14 Thermodynamics

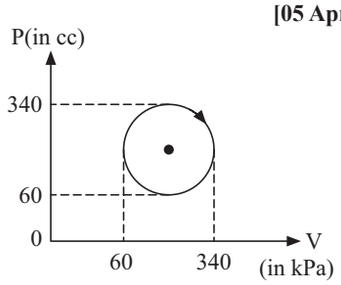
JEE-Main

First Law of Thermodynamics & Work Done, Heat Internal Energy

1. A diatomic gas ($\gamma = 1.4$) does 200 J of work when it is expanded isobarically. The heat given to the gas in the process is:
[1 Feb, 2024 (Shift-II)]

(*a*) 850 J (*b*) 800 J (*c*) 600 J (*d*) 700 J

2. The heat absorbed by a system in going through the given cyclic process is: **[05 April, 2024 (Shift-I)]**



(*a*) 61.6 J (*b*) 431.2 J (*c*) 616 J (*d*) 19.6 J

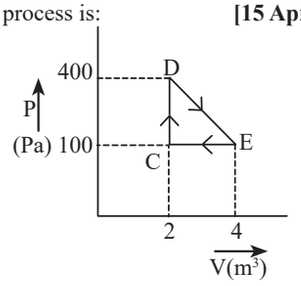
3. A total of 48 J heat is given to one mole of helium kept in a cylinder. The temperature of helium increases by 2°C. The work done by the gas is: **[06 April, 2024 (Shift-II)]**
(Given, $R = 8.3$ J $K^{-1}mol^{-1}$.)

(*a*) 72.9 J (*b*) 24.9 J (*c*) 48 J (*d*) 23.1 J

4. 1g of a liquid is converted to vapour at 3×10^5 *Pa* pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be: **[24 Jan, 2023 (Shift-I)]**

(*a*) 4320 *J* (*b*) 432000 *J* (*c*) 4800 *J* (*d*) 4.32×10^8 *J*

5. A thermodynamic system is taken through cyclic process. The total work done in the process is: **[15 Apr, 2023 (Shift-I)]**



(*a*) 100 J (*b*) 300 J
(*c*) Zero (*d*) 200 J

6. 1 kg of water at 100ºC is converted into steam at 100ºC by boiling at atmospheric pressure. The volume of water changes from 1.00×10^{-3} m^3 as a liquid to 1.671 m^3 as steam. The change in internal energy of the system during the process will be (Given latent heat of vaporisaiton = 2257 kJ/kg. Atmospheric pressure $=1 \times 10^5$ Pa)
[11 Apr, 2023 (Shift-I)]

(*a*) + 2090 kJ (*b*) – 2090 kJ
(*c*) – 2426 kJ (*d*) + 2476 kJ

7. A cylindrical furnace has height (H) and diameter (D) both 1 m. It is maintained at temperature 360 K. The air gets heated inside the furnace at constant pressure Pa and its temperature becomes T = 360 K. The hot air with density ρ rises up a vertical chimney of diameter d = 0.1 m and height h = 9 m above the furnace and exits the chimney (see the figure). As a result, atmospheric air of density ρa = 1.2 kg m^{-3}, pressure Pa and temperature Ta = 300 K enters the furnace. Assume air as an ideal gas, neglect the variations in ρ and T inside the chimney and the furnace. Also ignore the viscous effects. [Given: The acceleration due to gravity g = 10 ms−2 and π = 3.14]. Considering the air flow to be streamline, the steady mass flow rate of air exiting the chimney is_____ gm s^{-1}. **[JEE Adv, 2023]**

8. A source supplies heat to a system at the rate of 1000 W. If the system performs work at a rate of 200 W. The rate at which internal energy of the system increases **[6 Apr, 2023 (Shift-I)]**

(*a*) 1200 W (*b*) 600 W
(*c*) 500 W (*d*) 800 W

9. Given below are two statements:

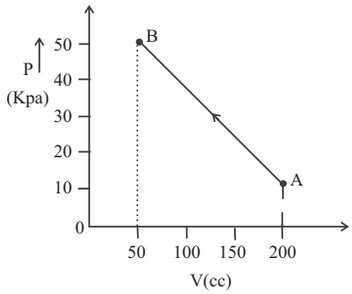
Statement-I: If heat is added to a system, its temperature must increase.

Statement-II: If positive work is done by a system in a thermodynamic process, its volume must increase.

In the light of the above statements, choose the correct answer from the options given below **[8 Apr, 2023 (Shift-I)]**

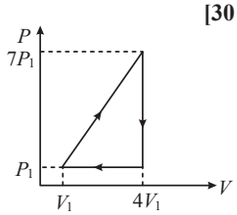
(*a*) Statement I is true but Statement II is false
(*b*) Both Statement I and Statement II are true
(*c*) Both Statement I and Statement II are false
(*d*) Statement I is false but Statement II is true

10. The pressure of a gas changes linearly with volume from A to B as shown in figure. If no heat is supplied to or extracted from the gas then change in the internal energy of the gas will be **[31 Jan, 2023 (Shift-I)]**



(*a*) 6 J (*b*) Zero (*c*) –4.5 J (*d*) 4.5 J

11. In the cyclic process shown in the figure, the work done by the gas in one cycle is **[30 Jan, 2023 (Shift-I)]**



(*a*) $28\,P_1V_1$ (*b*) $14\,P_1V_1$ (*c*) $18\,P_1V_1$ (*d*) $9\,P_1V_1$

12. Heat is given to an ideal gas in an isothermal process.

A. Internal energy of the gas will decrease.
B. Internal energy of the gas will increase.
C. Internal energy of the gas will not change.
D. The gas will do positive work.
E. The gas will do negative work.

Choose the correct answer from the options given below: **[30 Jan, 2023 (Shift-I)]**

(*a*) A and E only (*b*) B and D only
(*c*) C and E only (*d*) C and D only

13. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

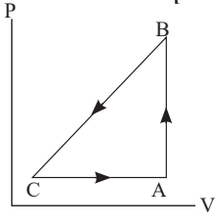
Assertion A: If dQ and dW represent the heat supplied to the system and the work done on the system respectively. Then according to the first law of thermodynamics $dQ = dU - dW$.

Reason R: First law of thermodynamics is based on law of conservation of energy.

In the light of the above statements, choose the correct answer from the option given below: **[29 Jan, 2023 (Shift-I)]**

(*a*) *A* is correct but *R* is not correct
(*b*) *A* is not correct but *R* is correct
(*c*) Both *A* and *R* are correct and *R* is the correct explanation of *A*
(*d*) Both *A* and *R* are correct but *R* is not the correct explanation of *A*

14. A sample of an ideal gas is taken through the cyclic process $ABCA$ as shown in figure. It absorbs, 40 J of heat during the part AB, no heat during BC and rejects 60 J of heat during CA. A work of 50 J is done on the during the part BC. The internal energy of the gas at A is 1560 J. The work donse by the gas during the part CA is: **[28 June, 2022 (Shift-II)]**



(*a*) 20 J (*b*) 30 J (*c*) –30 J (*d*) –60 J

15. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°*C* will be: **[29 June, 2022 (Shift-I)]**

(Given gas constant $R = 8.3\ JK^{-1} - mol^{-1}$)

(*a*) 249 J (*b*) 415 J (*c*) 498 J (*d*) 830 J

16. A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats 1.4. Vessel is moving with speed v and is suddenly brought to rest. Assuming no heat is lost to the surrounding and vessel temperature of the gas increases by: **[26 June, 2022 (Shift-I)]**

(R = universal gas constant)

(*a*) $\frac{Mv^2}{7R}$ (*b*) $\frac{Mv^2}{5R}$ (*c*) $2\frac{Mv^2}{7R}$ (*d*) $7\frac{Mv^2}{5R}$

17. At a certain temperature, the degrees of freedom per molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amount of heat absorbed by the gas will be _____ J. **[28 July, 2022 (Shift-II)]**

18. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be _____R during this transformation. Where R is the gas constant. **[24 June, 2022 (Shift-II)]**

