11 Thermodynamics

Conceptual MCQs

1. In changing the state of thermodynamics from A to B state, the heat required is Q and the work done by the system is W. The change in its internal energy is
(a) (Q + W) (b) (Q – W)
(c) Q (d) $\frac{Q-W}{2}$

2. A perfect gas contained in a cylinder is kept in vacuum. If the cylinder suddenly bursts, then the temperature of the gas
(a) Remains constant (b) Becomes zero
(c) Increases (d) Decreases

3. When two bodies A and B are in thermal equilibrium
(a) The kinetic energies of all the molecules of A and B will be equal
(b) The potential energies of all the molecules of A and B will be equal
(c) The internal energies of the two bodies will be equal
(d) The average kinetic energy of the molecules of the two bodies will be equal

4. If heat given to a system is 6 kcal and work done on the system is 6 kJ. Then change in internal energy is
(a) 19.1 kJ (b) 12.5 kJ
(c) 25 kJ (d) Zero

5. First law of thermodynamics is a special case of
(a) Newton's law
(b) Law of conservation of energy
(c) Charle's law
(d) Law of heat exchange

6. If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then
(a) E = 0 (b) Q = 0
(c) W = 0 (d) Q = W = 0

7. Out of the following which quantity does not depend on path
(a) Temperature (b) Energy
(c) Work (d) None of these

8. One mole of an ideal monoatomic gas is heated at a constant pressure of one atmosphere from 0°C to 100°C. Then the change in the internal energy is
(a) 6.56 joules (b) 8.32×10^2 joules
(c) 12.48×10^2 joules (d) 20.80 joules

9. The work done in which of the following processes is equal to the internal energy of the system?
(a) Adiabatic process (b) Isothermal process
(c) Isochoric process (d) None of these

10. Air is expanded from 50 litre to 150 litre at 2 atmospheric pressure (1 atm pressure = 10^5 kgm^{-2}). The external work done is
(a) 200 J (b) 2000 J
(c) 2×10^4 J (d) 2×10^{-12} J

11. The coefficient of performance of a Carnot's refrigerator working between 30°C and 0°C is
(a) 10 (b) 1 (c) 9 (d) 0

12. A Carnot engine absorbs an amount Q of heat from a reservoir at an absolute temperature T and rejects heat to a sink at a temperature of T/3. The amount of heat rejected is
(a) $\frac{Q}{4}$ (b) $\frac{Q}{3}$ (c) $\frac{Q}{2}$ (d) $\frac{2Q}{3}$

13. The slopes of isothermal and adiabatic curves are related as
(a) Isothermal curve slope = adiabatic curve slope
(b) Isothermal curve slope = $\gamma \times$ adiabatic curve slope
(c) Adiabatic curve slope = $\gamma \times$ isothermal curve slope
(d) Adiabatic curve slope = $1/2 \times$ isothermal curve slope

14. Pressure-temperature relationship for an ideal gas undergoing adiabatic change ($\gamma = C_P / C_V$)
(a) PT^{γ} = constant (b) $PT^{-1+\gamma}$ = constant
(c) $P^{\gamma-1}T^{\gamma}$ = constant (d) $P^{1-\gamma}T^{\gamma}$ = constant

15. Which of the following processes is adiabatic ?
(a) Melting of ice
(b) Bursting of tyre
(c) Motion of piston of an engine with constant speed
(d) None of these

Application Based MCQs

16. A system is given 300 calories of heat and it does 600 joules of work. How much does the internal energy of the system change in this process (J = 4.18 joules/cal)

(a) 654 joule (b) 156.5 joule
(c) –300 joule (d) –528.2 joule

17. When an ideal gas $(\gamma = 5/3)$ is heated under constant pressure, then what percentage of given heat energy will be utilised in doing external work?

(a) 40% (b) 30% (c) 60% (d) 20%

18. An ideal gas is made to go through a cyclic thermodynamical process in four steps. The amount of heat involed are $Q_1 = -600\,J, Q_2 = -400\,J, Q_3 = -300\,J$, and $Q_4 = 200\,J$ respectively. The corresponding work involved are $W_1 = 400\ J, W_2 = -200\ J, W_3 = -150\ J$, and W_4. What is the value of W_4?

