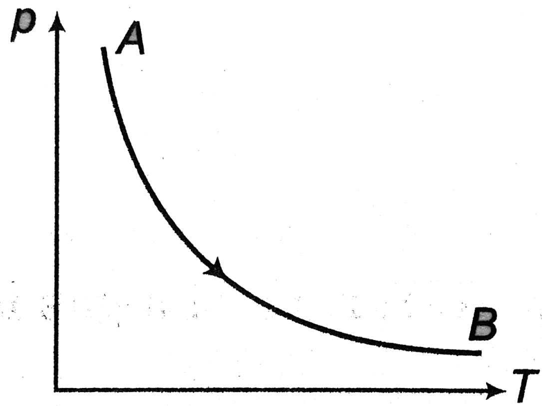
26. Two moles of an ideal monoatomic gas are expanded according to the equation pT=constant form its initial state (p_0, V_0) to the final state due to which its pressure becomes half of the initial pressure. The change in internal energy is



A. $\frac{3p_0V_0}{4}$

B. $\frac{3p_0V_0}{2}$

C. $\frac{9p_0V_0}{2}$

D. $\frac{5p_0V_0}{2}$

Answer: B

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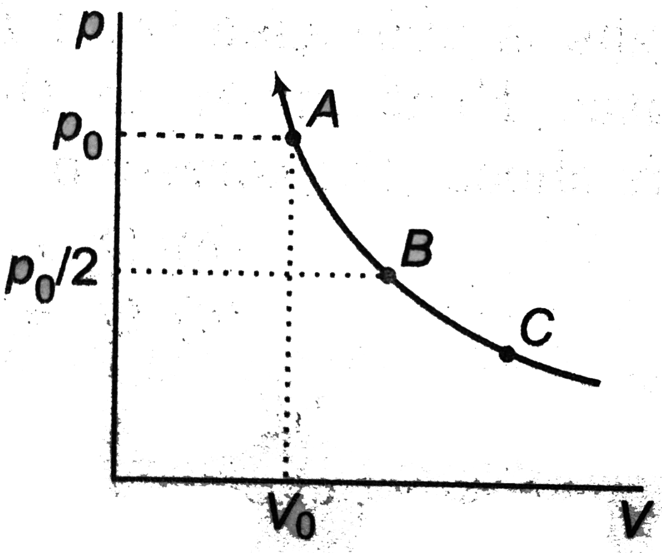
27. The state of an ideal gas is changed through an isothermal process at temperature T_0 as shown in figure. The work done by the gas in going from state B to C is double the work done by gas in going from state A to B. If the pressure in the state B is $\frac{p_0}{2}$, then the pressure of the gas in state C is



A. $\frac{p_0}{3}$

B. $\frac{p_0}{4}$

C. $\frac{p_0}{6}$

D. $\frac{p_0}{8}$

Answer: D

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Level 2 More Than One Correct

1. 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. (a) The work done by the gas in the process A to B is negative

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

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

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

Answer: B::D

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2. In the process $pV^2 =$ constant, if temperature of gas is increased, then

A. (a) change in internal energy of gas is positive

B. (b) work done by gas is positive

C. (c) heat is given to the gas

D. (d) heat is taken out from the gas

Answer: A::C

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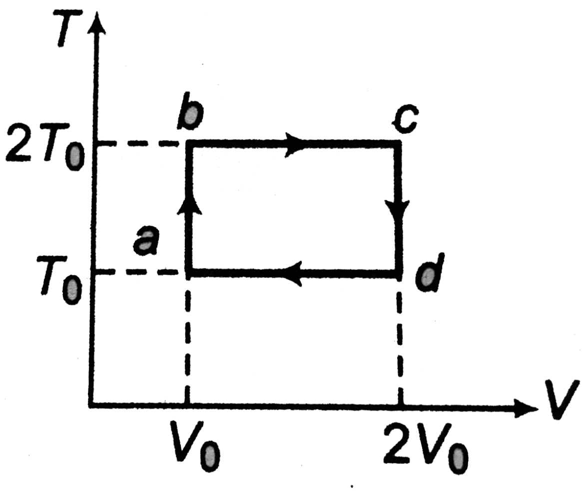
3. T-V diagram of two moles of a monoatomic gas is as shown in figure.

