DDS ACADEMY

THERMODYNAMICS DPP-1 **JEE-MAINS**

First Law of Thermodynamics

1. First law of thermodynamics is given by

(a) $dQ = dU + PdV$ (b) $dQ = dU \times PdV$

(c) $dQ = (dU + dV)P$ (d) $dQ = PdU + dV$

2. The internal energy of an ideal gas depends upon

(a) Specific volume (b) Pressure

(c) Temperature (d) Density

3. 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) $\frac{Q-W}{2}$

4. Heat given to a system is 35 joules and work done by the system is 15 *joules*. The change in the internal energy of the system will be

(a) – 50 J (b) 20 J

(c) 30 J (d) 50 J

5. The temperature of an ideal gas is kept constant as it expands. The gas does external work. During this process, the internal energy of the gas

(a) Decreases

(b) Increases

(c) Remains constant

(d) Depends on the molecular motion

6. The first law of thermodynamics is concerned with the conservation of

(a) Momentum (b) Energy

(c) Mass (d) Temperature

7. A thermodynamic system goes from states (i) P_1, V to $2P_1$, V (ii) P, V to P, $2V$. Then work done in the two cases is

(a) Zero, Zero (b) Zero, PV_1

(c) PV_1, Zero (d) PV_1, P_1V_1

8. If the amount of heat given to a system be 35 *joules* and the amount of work done by the system be -15 *joules*, then the change in the internal energy of the system is

(a) -50 *joules* (b) 20 *joules*

(c) 30 *joules* (d) 50 *joules*

9. 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*

10. Work done on or by a gas, in general depends upon the

(a) Initial state only

(b) Final state only

(c) Both initial and final states only

(d) Initial state, final state and the path

11. If R = universal gas constant, the amount of heat needed to raise the temperature of 2 mole of an ideal monoatomic gas from 273K to 373K when no work is done

(a) 100 R (b) 150 R

(c) 300 R (d) 500 R

12. Find the change in internal energy of the system when a system absorbs 2 *kilocalorie* of heat and at the same time does 500 *joule* of work

(a) 7900 J (b) 8200 J

(c) 5600 J (d) 6400 J

13. A system performs work ΔW when an amount of heat is ΔQ added to the system, the corresponding change in the internal energy is ΔU. A unique function of the initial and final states (irrespective of the mode of change) is

(a) ΔQ (b) ΔW

(c) ΔU and ΔQ (d) ΔU

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

(a) 300 K (b) 239 K

(c) 200 K (d) 100 K

15. 110 J of heat is added to a gaseous system, whose internal energy change is 40 J, then the amount of external work done is

(a) 150 J (b) 70 J

(c) 110 J (d) 40 J

16. Which of the following is not thermo dynamical function

(a) Enthalpy (b) Work done

(c) Gibb's energy (d) Internal energy

17. When the amount of work done is 333 *cal* and change in internal energy is 167 *cal*, then the heat supplied is

(a) 166 *cal* (b) 333 *cal*

(c) 500 *cal* (d) 400 *cal*

18. First law thermodynamics states that **[KCET 1999]**

(a) System can do work

(b) System has temperature

(c) System has pressure

(d) Heat is a form of energy

19. A thermo-dynamical system is changed from state (P_1, V_1) to (P_2, V_2) by two different processes. The quantity which will remain same will be

(a) ΔQ (b) ΔW

(c) $\Delta Q + \Delta W$ (d) $\Delta Q - \Delta W$

20. In thermodynamic process, 200 *Joules* of heat is given to a gas and 100 *Joules* of work is also done on it. The change in internal energy of the gas is

(a) 100 *J* (b) 300 *J*

(c) 419 *J* (d) 24 *J*

21. 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

22. If 150 *J* of heat is added to a system and the work done by the system is 110 *J*, then change in internal energy will be

(a) 260 *J* (b) 150 *J*

(c) 110 *J* (d) 40 *J*

23. If ΔQ and ΔW represent the heat supplied to the system and the work done on the system respectively, then the first law of thermodynamics can be written as

(a) $\Delta Q = \Delta U + \Delta W$ (b) $\Delta Q = \Delta U - \Delta W$

(c) $\Delta Q = \Delta W - \Delta U$ (d) $\Delta Q = -\Delta W - \Delta U$

where ΔU is the internal energy

24. For free expansion of the gas which of the following is true

(a) $Q = W = 0$ and $\Delta E_{\text{int}} = 0$

(b) $Q = 0, W > 0$ and $\Delta E_{\text{int}} = -W$

(c) $W = 0, Q > 0,$ and $\Delta E_{\text{int}} = Q$

(d) $W > 0, Q < 0$ and $\Delta E_{\text{int}} = 0$

25. Which of the following can not determine the state of a thermodynamic system

(a) Pressure and volume

(b) Volume and temperature

(c) Temperature and pressure

(d) Any one of pressure, volume or temperature

26. Which of the following is not a thermodynamics co-ordinate

(a) *P* (b) *T*

(c) *V* (d) *R*

27. In a given process for 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

28. The specific heat of hydrogen gas at constant pressure is $C_P = 3.4 \times 10^3 cal/kg\,^oC$ and at constant volume is $C_V = 2.4 \times 10^3 cal/kg\,^oC$. If one kilogram hydrogen gas is heated from 10^oC to 20^oC at constant pressure, the external work done on the gas to maintain it at constant pressure is

(a) 10^5 *cal* (b) 10^4 *cal*

(c) 10^3 *cal* (d) 5×10^3 *cal*

29. Which of the following parameters does not characterize the thermodynamic state of matter

(a) Volume (b) Temperature

(c) Pressure (d) Work

30. In a thermodynamic system working substance is ideal gas, its internal energy is in the form of

(a) Kinetic energy only

(b) Kinetic and potential energy

(c) Potential energy

(d) None of these

31. 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

32. A system is provided with 200 cal of heat and the work done by the system on the surrounding is 40 *J*. Then its internal energy

(a) Increases by 600 *J* (b) Decreases by 800 *J*

(c) Increases by 800 *J* (d) Decreases by 50 *J*

33. In a thermodynamic process, pressure of a fixed mass of a gas is changed in such a manner that the gas molecules gives out 20 *J* of heat and 10 *J* of work is done on the gas. If the initial internal energy of the gas was 40 *J*, then the final internal energy will be

(a) 30 *J* (b) 20 *J*

(c) 60 *J* (d) 40 *J*

34. Heat is not being exchanged in a body. If its internal energy is increased, then

(a) Its temperature will increase

(b) Its temperature will decrease

(c) Its temperature will remain constant

(d) None of these

35. Out of the following which quantity does not depend on path

(a) Temperature (b) Energy

(c) Work (d) None of these

36. 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

37. One mole of an ideal monoatomic gas is heated at a constant pressure of one atmosphere from 0^oC to 100^oC. 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*

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

(a) $R/(\gamma-1)$ (b) pV

(c) $pV/(\gamma-1)$ (d) $\gamma pV/(\gamma-1)$

39. If $C_V = 4.96 cal/mole\ K$, then increase in internal energy when temperature of 2 moles of this gas is increased from $340\ K$ to $342\ K$

(a) 27.80 *cal* (b) 19.84 *cal*

(c) 13.90 *cal* (d) 9.92 *cal*

40. Temperature is a measurement of coldness or hotness of an object. This definition is based on

(a) Zeroth law of thermodynamics

(b) First law of thermodynamics

(c) Second law of thermodynamics

(d) Newton's law of cooling

41. When heat energy of 1500 *Joules*, is supplied to a gas at constant pressure $2.1 \times 10^5\ N/m^2$, there was an increase in its volume equal to $2.5 \times 10^{-3} m^3$. The increase in internal energy of the gas in Joules is

(a) 450 (b) 525

(c) 975 (d) 2025

42. If heat given to a system is 6 *kcal* and work done is 6 k*J*. Then change in internal energy is

(a) 19.1 *kJ* (b) 12.5 *kJ*

(c) 25 *kJ* (d) Zero

43. In a thermodynamics process, pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 *J* of heat and 8*J* of work is done on the gas. If the initial internal energy of the gas was 30*J*. The final internal energy will be

(a) 18*J* (b) 9*J*

(c) 4.5*J* (d) 36*J*

44. A monoatomic gas of *n*-moles is heated from temperature T_1 to T_2 under two different conditions (i) at constant volume and (ii) at constant pressure. The change in internal energy of the gas is

(a) More for (i)

(b) More for (ii)

(c) Same in both cases

(d) Independent of number of moles

45. The state of a thermodynamic system is represented by

(a) Pressure only

(b) Volume only

(c) Pressure, volume and temperature

(d) Number of moles

46. A perfect gas goes from state *A* to another state *B* by absorbing $8 \times 10^5 J$ of heat and doing $6.5 \times 10^5 J$ of external work. It is now transferred between the same two states in another process in which it absorbs $10^5 J$ of heat. Then in the second process

(a) Work done on the gas is $0.5 \times 10^5 J$

(b) Work done by gas is $0.5 \times 10^5 J$

(c) Work done on gas is $10^5 J$

(d) Work done by gas is $10^5 J$

47. If a system undergoes contraction of volume then the work done by the system will be

(a) Zero (b) Negligible

(c) Negative (d) Positive

48. Which of the following is *incorrect* regarding the first law of thermodynamics

(a) It introduces the concept of the internal energy

(b) It introduces the concept of the entropy

(c) It is not applicable to any cyclic process

(d) None of the above

Isothermal Process

1. For an ideal gas, in an isothermal process

(a) Heat content remains constant

(b) Heat content and temperature remain constant

(c) Temperature remains constant

(d) None of the above

2. Can two isothermal curves cut each other

(a) Never

(b) Yes

(c) They will cut when temperature is $0°C$

(d) Yes, when the pressure is critical pressure

3. In an isothermal expansion

(a) Internal energy of the gas increases

(b) Internal energy of the gas decreases

(c) Internal energy remains unchanged

(d) Average kinetic energy of gas molecule decreases

4. In an isothermal reversible expansion, if the volume of 96 *gm* of oxygen at $27°C$ is increased from 70 *litres* to 140 *litres*, then the work done by the gas will be