(a) –50 J (b) 100 J (c) 150 J (d) 50 J

19. A cylinder fitted with a piston contains 0.2 moles of air at temperature 27°C. The piston is pushed so slowly that the air within the cylinder remains in thermal equilibrium with the surroundings. Find the approximate work done by the system if the final volume is twice of the initial volume

(a) 543 J (b) 345 J (c) 453 J (d) 600 J

20. The volume of an ideal gas is 1 litre and its pressure is equal to 72 cm of mercury column. The volume of gas is made 900 cm^3 by compressing it isothermally. The pressure of the gas will be

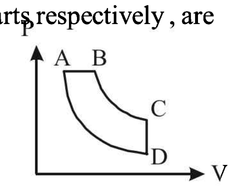
(a) 8 cm (mercury) (b) 7 cm (mercury)
(c) 6 cm (mercury) (d) 4 cm (mercury)

21. An ideal gas at 27°C is compressed adiabatically to $\left(\frac{8}{27}\right)$ of its original volume. If $\gamma = \frac{5}{3}$, then the rise in temperature is

(a) 575 K (b) 450 K (c) 225 K (d) 375 K

22. In pressure-volume diagram given below, the isochoric, isothermal, and isobaric parts, respectively, are

(a) BA, AD, DC
(b) DC, CB, BA
(c) AB, BC, CD
(d) CD, DA, AB



23. 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 of the gas is

(a) $\frac{4}{3}$ (b) 2 (c) $\frac{5}{3}$ (d) $\frac{3}{2}$

24. In an isothermal process the volume of an ideal gas is halved. One can say that

(a) Internal energy of the system decreases
(b) Work done by the gas is positive
(c) Work done by the gas is negative
(d) Internal energy of the system increases

25. The pressure and density of a diatomic gas $(\gamma = 7/5)$ change adiabatically from (P, d) to (P', d'). If d'/d = 32, then P'/P should be

(a) 1/128 (b) 32
(c) 128 (d) None of the above

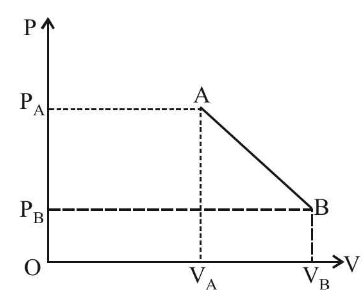
26. A Carnot engine takes 3×10^6 cal. of heat from a reservoir at $627^\circ C$, and gives it to a sink at $27^\circ C$. The work done by the engine is

(a) $4.2 \times 10^6\,J$ (b) $8.4 \times 10^6\,J$
(c) $16.8 \times 10^6\,J$ (d) zero

27. In Carnot engine efficiency is 40% at hot reservoir temperature T. For efficiency 50% what will be temperature of hot reservoir?

(a) $\frac{T}{5}$ (b) $\frac{2T}{5}$ (c) 6T (d) $\frac{6T}{5}$

28. An ideal gas is taken from point A to the point B, as shown in the P-V diagram, keeping the temperature constant. The work done in the process is



(a) $(P_A - P_B)(V_B - V_A)$ (b) $\frac{1}{2}(P_B - P_A)(V_B + V_A)$
(c) $\frac{1}{2}(P_B - P_A)(V_B - V_A)$ (d) $\frac{1}{2}(P_B + P_A)(V_B - V_A)$

29. A heat insulating cylinder with a movable piston contains 5 moles of hydrogen at standard temperature and pressure if the gas is compressed to quarter of its original volume then the pressure of the gas is increased by ($\gamma = 1.4$)

(a) $(2)^{1.4}$ (b) $(3)^{1.4}$ (c) $(4)^{1.4}$ (d) $(5)^{1.4}$

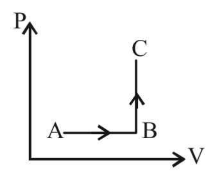
30. A refrigerator is to maintain eatables kept inside at 7°C. The coefficient of performance of refrigerator if room temperature is 38°C is

(a) 15.5 (b) 16.3 (c) 20.1 (d) 9.03

31. Heat engine works in a carnot cycle with a heat sink at a temperature of 2700K. The efficiency of the engine is 20%. Determine the temperature of heat source

