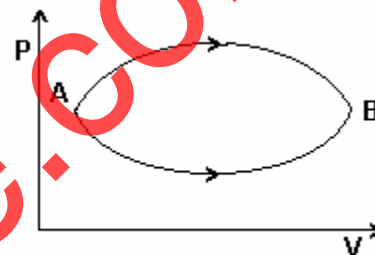


**11 - HEAT AND THERMODYNAMICS**  
**( including ideal gas and kinetic theory of gases )**  
 ( Answers at the end of all questions )

- 1) Which of the following is incorrect regarding the first law of thermodynamics ?  
 (a) It is the restatement of the principle of conservation of energy.  
 (b) It is not applicable to any cyclic process.  
 (c) It introduces the concept of entropy.  
 (d) It introduces the concept of the internal energy.

[ AIEEE 2005 ]

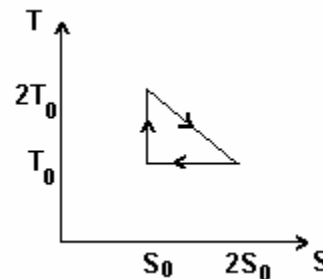
- 2) A system goes from A to B via two processes I and II as shown in figure. If  $\Delta U_1$  and  $\Delta U_2$  are the changes in internal energies in the processes I and II respectively, then



- (a) relation between  $\Delta U_1$  and  $\Delta U_2$  cannot be determined  
 (b)  $\Delta U_1 = \Delta U_2$  (c)  $\Delta U_2 < \Delta U_1$  (d)  $\Delta U_2 > \Delta U_1$

[ AIEEE 2004 ]

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



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

[ AIEEE 2005 ]

- 4) A gaseous mixture consists of 16 g of Helium and 16 g of oxygen. The ratio  $C_p / C_v$  of the mixture is

- (a) 1.62 (b) 1.59 (c) 1.54 (d) 1.4

[ AIEEE 2005 ]

- 5) Which of the following statements is correct for any thermodynamic system ?

- (a) The internal energy changes in all processes.  
 (b) Internal energy and entropy are state functions.  
 (c) The change in entropy can never be zero.  
 (d) The work done in an adiabatic process is always zero.

[ AIEEE 2004 ]

- 6) One mole of ideal monatomic gas ( $\gamma = 5/3$ ) is mixed with one mole of diatomic gas ( $\gamma = 7/5$ ). What is  $\gamma$  for the mixture ?

- (a) 3/2 (b) 23/15 (c) 35/23 (d) 4/3

[ AIEEE 2004 ]

- 7) Two thermally insulated vessels 1 and 2 are filled with air at temperature ( $T_1, T_2$ ), volume ( $V_1, V_2$ ) and pressure ( $P_1, P_2$ ) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be

- (a)  $T_1 + T_2$  (b)  $\frac{T_1 + T_2}{2}$  (c)  $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_2 + P_2 V_2 T_1}$  (d)  $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_1 + P_2 V_2 T_2}$

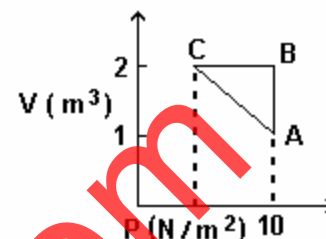
[ AIEEE 2004 ]

**11 - HEAT AND THERMODYNAMICS**  
**( including ideal gas and kinetic theory of gases )**  
( Answers at the end of all questions )