19. List I describes thermodynamic processes in four different systems. List II gives the magnitudes (either exactly or as a close approximation) of possible changes in the internal energy of the system due to the process. **[JEE Adv, 2022]**

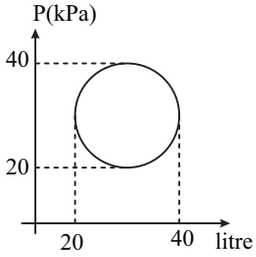
List-I		List-II	
A.	10^{-3} kg of water at 100°C is converted to steam at the same temperature, at a pressure of 10^5 Pa. The volume of the system changes from 10^{-6} m^3 to 10^{-3} m^3 in the process. Latent heat of water = 2250 kJ/kg.	I.	2 kJ
B.	0.2 moles of a rigid diatomic ideal gas with volume V at temperature 500 K undergoes an isobaric expansion to volume 3 V. Assume $R = 8.0 Jmol^{-1} K^{-1}$.	II.	7 kJ
C.	On mole of a monoatomic ideal gas is compressed adiabatically from volume $V = \frac{1}{3}$ m^3 and pressure 2kPa to volume $\frac{v}{8}$.	III.	4 kJ
D.	Three moles of a diatomic ideal gas whose molecules can vibrate, is given 9 kJ of heat and undergoes isobaric expansion.	IV.	5 kJ
		V.	3 kJ

(*a*) A → V; B → III; C → IV; D → II
(*b*) A → I; B → III; C → V; D → II
(*c*) A → IV; B → I; C → V; D → I
(*d*) A → II; B → III; C → IV; D → V

20. The volume V of a given mass of monoatomic gas changes with temperature T according to the relation $V = kT^{\frac{2}{3}}$. The work done when temperature changes by 90K will be xR. The value of x is _____. **[26 Feb, 2021 (Shift-II)]**

[R = universal gas constant]

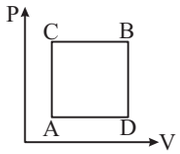
21. In the reported figure, heat energy absorbed by a system in going through a cyclic process is _____ πJ. **[20 July, 2021 (Shift-I)]**



22. 1 mole of rigid diatomic gas performs a work of $\frac{Q}{5}$ when heat Q is supplied to it. The molar heat capacity of the gas during this transformation is $\frac{xR}{8}$. The value of x is _____.

[R = universal gas constant] **[26 Feb, 2021 (Shift-II)]**

23. A gas can be taken from A to B via two different processes ACB and ADB. When path ACB is used 60 J of heat flows into the system and 30 J of work is done by the system. If path ADB is used work down by the system is 10 J. the heat flow into the system in path ADB is **[9 Jan, 2019 (Shift-I)]**



(*a*) 40 J (*b*) 80 J (*c*) 100 J (*d*) 20 J

24. Half mole of an ideal monoatomic gas is heated at constant pressure of 1 atm from 20°C to 90°C. Work done by has is close to: (Gas constant R = 8.31 J/mol.K) **[10 Jan, 2019 (Shift-II)]**

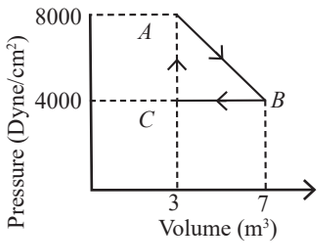
(*a*) 581 J (*b*) 291 J (*c*) 146 J (*d*) 73 J

Thermodynamics Process

25. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is: **[27 JAN, 2024 (Shift-II)]**

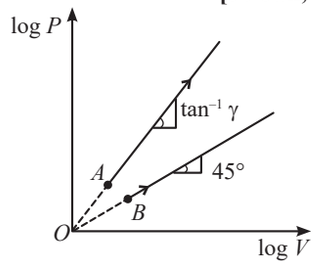
(*a*) $\frac{5}{3}$ (*b*) $\frac{3}{2}$ (*c*) $\frac{7}{5}$ (*d*) $\frac{9}{7}$

26. A thermodynamic system is taken from an original state A to an intermediate state B by a linear process as shown in the figure. It's volume is then reduced to the original value from B to C by an isobaric process. The total work done by the gas from A to B and B to C would be: **[29 Jan, 2024 (Shift-I)]**



(*a*) 33800J (*b*) 2200J (*c*) 600J (*d*) 1200J

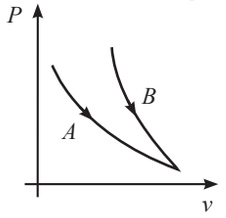
27. Two thermodynamical process are shown in the figure. The molar heat capacity for process A and B are C_A and C_B. The molar heat capacity at constant pressure and constant volume are represented by C_P and C_V, respectively. Choose the correct statement. **[30 Jan, 2024 (Shift-I)]**



(*a*) $C_B = \infty, C_A = 0$ (*b*) $C_A = 0$ and $C_B = \infty$

(*c*) $C_P > C_V > C_A = C_B$ (*d*) $C_A > C_P > C_V$

28. Choose the correct statement for processes A & B shown in figure. **[30 Jan, 2024 (Shift-II)]**



(*a*) $PV^{\gamma} = k$ for process B and $PV = k$ for process A.

(*b*) $PV = k$ for process B and A.

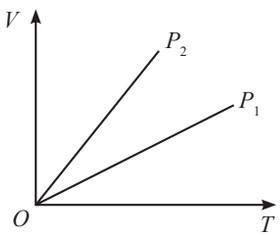
(*c*) $\frac{P^{\gamma-1}}{T^{\gamma}} = k$ for process B and $T = k$ for process A.

(*d*) $\frac{T^{\gamma}}{P^{\gamma-1}}$ k for process A and $PV = k$ for process.

29. If three moles of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ mixed with two moles of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$ the value of adiabatic exponent γ for the mixture is: **[30 Jan, 2024 (Shift-II)]**

(*a*) 1.75 (*b*) 1.40 (*c*) 1.52 (*d*) 1.35

30. The given figure represents two isobaric processes for the same mass of an ideal gas, then **[31 Jan, 2024 (Shift-I)]**



(*a*) $P_2 \geq P_1$ (*b*) $P_2 > P_1$ (*c*) $P_1 = P_2$ (*d*) $P_1 > P_2$

31. The pressure and volume of an ideal gas are related as $PV^{3/2} = K$ (Constant). The work done when the gas is taken from state A (P_1, V_1, T_1) to state B (P_2, V_2, T_2) is: **[1 Feb, 2024 (Shift-I)]**

(*a*) $2(P_1V_1 - P_2V_2)$ (*b*) $2(P_2V_2 - P_1V_1)$

(*c*) $2\left(\sqrt{P_1}V_1 - \sqrt{P_2}V_2\right)$ (*d*) $2\left(P_2\sqrt{V_2} - P_1\sqrt{V_1}\right)$

32. A sample of gas at temperature T is adiabatically expanded to double its volume. Adiabatic constant for the gas is $\gamma = 3/2$. The work done by the gas in the process is : (μ = 1 mole) **[04 April, 2024 (Shift-II)]**

(*a*) $RT\left[\sqrt{2}-2\right]$ (*b*) $RT\left[1-2\sqrt{2}\right]$

(*c*) $RT\left[2\sqrt{2}-1\right]$ (*d*) $RT\left[2-\sqrt{2}\right]$

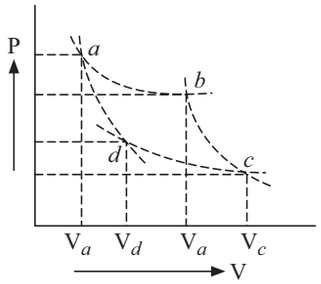
33. During an adiabatic process, if the pressure of a gas is found to be proportional to the cube of its absolute temperature, then the ratio of $\frac{C_P}{C_V}$ for the gas is: **[05 April, 2024 (Shift-II)]**