For the process abcda choose the correct options given below



A. (a) $\Delta U = 0$

B. (b) work done by gasgt0

C. (c) heat given to the gas is $4RT_0$

D. (d) heat given to the gas is $2RT_0$

Answer: A::B

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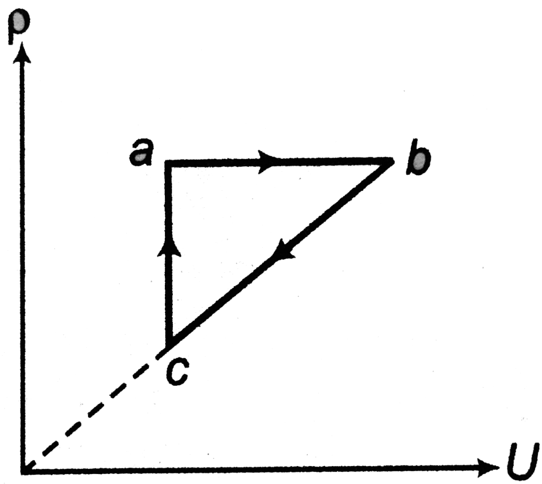
4. Density (ρ) versus internal energy (U) graph of a gas is as shown in figure. Choose the correct options.



Here, W is work done by gas and Q is heat given to the gas.

A. (a) $Q_{bc} = 0$

B. (b) $W_{bc} = 0$

C. (c) $W_{ca} < 0$

D. (d) $Q_{ab} > 0$

Answer: C::D

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5. Temperature of a monoatomic gas is increased from T_0 to $2T_0$ in three different processes:

isochoric, isobaric and adiabatic. Heat given to the gas in these three processes are Q_1, Q_2 and Q_3 respectively. Then, choose the correct option.

A. (a) $Q_1 > Q_3$

B. (b) $Q_2 > Q_1$

C. (c) $Q_2 > Q_3$

D. (d) $Q_3 = 0$

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

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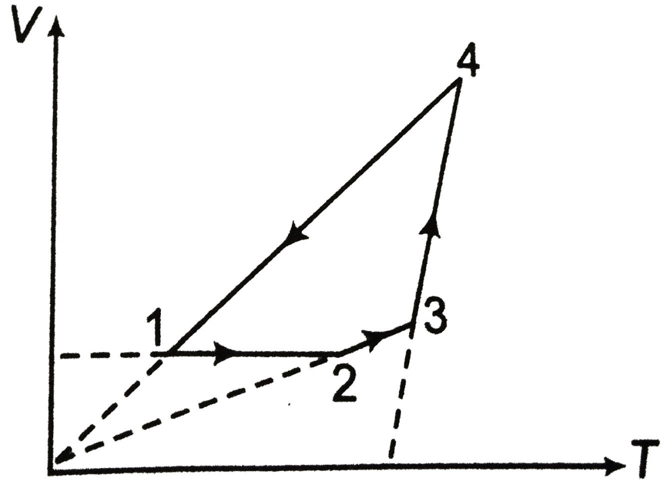
6. A cyclic process 1-2-3-4-1 is depicted on V-T diagram. The p-T and p-V diagrams for this cyclic process are given below. Select the correct choices (more than one options is/are correct)



A. (a)

B. (b)

C. (c)

D. (d) None of these

Answer: A::B

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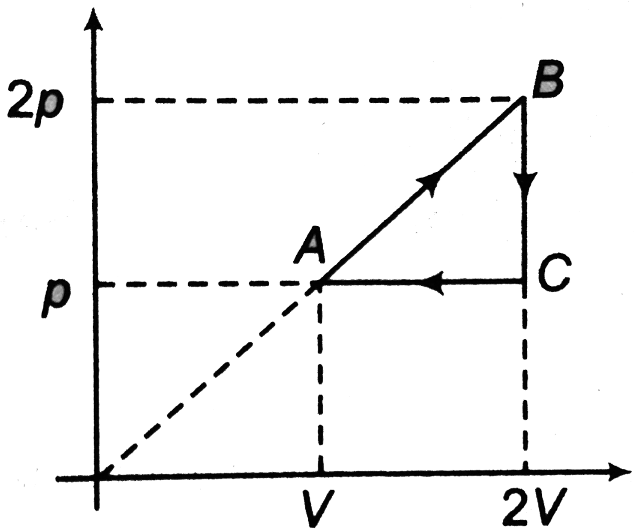
Level 2 Passage I