- 8 ) "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement as a consequence of  
( a ) conservation of mass                      ( b ) conservation of momentum  
( c ) first law of thermodynamics      ( d ) second law of thermodynamics      [ AIEEE 2003 ]
- 9 ) During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio  $C_p/C_v$  for the gas is  
( a ) 2      ( b ) 3/2      ( c ) 4/3      ( d ) 5/3      [ AIEEE 2003 ]
- 10 ) A Carnot engine takes  $3 \times 10^6$  cal. of heat from a reservoir at  $627^\circ\text{C}$  and gives it to a sink at  $27^\circ\text{C}$ . The work done by the engine is  
( a ) zero      ( b )  $4.2 \times 10^6$  J      ( c )  $8.4 \times 10^6$  J      ( d )  $16.8 \times 10^6$  J      [ AIEEE 2003 ]
- 11 ) Which of the following parameters does not characterize the thermodynamic state of matter ?  
( a ) work      ( b ) volume      ( c ) pressure      ( d ) temperature      [ AIEEE 2003 ]
- 12 ) For an isothermal expansion of a perfect gas, the value of  $\Delta P/P$  is equal to  
( a )  $-\Delta V/V$       ( b )  $\gamma \Delta V/V$       ( c )  $\gamma \Delta V/V$       ( d )  $-\gamma^2 \Delta V/V$       [ AIEEE 2002 ]
- 13 ) The translational kinetic energy of gas molecules at temperature  $T$  for one mole of a gas is  
( a )  $(3/2) RT$       ( b )  $(9/2) RT$       ( c )  $(1/3) RT$       ( d )  $(5/2) RT$       [ AIEEE 2002 ]
- 14 ) A gas at  $300\text{K}$ , enclosed in a container, is placed in a fast moving train. When the train is in motion, the temperature of the gas  
( a ) rises above  $300\text{K}$       ( b ) falls below  $300\text{K}$   
( c ) remains unchanged      ( d ) becomes unsteady      [ AIEEE 2002 ]
- 15 ) An ideal gas expands isothermally from volume  $V_1$  to  $V_2$  and then compressed to original volume  $V_1$  adiabatically. Initial pressure is  $P_1$  and final pressure is  $P_3$ . The total work done is  $W$ . Then  
( a )  $P_3 > P_1, W > 0$       ( b )  $P_3 < P_1, W < 0$   
( c )  $P_3 > P_1, W < 0$       ( d )  $P_3 = P_1, W = 0$       [ IIT 2004 ]
- 16 ) Two rods, one of aluminium and the other made of steel, having initial length  $l_1$  and  $l_2$  are connected together to form a single rod of length  $l_1 + l_2$ . The coefficients of linear expansion for aluminium and steel are  $\alpha_a$  and  $\alpha_s$  respectively. If the length of each rod increases by the same amount when their temperatures are raised by  $t^\circ\text{C}$ , then the ratio  $\frac{l_1}{l_1 + l_2}$  is equal to  
( a )  $\frac{\alpha_s}{\alpha_a}$       ( b )  $\frac{\alpha_a}{\alpha_s}$       ( c )  $\frac{\alpha_s}{\alpha_a + \alpha_s}$       ( d )  $\frac{\alpha_a}{\alpha_a + \alpha_s}$       [ IIT 2003 ]

**11 - HEAT AND THERMODYNAMICS**  
**(including ideal gas and kinetic theory of gases)**  
 (Answers at the end of all questions)

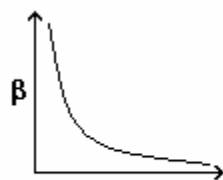
- 17) An ideal gas is taken through the cycle  $A \rightarrow B \rightarrow C \rightarrow A$ , as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, the work done by the gas in the process  $C \rightarrow A$  is



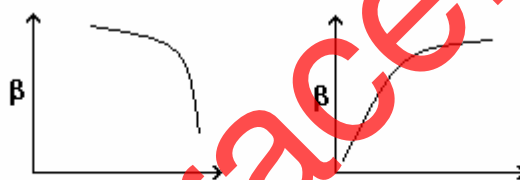
- (a) - 5 J      (b) - 10 J      (c) - 15 J      (d) - 20 J

[ IIT 2002 ]

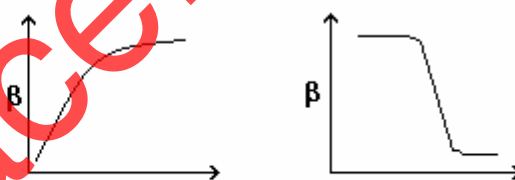
- 18) Which of the following graphs correctly represents the variation of  $\beta = -\frac{dV/dP}{V}$  with P for an ideal gas at constant temperature ?