(*a*) $\frac{5}{3}$ (*b*) $\frac{9}{7}$ (*c*) $\frac{3}{2}$ (*d*) $\frac{7}{5}$

34. The specific heat at constant pressure of a real gas obeying $PV^2 = RT$ equation is: **[06 April, 2024 (Shift-II)]**

(*a*) $C_V + R$ (*b*) $\frac{R}{3} + C_V$ (*c*) R (*d*) $C_V + \frac{R}{2V}$

35. Two different adiabatic paths for the same gas intersect two isothermal curves as shown in *P-V* diagram. The relation between the ratio $\frac{V_a}{V_d}$ and the ratio $\frac{V_b}{V_c}$ is: [08 April, 2024 (Shift-I)]



(*a*) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$ (*b*) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$

(*c*) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$ (*d*) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^2$

36. A diatomic gas (γ = 1.4) does 100 J of work in an isobaric expansion. The heat given to the gas is: [08 April, 2024 (Shift-II)]

(*a*) 350 J (*b*) 490 J (*c*) 150 J (*d*) 250 J

37. The volume of an ideal gas (γ = 1.5) is changed adiabatically from 5 litres to 4 litres. The ratio of initial pressure to final pressure is: **[09 April, 2024 (Shift-I)]**

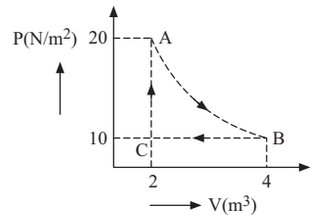
(*a*) $\frac{4}{5}$ (*b*) $\frac{16}{25}$ (*c*) $\frac{8}{5\sqrt{5}}$ (*d*) $\frac{2}{\sqrt{5}}$

38. A sample of 1 mole gas at temperature T is adiabatically expanded to double its volume. If adiabatic constant for the gas is $\gamma = 3/2$, then the work done by the gas in the process is: **[09 April, 2024 (Shift-I)]**

(*a*) $RT\left[2-\sqrt{2}\right]$ (*b*) $\frac{R}{T}\left[2-\sqrt{2}\right]$

(*c*) $RT\left[2+\sqrt{2}\right]$ (*d*) $\frac{T}{R}\left[2+\sqrt{2}\right]$

39. A real gas within a closed chamber at 27°C undergoes the cyclic process as shown in figure. The gas obeys $PV^3 = RT$ equation for the path *A* to *B*. The net work done in the complete cycle is (assuming R = 8J/molK): **[09 April, 2024 (Shift-II)]**



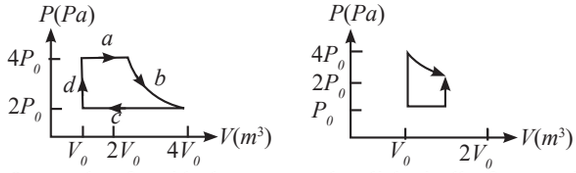
(*a*) 225 J (*b*) 205 J (*c*) 20 J (*d*) –20 J

40. A sample of gas at temperature T is adiabatically expanded to double its volume. The work done by the gas in the process is $\left(\text{given, } \gamma = \frac{3}{2}\right)$: **[01 Feb, 2023 (Shift-I)]**

(*a*) $W = TR\left[\sqrt{2}-2\right]$ (*b*) $W = \frac{T}{R}\left[\sqrt{2}-2\right]$

(*c*) $W = \frac{R}{T}\left[2-\sqrt{2}\right]$ (*d*) $W = RT\left[2-\sqrt{2}\right]$

41. One mole of an ideal gas undergoes two different cyclic processes I and II, as shown in the *P–V* diagrams below. In cycle I, processes *a, b, c* and *d* are isobaric, isothermal, isobaric and isochoric, respectively. In cycle II, processes a′, b′, c′ and d′ are isothermal, isochoric, isobaric and isochoric, respectively. The total work done during cycle I is W_1 and that during cycle II is W_{11}. The ratio W_1/W_{11} is _____. **[JEE Adv, 2023]**



42. One mole of an ideal gas expands adiabatically from an initial state (T_A, V_0) to final state (T_f, $5V_0$). Another mole of the same gas expands isothermally from a different initial state (T_B, V_0) to the same final state (T_f, $5V_0$). The ratio of the specific heats at constant pressure and constant volume of this ideal gas is γ. What is the ratio T_A/T_B? **[JEE Adv, 2023]**

(*a*) $5^{\gamma-1}$ (*b*) $5^{1-\gamma}$ (*c*) 5^{γ} (*d*) $5^{1+\gamma}$

43. The initial pressure and volume of an ideal gas are P_0 and V_0. The final pressure of the gas when the gas is suddenly compressed to volume $\frac{V_0}{4}$ will be: (Given γ = ratio of specific heats at constant pressure and at constant volume) **[13 Apr, 2023 (Shift-II)]**

(*a*) $P_0(4)^{\frac{1}{\gamma}}$ (*b*) $P_0(4)^{\gamma}$ (*c*) P_0 (*d*) $4P_0$

44. Consider two containers *A* and *B* containing monoatomic gases at the same Pressure (P), Volume (V) and Temperature (T). The gas in A is compressed isothermally to $\frac{1}{8}$ of its original volume while the gas *B* is compressed adiabatically to $\frac{1}{8}$ of its original volume. The ratio of final pressure of gas in *B* to that of gas in *A* is: **[10 Apr, 2023 (Shift-I)]**

(*a*) 8 (*b*) $8^{\frac{3}{2}}$ (*c*) $\frac{1}{8}$ (*d*) 4

45. A gas is compressed adiabatically, which one of the following statement is NOT true. **[10 Apr, 2023 (Shift-II)]**

(*a*) There is no heat supplied to the system

(*b*) The temperature of the gas increases

(*c*) The change in the internal energy is equal to the work done on the gas.

(*d*) There is no change in the internal energy

46. Match List-I with List-II:

List-I		List-II	
A.	Isothermal Process	I.	Work done by the gas decreases internal energy
B.	Adiabatic Process	II.	No change in internal energy
C.	Isochoric Process	III.	The heat absorbed goes partly to increase internal energy and partly to do work
D.	Isobaric Process	IV.	No work is done on or by the gas

Choose the correct answer from the options given below:

[25 Jan, 2023 (Shift-II)]

(*a*) A → II; B → I; C → III; D → IV
(*b*) A → II; B → I; C → IV; D → III
(*c*) A → I; B → II; C → IV; D → III
(*d*) A → I; B → II; C → III; D → IV

47. The thermodynamic process, in which internal energy of the system remains constant is **[11 Apr, 2023 (Shift-II)]**

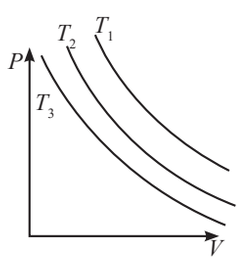
(*a*) Isochoric (*b*) Isothermal (*c*) Adiabatic (*d*) Isobaric

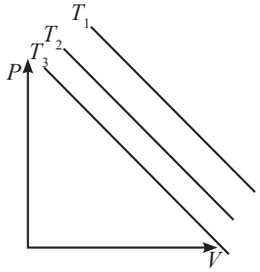
48. Under isothermal condition, the pressure of a gas is given by $P = aV^{-3}$, where a is a constant and V is the volume of the gas. The bulk modulus at constant temperature is equal to

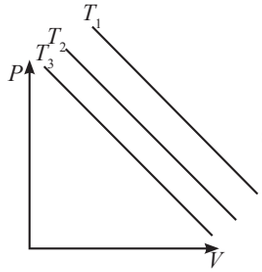
[13 Apr, 2023 (Shift-I)]

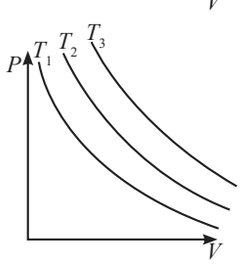
(*a*) $P/2$ (*b*) $3P$ (*c*) $2P$ (*d*) P

49. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperature; $T_3 > T_2 > T_1$ as: **[24 Jan, 2023 (Shift-II)]**

(*a*)


(*b*)


(*a*)


(*b*)


50. A hypothetical gas expands adiabatically such that its volume changes from 08 litres to 27 litres. If the ratio of final pressure of the gas to initial pressure of the gas is $\frac{16}{81}$. Then the ratio of $\frac{C_P}{C_V}$ will be. **[31 Jan, 2023 (Shift-II)]**

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

51. A monoatomic gas at pressure P and volume V is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be: **[26 July, 2022 (Shift-I)]**

(*a*) P (*b*) 8P (*c*) 32P (*d*) 64P

52. A bubble has surface tension S. The ideal gas inside the bubble has ratio of specific heats $\gamma = \frac{5}{3}$. The bubble is exposed to the atmosphere and it always retains its spherical shape. When the atmospheric pressure is P_{a1}, the radius of the bubble is found to be r_1 and the temperature of the enclosed gas is T_1. When the atmospheric pressure is P_{a2}, the radius of the bubble and the temperature of the enclosed gas are r_2 and T_2, respectively. **[JEE Advance 2022]**
Which of the following statement(s) is(are) correct?