(a) 3275K (b) 3295K (c) 3375K (d) 4375K

32. The P-V diagram of a system undergoing thermodynamic transformation is shown in figure. The work done by the system in going from $A \rightarrow B \rightarrow C$ is 30 J and 40 J heat is given to the system. The change in internal energy between A and C is

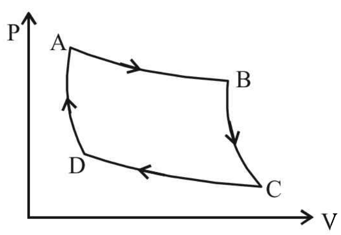


(a) 10 J (b) 70 J (c) 84 J (d) 137 J

33. In an adiabatic process, the pressure is increased by $\frac{2}{3}\%$. If $\gamma = \frac{3}{2}$, then the volume decreases by nearly

(a) $\frac{4}{9}\%$ (b) $\frac{2}{3}\%$ (c) 1% (d) $\frac{9}{4}\%$

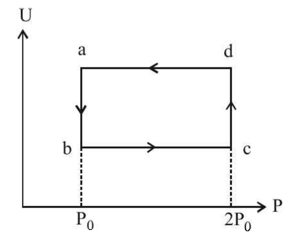
34. The P-V graph of an ideal gas cycle is shown here as below. The adiabatic process is described by



(a) AB and BC (b) AB and CD

(c) BC and DA (d) BC and CD

35. Figure shows the variation of internal energy (U) with the pressure (P) of 2.0 mole gas in cyclic process abcda. The temperature of gas at c and d are 300 K and 500 K. Calculate the heat absorbed by the gas during the process.



(a) 400 R ln 2

(b) 200 R ln 2

(c) 100 R ln 2

(d) 300 R ln 2

36. An ideal refrigerator has a freezer at a temperature of – 13°C. The coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) will be

(a) 325°C (b) 325 K (c) 39°C (d) 320°C

37. A thermus flask made of stainless steel contains several tiny lead shots. If the flask is quickly shaken, up and down several times, the temperature of lead shots

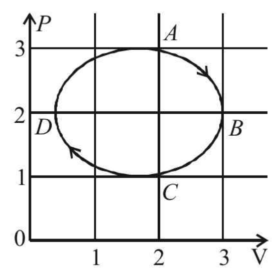
(a) Increases by adiabatic process

(b) Increases by isothermal process

(c) Decreases by adiabatic process

(d) Remains same

38. The figure shows the P-V plot of an ideal gas taken through a cycle *ABCDA*. The part *ABC* is a semi-circle and *CDA* is half of an ellipse. Then,



(a) the process during the path $A \rightarrow B$ is isothermal

(b) heat flows out of the gas during the path $B \rightarrow C \rightarrow D$

(c) work done during the path $A \rightarrow B \rightarrow C$ is zero

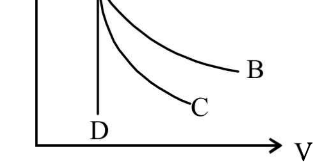
(d) negative work is done by the gas in the cycle *ABCDA*

39. Ideal gas undergoes an adiabatic change in its state from (P_1, V_1, T_1) to (P_2, V_2, T_2). The work done (W) in the process is (μ = number of moles, C_P and C_v are molar specific heats of gas)

(a) $W = \mu(T_1 - T_2)C_P$ (b) $W = \mu(T_1 - T_2)C_v$

(c) $W = \mu(T_1 + T_2)C_P$ (d) $W = \mu(T_1 + T_2)C_v$

40. A graph of pressure versus volume for an ideal gas for different processes is as shown. In the graph curve OC represents



(a) Isochoric process (b) Isothermal process

(c) Isobaric process (d) Adiabatic process

41. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?