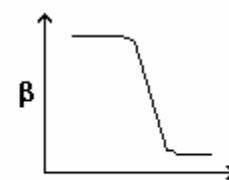
(a)



(b)



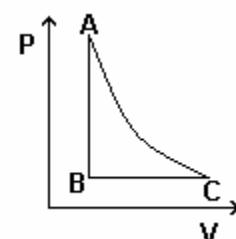
(c)



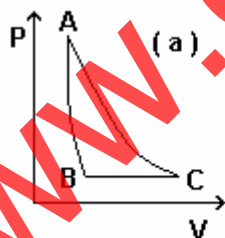
(d)

[ IIT 2002 ]

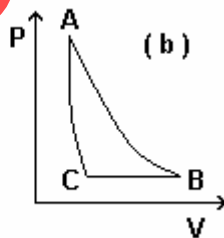
- 19) The PT diagram for an ideal gas is shown in the figure, where AC is an adiabatic process. Which of the following is the corresponding PV diagram ?



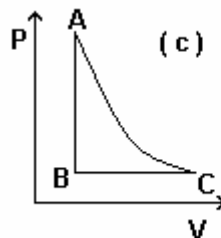
[ IIT 2003 ]



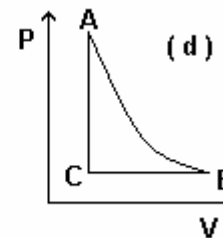
(a)



(b)



(c)



(d)

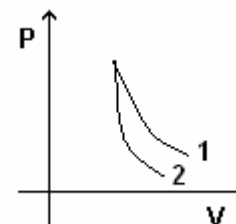
- 20) In a given process of an ideal gas,  $dW = 0$  and  $dQ < 0$ . Then for the gas  
 (a) the temperature will decrease      (b) the volume will increase  
 (c) the pressure will remain constant      (d) the temperature will increase

[ IIT 2001 ]

- 21) P - V plots for two gases during adiabatic processes are shown in the figure. Plots 1 and 2 should correspond respectively to:

- (a) He and  $O_2$       (b)  $O_2$  and He  
 (c) He and Ar      (d)  $O_2$  and  $N_2$

[ IIT 2001 ]



**11 - HEAT AND THERMODYNAMICS**  
**(including ideal gas and kinetic theory of gases)**  
 (Answers at the end of all questions)

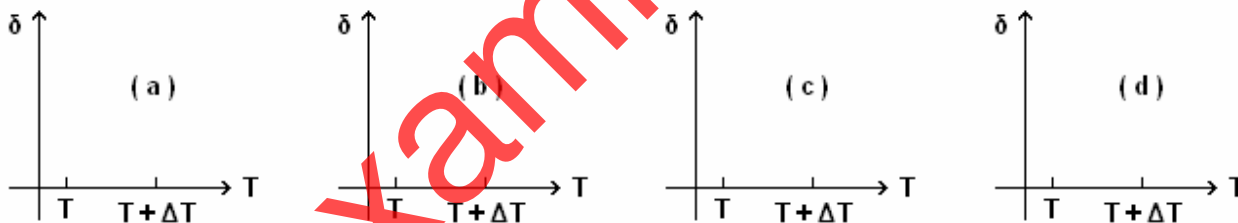
- 22) A monatomic ideal gas, initially at temperature  $T_1$ , is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature  $T_2$  by releasing the piston suddenly. If  $L_1$  and  $L_2$  are the lengths of the gas column before and after expansion respectively, then  $T_1/T_2$  is given by