(*a*) If the surface of the bubble is a perfect heat insulator, then
$$\left(\frac{r_1}{r_2}\right)^5 = \frac{P_{a_2} + \frac{2S}{r_2}}{P_{a_1} + \frac{2S}{r_1}}$$

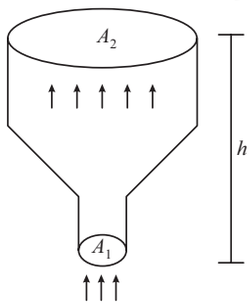
(*b*) If the surface of the bubble is a perfect heat insulator, then the total internal energy of the bubble including its surface energy does not change with the external atmospheric pressure.

(*c*) If the surface of the bubble is a perfect heat conductor and the change in atmospheric temperature is negligible, then
$$\left(\frac{r_1}{r_2}\right)^3 = \frac{P_{a2} + \frac{4S}{r_2}}{P_{a1} + \frac{4S}{r_1}}.$$

(*d*) If the surface of the bubble is a perfect heat insulator, then
$$\left(\frac{T_2}{T_1}\right)^{\frac{5}{2}} = \frac{P_{a_2} + \frac{4S}{r_2}}{P_{a_1} + \frac{4S}{r_1}}.$$

53. An ideal gas of density r = 0.2 kg m^{-3} enters a chimney of height h at the rate of a = 0.8 kg s^{-3} from its lower end, and escapes through the upper end as shown in the figure. The cross-sectional area of the lower end is $A_1 = 0.1$ m^{-2} and $A_2 = 0.4$ m^{-2} the upper end is . The pressure and the temperature of the gas at the lower end are 600 Pa and 300K respectively, while its temperature at the upper end is 150K. The chimney is heat insulated so that the gas undergoes adiabatic expansion. Take $g = 10$ ms^{-2} and the ratio of specific heats of the gas g = 2. Ignore atmospheric pressure.

[JEE Advance 2022]



Which of the following statement(s) is (are) correct?

(*a*) The pressure of the gas at the upper end of the chimney is 300Pa.

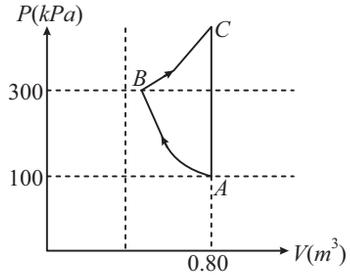
(*b*) The velocity of the gas at the lower end of the chimney is 40 ms^{-1} and at the upper end is 20 ms^{-1}.

(*c*) The height of the chimney is 590m.

(*d*) The density of the gas at the upper end is 0.05 kg m^{-3}.

54. In the given $P - V$ diagram, a monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is first compressed adiabatically from state A to state B. Then it expands isothermally from state B to state C.

[Given: $\left(\frac{1}{3}\right)^{0.6}$ 0.5, in 2 = 0.7]. **[JEE Advance 2022]**



Which of the following statement(s) is(are) correct?

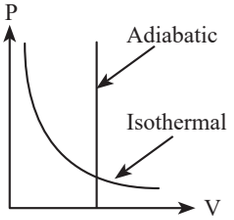
(*a*) The magnitude of the total work done in the process $A \to B \to C$ is 144 kJ.

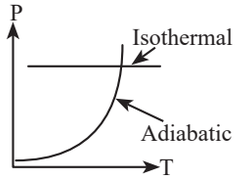
(*b*) The magnitude of the work done in the process $B \to C$ is 84 kJ.

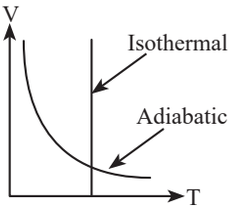
(*c*) The magnitude of the work done in the process $A \to B$ is 60 kJ.

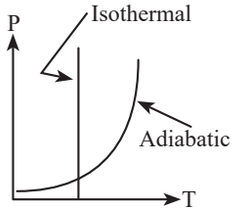
(*d*) The magnitude of the work done in the process $C \to A$ is zero.

55. Which one is the correct option for the two different thermodynamic processes? **[17 March, 2021 (Shift-II)]**

(A)


(B)


(C)


(D)


(*a*) (C) and (A) (*b*) (B) and (C)

(*c*) (C) and (D) (*d*) (A) only

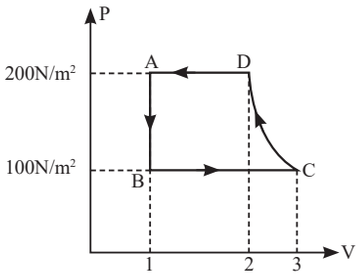
56. The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0°C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of work done by the gas is $\frac{x}{10}$. Then the value of x (round off to the nearest integer) is _____. (Given R = 8.31 J mol^{-1} K^{-1}) **[1 Sept, 2021 (Shift-II)]**

57. The amount of heat needed to raise the temperature of 4 moles of a rigid diatomic gas from 0ºC to 50ºC when no work is done is _____. (R is the universal gas constant)

[20 July, 2021 (Shift-I)]

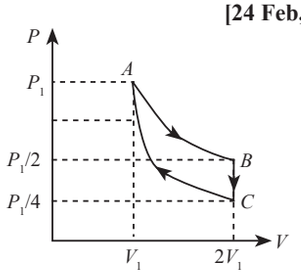
(*a*) 175 R (*b*) 750 R (*c*) 250 R (*d*) 500 R

58. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use $\gamma = 14$): **[18 March, 2021 (Shift-I)]**



(*a*) – 500J (*b*) 400J (*c*) – 400J (*d*) 200J

59. If one mole of an ideal gas at (P_1 V_1) is allowed to expand reversibly and isothermally (A to B) its pressure is reduced to one-half of the original pressure (see figure). This is followed by a constant volume cooling till its pressure is reduced to one-fourth of the initial value ($B \to C$). Then it is restored to its initial state by a reversible adiabatic compression (C to A). The net work done by the gas is equal to: **[24 Feb, 2021 (Shift-II)]**



(*a*) 0 (*b*) $RT \ln 2$

(*c*) $RT\left(\ln 2 - \frac{1}{2(\gamma-1)}\right)$ (*d*) $-\frac{RT}{2(\gamma-1)}$

60. n mole of perfect gas undergoes a cyclic process $ABCA$ (see figure) consisting of the following processes.

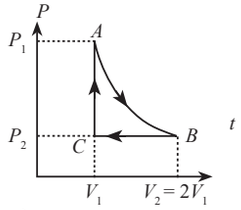
$A \to B$: Isothermal expansion at temperature T so that the volume is doubled from V_1 to $V_2 = 2V_1$ and Pressure changes from P_1 to P_2.

$B \to C$: Isobaric compression at pressure P_2 to initial volume V_1.

$C \to A$: Isobaric change leading to change of pressure from P_2 to P_1.