(a) $300\,R\log_{10} 2$ (b) $81\,R\log_e 2$

(c) $900\,R\log_{10} 2$ (d) $2.3\times 900\,R\log_{10} 2$

5. A vessel containing 5 *litres* of a gas at 0.8 *m* pressure is connected to an evacuated vessel of volume 3 *litres*. The resultant pressure inside will be (assuming whole system to be isolated)

(a) 4/3 *m* (b) 0.5 *m*

(c) 2.0 *m* (d) 3/4 *m*

6. For an isothermal expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal

(a) $-\gamma^{1/2}\frac{\Delta V}{V}$ (b) $-\frac{\Delta V}{V}$

(c) $-\gamma\frac{\Delta V}{V}$ (d) $-\gamma^2\frac{\Delta V}{V}$

7. The gas law $\frac{PV}{T}=$ constant is true for

(a) Isothermal changes only

(b) Adiabatic changes only

(c) Both isothermal and adiabatic changes

(d) Neither isothermal nor adiabatic changes

8. One mole of O_2 gas having a volume equal to 22.4 *litres* at 0^oC and 1 atmospheric pressure in compressed isothermally so that its volume reduces to 11.2 *litres*. The work done in this process is

(a) $1672.5\,J$ (b) $1728\,J$

(c) $-1728\,J$ (d) $-1572.5\,J$

9. If a gas is heated at constant pressure, its isothermal compressibility

(a) Remains constant

(b) Increases linearly with temperature

(c) Decreases linearly with temperature

(d) Decreases inversely with temperature

10. Work done per mol in an isothermal change is

(a) $RT \log_{10} \frac{V_2}{V_1}$ (b) $RT \log_{10} \frac{V_1}{V_2}$

(c) $RT \log_e \frac{V_2}{V_1}$ (d) $RT \log_e \frac{V_1}{V_2}$

11. The isothermal Bulk modulus of an ideal gas at pressure P is

(a) P (b) γP

(c) $P / 2$ (d) P / γ

12. In isothermal expansion, the pressure is determined by

(a) Temperature only

(b) Compressibility only

(c) Both temperature and compressibility

(d) None of these

13. The isothermal bulk modulus of a perfect gas at normal pressure is

(a) $1.013 \times 10^5 N / m^2$ (b) $1.013 \times 10^6 N / m^2$

(c) $1.,013 \times 10^{-11} N / m^2$ (d) $1.013 \times 10^{11} N / m^2$

14. In an isothermal change, an ideal gas obeys

(a) Boyle's law (b) Charle's law

(c) Gaylussac law (d) None of the above

15. In isothermic process, which statement is wrong

(a) Temperature is constant

(b) Internal energy is constant

(c) No exchange of energy

(d) (a) and (b) are correct

16. An ideal gas A and a real gas B have their volumes increased from V to $2\ V$ under isothermal conditions. The increase in internal energy

(a) Will be same in both A and B

(b) Will be zero in both the gases

(c) Of B will be more than that of A

(d) Of A will be more than that of B

17. The specific heat of a gas in an isothermal process is

(a) Infinite (b) Zero

(c) Negative (d) Remains constant

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

(a) Decrease (b) Increase

(c) Remain same (d) None of the above

19. A container that suits the occurrence of an isothermal process should be made of

(a) Copper (b) Glass

(c) Wood (d) Cloth

20. 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

21. A thermodynamic process in which temperature T of the system remains constant though other variable P and V may change, is called

(a) Isochoric process (b) Isothermal process

(c) Isobaric process (d) None of these

22. If an ideal gas is compressed isothermally then

(a) No work is done against gas

(b) Heat is relased by the gas

(c) The internal energy of gas will increase

(d) Pressure does not change

23. When an ideal gas in a cylinder was compressed isothermally by a piston, the work done on the gas was found to be 1.5×10^4 *joules*. During this process about

(a) 3.6×10^3 *cal* of heat flowed out from the gas

(b) 3.6×10^3 *cal* of heat flowed into the gas

(c) 1.5×10^4 *cal* of heat flowed into the gas

(d) 1.5×10^4 *cal* of heat flowed out from the gas

24. When heat is given to a gas in an isothermal change, the result will be

(a) External work done

(b) Rise in temperature

(c) Increase in internal energy

(d) External work done and also rise in temp.

25. When 1 *gm* of water at 0^oC and $1 \times 10^5\ N/m^2$ pressure is converted into ice of volume $1.091\ cm^2$, the external work done will be

(a) 0.0091 *joule* (b) 0.0182 *joule*

(c) – 0.0091 *joule* (d) – 0.0182 *joule*

26. The latent heat of vaporisation of water is 2240 *J/gm*. If the work done in the process of expansion of 1 *g* is 168 *J*, then increase in internal energy is

(a) 2408 *J* (b) 2240 *J*

(c) 2072 *J* (d) 1904 *J*

27. 540 *calories* of heat convert 1 cubic centimeter of water at 100^oC into 1671 cubic centimeter of steam at 100^oC at a pressure of one atmosphere. Then the work done against the atmospheric pressure is nearly

(a) 540 *cal* (b) 40 *cal*

(c) Zero *cal* (d) 500 *cal*

28. One mole of an ideal gas expands at a constant temperature of 300 *K* from an initial volume of 10 *litres* to a final volume of 20 *litres*. The work done in expanding the gas is

(R = 8.31 *J/mole-K*)

(a) 750 *joules* (b) 1728 *joules*

(c) 1500 *joules* (d) 3456 *joules*

29. 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 the initial volume

(a) 543 *J* (b) 345 *J*

(c) 453 *J* (d) 600 *J*

30. 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 stress of the gas will be

(a) 8 *cm* (mercury) (b) 7 *cm* (mercury)

(c) 6 *cm* (mercury) (d) 4 *cm* (mercury)

31. During an isothermal expansion of an ideal gas

(a) Its internal energy decreases

(b) Its internal energy does not change

(c) The work done by the gas is equal to the quantity of heat absorbed by it

(d) Both (b) and (c) are correct

Adiabatic Process

1. If a cylinder containing a gas at high pressure explodes, the gas undergoes

(a) Reversible adiabatic change and fall of temperature

(b) Reversible adiabatic change and rise of temperature

(c) Irreversible adiabatic change and fall of temperature

(d) Irreversible adiabatic change and rise of temperature

2. The work done in an adiabatic change in a gas depends only on

(a) Change is pressure (b) Change is volume

(c) Change in temperature (d) None of the above

3. In adiabatic expansion

(a) $\Delta U = 0$ (b) $\Delta U =$ negative

(c) $\Delta U =$ positive (d) $\Delta W =$ zero

4. The pressure in the tyre of a car is four times the atmospheric pressure at 300 *K*. If this tyre suddenly bursts, its new temperature will be $(\gamma = 1.4)$

(a) $300\,(4)^{1.4/0.4}$ (b) $300\left(\frac{1}{4}\right)^{-0.4/1.4}$

(c) $300\,(2)^{-0.4/1.4}$ (d) $300\,(4)^{-0.4/1.4}$

5. A gas at NTP is suddenly compressed to one-fourth of its original volume. If γ is supposed to be $\frac{3}{2}$, then the final pressure is

(a) 4 atmosphere (b) $\frac{3}{2}$ atmosphere

(c) 8 atmosphere (d) $\frac{1}{4}$ atmosphere

6. A monoatomic gas $(\gamma = 5/3)$ is suddenly compressed to $\frac{1}{8}$ of its original volume adiabatically, then the pressure of the gas will change to

(a) $\frac{24}{5}$

(b) 8

(c) $\frac{40}{3}$

(d) 32 times its initial pressure

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

(a) 1/128 (b) 32

(c) 128 (d) None of the above

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

(a) 450 K (b) 375 K

(c) 225 K (d) 405 K

9. Two identical samples of a gas are allowed to expand (i) isothermally (ii) adiabatically. Work done is

(a) More in the isothermal process

(b) More in the adiabatic process

(c) Neither of them

(d) Equal in both processes

10. Which is the correct statement

(a) For an isothermal change PV = constant

(b) In an isothermal process the change in internal energy must be equal to the work done

(c) For an adiabatic change $\frac{P_2}{P_1} = \left(\frac{V_2}{V_1}\right)^\gamma$, where γ is the ratio of specific heats

(d) In an adiabatic process work done must be equal to the heat entering the system

11. 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 = $\frac{1}{2} \times$ isothermal curve slope

12. Pressure-temperature relationship for an ideal gas undergoing adiabatic change is $(\gamma = C_p / C_v)$

(a) $PT^\gamma =$ constant (b) $PT^{-1+\gamma} =$ constant

(c) $P^{\gamma-1}T^\gamma =$ constant (d) $P^{1-\gamma}T^\gamma =$ constant

13. The amount of work done in an adiabatic expansion from temperature T to T_1 is

(a) $R(T - T_1)$ (b) $\frac{R}{\gamma - 1}(T - T_1)$

(c) RT (d) $R(T - T_1)(\gamma - 1)$

14. During the adiabatic expansion of 2 moles of a gas, the internal energy of the gas is found to decrease by 2 *joules*, the work done during the process on the gas will be equal to

(a) 1 J (b) -1 J

(c) 2 J (d) – 2 J

15. The adiabatic elasticity of hydrogen gas $(\gamma = 1.4)$ at NTP is

(a) $1 \times 10^5\ N/m^2$ (b) $1 \times 10^{-8}\ N/m2$

(c) $1.4\ N/m^2$ (d) $1.4 \times 10^5 N/m^2$

16. If γ denotes the ratio of two specific heats of a gas, the ratio of slopes of adiabatic and isothermal PV curves at their point of intersection is