(a)  $\left(\frac{L_1}{L_2}\right)^{\frac{2}{3}}$       (b)  $\frac{L_1}{L_2}$       (c)  $\frac{L_2}{L_1}$       (d)  $\left(\frac{L_2}{L_1}\right)^{\frac{2}{3}}$       [ IIT 2000 ]

- 23) 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)  $W_2 > W_1 > W_3$       (b)  $W_2 > W_3 > W_1$   
 (c)  $W_1 > W_2 > W_3$       (d)  $W_1 > W_3 > W_2$       [ IIT 2000 ]

- 24) An ideal gas is initially at temperature  $T$  and volume  $V$ . Its volume is increased by  $\Delta V$  due to an increase in temperature  $\Delta T$ , pressure remaining constant. The quantity  $\delta = \Delta V / V\Delta T$  varies with temperature as      [ IIT 2000 ]



- 25) A gas mixture consists 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      [ IIT 1999 ]  
 (a)  $4 RT$       (b)  $15 RT$       (c)  $9 RT$       (d)  $11 RT$

- 26) Let  $\bar{v}$ ,  $v_{rms}$  and  $v_p$  respectively denote the mean speed, root mean square speed and most probable speed of the molecules in an ideal monatomic gas at absolute temperature  $T$ . The mass of a molecule is  $m$ . Then

(a) no molecule can have energy greater than  $\sqrt{2} v_{rms}$   
 (b) no molecule can have speed less than  $v_p / \sqrt{2}$   
 (c)  $v_p < \bar{v} < v_{rms}$   
 (d) the average kinetic energy of a molecule is  $\frac{3}{4} m v_p^2$       [ IIT 1998 ]

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

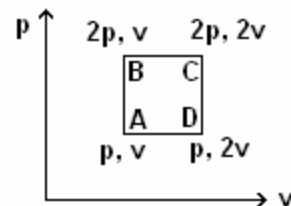
(a) 1:1      (b) 1:2      (c) 2:1  
 (d) depends on the moment of inertia of the two molecules      [ IIT 1998 ]

**11 - HEAT AND THERMODYNAMICS**  
**( including ideal gas and kinetic theory of gases )**  
( Answers at the end of all questions )

- 28) Two cylinders A and B fitted with pistons contain equal amounts of an ideal diatomic gas at 300 K. The piston of A is free to move, while that of B is held fixed. The same amount of heat is given to the gas in each cylinder. If the rise in temperature of the gas in A is 30 K, then the rise in temperature of the gas in B is  
(a) 30 K      (b) 18 K      (c) 50 K      (d) 42 K      [ IIT 1998 ]
- 29) Two identical containers A and B with frictionless pistons contain the same ideal gas at the same temperature and the same volume V. The mass of the gas in A is  $m_A$  and that in B is  $m_B$ . The gas in each cylinder is now allowed to expand isothermally to the same final volume 2V. The changes in the pressure in A and B are found to be  $\Delta P$  and  $1.5 \Delta P$  respectively. Then  
(a)  $4m_A = 9m_B$       (b)  $2m_A = 3m_B$       (c)  $3m_A = 2m_B$       (d)  $9m_A = 4m_B$       [ IIT 1998 ]
- 30) During the melting of a slab of ice at 273 K at atmospheric pressure  
(a) positive work is done by the ice-water system on the atmosphere  
(b) positive work is done by the atmosphere on the ice-water system  
(c) the internal energy of the ice-water system increases  
(d) the internal energy of the ice-water system decreases      [ IIT 1998 ]
- 31) A given quantity of an ideal gas is at pressure P and absolute temperature T. The isothermal bulk modulus of the gas is  
(a)  $\frac{2}{3}P$       (b) P      (c)  $\frac{3}{2}P$       (d) 2P      [ IIT 1998 ]
- 32) The average translational kinetic energy of  $O_2$  ( molar mass 32 ) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of  $N_2$  ( molar mass 28 ) in eV at the same temperature is  
(a) 0.0015      (b) 0.003      (c) 0.048      (d) 0.768      [ IIT 1997 ]
- 33) 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  
(a)  $P/8$       (b) P      (c) 2P      (d) 8P      [ IIT 1997 ]
- 34) The temperature of an ideal gas is increased from 120 K to 480 K. If at 120 K the root mean square velocity of the gas molecules is V, then at 480 K it becomes  
(a) 4V      (b) 2V      (c)  $V/2$       (d)  $V/4$       [ IIT 1996 ]
- 35) An ideal gas is taken from the state A ( pressure P, volume V ) to state B ( pressure  $P/2$ , volume 2V ) along a straight line path in the P-V diagram. Select the correct statement(s) from the following:  
(a) The work done by the gas in the process A to B exceeds that work that would be done by it if the system were taken from A to B along an isotherm.  
(b) In the T-V diagram, the path AB becomes a part of a parabola.  
(c) In the P-T diagram, the path AB becomes a part of a hyperbola.  
(d) In going from A to B, the temperature T of the gas first increases to a maximum value and then decreases.      [ IIT 1993 ]

