Chapter Twelve

THERMODYNAMICS

MCQ I

12.1 An ideal gas undergoes four different processes from the same initial state (Fig. 12.1). Four processes are adiabatic, isothermal, isobaric and isochoric. Out of 1, 2, 3 and 4 which one is adiabatic.

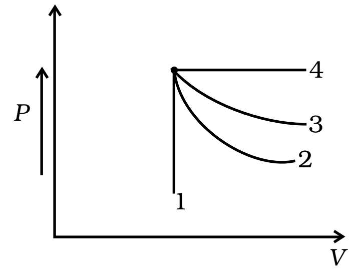

Fig. 12.1

(a) 4
(b) 3
(c) 2
(d) 1

12.2 If an average person jogs, hse produces 14.5×10^3 cal/min. This is removed by the evaporation of sweat. The amount of sweat evaporated per minute (assuming 1 kg requires 580×10^3 cal for evaparation) is

(a) 0.25 kg
(b) 2.25 kg
(c) 0.05 kg
(d) 0.20 kg

12.3 Consider P-V diagram for an ideal gas shown in Fig 12.2.

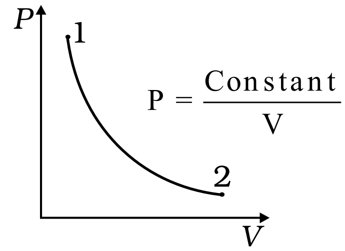

Fig. 12.2

Out of the following diagrams (Fig. 12.3), which represents the T-P diagram?

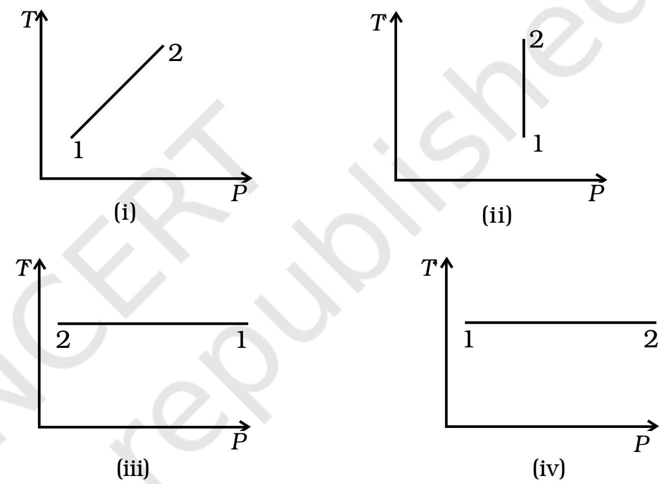

Fig. 12.3

(a) (iv)
(b) (ii)
(c) (iii)
(d) (i)

12.4 An ideal gas undergoes cyclic process ABCDA as shown in given P-V diagram (Fig. 12.4).

The amount of work done by the gas is

(a) $6P_oV_o$
(b) $-2\,P_oV_o$
(c) $+\,2\,P_oV_o$
(d) $+\,4\,P_oV_o$

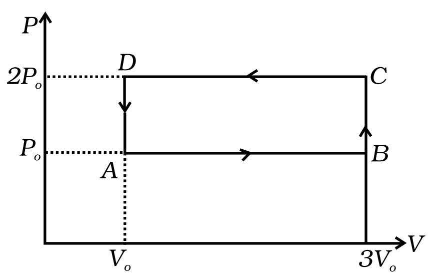

Fig 12.4

12.5 Consider two containers A and B containing identical gases at the same pressure, volume and temperature. The gas in container A is compressed to half of its original volume isothermally while the gas in container B is compressed to half of its original value adiabatically. The ratio of final pressure of gas in B to that of gas in A is

(a) $2^{\gamma-1}$

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

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

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

12.6 Three copper blocks of masses M_1, M_2 and M_3 kg respectively are brought into thermal contact till they reach equilibrium. Before contact, they were at T_1, T_2, T_3 $(T_1 > T_2 > T_3)$. Assuming there is no heat loss to the surroundings, the equilibrium temprature T is (s is specific heat of copper)

(a) $T = \frac{T_1 + T_2 + T_3}{3}$

(b) $T = \frac{M_1T_1 + M_2T_2 + M_3T_3}{M_1 + M_2 + M_3}$

(c) $T = \frac{M_1T_1 + M_2T_2 + M_3T_3}{3(M_1 + M_2 + M_3)}$

(d) $T = \frac{M_1T_1s + M_2T_2s + M_3T_3s}{M_1 + M_2 + M_3}$

MCQ II

12.7 Which of the processes described below are irreversible?

(a) The increase in temprature of an iron rod by hammering it.
(b) A gas in a small cantainer at a temprature T_1 is brought in contact with a big reservoir at a higher temprature T_2 which increases the temprature of the gas.
(c) A quasi-static isothermal expansion of an ideal gas in cylinder fitted with a frictionless piston.