Total work done in the complete cycle $ABCA$ is:

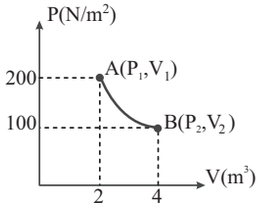
[24 Feb, 2021 (Shift-I)]



(*a*) $nRT\left(\ln 2 + \frac{1}{2}\right)$ (*b*) $nRT\left(\ln 2 - \frac{1}{2}\right)$

(*c*) 0 (*d*) $nRT \ln 2$

61. One mole of an ideal gas at 27ºC is taken from A to B as shown in the given PV indicator diagram. The work done by the system will be _____ × 10^{-1}J. **[20 July, 2021 (Shift-II)]**



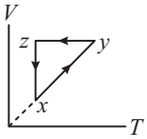
[Given: R = 8.3J/mole K, $\ell n2$ = 0.6931]
(Round off to the nearest integer)

62. In a certain thermodynamical process, the pressure of a gas depends on its volume as kV^3. The work done when the temperature changes from 100°C to 300°C will be _____ nR, where n denotes numbers of moles of a gas. **[25 Feb, 2021 (Shift-I)]**

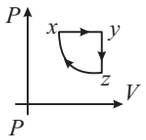
63. Consider one mole of helium gas enclosed in a container at initial pressure P_1 and volume V_1. It expands isothermally to volume $4V_1$. After this, the gas expands adiabatically and its volume becomes $32V_1$. The work done by the gas during isothermal and adiabatic expansion processes are W_{iso} and W_{adia}, respectively. If the ratio $\frac{W_{iso}}{W_{adia}} = f\ ln\ 2$, then f is _____. **[JEE Advance 2020]**

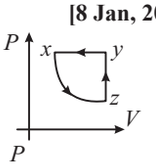
64. A spherical bubble inside water has radius R. Take the pressure inside the bubble and the water pressure to be p_0. The bubble now gets compressed radially in an adiabatic manner so that its radius becomes $(R–a)$. For $a << R$ the magnitude of the work done in the process is given by $(4\pi p_0 Ra^2)X$, where X is a constant and $\gamma = C_p/C_V = 41/30$. The value of X is **[JEE Advance 2020]**

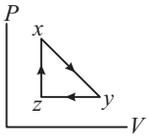
65. A thermodynamic cycle $xyzx$ is shown on a V-T diagram.

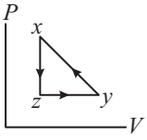


The P-V diagram that best describes this cycle is: (Diagrams are schematic and not to scale) **[8 Jan, 2020 (Shift-I)]**

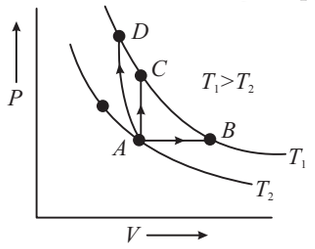
(*a*) 

(*b*) 

(*c*) 

(*d*) 

66. Three different processes that can occur in an ideal monoatomic gas are shown in the P vs V diagram. The paths are labelled as $A \rightarrow B$, $A \rightarrow C$ and $A \rightarrow D$. The change in internal energies during these process are taken as E_{AB}, E_{AC} and E_{AD} and the work done as W_{AB}, W_{AC} and W_{AD}.
The correct relation between these parameters are **[05 Sep, 2020 (Shift-I)]**



(*a*) $E_{AB} < E_{AC} < E_{AD}$, $W_{AB} > 0$, $W_{AC} > W_{AD}$

(*b*) $E_{AB} = E_{AC} = E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} > 0$

(*c*) $E_{AB} > E_{AC} > E_{AD}$, $W_{AB} < W_{AC} < W_{AD}$

(*d*) $E_{AB} = E_{AC} = E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} < 0$

67. In an adiabatic process, the density of a diatomic gas becomes 32 times its initial value. The final pressure of the gas is found to be n times the initial pressure. The value of n is **[05 Sep, 2020 (Shift-II)]**

(*a*) 128 (*b*) 32 (*c*) $\frac{1}{32}$ (*d*) 326

68. A litre of dry air at STP expands adiabatically to a volume of 3 litres. If $\gamma = 1.40$, the work done by air is:
$(3^{1.4} = 4.6555)$ [Take air to be an ideal gas]
[7 Jan, 2020 (Shift-I)]

(*a*) 90.5 *J* (*b*) 48 *J* (*c*) 60.7 *J* (*d*) 100.8 *J*

69. Under an adiabatic process, the volume of an ideal gas gets doubled. Consequently the mean collision time between the gas molecules changes from τ_1 to τ_2. If for $\frac{C_P}{C_V} = \gamma$ for the gas then a good estimate for $\frac{\tau_2}{\tau_1}$ is given by: **[7 Jan, 2020 (Shift-II)]**

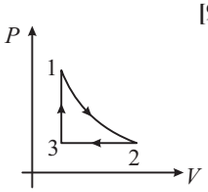
(*a*) $\left(\frac{1}{2}\right)^{\gamma}$ (*b*) $2^{\frac{1+\gamma}{2}}$ (*c*) $\frac{1}{2}$ (*d*) $\left(\frac{1}{2}\right)^{\frac{\gamma+1}{2}}$

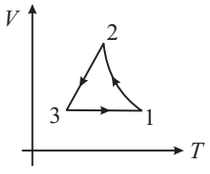
70. Match the thermodynamics processes taking place in a system with the correct conditions. In the table: ΔQ is the heat supplied, ΔW is the work done and ΔU is change in internal energy of the system. Match the following: **[4 Sep, 2020 (Shift-II)]**

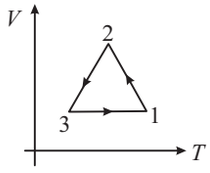
Process		Condition	
A.	Adiabatic	I.	$\Delta W = 0$
B.	Isothermal	II.	$\Delta Q = 0$
C.	Isochoric	III.	$\Delta U \neq 0$, $\Delta W \neq O$, $\Delta Q \neq 0$
D.	Isobaric	IV.	$\Delta U = 0$

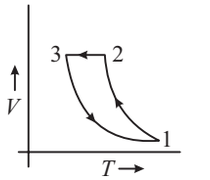
(*a*) A → II; B → IV; C → I; D → III
(*b*) A → I; B → I; C → II; D → III
(*c*) A → I; B → II; C → IV; D → IV
(*d*) A → II; B → I; C → IV; D → III

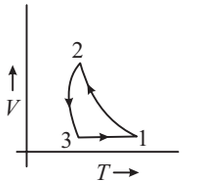
71. Which of the following is an equivalent cyclic process corresponding to the thermodynamic cyclic given in the figure? Where, $1 \rightarrow 2$ is adiabatic. (Graphs are schematic and are not to scale) **[9 Jan, 2020 (Shift-I)]**



(*a*) 

(*b*) 

(*c*) 

(*d*) 

72. A balloon filled with helium (32°C and 1.7 atm.) bursts. Immediately afterwards the expansion of helium can be considered as:
[03 Sep, 2020 (Shift-I)]

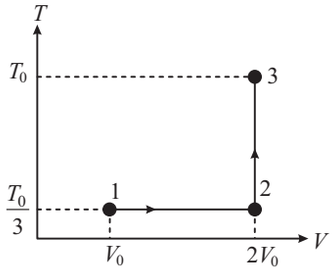
(*a*) Irreversible adiabatic (*b*) Reversible isothermal
(*c*) Reversible adiabatic (*d*) Irreversible isothermal

73. Starting at temperature 300 K, one mole of an ideal diatomic gas ($\gamma = 1.4$) is first compressed adiabatically from volume V_1 to $V_2 = V_1/16$. It is then allowed to expand isobarically to volume $2V_2$. If all the processes are the quasi-static then the final temperature of the gas (in °K) is (to the nearest integer) _____. **[9 Jan, 2020 (Shift-II)]**