**11 - HEAT AND THERMODYNAMICS**  
**( including ideal gas and kinetic theory of gases )**  
 ( Answers at the end of all questions )

- 36 ) Three closed vessels A, B and C are at the same temperature  $T$  and contain gases which obey the Maxwellian distribution law of velocities. Vessel A contains only  $O_2$ , B only  $N_2$  and C a mixture of equal quantities of  $O_2$  and  $N_2$ . If the average speed of the  $O_2$  molecules in vessel A is  $V_1$ , that of the  $N_2$  molecules in vessel B is  $V_2$  the average speed of the  $O_2$  molecules in vessel C is  
 ( a )  $(V_1 + V_2)/2$     ( b )  $V_1$     ( c )  $(V_1 V_2)^{1/2}$     ( d )  $\sqrt{(3kT/M)}$     [ IIT 1992 ]
- 37 ) 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 )  $2/5$     ( b )  $3/5$     ( c )  $3/7$     ( d )  $5/7$     [ IIT 1990 ]
- 38 ) For an ideal gas:  
 ( a ) the change in internal energy in a constant pressure process from temperature  $T_1$  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 change in an isothermal process  
 ( d ) no heat is added or removed in an adiabatic process    [ IIT 1989 ]
- 39 ) If one mole of a monatomic gas ( $\gamma = 5/3$ ) is mixed with one mole of a diatomic gas ( $\gamma = 7/5$ ), the value of  $\gamma$  for the mixture is  
 ( a ) 1.40    ( b ) 1.50    ( c ) 1.53    ( d ) 3.07    [ IIT 1988 ]
- 40 ) 70 calories of heat are required to raise the temperature of 2 moles of an ideal gas at constant pressure from  $30^\circ C$  to  $35^\circ C$ . The amount of heat required (in calories) to raise the temperature of the same gas through the same range ( $30^\circ C$  to  $35^\circ C$ ) at constant volume is  
 ( a ) 30    ( b ) 50    ( c ) 70    ( d ) 90    [ IIT 1985 ]
- 41 ) At room temperature, the r.m.s. speed of the molecules of a certain diatomic gas is found to be  $1930 \text{ m/s}$ . The gas is  
 ( a )  $H_2$     ( b )  $F_2$     ( c )  $O_2$     ( d )  $Cl_2$     [ IIT 1984 ]
- 42 ) An ideal monatomic gas is taken round the cycle ABCDA as shown in the p-v diagram. The work done during the cycle is  
 ( a )  $pv$     ( b )  $2pv$     ( c )  $\frac{1}{2}pv$     ( d ) zero    [ IIT 1983 ]



**Answers**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
b,c	b	d	a	b	a	c	d	b	c	a	a	a	c	c	c	a	a	none	a	b

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
d	a	c	d	c,d	a	d	c	b,c	b	c	c	b	a,b	d	d	a,b,c,d	c	b

41	42
a	a