(a) $1/\gamma$ (b) γ

(c) $\gamma - 1$ (d) $\gamma + 1$

17. Air in a cylinder is suddenly compressed by a piston, which is then maintained at the same position. With the passage of time

(a) The pressure decreases

(b) The pressure increases

(c) The pressure remains the same

(d) The pressure may increase or decrease depending upon the nature of the gas

18. When a gas expands adiabatically

(a) No energy is required for expansion

(b) Energy is required and it comes from the wall of the container of the gas

(c) Internal energy of the gas is used in doing work

(d) Law of conservation of energy does not hold

19. One *gm* mol of a diatomic gas $(\gamma = 1.4)$ is compressed adiabatically so that its temperature rises from 27^oC to 127^oC. The work done will be

(a) 2077.5 *joules* (b) 207.5 *joules*

(c) 207.5 *ergs* (d) None of the above

20. Compressed air in the tube of a wheel of a cycle at normal temperature suddenly starts coming out from a puncture. The air inside

(a) Starts becoming hotter

(b) Remains at the same temperature

(c) Starts becoming cooler

(d) May become hotter or cooler depending upon the amount of water vapour present

21. The adiabatic Bulk modulus of a perfect gas at pressure is given by

(a) P (b) $2P$

(c) $P/2$ (d) γP

22. An adiabatic process occurs at constant

(a) Temperature

(b) Pressure

(c) Heat

(d) Temperature and pressure

23. A polyatomic gas $\left(\gamma = \frac{4}{3}\right)$ is compressed to $\frac{1}{8}$ of its volume adiabatically. If its initial pressure is P_o, its new pressure will be

(a) $8P_o$ (b) $16P_0$

(c) $6P_o$ (d) $2P_o$

24. For adiabatic processes $\left(\gamma = \frac{C_p}{C_v}\right)$

(a) $P^\gamma V$ = constant (b) $T^\gamma V$ = constant

(c) $TV^{\gamma-1}$ =constant (d) TV^γ = constant

25. An ideal gas is expanded adiabatically at an initial temperature of 300 *K* so that its volume is doubled. The final temperature of the hydrogen gas is $(\gamma = 1.40)$

(a) 227.36 *K* (b) 500.30 *K*

(c) 454.76 *K* (d) -47^oC

26. A given system undergoes a change in which the work done by the system equals the decrease in its internal energy. The system must have undergone an

(a) Isothermal change (b) Adiabatic change

(c) Isobaric change (d) Isochoric change

27. During the adiabatic expansion of 2 moles of a gas, the internal energy was found to have decreased by 100 J. The work done by the gas in this process is

(a) Zero (b) $-100\ J$

(c) $200\ J$ (d) $100\ J$

28. In an adiabatic expansion of a gas initial and final temperatures are T_1 and T_2 respectively, then the change in internal energy of the gas is

(a) $\frac{R}{\gamma-1}(T_2-T_1)$ (b) $\frac{R}{\gamma-1}(T_1-T_2)$

(c) $R(T_1-T_2)$ (d) Zero

29. Helium at 27^oC has a volume of 8 *litres*. It is suddenly compressed to a volume of 1 *litre*. The temperature of the gas will be $[\gamma=5/3]$

(a) 108^oC (b) 9327^oC

(c) 1200^oC (d) 927^oC

30. A cycle tyre bursts suddenly. This represents an

(a) Isothermal process (b) Isobaric process

(c) Isochoric process (d) Adiabatic process

31. One mole of helium is adiabatically expanded from its initial state (P_i, V_i, T_i) to its final state (P_f, V_f, T_f). The decrease in the internal energy associated with this expansion is equal to

(a) $C_V(T_i-T_f)$ (b) $C_P(T_i-T_f)$

(c) $\frac{1}{2}(C_P+C_V)(Ti-T_f)$ (d) $(C_P-C_V)(T_i-T_f)$

32. At N.T.P. one mole of diatomic gas is compressed adiabatically to half of its volume $\gamma=1.41$. The work done on gas will be

(a) 1280 J (b) 1610 J

(c) 1815 J (d) 2025 J

33. For adiabatic process, wrong statement is

(a) $dQ=0$ (b) $dU=-dW$

(c) Q = constant (d) Entropy is not constant

34. A diatomic gas initially at 18°C is compressed adiabatically to one-eighth of its original volume. The temperature after compression will be

(a) 10^oC (b) 887^oC

(c) $668\ K$ (d) 144^oC

35. A gas is being compressed adiabatically. The specific heat of the gas during compression is

(a) Zero (b) Infinite

(c) Finite but non-zero (d) Undefined

36. The process in which no heat enters or leaves the system is termed as

(a) Isochoric (b) Isobaric

(c) Isothermal (d) Adiabatic

37. Two moles of an ideal monoatomic gas at 27^oC occupies a volume of V. If the gas is expanded adiabatically to the volume $2V$, then the work done by the gas will be $[\gamma=5/3, R=8.31\ J/mol\ K]$

(a) $-2767.23\ J$ (b) $2767.23\ J$

(c) $2500\ J$ (d) $-2500\ J$

38. At 27^oC a gas is suddenly compressed such that its pressure becomes $\frac{1}{8}th$ of original pressure. Temperature of the gas will be $(\gamma = 5/3)$

(a) $420K$ (b) 327^oC

(c) $300\,K$ (d) -142^oC

39. $\Delta U + \Delta W = 0$ is valid for

(a) Adiabatic process (b) Isothermal process

(c) Isobaric process (d) Isochoric process

40. An ideal gas at a pressures of 1 atmosphere and temperature of 27^oC is compressed adiabatically until its pressure becomes 8 times the initial pressure, then the final temperature is (γ = 3/2)

(a) 627^oC (b) 527^oC

(c) 427^oC (d) 327^oC

41. Air is filled in a motor tube at 27^oC and at a pressure of 8 atmospheres. The tube suddenly bursts, then temperature of air is [Given γ of air $= 1.5$]

(a) 27.5^oC (b) 75^oK

(c) $150\,K$ (d) 150^oC

42. If $\gamma = 2.5$ and volume is equal to $\frac{1}{8}$ times to the initial volume then pressure P' is equal to (Initial pressure = P)

(a) $P' = P$ (b) $P' = 2P$

(c) $P' = P \times (2)^{15/2}$ (d) $P' = 7P$

43. In an adiabatic process, the state of a gas is changed from $P_1, V_1, T_1,$ to P_2, V_2, T_2. Which of the following relation is correct

(a) $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$ (b) $P_1V_1^{\gamma-1} = P_2V_2^{\gamma-1}$

(c) $T_1P_1^{\gamma} = T_2P_2^{\gamma}$ (d) $T_1V_1^{\gamma} = T_2V_2^{\gamma}$

44. 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) $\frac{3}{2}$ (b) $\frac{4}{3}$

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

45. In adiabatic expansion of a gas

(a) Its pressure increases

(b) Its temperature falls

(c) Its density increases

(d) Its thermal energy increases

46. One mole of an ideal gas at an initial temperature of $T\,K$ does 6 R joules of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is 5/3, the final temperature of gas will be

(a) $(T + 2.4)K$ (b) $(T - 2.4)K$

(c) $(T + 4)K$ (d) $(T - 4)K$

47. A gas is suddenly compressed to 1/4 th of its original volume at normal temperature. The increase in its temperature is $(\gamma = 1.5)$

(a) 273 K (b) 573 K

(c) 373 K (d) 473 K

48. A gas ($\gamma = 1.3$) is enclosed in an insulated vessel fitted with insulating piston at a pressure of $10^5\ N/m^2$. On suddenly pressing the piston the volume is reduced to half the initial volume. The final pressure of the gas is

(a) $2^{0.7} \times 10^5$ (b) $2^{1.3} \times 10^5$

(c) $2^{1.4} \times 10^5$ (d) None of these

49. The internal energy of the gas increases In

(a) Adiabatic expansion (b) Adiabatic compression

(c) Isothermal expansion (d) Isothermal compression

50. We consider a thermodynamic system. If ΔU represents the increase in its internal energy and W the work done by the system, which of the following statements is true

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

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

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

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

51. A gas is suddenly compressed to one fourth of its original volume. What will be its final pressure, if its initial pressure is P

(a) Lesss than P (b) More than P

(c) P (d) Either (a) or (c)

52. A gas for which $\gamma = 1.5$ is suddenly compressed to $\frac{1}{4}$ *th* of the initial volume. Then the ratio of the final to the initial pressure is

(a) 1 : 16 (b) 1 : 8

(c) 1 : 4 (d) 8 : 1

53. One mole of an ideal gas with $\gamma = 1.4$, is adiabatically compressed so that its temperature rises from 27°C to 35°C. The change in the internal energy of the gas is $(R = 8.3\ J/mol.K)$

(a) –166 J (b) 166 J

(c) –168 J (d) 168 J

54. The volume of a gas is reduced adiabatically to $\frac{1}{4}$ of its volume at 27°C, if the value of $\gamma = 1.4$, then the new temperature will be

(a) $350 \times 4^{0.4}\ K$ (b) $300 \times 4^{0.4}\ K$

(c) $150 \times 4^{0.4}\ K$ (d) None of these

55. During an adiabatic expansion of 2 moles of a gas, the change in internal energy was found – 50J. The work done during the process is

(a) Zero (b) 100J

(c) – 50J (d) 50J

56. Adiabatic modulus of elasticity of a gas is $2.1 \times 10^5\ N/m^2$. What will be its isothermal modulus of elasticity $\left(\frac{C_p}{C_v} = 1.4\right)$