74. An engine takes in 5 moles of air at 20°C and 1 atm, and compresses it adiabatically to 1/10th of the original volume. Assuming air to be a diatomic ideal gas made up of rigid molecules, the change in its internal energy during this process comes out to be X kJ. The value of X to the nearest integer is **[2 Sep, 2020 (Shift-I)]**

75. If the process on one mole of monotomic ideal gas is as shown in the TV-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is **[JEE Advance 2019]**

List-I		List-II	
A.	Work done by the system in process energy $1 \to 2 \to 3$	I.	$\frac{1}{3}RT_0 \ln 2$
B.	Change in internal in process $1 \to 2 \to 3$	II.	$\frac{1}{3}RT_0$
C.	Heat absorbed by the system in process $1 \to 2 \to 3$	III.	RT_0
D.	Heat absorbed by the system in process $1 \to 2$	IV.	$\frac{4}{3}RT_0$
		V.	$\frac{1}{3}RT_0(3+\ln_2)$
		VI,	$\frac{5}{6}RT_0$



(*a*) A → IV; B → V; C → II; D → VI
(*b*) A → I; B → III; C → V; D → IV
(*c*) A → I; B → V; C → II; D → V
(*d*) A → I; B → III; C → V; D → I

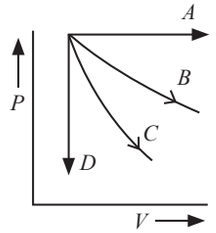
76. A thermally insulated vessel contains 150g of water at 0°C. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°C itself. The mass of evaporated water will be closes to:
(Latent heat of vaporization of water = 2.10×10^6 J kg^{-1} and Latent heat of Fusion of water = 3.36×10^5 J kg^{-1}) **[8 April, 2019 (Shift-I)]**
(*a*) 130 g (*b*) 35 g (*c*) 20 g (*d*) 150 g

77. n-moles of an ideal gas with constant volume heat capacity C_V undergo an isobaric expansion by certain volume. The ratio of the work done in the process, to the heat supplied is **[10 April, 2019 (Shift-I)]**

(*a*) $\frac{4nR}{C_v - nR}$ (*b*) $\frac{nR}{C_v - nR}$ (*c*) $\frac{nR}{C_v + nR}$ (*d*) $\frac{4nR}{C_v + nR}$

78. A rigid diatomic ideal gas undergoes an adiabatic process at room temperature. The rational between temperature and volume for the process is TV^x = constant, then x is: **[11 Jan, 2019 (Shift-I)]**
(*a*) 3/5 (*b*) 2/5 (*c*) 2/3 (*d*) 5/3

79. The given diagram shows four processes i.e., isochoric, isobaric, isothermal and adiabatic. The correct assignment of the processes, in the same order is given by: **[8 April, 2019 (Shift-II)]**



(*a*) *A D C B* (*b*) *A D B C* (*c*) *D A C B* (*d*) *D A B C*

Second Law of Thermodynamics

80. Given below are two statements: one is labelled as Assertion *A* and the other is labelled as Reason *R*.
Assertion A: Efficiency of a reversible heat engine will be highest at -273°C temperature of cold reservoir.
Reason R: The efficiency of a Carnot's engine depends not only on the temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1 - \frac{T_2}{T_1}\right)$.
In the light of the above statements, choose the correct answer from the options given below: **[30 Jan, 2023 (Shift-II)]**
(*a*) A is true but R is false
(*b*) Both A and R are true but R is not the correct explanation of A
(*c*) A is false but R is true
(*d*) Both A and R are true and R is the correct explanation of A

81. Read the following statements: **[27 July, 2022 (Shift-I)]**
(A) When small temperature difference between a liquid and its surrounding is doubled the rate of loss of heat of the liquid becomes twice.
(B) Two bodies P and Q having equal surface areas are maintained at temperature 10°C and 20°C. The thermal radiation emitted in a given time by P and Q are in the ratio 1:1.15
(C) A carnot Engine working between 100K and 400K has an efficiency of 75%
(D) When small temperature difference between a liquid and its surrounding is quadrupled, the rate of loss of heat of the liquid becomes twice.
Choose the correct answer from the options given below:
(*a*) A, B, C only (*b*) A, B only
(*c*) A, C only (*d*) B, C, D only

82. Let η_1 is the efficiency of an engine at T_1 = 447°C and T_2 = 147°C while η_2 is the efficiency at T_1 = 947°C and T_2 = 47°C. The ratio η_1/η_2 will be: **[25 July, 2022 (Shift-II)]**
(*a*) 0.41 (*b*) 0.56 (*c*) 0.73 (*d*) 0.70

83. A steam engine intakes 50g of steam at 100°C per minute and cools it down to 20°C. If latent heat of vaporization of steam is 540 cal g^{-1}. then the heat rejected by the steam engine per minute is_____× 10^3 cal. **[25 June, 2022 (Shift-I)]**

84. A heat engine operates with the could reservoir at temperature 324 *K*. The minimum temperature of the hot reservoir, if the heat engine takes 300J heat from the hot reservoir and delivers 180 J heat to the cold reservoir per cycle, is _____ *K*. **[26 June, 2022 (Shift-II)]**

85. 300 cal. of heat is given to a heat engine and it rejects 225 cal. of heat. If source temperature is 227°C, then the temperature of sink will be _____°C. **[29 June, 2022 (Shift-I)]**

86. A reversible engine has an efficiency of 1/4. If the temperature of the sink is reduced by 58°C, its efficiency becomes double. Calculate the temperature of the sink: **[31 Aug, 2021 (Shift-I)]**
(*a*) 280°C (*b*) 382°C (*c*) 180.4°C (*d*) 174°C

87. The entropy of any system is given by $S = \alpha^2\beta\, \ell n\left[\frac{\mu kR}{J\beta^2}+3\right]$

Where α and β are the constants. μ, *J*, *k* and *R* no. of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively. [Take $S = \frac{dQ}{T}$] **[20 July, 2021 (Shift-I)]**

Choose the incorrect option from the following:

(*a*) S, β, *k* and μ *R* have the same dimensions
(*b*) α and *k* have the same dimensions
(*c*) *S* and α have different dimensions
(*d*) α and *J* have the same dimensions

88. An ideal gas in a cylinder is separated by a piston in such a way that the entropy of one part is S_1 and that of the other part is S_2. Given that $S_1 > S_2$. If the piston is removed then the total entropy of the system will be: **[18 March, 2021 (Shift-II)]**
(*a*) $S_1 - S_2$ (*b*) $\frac{S_1}{S_2}$ (*c*) $S_1 \times S_2$ (*d*) $S_1 + S_2$

89. A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C, its efficiency get doubled. The temperature of the source is: **[25 July, 2021 (Shift-II)]**
(*a*) 124°C (*b*) 99°C (*c*) 37°C (*d*) 62°C

90. A heat engine operates between a cold reservoir at temperature T_2 = 400 K and a hot reservoir at temperature T_1. It takes 300 J of heat from the hot reservoir and delivers 240 J of heat to the cold reservoir in a cycle. The minimum temperature of the hot reservoir has to be _____K. **[27 Aug, 2021 (Shift-II)]**

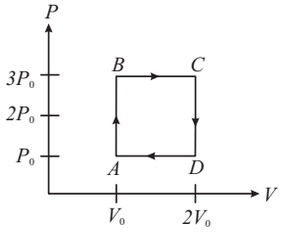
91. A reversible heat engine converts one-fourth of the heat input into work. When the temperature of the sink is reduced by 52 K, its efficiency is doubled. The temperature in Kelvin of the source will be_____ **[25 Feb, 2021 (Shift-II)]**

92. A refrigerator consumes an average 35 W power to operate between temperature –10°C to 25°C. If there is no loss of energy then how much average heat per second does it transfer? **[26 Aug, 2021 (Shift-II)]**
(*a*) 350 J/s (*b*) 298 J/s (*c*) 35 J/s (*d*) 263 J/s

93. A heat engine is involved with exchange of heat of 1915 J, –40 J, +125 J and –QJ, during on cycle achieving and efficiency of 50.0%. The value of Q is: **[2 Sep, 2020 (Shift-II)]**
(*a*) 40 J (*b*) 640 J (*c*) 400 J (*d*) 980 J

94. If minimum possible work is done by a refrigerator in converting 100 grams of water at 0°C to ice, how much heat (in calories) is released to the surroundings at temperature 27°C (Latent heat of ice = 80 Cal/gram) to the nearest integer? **[3 Sep, 2020 (Shift-II)]**

95. An engine operates by taking a monoatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to _____. **[6 Sep, 2020 (Shift-II)]**



JEE-Advanced

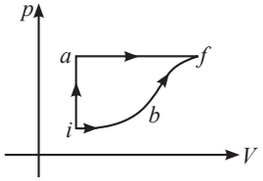
Work

Multiple Correct

1. During the melting of a slab of ice at 273 K at atmospheric pressure **(IIT-JEE 1998)**
(*a*) positive work is done by the 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 increases
(*d*) the internal energy of the ice-water system decreases

Numerical Types/Integer Types

2. A thermodynamic system is taken from an initial state *i* with internal energy u_i = 100 J to the final state *f* along two different paths *iaf* and *ibf*, as schematically shown in the figure.