1. One mole of a monatomic ideal gas is taken along the cycle ABCA as shown in the diagram.



The net heat absorbed by the gas in the given cycle is

A. (a) pV

B. (b) $\frac{pV}{2}$

C. (c) 2pV

D. (d) 4pV

Answer: B

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2. One mole of a monatomic ideal gas is taken along the cycle ABCA as shown in the diagram.

The ratio of specific heat in the process CA to the specific heat in the process BC is

A. 2

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

C. (c) 4

D. (d) None of these

Answer: B

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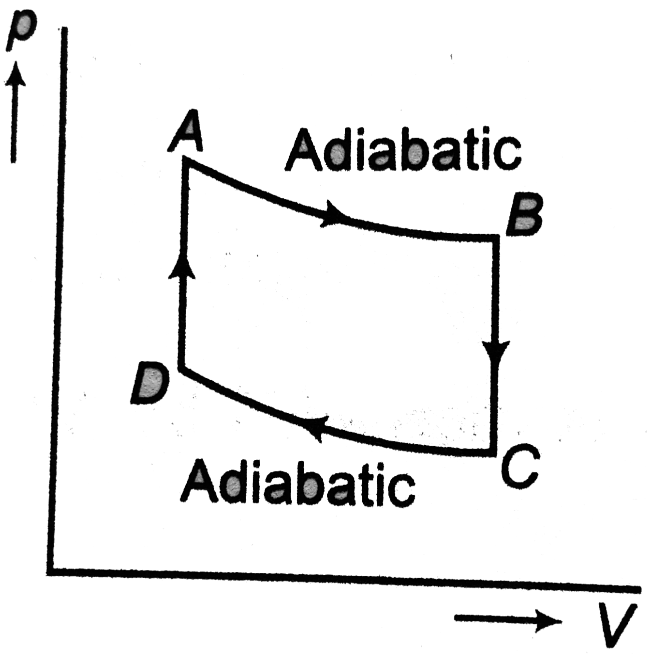
Level 2 Passage Ii

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

$T_A = 1000K$ and $2p_A = 3p_B = 6p_C$



$$\left[Assume\left(\frac{2}{3}\right)^{0.4} = 0.85 \text{ and } R = \frac{25}{3}JK^{-1}mol^{-1}\right]$$

The temperature at B is

A. 350K

B. 1175K

C. 850K

D. 577K

Answer: C

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

$T_A = 1000K$ and $2p_A = 3p_B = 6p_C$

$$\left[Assume\left(\frac{2}{3}\right)^{0.4} = 0.85 \text{ and } R = \frac{25}{3}JK^{-1}mol^{-1}\right]$$

Work done by the gas in the process $A \to B$ is

A. (a) 5312J

B. (b) 1875J

C. (c) 6251J

D. (d) 8854J

Answer: B

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

$T_A = 1000K$ and $2p_A = 3p_B = 6p_C$

$\left[Assume\left(\frac{2}{3}\right)^{0.4} = 0.85 \text{ and } R = \frac{25}{3} JK^{-1} mol^{-1}\right]$

Heat lost by the gas in the process $B \to C$ is

A. (a) 5312J

B. (b) 1875J

C. (c) 6251J

D. (d) 8854J

Answer: A

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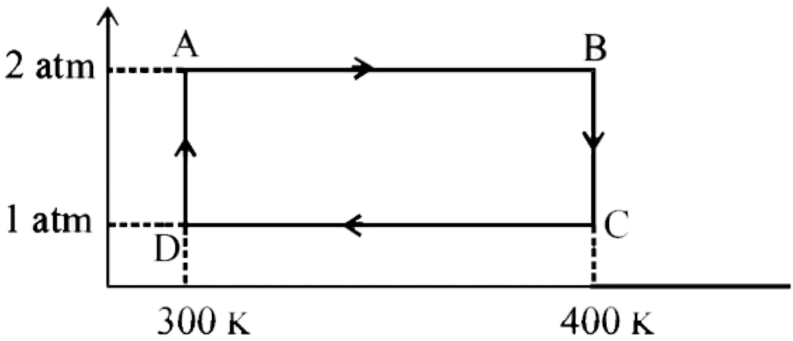
Level 2 Subjective