(a) $1.8 \times 10^5\ N/m^2$ (b) $1.5 \times 10^5\ N/m^2$

(c) $1.4 \times 10^5\ N/m^2$ (d) $1.2 \times 10^5\ N/m^2$

57. For an adiabatic expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to

(a) $-\sqrt{\gamma}\frac{\Delta V}{V}$ (b) $-\frac{\Delta V}{V}$

(c) $-\gamma \frac{\Delta V}{V}$ (d) $-\gamma^2 \frac{\Delta V}{V}$

Isobaric and Isochoric Processes

1. A gas expands under constant pressure *P* from volume V_1 to V_2. The work done by the gas is

(a) $P(V_2 - V_1)$ (b) $P(V_1 - V_2)$

(c) $P(V_1^\gamma - V_2^\gamma)$ (d) $P\frac{V_1 V_2}{V_2 - V_1}$

2. When heat in given to a gas in an isobaric process, then

(a) The work is done by the gas

(b) Internal energy of the gas increases

(c) Both (a) and (b)

(d) None from (a) and (b)

3. One mole of a perfect gas in a cylinder fitted with a piston has a pressure *P*, volume *V* and temperature *T*. If the temperature is increased by 1 *K* keeping pressure constant, the increase in volume is

(a) $\frac{2V}{273}$ (b) $\frac{V}{91}$

(c) $\frac{V}{273}$ (d) V

4. A gas is compressed at a constant pressure of $50\,N/m^2$ from a volume of $10\,m^3$ to a volume of $4\,m^3$. Energy of 100 *J* then added to the gas by heating. Its internal energy is

(a) Increased by 400 *J* (b) Increased by 200 *J*

(c) Increased by 100 *J* (d) Decreased by 200 *J*

5. Work done by air when it expands from 50 *litres* to 150 *litres* at a constant pressure of 2 atmosphere is

(a) 2×10^4 *joules* (b) 2×100 *joules*

(c) $2\times10^5\times100$ *joules* (d) $2\times10^{-5}\times100$ joules

6. Work done by 0.1 mole of a gas at 27^oC to double its volume at constant pressure is (R = 2 *cal* $mol^{-1}\,{}^oC^{-1}$)

(a) 54 *cal* (b) 600 *cal*

(c) 60 *cal* (d) 546 *cal*

7. Unit mass of a liquid with volume V_1 is completely changed into a gas of volume V_2 at a constant external pressure *P* and temperature *T*. If the latent heat of evaporation for the given mass is *L*, then the increase in the internal energy of the system is

(a) Zero (b) $P(V_2 - V_1)$

(c) $L - P(V_2 - V_1)$ (d) L

8. A gas expands $0.25\,m^3$ at constant pressure $10^3\,N/m^2$, the work done is

(a) 2.5 *ergs* (b) 250 *J*

(c) 250 *W* (d) 250 *N*

9. Two kg of water is converted into steam by boiling at atmospheric pressure. The volume changes from $2\times10^{-3}\,m^3$ to $3.34\,m^3$. The work done by the system is about

(a) – 340 *kJ* (b) – 170 *kJ*

(c) 170 *kJ* (d) 340 *kJ*

10. An ideal gas has volume V_0 at $27^o C$. It is heated at constant pressure so that its volume becomes $2V_0$. The final temperature is

(a) $54^o C$ (b) $32.6^o C$

(c) $327\ °C$ (d) 150 K

11. If 300 *ml* of a gas at $27^o C$ is cooled to $7^o C$ at constant pressure, then its final volume will be

(a) 540 *ml* (b) 350 *ml*

(c) 280 *ml* (d) 135 *ml*

12. Which of the following is correct in terms of increasing work done for the same initial and final state

(a) Adiabatic < Isothermal < Isobaric

(b) Isobaric < Adiabatic < Isothermal

(c) Adiabatic < Isobaric < Isothermal

(d) None of these

13. A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is

(a) Isothermal (b) Isobaric

(c) Adiabatic (d) Equal in all cases

14. Which of the following is a slow process

(a) Isothermal (b) Adiabatic

(c) Isobaric (d) None of these

15. How much work to be done in decreasing the volume of and ideal gas by an amount of $2.4 \times 10^{-4} m^3$ at normal temperature and constant normal pressure of $1 \times 10^5 N/m^2$

(a) 28 *joule* (b) 27 *joule*

(c) 25 *joule* (d) 24 *joule*

16. A Container having 1 mole of a gas at a temperature 27°*C* has a movable piston which maintains at constant pressure in container of 1 *atm*. The gas is compressed until temperature becomes 127°*C*. The work done is (C_P for gas is 7.03 $cal/mol^{-}K$)

(a) 703 J (b) 814 J

(c) 121 J (d) 2035 J

17. In a reversible isochoric change

(a) $\Delta W = 0$ (b) $\Delta Q = 0$

(c) $\Delta T = 0$ (d) $\Delta U = 0$

18. Entropy of a thermodynamic system does not change when this system is used for

(a) Conduction of heat from a hot reservoir to a cold reservoir

(b) Conversion of heat into work isobarically

(c) Conversion of heat into internal energy isochorically

(d) Conversion of work into heat isochorically

19. The work done in which of the following processes is zero

(a) Isothermal process (b) Adiabatic process

(c) Isochoric process (d) None of these

20. In which thermodynamic process, volume remains same

(a) Isobaric (b) Isothermal

(c) Adiabatic (d) Isochoric

21. In an isochoric process if $T_1 = 27^o C$ and $T_2 = 127^o C$, then P_1 / P_2 will be equal to

(a) 9 / 59 (b) 2 / 3

(c) 3 / 4 (d) None of these

22. Which is incorrect

(a) In an isobaric process, $\Delta p = 0$

(b) In an isochoric process, $\Delta W = 0$

(c) In an isothermal process, $\Delta T = 0$

(d) In an isothermal process, $\Delta Q = 0$

23. Which relation is correct for isometric process

(a) $\Delta Q = \Delta U$ (b) $\Delta W = \Delta U$

(c) $\Delta Q = \Delta W$ (d) None of these

Heat Engine, Refrigerator and Second Law of Thermodynamics

1. A Carnot engine working between $300\ K$ and $600 K$ has work output of $800\ J$ per cycle. What is amount of heat energy supplied to the engine from source per cycle

(a) $1800\ J/cycle$ (b) $1000\ J/cycle$

(c) $2000\ J/cycle$ (d) $1600\ J/cycle$

2. The coefficient of performance of a Carnot refrigerator working between 30^oC and 0^oC is

(a) 10 (b) 1

(c) 9 (d) 0

3. If the door of a refrigerator is kept open, then which of the following is true

(a) Room is cooled

(b) Room is heated

(c) Room is either cooled or heated

(d) Room is neither cooled nor heated

4. In a cyclic process, the internal energy of the gas

(a) Increases (b) Decreases

(c) Remains constant (d) Becomes zero

5. Irreversible process is

(a) Adiabatic process

(b) Joule-Thomson expansion

(c) Ideal isothermal process

(d) None of the above

6. For a reversible process, necessary condition is

(a) In the whole cycle of the system, the loss of any type of heat energy should be zero

(b) That the process should be too fast

(c) That the process should be slow so that the working substance should remain in thermal and mechanical equilibrium with the surroundings

(d) The loss of energy should be zero and it should be *quasistatic*

7. In a cyclic process, work done by the system is

(a) Zero

(b) Equal to heat given to the system

(c) More than the heat given to system

(d) Independent of heat given to the system

8. An ideal gas heat engine operates in a Carnot's cycle between 227^oC and 127^oC. It absorbs $6 \times 10^4\ J$ at high temperature. The amount of heat converted into work is ....

(a) $4.8\times10^{4}\ J$ (b) $3.5\times10^{4}\ J$

(c) $1.6\times10^{4}\ J$ (d) $1.2\times10^{4}\ J$

9. An ideal heat engine exhausting heat at $77^{o}C$ is to have a 30% efficiency. It must take heat at

(a) $127^{o}C$ (b) $227^{o}C$

(c) $327^{o}C$ (d) $673^{o}C$

10. Efficiency of Carnot engine is 100% if

(a) $T_2 = 273\ K$ (b) $T_2 = 0\ K$

(c) $T_1 = 273\ K$ (d) $T_1 = 0\ K$

11. A Carnot's engine used first an ideal monoatomic gas then an ideal diatomic gas. If the source and sink temperature are $411^{o}C$ and $69^{o}C$ respectively and the engine extracts 1000 J of heat in each cycle, then area enclosed by the PV diagram is

(a) 100 J (b) 300 J

(c) 500 J (d) 700 J

12. A Carnot engine absorbs an amount Q of heat from a reservoir at an abosolute temperature T and rejects heat to a sink at a temperature of $T/3$. The amount of heat rejected is

(a) $Q/4$ (b) $Q/3$

(c) $Q/2$ (d) $2Q/3$

13. The temperature of sink of Carnot engine is $27^{o}C$. Efficiency of engine is 25%. Then temperature of source is

(a) $227^{o}C$ (b) $327^{o}C$

(c) $127^{o}C$ (d) $27^{o}C$

14. The temperature of reservoir of Carnot's engine operating with an efficiency of 70% is 1000K. The temperature of its sink is

(a) 300 K (b) 400 K

(c) 500 K (d) 700 K

15. In a Carnot engine, when $T_2 = 0^{o}C$ and $T_1 = 200^{o}C$, its efficiency is η_1 and when $T_1 = 0\ ^{o}C$ and $T_2 = -200\ ^{o}C$, Its efficiency is η_2, then what is η_1/η_2

(a) 0.577 (b) 0.733

(c) 0.638 (d) Can not be calculated

16. The efficiency of Carnot's engine operating between reservoirs, maintained at temperatures $27^{o}C$ and $-123^{o}C$, is