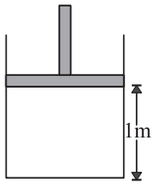
The work done by the system along the paths *af, ib* and *bf* are W_{af} = 200 J, W_{ib} = 50 J and W_{bf} = 100 J respectively. The heat supplied to the system along the path *iaf, ib* and *bf* are Q_{iaf}, Q_{ib} and Q_{bf} respectively. If the internal energy of the system in the state *b* is U_b = 200 J and Q_{iaf} = 500 J, the ratio Q_{bf}/Q_{ib} is

C-39.68, W-50.61, UA-9.7(JEE Adv. 2014)

3. Calculate the work done when one mole of a perfect gas is compressed adiabatically. The initial pressure and volume of the gas are 10^5 N/m^2 and 6 L respectively. The final volume of the gas is 2 L molar specific heat of the gas at constant volume is 3*R*/2. **(IIT-JEE 1982)**

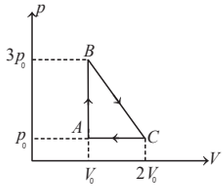
Subjective

4. The piston cylinder arrangement shown contains a diatomic gas at temperature 300 *K*. The cross-sectional area of the cylinder is 1m^2. Initially the height of the piston above the base of the cylinder is 1m^2. The temperature is now raised to 400*K* at constant pressure. Find the new height of the piston above the base of the cylinder.



If the piston is now brought back to its original height without any heat loss, find the new equilibrium temperature of the gas. You can leave the answer in fraction. **(IIT-JEE 2004)**

5. One mole of an ideal monoatomic gas is taken round the cyclic process *ABCA* as shown in figure. **(IIT-JEE 1998)**



Calculate

(*a*) the work done by the gas.

(*b*) the heat rejected by the gas in the path *CA* and the heat absorbed by the gas in the path *AB*.

(*c*) the net heat absorbed by the gas in the path *BC*.

(*d*) the maximum temperature attained by the gas during the cycle.

First Law of Thermodynamics

Match the Column

6. List-I describes thermodynamic processes in four different systems. List-II gives the magnitudes (either exactly or as a close approximation) of possible changes in the internal energy of the system due to the process.

C-28.64 W-29.47 UA-41.88 (JEE Adv. 2022)

	List-I	List-II	
A.	10^{-3} kg of water at 100°C is converted to steam at the same temperature, at a pressure of 10^5 Pa. The volume of the system changes from 10^{-6} m^3 to 10^{-3} m^3 in the process. Latent heat of water = 2250 kJ/kg.	I.	2 kJ
B.	0.2 moles of a rigid diatomic ideal gas with volume V at temperature 500 K undergoes an isobaric expansion to volume 3 V. Assume $R = 8.0$J mol^{-1} K^{-1}.	II.	7 kJ
C.	On mole of a monoatomic ideal gas is compressed adiabatically from volume $V = \frac{1}{3}$ m^3 and pressure 2kPa to volume $\frac{v}{8}$.	III.	4 kJ
D.	Three moles of a diatomic ideal gas whose molecules can vibrate, is given 9 kJ of heat and undergoes isobaric expansion.	IV.	5 kJ
		V.	3 kJ

(*a*) A → V; B → III; C → IV; D → II

(*b*) A → I; B → III; C → V; D → II

(*c*) A → IV; B → I; C → V; D → I

(*d*) A → II; B → III; C → IV; D → V

Thermodynamic Process

Single Correct

7. The thermodynamic process, in which internal energy of the system remains constant is **C-29.88 W-25.05 UA-45.07 (JEE Adv. 2023)**

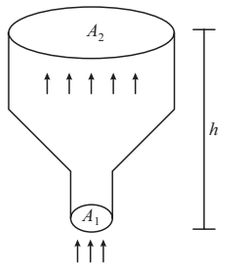
(*a*) Isochoric (*b*) Isothermal (*c*) Adiabatic (*d*) Isobaric

8. One mole of an ideal gas expands adiabatically from an initial state (T_A, V_0) to final state $(T_f, 5V_0)$. Another mole of the same gas expands isothermally from a different initial state (T_B, V_0) to the same final state $(T_f, 5V_0)$. The ratio of the specific heats at constant pressure and constant volume of this ideal gas is γ. What is the ratio T_A/T_B?

C-38 W-24.42 UA-37.59 (JEE Adv. 2023)

(*a*) $5^{\gamma-1}$ (*b*) $5^{1-\gamma}$ (*c*) 5γ (*d*) $5^{1+\gamma}$

9. An ideal gas of density $\rho = 0.2$ kg m^{-3} enters a chimney of height *h* at the rate of $\alpha = 0.8$ kg s^{-3} from its lower end, and escapes through the upper end as shown in the figure. The cross-sectional area of the lower end is $A_1 = 0.1$ m^2 and the upper end is $A_2 = 0.4$ m^2. The pressure and the temperature of the gas at the lower end are 600 Pa and 300K respectively, while its temperature at the upper end is 150K. The chimney is heat insulated so that the gas undergoes adiabatic expansion. Take $g = 10$ ms^{-2} and the ratio of specific heats of the gas $\gamma = 2$. Ignore atmospheric pressure.



C-4.11 W-28.92 UA-66.97 (JEE Adv. 2022)

Which of the following statement(s) is (are) correct?

(*a*) The pressure of the gas at the upper end of the chimney is 300Pa.

(*b*) The velocity of the gas at the lower end of the chimney is 40 ms^{-1} and at the upper end is 20 ms^{-1}.

(*c*) The height of the chimney is 590m.

(*d*) The density of the gas at the upper end is 0.05 kg m^{-3}.

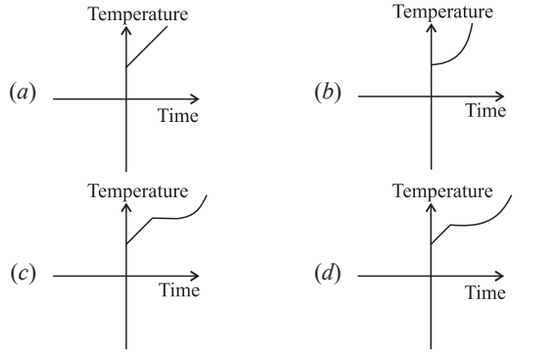
10. Two moles of ideal helium gas are in a rubber balloon at 30°C. The balloon is fully expandable and can be assumed to require no energy in its expansion. The temperature of the gas in the balloon is slowly changed to 35°C. The amount of heat required in raising the temperature is nearly (take = 8.31 J/mol – K). **(IIT-JEE 2012)**