1. 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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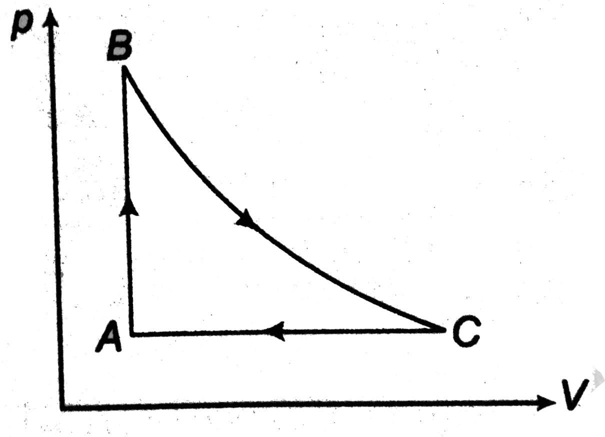
2. 1.0 k-mol of a sample of helium gas is put through the cycle of operations shown in figure. BC is an isothermal process and $p_A = 1.00 atm, V_A = 22.4 m^3, p_B = 2.00 atm$. What are T_A, T_B and V_C?



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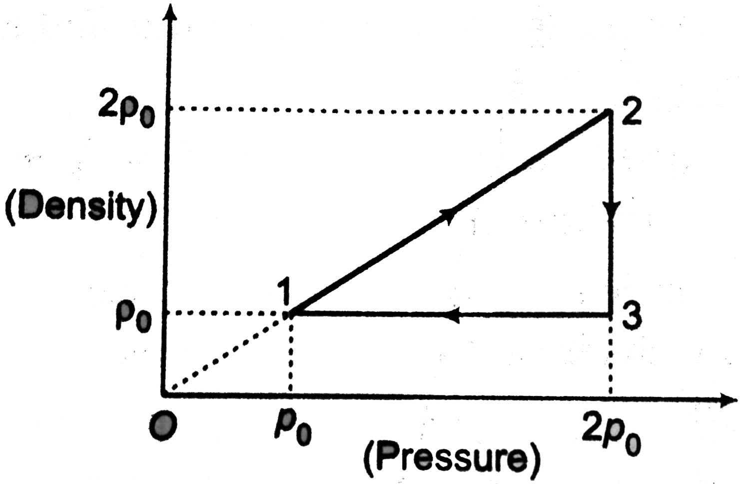
3. The density (ρ) versus pressure (p) graph of one mole of an ideal monoatomic gas undergoing a cyclic process is shown in figure. Molecular mass of gas is M.



(a) Find work done in each process.

(b) Find heat rejected by gas in one complete cycle.

(c) Find the efficiency of the cycle.

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4. An ideal gas goes through the cycle abc. For the complete cycle 800J of heat flows out of the gas. Process ab is at constant pressure and process bc is at constant volume. In process c-a, $p \propto V$. States a and b have temperature $T_a = 200K$ and $T_b = 300K$. (a) Sketch the p-V diagram for the cycle. (b) What is the work done by the gas for the process ca?

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5. 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.

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6. Three moles of an ideal gas $\left(C_p = \frac{7}{2}R\right)$ at pressure p_0 and temperature T_0 is isothermally expanded to twice its initial volume. It is then compressed at a constant pressure to its original volume.

(a) Sketch p-V and p-T diagram for complete process.

(b) Calculate net work done by the gas.

(c) Calculate net heat supplied to the gas during complete process.