(a) 50% (b) 24%

(c) 0.75% (d) 0.4%

17. A Carnot engine operates between $227^{o}C$ and $27^{o}C$. Efficiency of the engine will be

(a) $\frac{1}{3}$ (b) $\frac{2}{5}$

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

18. A measure of the degree of disorder of a system is known as

(a) Isobaric (b) Isotropy

(c) Enthalpy (d) Entropy

19. A carnot engine has the same efficiency between 800 K to 500 K and x K to 600 K. The value of x is

(a) 1000 K (b) 960 K

(c) 846 K (d) 754 K

20. A scientist says that the efficiency of his heat engine which operates at source temperature 127°C and sink temperature 27°C is 26%, then

(a) It is impossible

(b) It is possible but less probable

(c) It is quite probable

(d) Data are incomplete

21. A Carnot's engine is made to work between 200°C and 0°C first and then between 0°C and –200°C. The ratio of efficiencies of the engine in the two cases is

(a) 1.73 : 1 (b) 1 : 1.73

(c) 1 : 1 (d) 1 : 2

22. Efficiency of a Carnot engine is 50% when temperature of outlet is 500 K. In order to increase efficiency up to 60% keeping temperature of intake the same what is temperature of outlet

(a) 200 K (b) 400 K

(c) 600 K (d) 800 K

23. Even Carnot engine cannot give 100% efficiency because we cannot

(a) Prevent radiation

(b) Find ideal sources

(c) Reach absolute zero temperature

(d) Eliminate friction

24. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of

(a) Second law of thermodynamics

(b) Conservation of momentum

(c) Conservation of mass

(d) First law of thermodynamics

25. A Carnot engine takes $3\times10^{6}\,cal$. of heat from a reservoir at 627°C, and gives it to a sink at 27°C. The work done by the engine is

(a) $4.2\times10^{6}\,J$ (b) $8.4\times10^{6}\,J$

(c) $16.8\times10^{6}\,J$ (d) Zero

26. The first operation involved in a Carnot cycle is

(a) Isothermal expansion (b) Adiabatic expansion

(c) Isothermal compression (d) Adiabatic compression

27. For which combination of working temperatures the efficiency of Carnot's engine is highest

(a) 80 K, 60 K (b) 100 K, 80 K

(c) 60 K, 40 K (d) 40 K, 20 K

28. The efficiency of Carnot engine when source temperature is T_1 and sink temperature is T_2 will be

(a) $\frac{T_1-T_2}{T_1}$ (b) $\frac{T_2-T_1}{T_2}$

(c) $\frac{T_1-T_2}{T_2}$ (d) $\frac{T_1}{T_2}$

29. An ideal heat engine working between temperature T_1 and T_2 has an efficiency η, the new efficiency if both the source and sink temperature are doubled, will be

(a) $\frac{\eta}{2}$ (b) η

(c) 2η (d) 3η

30. 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) $325K$

(c) $39°C$ (d) $320°C$

31. In a mechanical refrigerator, the low temperature coils are at a temperature of – $23°C$ and the compressed gas in the condenser has a temperature of $27°C$. The theoretical coefficient of performance is

(a) 5 (b) 8

(c) 6 (d) 6.5

32. An engine is supposed to operate between two reservoirs at temperature $727°C$ and $227°C$. The maximum possible efficiency of such an engine is

(a) 1/2 (b) 1/4

(c) 3/4 (d) 1

33. An ideal gas heat engine operates in Carnot cycle between $227°C$ and $127°C$. It absorbs 6×10^4 *cals* of heat at higher temperature. Amount of heat converted to work is

(a) 2.4×10^4 *cal* (b) 6×10^4 *cal*

(c) 1.2×10^4 *cal* (d) 4.8×10^4 *cal*

34. Which of the following processes is reversible

(a) Transfer of heat by radiation

(b) Electrical heating of a nichrome wire

(c) Transfer of heat by conduction

(d) Isothermal compression

Miscellaneous Problems

1. 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) $\frac{5}{7}$

2. $1cm^3$ of water at its boiling point absorbs 540 calories of heat to become steam with a volume of $1671 cm^3$.If the atmospheric pressure = $1.013 x 10^5 N/m^2$ and the mechanical equivalent of heat = $4.19 J/calorie$, the energy spent in this process in overcoming intermolecular forces is

(a) 540 *cal* (b) 40 *cal*

(c) 500 *cal* (d) Zero

3. During the melting of a slab of ice at 273 K at atmospheric pressure

(a) Positive work is done by ice-water system on the atmosphere

(b) Positive work is done on the ice-water system by the atmosphere

(c) The internal energy of the ice-water system increases

(d) The internal energy of the ice-water system decreases

4. 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 ΔP and 1.5 ΔP respectively. Then

(a) $4m_A = 9m_B$ (b) $2m_A = 3m_B$

(c) $3m_A = 2m_B$ (d) $9m_A = 3m_B$

5. A monoatomic 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) $\left(\frac{L_1}{L_2}\right)^{2/3}$ (b) $\frac{L_1}{L_2}$

(c) $\frac{L_2}{L_1}$ (d) $\left(\frac{L_2}{L_1}\right)^{2/3}$

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

(a) 13.65 *cm* (b) 27.3 *cm*

(c) 38.6 *cm* (d) 64.6 *cm*

7. A mono atomic gas is supplied the heat *Q* very slowly keeping the pressure constant. The work done by the gas will be

(a) $\frac{2}{3}Q$ (b) $\frac{3}{5}Q$

(c) $\frac{2}{5}Q$ (d) $\frac{1}{5}Q$

8. A gas mixture consists of 2 moles of oxygen and 4 moles argon at temperature *T*. Neglecting all vibrational modes, the total internal energy of the system is

(a) 4 *RT* (b) 15 *RT*

(c) 9 *RT* (d) 11 *RT*

9. An ideal gas expands isothermally from a 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) $P_3 = P_1, W = 0$

10. Work done by a system under isothermal change from a volume V_1 to V_2 for a gas which obeys Vander Waal's equation $(V - \beta n)\left(P + \frac{\alpha n^2}{V}\right) = nRT$

(a) $nRT \log_e\left(\frac{V_2 - n\beta}{V_1 - n\beta}\right) + \alpha n^2\left(\frac{V_1 - V_2}{V_1 V_2}\right)$

(b) $nRT \log_{10}\left(\frac{V_2 - \alpha\beta}{V_1 - \alpha\beta}\right) + \alpha n^2\left(\frac{V_1 - V_2}{V_1 V_2}\right)$

(c) $nRT \log_e\left(\frac{V_2 - n\alpha}{V_1 - n\alpha}\right) + \beta n^2\left(\frac{V_1 - V_2}{V_1 V_2}\right)$

(d) $nRT \log_e\left(\frac{V_1 - n\beta}{V_2 - n\beta}\right) + \alpha n^2\left(\frac{V_1 V_2}{V_1 - V_2}\right)$

11. A cylindrical tube of uniform cross-sectional area *A* is fitted with two air tight frictionless pistons. The pistons are connected to each other by a metallic wire. Initially the pressure of the gas is P_0 and temperature is T_0, atmospheric pressure is also P_0. Now the temperature of the gas is increased to $2T_0$, the tension in the wire will be

(a) $2P_0A$ (b) P_0A

(c) $\frac{P_0A}{2}$ (d) $4P_0A$

12. The molar heat capacity in a process of a diatomic gas if it does a work of $\frac{Q}{4}$ when a heat of Q is supplied to it is

(a) $\frac{2}{5}R$ (b) $\frac{5}{2}R$

(c) $\frac{10}{3}R$ (d) $\frac{6}{7}R$

13. An insulator container contains 4 moles of an ideal diatomic gas at temperature T. Heat Q is supplied to this gas, due to which 2 moles of the gas are dissociated into atoms but temperature of the gas remains constant. Then

(a) $Q = 2RT$ (b) $Q = RT$

(c) $Q = 3RT$ (d) $Q = 4RT$

14. The volume of air increases by 5% in its adiabatic expansion. The percentage decrease in its pressure will be

(a) 5% (b) 6%

(c) 7% (d) 8%

15. The temperature of a hypothetical gas increases to $\sqrt{2}$ times when compressed adiabatically to half the volume. Its equation can be written as

(a) $PV^{3/2}$ = constant (b) $PV^{5/2}$ = constant

(c) $PV^{7/3}$ = constant (d) $PV^{4/3}$ = constant

16. Two Carnot engines A and B are operated in succession. The first one, A receives heat from a source at $T_1 = 800\,K$ and rejects to sink at T_2K. The second engine B receives heat rejected by the first engine and rejects to another sink at $T_3 = 300\,K$. If the work outputs of two engines are equal, then the value of T_2 is

(a) 100K (b) 300K

(c) 550K (d) 700K

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

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

(c) $\frac{3}{7}$ (d) $\frac{3}{4}$

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

(a) 40 % (b) 30 %

(c) 60 % (d) 20 %

19. Which one of the following gases possesses the largest internal energy

(a) 2 moles of helium occupying $1m^3$ at 300 K

(b) 56 kg of nitrogen at $107\ Nm^{-2}$ and 300 K

(c) 8 grams of oxygen at 8 atm and 300 K

(d) 6×10^{26} molecules of argon occupying $40m^3$ at 900 K

20. Two samples A and B of a gas initially at the same pressure and temperature are compressed from volume V to $V/2$ (A isothermally and adiabatically). The final pressure of A is

(a) Greater than the final pressure of B

(b) Equal to the final pressure of B

(c) Less than the final pressure of B

(d) Twice the final pressure of B

21. Initial pressure and volume of a gas are P and V respectively. First it is expanded isothermally to volume $4V$ and then compressed adiabatically to volume V. The final pressure of gas will be