(a) $\Delta U = -\Delta W$, in an adiabatic process

(b) $\Delta U = \Delta W$, in an isothermal process

(c) $\Delta U = \Delta W$, in an adiabatic process

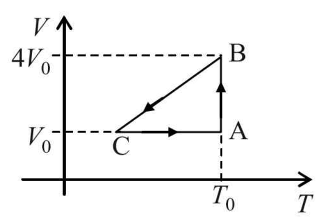
(d) $\Delta U = -\Delta W$, in an isothermal process

42. A diatomic ideal gas is used in a car engine as the working substance. If during the adiabatic expansion part of the cycle, volume of the gas increases from V to 32 V, the efficiency of the engine is

(a) 0.5 (b) 0.75

(c) 0.99 (d) 0.25

43. One mole of an ideal gas in initial state A undergoes a cyclic process ABCA, as shown in the figure. Its pressure at A is P_0. Choose the correct option from the following.



(a) Internal energies at A and B are the same

(b) Work done by the gas in process AB is $P_0 V_0 \, ln \, \frac{1}{4}$

(c) Pressure at C is $\frac{P_0}{4}$

(d) Temperature at C is $\frac{T_0}{4}$

44. During an isothermal expansion, a confined ideal gas does –150 J of work against its surroundings. This implies that

(a) 150 J heat has been removed from the gas

(b) 300 J of heat has been added to the gas

(c) no heat is transferred because the process is isothermal

(d) 150 J of heat has been added to the gas

45. A container with insulating walls is divided into two equal parts by a partition fitted with a valve. One part is filled with an ideal gas at a pressure p and temperature T, whereas the other part is completely evacuated. If the valve is suddenly opened, the pressure and temperature of the gas will be

(a) $\frac{p}{2}, T$ (b) $\frac{p}{2}, \frac{T}{2}$

(c) p, T (d) $p, \frac{T}{2}$

46. A Carnot engine operating between temperatures T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62 K its efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are, respectively

(a) 372 K and 330 K (b) 330 K and 268 K

(c) 310 K and 248 K (d) 372 K and 310 K

47. 100 g of water is heated from 30°C to 50°C. Ignoring the slight expansion of the water, the change in its internal energy is (specific heat of water is 4184 J/Kg/K)

(a) 8.4 kJ (b) 84 kJ

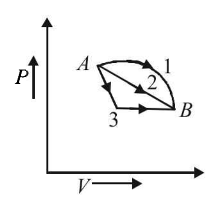
(c) 2.1 kJ (d) 4.2 kJ

48. 5.6 liter of helium gas at STP is adiabatically compressed to 0.7 liter. Taking the initial temperature to be T_1, the work done in the process is

(a) $\frac{9}{8} RT_1$ (b) $\frac{3}{2} RT_1$

(c) $\frac{15}{8} RT_1$ (d) $\frac{9}{2} RT_1$

49. An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram :



If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and $\Delta U_1, \Delta U_2, \Delta U_3$ indicate the change in internal energy along the three processes respectively, then

(a) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

(b) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

(c) $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

(d) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

50. The coefficient of performance of a refrigerator is 5. If the inside temperature of freezer is –20°C, then the temperature of the surroundings to which it rejects heat is

(a) 41°C (b) 11°C (c) 21°C (d) 31°C

Skill Based MCQs

51. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (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) $T_1T_2(P_1V_1 + P_2V_2)/(P_1V_1T_2 + P_2V_2T_1)$

(b) $(T_1 + T_2)/2$

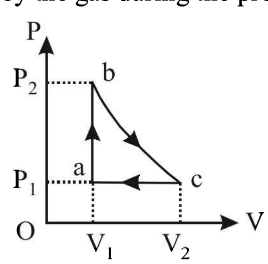
(c) $T_1 + T_2$

(d) $T_1T_2(P_1V_1 + P_2V_2)/(P_1V_1T_1 + P_2V_2T_2)$

52. Calculate the work done when 1 mole of a perfect gas is compressed adiabatically. The initial pressure and volume of the gas are 10^5 N/m^2 and 6 litre respectively. The final volume of the gas is 2 litres. Molar specific heat of the gas at constant volume is 3R/2. [Given $(3)^{5/3} = 6.19$]

(a) –957 J (b) +957 J (c) – 805 J (d) + 805 J

53. Carbon monoxide is carried around a closed cycle abc in which bc is an isothermal process as shown in the figure. The gas absorbs 7000 J of heat as its temperture increases from 300 K to 1000 K in going from a to b. The quantity of heat rejected by the gas during the process ca is



(a) 4200 J (b) 5000 J (c) 9000 J (d) 9800 J

54. Two moles of helium gas (γ = 5/3) are initially at temperature 27°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 the initial value. What is the final volume of the gas?