(d) An ideal gas is enclosed in a piston cylinder arrangement with adiabatic walls. A weight W is added to the piston, resulting in compression of gas.

12.8 An ideal gas undergoes isothermal process from some initial state i to final state f. Choose the correct alternatives.

(a) $dU = 0$
(b) $dQ = 0$
(c) $dQ = dU$
(d) $dQ = dW$

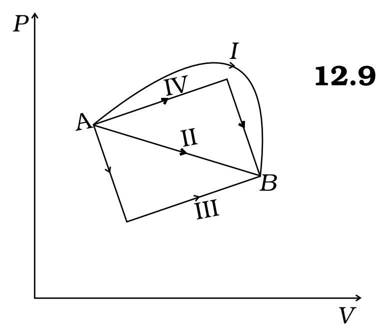

Fig. 12.5

12.9 Figure 12.5 shows the *P-V* diagram of an ideal gas undergoing a change of state from A to B. Four different parts I, II, III and IV as shown in the figure may lead to the same change of state.

(a) Change in internal energy is same in IV and III cases, but not in I and II.
(b) Change in internal energy is same in all the four cases.
(c) Work done is maximum in case I
(d) Work done is minimum in case II.

12.10 Consider a cycle followed by an engine (Fig. 12.6)

1 to 2 is isothermal
2 to 3 is adiabatic
3 to 1 is adiabatic

Such a process does not exist because

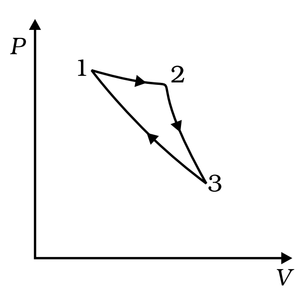

Fig. 12.6

(a) heat is completely converted to mechanical energy in such a process, which is not possible.
(b) mechanical energy is completely converted to heat in this process, which is not possible.
(c) curves representing two adiabatic processes don't intersect.
(d) curves representing an adiabatic process and an isothermal process don't intersect.

12.11 Consider a heat engine as shown in Fig. 12.7. Q_1 and Q_2 are heat added to heat bath T_1 and heat taken from T_2 in one cycle of engine. W is the mechanical work done on the engine.

If $W > 0$, then possibilities are:

(a) $Q_1 > Q_2 > 0$
(b) $Q_2 > Q_1 > 0$
(c) $Q_2 < Q_1 < 0$
(d) $Q_1 < 0, Q_2 > 0$

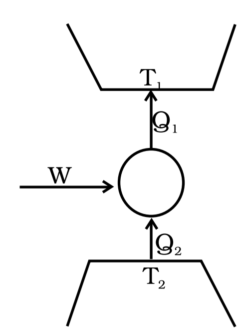

Fig .12.7

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12.12 Can a system be heated and its temperature remains constant?

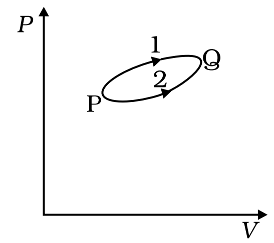

Fig. 12.8

12.13 A system goes from P to Q by two different paths in the *P-V* diagram as shown in Fig. 12.8. Heat given to the system in path 1 is 1000 J. The work done by the system along path 1 is more than path 2 by 100 J. What is the heat exchanged by the system in path 2?

12.14 If a refrigerator's door is kept open, will the room become cool or hot? Explain.

12.15 Is it possible to increase the temperature of a gas without adding heat to it? Explain.

12.16 Air pressure in a car tyre increases during driving. Explain.

SA

12.17 Consider a Carnot's cycle operating between $T_1 = 500\,K$ and T_2=300K producing 1 k J of mechanical work per cycle. Find the heat transferred to the engine by the reservoirs.

12.18 A person of mass 60 kg wants to lose 5kg by going up and down a 10m high stairs. Assume he burns twice as much fat while going up than coming down. If 1 kg of fat is burnt on expending 7000 kilo calories, how many times must he go up and down to reduce his weight by 5 kg?

12.19 Consider a cycle tyre being filled with air by a pump. Let V be the volume of the tyre (fixed) and at each stroke of the pump $\Delta V (\ll V)$ of air is transferred to the tube adiabatically. What is the work done when the pressure in the tube is increased from P_1 to P_2?