(a) $1P$ (b) $2P$

(c) $4P$ (d) $8P$

22. A thermally insulated rigid container contains an ideal gas heated by a filament of resistance 100 Ω through a current of $1A$ for 5 min then change in internal energy is

(a) 0 kJ (b) 10 kJ

(c) 20 kJ (d) 30 kJ

23. A reversible engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by 62°C, the efficiency of the engine is doubled. The temperatures of the source and sink are

(a) 80°C, 37°C (b) 95°C, 28°C

(c) 90°C, 37°C (d) 99°C, 37°C

24. An engineer claims to have made an engine delivering 10 kW power with fuel consumption of 1 g/sec. The calorific value of the fuel is 2 $kcal/g$. Is the claim of the engineer

(a) Valid

(b) Invalid

(c) Depends on engine design

(d) Depends of the load

25. Find the change in the entropy in the following process 100 gm of ice at 0°C melts when dropped in a bucket of water at 50°C (Assume temperature of water does not change)

(a) – 4.5 cal/K (b) + 4.5 cal/K

(c) +5.4 cal/K (d) – 5.4 cal/K

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

(a) Heated

(b) Cooled

(c) Neither heated nor cooled

(d) First heated and then cooled

27. A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the high temperature reservoir be increased

(a) 840 K (b) 280 K

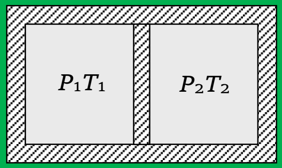
(c) 560 K (d) 380 K

28. *P-V* diagram of a diatomic gas is a straight line passing through origin. The molar heat capacity of the gas in the process will be

(a) $4\,R$ (b) $2.5\,R$

(c) $3\,R$ (d) $\frac{4R}{3}$

29. Following figure shows on adiabatic cylindrical container of volume V_0 divided by an adiabatic smooth piston (area of cross-section = A) in two equal parts. An ideal gas $(C_P/C_V=\gamma)$ is at pressure P_1 and temperature T_1 in left part and gas at pressure P_2 and temperature T_2 in right part. The piston is slowly displaced and released at a position where it can stay in equilibrium. The final pressure of the two parts will be (Suppose x = displacement of the piston)



(a) P_2 (b) P_1

(c) $\dfrac{P_1\left(\frac{V_0}{2}\right)^{\gamma}}{\left(\frac{V_0}{2}+Ax\right)^{\gamma}}$ (d) $\dfrac{P_2\left(\frac{V_0}{2}\right)^{\gamma}}{\left(\frac{V_0}{2}+Ax\right)^{\gamma}}$

30. 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

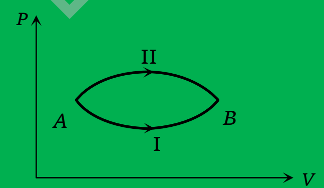
Indicator Diagrams

1. A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies in the processes I and II respectively, then

(a) $\Delta U_{II} > \Delta U_I$

(b) $\Delta U_{II} < \Delta U_I$

(c) $\Delta U_I = \Delta U_{II}$



(d) Relation between ΔU_I and ΔU_{II} cannot be determined

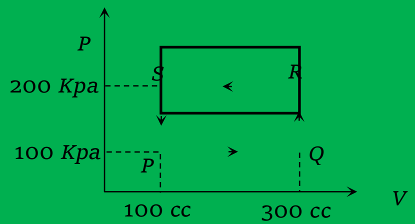
2. A thermodynamic system is taken through the cycle *PQRSP* process. The net work done by the system is

(a) 20 J

(b) – 20 J

(c) 400 J

(d) – 374 J



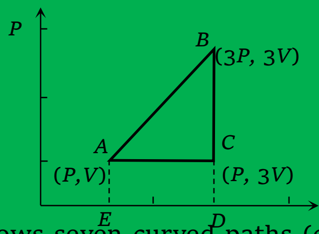
3. An ideal gas is taken around $ABCA$ as shown in the above P-V diagram. The work done during a cycle is

(a) $2PV$

(b) PV

(c) $1/2PV$

(d) Zero



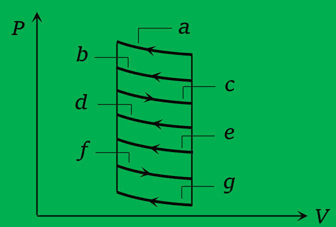
4. The P-V diagram shows seven curved paths (connected by vertical paths) that can be followed by a gas. Which two of them should be parts of a closed cycle if the net work done by the gas is to be at its maximum value

(a) ac

(b) cg

(c) af

(d) cd



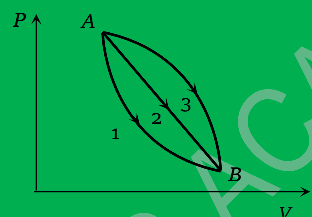
5. An ideal gas of mass m in a state A goes to another state B via three different processes as shown in figure. If Q_1, Q_2 and Q_3 denote the heat absorbed by the gas along the three paths, then

(a) $Q_1 < Q_2 < Q_3$

(b) $Q_1 < Q_2 = Q_3$

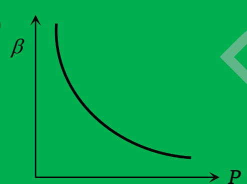
(c) $Q_1 = Q_2 > Q_3$

(d) $Q_1 > Q_2 > Q_3$

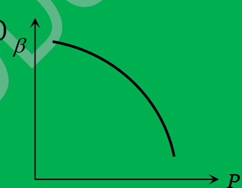


6. Which of the following graphs correctly represents the variation of $\beta = -(dV/dP)/V$ with P for an ideal gas at constant temperature

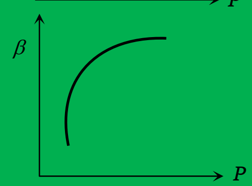
(a)



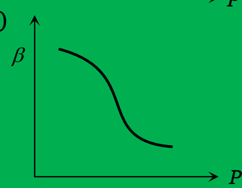
(b)



(c)



(d)



7. A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are : $P_A = 3\times10^4\,Pa, P_B = 8\times10^4\,Pa$ and $V_A = 2\times10^{-3}\,m^3, V_D = 5\times10^{-3}\,m^3$

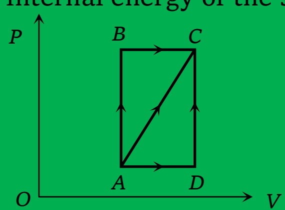
In process AB, 600 J of heat is added to the system and in process BC, 200 J of heat is added to the system. The change in internal energy of the system in process AC would be

(a) 560 J

(b) 800 J

(c) 600 J

(d) 640 J



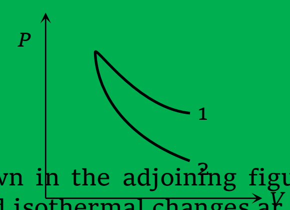
8. *P-V* plots for two gases during adiabatic process are shown in the figure. Plots 1 and 2 should correspond respectively to

(a) He and O_2

(b) O_2 and He

(c) He and Ar

(d) O_2 and N_2



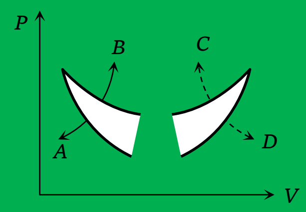
9. Four curves A, B, C and D are drawn in the adjoining figure for a given amount of gas. The curves which represent adiabatic and isothermal changes are

(a) C and D respectively

(b) D and C respectively

(c) A and B respectively

(d) B and A respectively



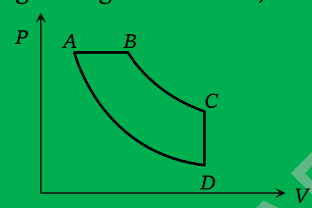
10. In pressure-volume diagram given below, the isochoric, isothermal, and isobaric parts respectively, are

(a) BA, AD, DC

(b) DC, CB, BA

(c) AB, BC, CD

(d) CD, DA, AB



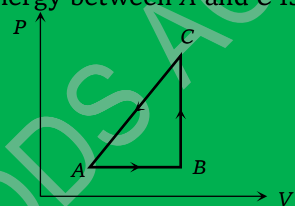
11. The *P-V* diagram of a system undergoing thermodynamic transformation is shown in figure. The work done on the system in going from $A \to B \to C$ is 50 J and 20 cal heat is given to the system. The change in internal energy between A and C is

(a) 34 J

(b) 70 J

(c) 84 J

(d) 134 J



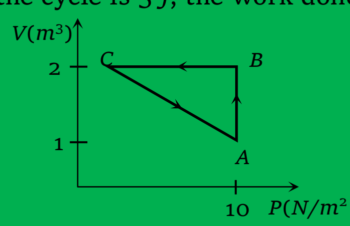
12. An ideal gas is taken through the cycle $A \to B \to C \to A$, as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, the work done by the gas in the process $C \to A$ is

(a) – 5 J

(b) – 10 J

(c) – 15 J

(d) – 20 J



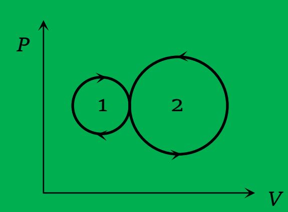
13. In the following indicator diagram, the net amount of work done will be

(a) Positive

(b) Negative

(c) Zero

(d) Infinity



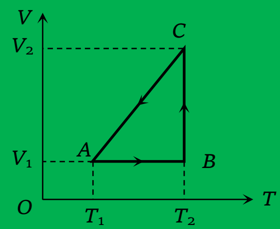
14. A cyclic process for 1 mole of an ideal gas is shown in figure in the *V*-*T*, diagram. The work done in *AB*, *BC* and *CA* respectively