(a) 112.4 lit. (b) 115.2 lit (c) 120 lit (d) 125 lit

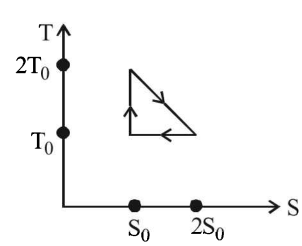
55. The temperature-entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is

(a) $\frac{1}{4}$

(b) $\frac{1}{2}$

(c) $\frac{2}{3}$

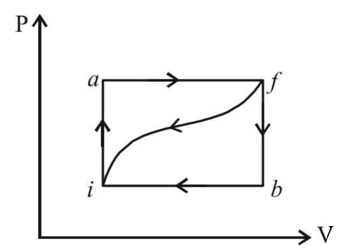
(d) $\frac{1}{3}$



56. 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

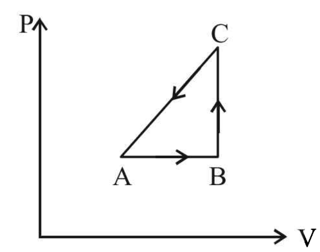
(a) $2RT_0$ (b) RT_0 (c) $\frac{3}{2}RT_0$ (d) $\frac{1}{2}RT_0$

57. When a system is taken from state i to a state f along path iaf, Q = 50 J and W = 20J. Along path ibf, Q = 35J. If W = 13 J for the curved return path f i, Q for this path is



(a) 33 J (b) 23 J (c) –7 J (d) –43 J

58. The P-V diagram of a system undergoing thermodynamic transformation is shown in figure. The work done on the system in going from A → B → C is 50 J and 20 cal heat is given to the system. The change in internal energy between A and C is



(a) 34 J

(b) 70 J

(c) 84 J

(d) 134 J

59. The temperature of n moles of an ideal gas is increased from T to $4T$ through a process for which pressure $P = aT^{-1}$ where a is a constant. Then, the work done by the gas is

(a) nRT (b) $4nRT$ (c) $2nRT$ (d) $6nRT$

60. The specific heat capacity of a metal at low temperature (T) is given as $C_p(\text{kJK}^{-1}\text{kg}^{-1}) = 32\left(\frac{T}{400}\right)^3$. A 100 g vessel of this metal is to be cooled from 20 K to 4 K by a special refrigerator operating at room temperature (27°C). The amount of work required to cool in vessel is

(a) equal to 0.002 kJ

(b) greater than 0.148 kJ

(c) between 0.148 kJ and 0.028 kJ

(d) less than 0.028 kJ

ANSWER KEY																			
Conceptual MCQs																			
1	(b)	**3**	(c)	**5**	(b)	**7**	(a)	**9**	(a)	**11**	(c)	**13**	(c)	**15**	(b)				
2	(a)	**4**	(a)	**6**	(a)	**8**	(c)	**10**	(c)	**12**	(b)	**14**	(d)						
Application Based MCQs																			
16	(a)	**20**	(a)	**24**	(c)	**28**	(d)	**32**	(a)	**36**	(c)	**40**	(d)	**44**	(d)	**48**	(a)		
17	(a)	**21**	(d)	**25**	(c)	**29**	(c)	**33**	(a)	**37**	(a)	**41**	(a)	**45**	(a)	**49**	(a)		
18	(c)	**22**	(d)	**26**	(b)	**30**	(d)	**34**	(c)	**38**	(b)	**42**	(b)	**46**	(d)	**50**	(d)		
19	(b)	**23**	(d)	**27**	(d)	**31**	(c)	**35**	(a)	**39**	(b)	**43**	(a)	**47**	(a)				
Skill Based MCQs																			
51	(a)	**52**	(a)	**53**	(d)	**54**	(a)	**55**	(d)	**56**	(a)	**57**	(d)	**58**	(d)	**59**	(d)	**60**	(c)