(Write your answer in terms of gas constant =R)

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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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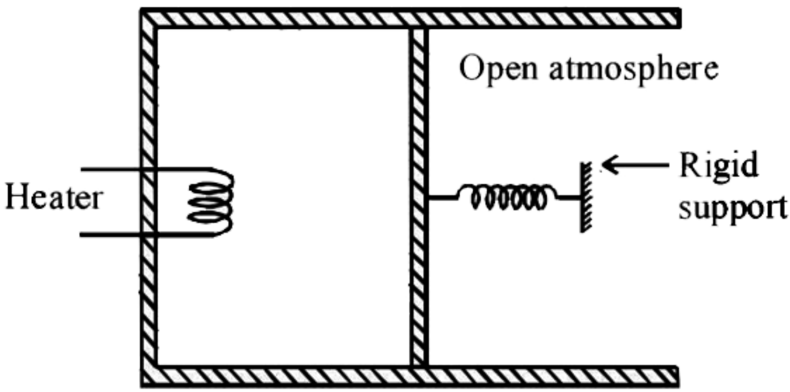
8. An ideal monoatomic gas is confined in a cylinder by a spring-loaded piston of cross-section $8.0 \times 10^{-3} m^2$. Initially the gas is at 300K and occupies a volume of $2.4 \times 10^{-3} m^3$ and the spring is in its relaxed (unstretched, unompressed) state, fig. The gas is heated by a small 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. An ideal diatomic gas $\left(\gamma = \frac{7}{5}\right)$ undergoes a process in which its internal energy relates to the volume as $U = \alpha\sqrt{V}$, where α is a constant.

(a) Find the work performed by the gas to increase its internal energy by

100J.

(b) Find the molar specific heat of the gas.

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10. For an ideal gas the molar heat capacity varies as $C = C_V + 3aT^2$. Find the equation of the process in the variables (T,V) where a is a constant.

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11. 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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12. One mole of a gas is put under a weightless piston of a vertical cylinder at temperature T. The space over the piston opens into atmosphere. Initially, piston was in equilibrium. How much work should be performed by some external force to increase isothermally the volume under the piston to twice the volume? (Neglect friction of piston).

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13. An ideal monatomic gas undergoes a process where its pressure is inversely proportional to its temperature.

(a) Calculate the molar specific heat of the process.

(b) Find the work done by two moles of gas if the temperature change from T_1 to T_2.

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14. 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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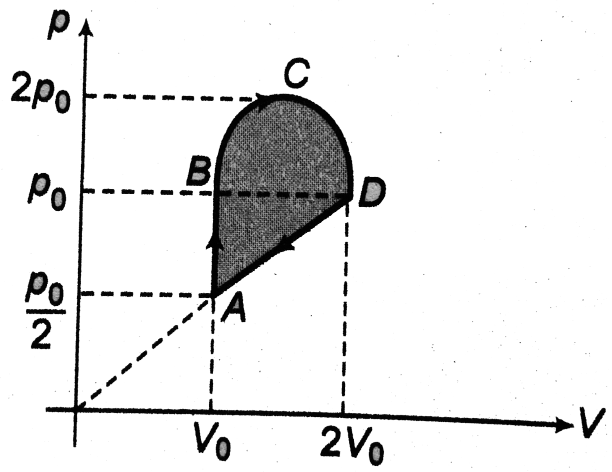
15. Two moles of a monatomic ideal gas undergo a cyclic process ABCDA as shown in figure. BCD is a semicircle. Find the efficiency of the cycle.



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16. Pressure p, volume V and temperature T for a certain gas are related by

$$p = \frac{\alpha T - \beta T^2}{V}$$

where, α and β are constants. Find the work done by the gas if the temperature changes from T_1 to T_2 while the pressure remains the constant.

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17. An ideal gas has a specific heat at constant pressure $C_p = \frac{5R}{2}$. The gas is kept in a closed vessel of volume V_0 at temperature T_0 and pressure p_0. An amount fo $10p_0V_0$ of heat is supplied to the gas.

(a) Calculate the final pressure and temperature of the gas.

(b) Show the process on p-V diagram.

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18. Three moles of an ideal gas being initially at a temperature $T_i = 273K$ were isothermally expanded 5 times its initial volume and then isochorically heated so that the pressure in the final state becomes equal to that in the initial state. The total heat supplied in the process is 80kJ. Find $\gamma\left(=\frac{C_p}{C_V}\right)$ of the gas.

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