(a) $0, RT_2 \ln\left(\frac{V_1}{V_2}\right), R(T_1 - T_2)$

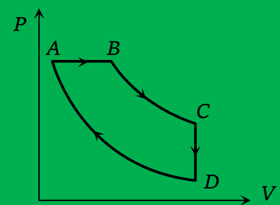
(b) $R(T_1 - T_2), 0, RT_1 \ln\frac{V_1}{V_2}$

(c) $0, RT_2 \ln\left(\frac{V_2}{V_1}\right), R(T_1 - T_2)$

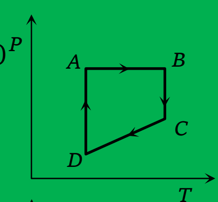
(d) $0, RT_2 \ln\left(\frac{V_2}{V_1}\right), R(T_2 - T_1)$



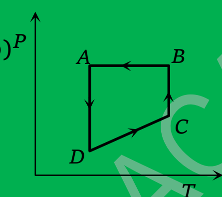
15. A cyclic process *ABCD* is shown in the figure *P*-*V* diagram. Which of the following curves represent the same process



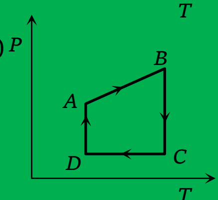
(a)



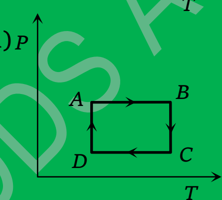
(b)



(c)



(d)



16. Carnot cycle (reversible) of a gas represented by a Pressure-Volume curve is shown in the diagram

Consider the following statements

I. Area *ABCD* = Work done on the gas

II. Area *ABCD* = Net heat absorbed

III. Change in the internal energy in cycle = 0

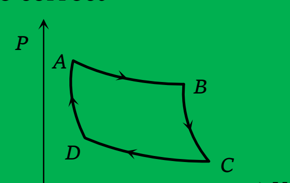
Which of these are correct

(a) I only

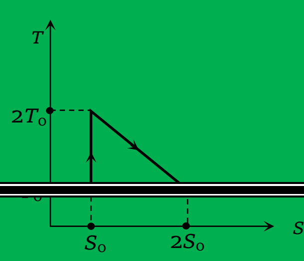
(b) II only

(c) II and III

(d) I, II and III



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



(a) $1/3$

(b) $2/3$

(c) $1/2$

(d) $1/4$

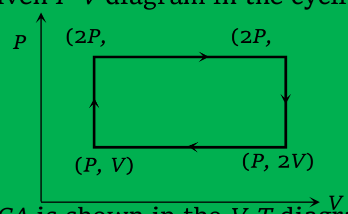
18. Work done in the given *P-V* diagram in the cyclic process is

(a) PV

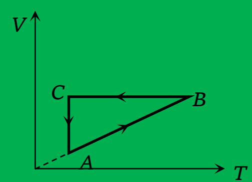
(b) $2PV$

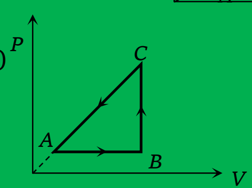
(c) $PV/2$

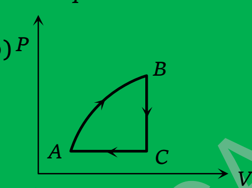
(d) $3PV$

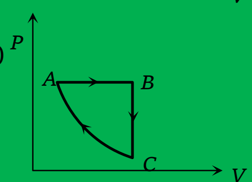


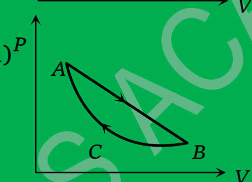
19. A cyclic process *ABCA* is shown in the *V-T* diagram. Process on the *P-V* diagram is



(a)


(b)


(c)


(d)


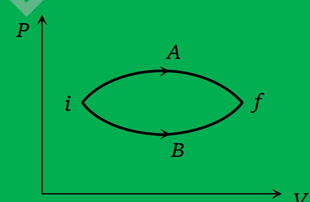
20. In the figure given two processes *A* and *B* are shown by which a thermo-dynamical system goes from initial to final state *F*. If ΔQ_A and ΔQ_B are respectively the heats supplied to the systems then

(a) $\Delta Q_A = \Delta Q_B$

(b) $\Delta Q_A \geq \Delta Q_B$

(c) $\Delta Q_A < \Delta Q_B$

(d) $\Delta Q_A > \Delta Q_B$



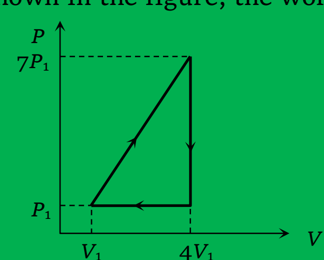
21. In the cyclic process shown in the figure, the work done by the gas in one cycle is

(a) $28\ P_1V_1$

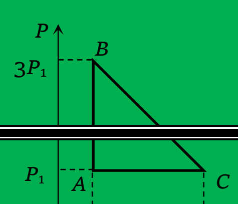
(b) $14\ P_1V_1$

(c) $18\ P_1V_1$

(d) $9\ P_1V_1$



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



(a) $12\,P_1V_1$

(b) $6\,P_1V_1$

(c) $3\,P_1V_1$

(d) $2P_1V_1$

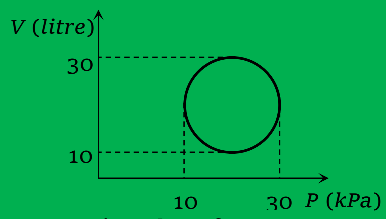
23. Heat energy absorbed by a system in going through a cyclic process shown in figure is

(a) $10^7\,\pi\,J$

(b) $10^4\,\pi\,J$

(c) $10^2\pi\,J$

(d) $10^{-3}\,\pi J$



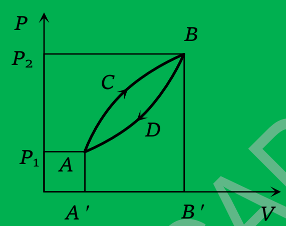
24. A thermodynamic system is taken from state A to B along ACB and is brought back to A along BDA as shown in the PV diagram. The net work done during the complete cycle is given by the area

(a) $P_1ACBP_2P_1$

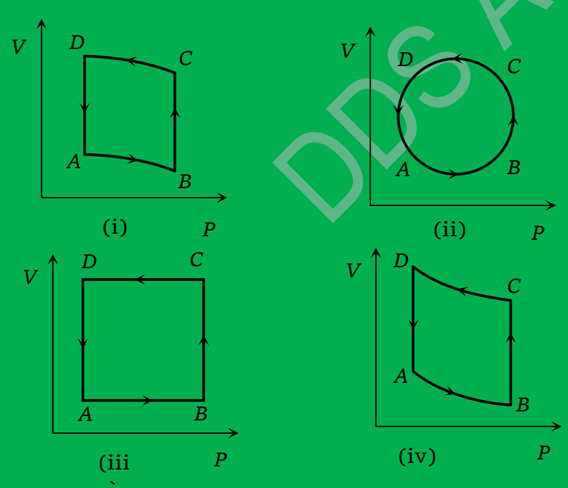
(b) $ACBB'A'A$

(c) $ACBDA$

(d) $ADBB'A'A$



25. In the diagrams (i) to (iv) of variation of volume with changing pressure is shown. A gas is taken along the path $ABCD$. The change in internal energy of the gas will be



(a) Positive in all cases (i) to (iv)

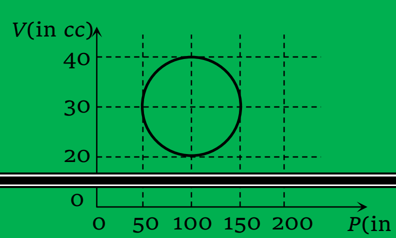
(b) Positive in cases (i), (ii) and (iii) but zero in (iv) case

(c) Negative in cases (i), (ii) and (iii) but zero in (iv) case

(d) Zero in all four cases

26. A system is taken through a cyclic process represented by a circle as shown. The heat absorbed by the system is

(a) $\pi \times 10^3\,J$



(b) $\frac{\pi}{2} J$

(c) $4\pi \times 10^2 J$

(d) πJ

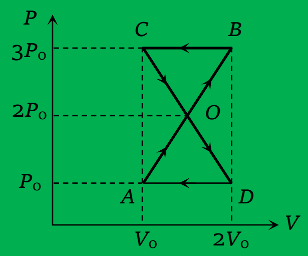
27. A thermodynamic system undergoes cyclic process *ABCDA* as shown in figure. The work done by the system is

(a) P_0V_0

(b) $2P_0V_0$

(c) $\frac{P_0V_0}{2}$

(d) Zero



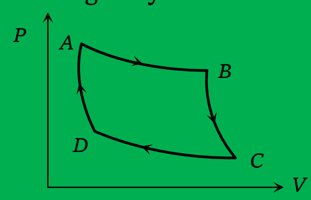
28. The *P*-*V* graph of an ideal gas cycle is shown here as below. The adiabatic process is described by

(a) *AB* and *BC*

(b) *AB* and *CD*

(c) *BC* and *DA*

(d) *BC* and *CD*



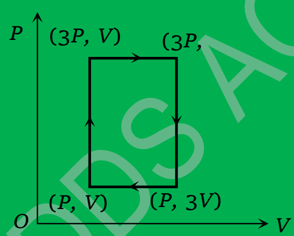
29. An ideal monoatomic gas is taken round the cycle ABCDA as shown in following *P*-*V* diagram. The work done during the cycle is

(a) *PV*

(b) 2 *PV*

(c) 4 *PV*

(d) Zero



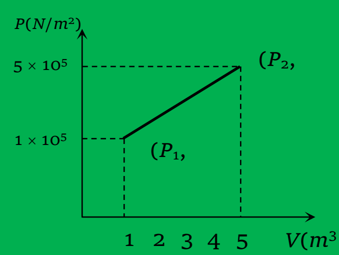
30. A system changes from the state (P_1, V_1) to $(P_2 V_2)$ as shown in the figure. What is the work done by the system