12.20 In a refrigerator one removes heat from a lower temperature and deposits to the surroundings at a higher temperature. In this process, mechanical work has to be done, which is provided by an electric motor. If the motor is of 1kW power, and heat is transferred from –3°C to 27°C, find the heat taken out of the refrigerator per second assuming its efficiency is 50% of a perfect engine.

12.21 If the co-efficient of performance of a refrigerator is 5 and operates at the room temperature (27 °C), find the temperature inside the refrigerator.

12.22 The initial state of a certain gas is (P_i, V_i, T_i). It undergoes expansion till its volume becomes V_f. Consider the following two cases:

(a) the expansion takes place at constant temperature.
(b) the expansion takes place at constant pressure.

Plot the *P-V* diagram for each case. In which of the two cases, is the work done by the gas more?

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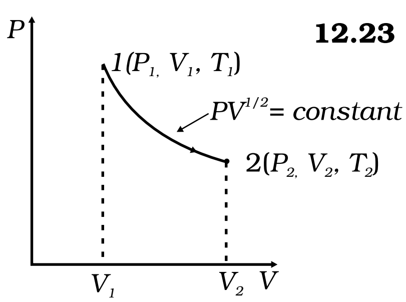

Fig. 12.9

12.23 Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig. 12.9.

(a) Find the work done when the gas is taken from state 1 to state 2.
(b) What is the ratio of temperature T_1/T_2, if $V_2 = 2V_1$?
(c) Given the internal energy for one mole of gas at temperature T is (3/2) RT, find the heat supplied to the gas when it is taken from state 1 to 2, with $V_2 = 2V_1$.

12.24 A cycle followed by an engine (made of one mole of perfect gas in a cylinder with a piston) is shown in Fig. 12.10.

A to B : volume constant
B to C : adiabatic
C to D : volume constant
D to A : adiabatic

$V_C = V_D = 2V_A = 2V_B$

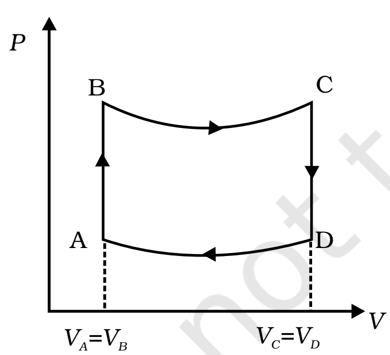

Fig. 12.10

(a) In which part of the cycle heat is supplied to the engine from outside?
(b) In which part of the cycle heat is being given to the surrounding by the engine?
(c) What is the work done by the engine in one cycle? Write your answer in term of P_A, P_B, V_A.
(d) What is the efficiency of the engine?

[$\gamma = 5/3$ for the gas], ($C_v = \frac{3}{2}R$ for one mole)

12.25 A cycle followed by an engine (made of one mole of an ideal gas in a cylinder with a piston) is shown in Fig. 12.11. Find heat exchanged by the engine, with the surroundings for each section of the cycle. ($C_v = (3/2)\ R$)

AB	:	constant volume
BC	:	constant pressure
CD	:	adiabatic
DA	:	constant pressure

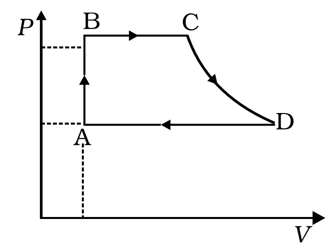

Fig. 12.11

12.26 Consider that an ideal gas (n moles) is expanding in a process given by $P = f(V)$, which passes through a point (V_0, P_0). Show that the gas is absorbing heat at (P_0, V_0) if the slope of the curve $P = f(V)$ is larger than the slope of the adiabat passing through (P_0, V_0).

12.27 Consider one mole of perfect gas in a cylinder of unit cross section with a piston attached (Fig. 12.12). A spring (spring constant k) is attached (unstretched length L) to the piston and to the bottom of the cylinder. Initially the spring is unstretched and the gas is in equilibrium. A certain amount of heat Q is supplied to the gas causing an increase of volume from V_o to V_1.

(a) What is the initial pressure of the system?
(b) What is the final pressure of the system?
(c) Using the first law of thermodynamics, write down a relation between Q, P_a, V, V_o and k.

Atomospheric pressure = P_a

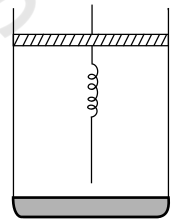
Fig. 12.12