(a) 7.5×10^5 *joule*

(b) 7.5×10^5 *erg*

(c) 12×10^5 *joule*

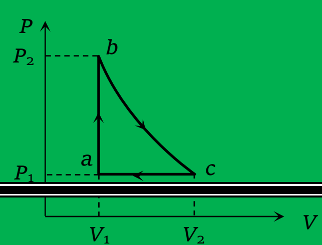
(d) 6×10^5 *joule*



31. 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 temperature 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*

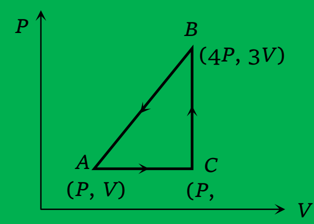
(b) 5000 *J*



(c) 9000 J

(d) 9800 J

32. A sample of ideal monoatomic gas is taken round the cycle *ABCA* as shown in the figure. The work done during the cycle is



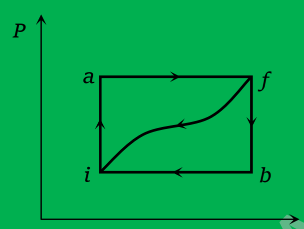
(a) Zero

(b) 3 PV

(c) 6 PV

(d) 9PV

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



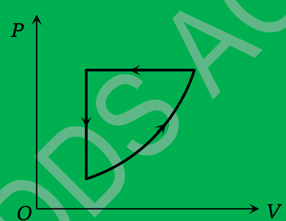
(a) 33 J

(b) 23 J

(c) – 7 J

(d) – 43 J

34. For one complete cycle of a thermodynamic process on a gas as shown in the *P-V* diagram, Which of following is correct



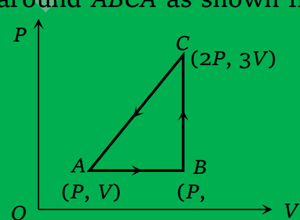
(a) $\Delta E_{\text{int}} = 0, Q < O$

(b) $\Delta E_{\text{int}} = 0, Q > 0$

(c) $\Delta E_{\text{int}} > 0, Q < 0$

(d) $\Delta E_{\text{int}} < 0, Q > 0$

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



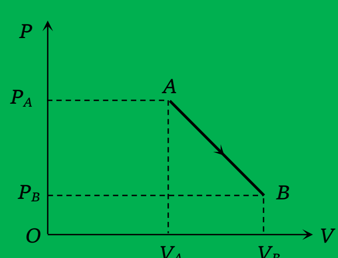
(a) Zero

(b) $\dfrac{1}{2}PV$

(c) 2 PV

(d) PV

36. 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



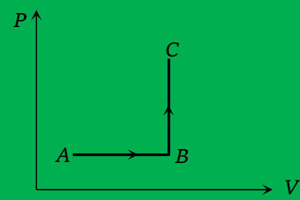
(a) $(P_A - P_B)(V_B - V_A)$

(b) $\dfrac{1}{2}(P_B - P_A)(V_B + V_A)$

(c) $\dfrac{1}{2}(P_B - P_A)(V_B - V_A)$

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

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



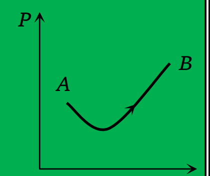
(a) 10 J

(b) 70 J

(c) 84 J

(d) 134 J

38. Consider a process shown in the figure. During this process the work done by the system



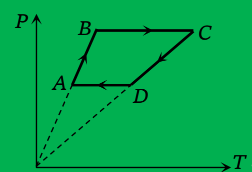
(a) Continuously increases

(b) Continuously decreases

(c) First increases, then decreases

(d) First decreases, then increases

39. Six moles of an ideal gas perfomrs a cycle shown in figure. If the temperature are T_A = 600 K, T_B = 800 K, T_C = 2200 K and T_D = 1200 K, the work done per cycle is



(a) 20 kJ

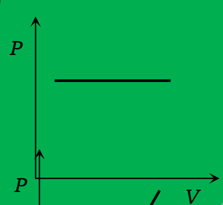
(b) 30 kJ

(c) 40 kJ

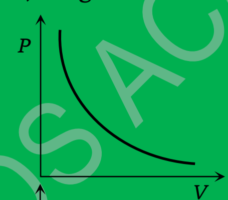
(d) 60 kJ

40. Which of the accompanying PV, diagrams best represents an isothermal process

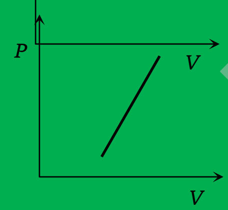
(a)



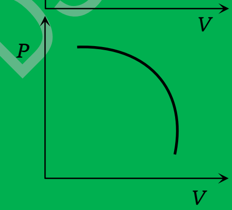
(b)



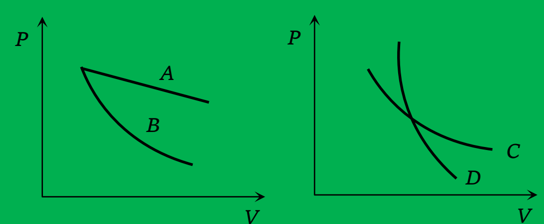
(c)



(d)



41. In the following figure, four curves A, B, C and D are shown. The curves are



(a) Isothermal for A and D while adiabatic for B and C

(b) Adiabatic for A and C while isothermal for B and D

(c) Isothermal for A and B while adiabatic for C and D

(d) Isothermal for A and C while adiabatic for B and D

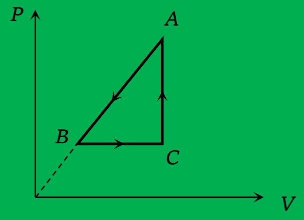
42. *P-V* diagram of a cyclic process *ABCA* is as shown in figure. Choose the correct statement

(a) $\Delta Q_{A\to B}$ = negative

(b) $\Delta U_{B\to C}$ = positive

(c) ΔW_{CAB} = negative

(d) All of these



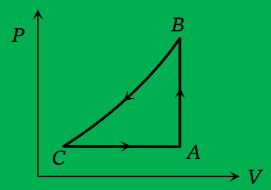
43. A sample of an ideal gas is taken through a cycle a shown in figure. It absorbs 50*J* of energy during the process *AB*, no heat during *BC*, rejects 70*J* during *CA*. 40*J* of work is done on the gas during *BC*. Internal energy of gas at *A* is 1500*J*, the internal energy at *C* would be

(a) 1590 *J*

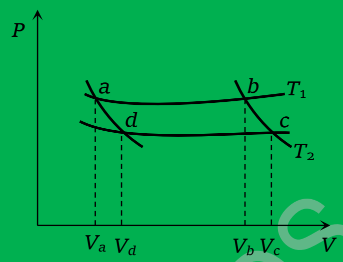
(b) 1620 *J*

(c) 1540 *J*

(d) 1570 *J*



44. In the following *P-V* diagram two adiabatic cut two isothermals at temperatures T_1 and T_2 (fig.). The value of $\frac{V_a}{V_d}$ will be



(a) $\frac{V_b}{V_c}$

(b) $\frac{V_c}{V_b}$

(c) $\frac{V_d}{V_a}$

(d) $V_b V_c$

ANSWER KEY

First Law of Thermodynamics

1	a	2	c	3	b	4	b	5	c
6	b	7	b	8	d	9	a	10	d
11	c	12	a	13	d	14	a	15	b
16	b	17	c	18	d	19	d	20	b
21	a	22	d	23	b	24	a	25	d
26	d	27	a	28	b	29	d	30	a
31	b	32	c	33	c	34	a	35	a
36	b	37	c	38	c	39	b	40	a
41	c	42	a	43	a	44	c	45	c
46	a	47	c	48	b				

Isothermal Process

1	c	2	a	3	c	4	d	5	b
6	b	7	c	8	d	9	a	10	c
11	a	12	b	13	a	14	a	15	c
16	c	17	a	18	c	19	a	20	c
21	b	22	b	23	a	24	a	25	a
26	c	27	b	28	b	29	b	30	a
31	d								

Adiabatic Process

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

Isobaric and Isochoric Processes

1	a	2	c	3	c	4	a	5	a
6	c	7	c	8	b	9	d	10	c
11	c	12	a	13	b	14	a	15	d
16	b	17	a	18	d	19	c	20	d
21	d	22	d	23	a				

Heat Engine, Refrigerator and Second Law of Thermodynamics

1	d	2	c	3	b	4	c	5	b
6	d	7	b	8	d	9	b	10	b
11	c	12	b	13	c	14	a	15	a
16	a	17	b	18	d	19	b	20	a
21	b	22	b	23	c	24	a	25	b
26	a	27	d	28	a	29	b	30	c
31	a	32	a	33	c	34	d		

Miscellaneous Problems

1	d	2	c	3	bc	4	c	5	d
6	d	7	c	8	d	9	c	10	a
11	b	12	c	13	b	14	c	15	a
16	c	17	b	18	a	19	b	20	c
21	b	22	d	23	d	24	b	25	b
26	b	27	d	28	c	29	c	30	d

Indicator Diagram

1	c	2	b	3	a	4	c	5	a
6	a	7	a	8	b	9	c	10	d
11	d	12	a	13	b	14	c	15	a
16	c	17	a	18	a	19	c	20	d
21	d	22	d	23	c	24	c	25	d
26	b	27	d	28	c	29	c	30	c
31	d	32	b	33	d	34	a	35	d
36	d	37	a	38	a	39	c	40	b
41	d	42	d	43	a	44	a		