(*a*) 62J (*b*) 104J (*c*) 124J (*d*) 208J

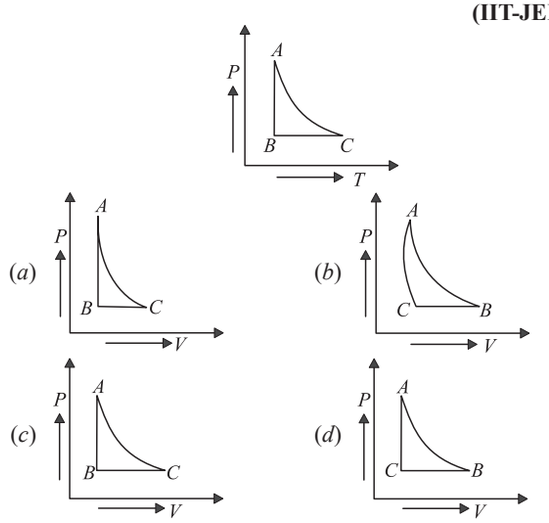
11. An ideal gas is expanding such that pT^2 constant. The coefficient of volume expansion of the gas is **(IIT-JEE 2008)**

(*a*) $\frac{1}{T}$ (*b*) $\frac{2}{T}$ (*c*) $\frac{3}{T}$ (*d*) $\frac{4}{T}$

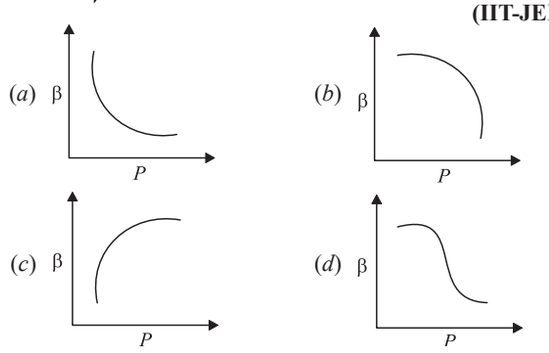
12. Liquid oxygen at 50K is heated to 300K at constant pressure of 1atm. The rate of heating is constant. Which of the following graphs represent the variation of temperature with time? **(IIT-JEE 2004)**



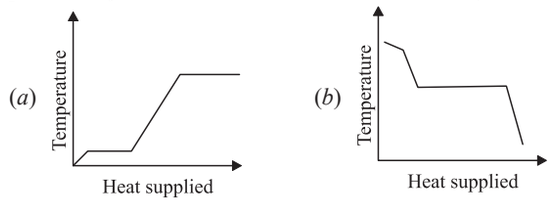
13. The p-T diagram for an ideal gas is shown in the figure, where AC is an adiabatic process, find the corresponding p-V diagram **(IIT-JEE 2003)**

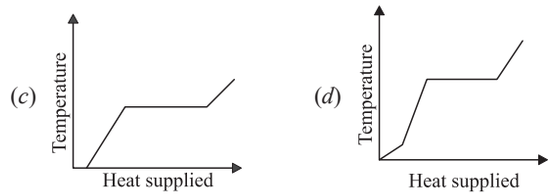


14. Which of the following graphs correctly represent the variation of $\beta = -\frac{dV/dp}{V}$ with p for an ideal gas at constant temperature? **(IIT-JEE 2002)**

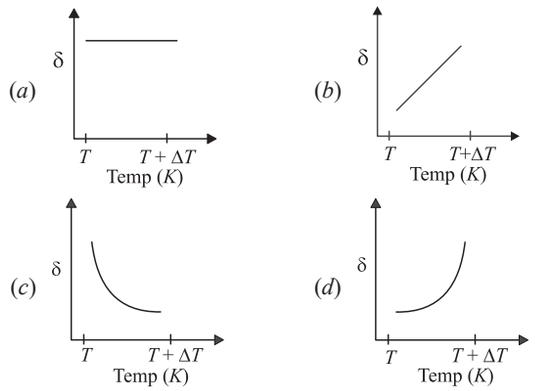


15. A block of ice at –10°C is slowly heated and converted to steam at 100°C. Which of the following curves represents the phenomena qualitatively? **(IIT-JEE 2000)**





16. An ideal gas is initially at temperature T and volume V. Its volume is increased by V due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \frac{\Delta V}{V \Delta T}$ varies with temperature as **(IIT-JEE 2000)**



17. 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 $1.5\ \Delta p$ respectively. Then **(IIT-JEE 1998)**

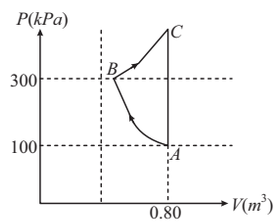
(*a*) $4\ m_A = 9\ m_B$ (*b*) $2\ m_A = 3\ m_B$

(*c*) $3\ m_A = 2\ m_B$ (*d*) $9\ m_A = 4\ m_B$

Multiple Correct

18. In the given $P - V$ diagram, a monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is first compressed adiabatically from state A to state B. Then it expands isothermally from state B to state C.

[Given: $\left(\frac{1}{3}\right)^{0.6}$ 0.5, in 2 = 0.7]. **(JEE Adv. 2022)**



Which of the following statement(s) is(are) correct?

(*a*) The magnitude of the total work done in the process $A \to B \to C$ is 144 kJ.

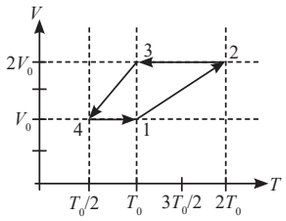
(*b*) The magnitude of the work done in the process $B \to C$ is 84 kJ.

(*c*) The magnitude of the work done in the process $A \to B$ is 60 kJ.

(*d*) The magnitude of the work done in the process $C \to A$ is zero.

19. One mole of a monoatomic ideal gas goes through a thermodynamic cycle, as shown in the volume versus temperature ($V - T$) diagram. The correct statement(s) is/are: [R is the gas constant]

C-19 W-40 UA-27 PC-14 (JEE Adv. 2019)



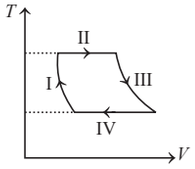
(*a*) Work done in this thermodynamic cycle ($1 \to 2 \to 3 \to 4 \to 1$) is $|W| = \frac{1}{2}RT_0$

(*b*) The above thermodynamic cycle exhibits only isochoric and adiabatic processes.

(*c*) The ratio of heat transfer during processes $1 \to 2$ and $2 \to 3$ is $\left|\frac{Q_{1\to2}}{Q_{2\to3}}\right| = \frac{5}{3}$

(*d*) The ratio of heat transfer during processes $1 \to 2$ and $3 \to 4$ is $\left|\frac{Q_{1\to2}}{Q_{3\to4}}\right| = \frac{1}{2}$

20. One mole of a monoatomic ideal gas undergoes a cyclic process as shown in the figure (where, V is the volume and T is the temperature).



Which of the statements below is (are) true? **(JEE Adv. 2018)**

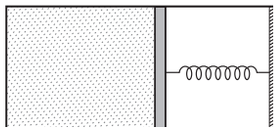
(*a*) Process I is an isochoric process

(*b*) In process II, gas absorbs heat

(*c*) In process IV, gas releases heat

(*d*) Processes I and III are not isobaric

21. An ideal monoatomic gas is confined in a horizontal cylinder by a spring loaded piston (as shown in the figure). Initially the gas is at temperature T_1, pressure p_1 and volume V_1 and the spring is in its relaxed state. The gas is then heated very slowly to temperature T_2, pressure p_2 and volume V_2. During this process the piston moves out by a distance x. **(JEE Adv. 2015)**



Ignoring the friction between the piston and the cylinder, the correct statements is/are

(*a*) If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the energy stored in the spring is $\frac{1}{4}p_1V_1$

(*b*) If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the change in internal energy is $3p_1V_1$

(*c*) If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the work done by the gas is $\frac{7}{3}p_1V_1$

(*d*) If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the heat supplied to the gas is $\frac{17}{6}p_1V_1$

22. An ideal gas is taken from the state A (pressure p, volume V) to the state B (pressure $p/2$, volume $2V$) along a straight line path in the $p - V$ diagram. Select the correct statements from the following: **(IIT-JEE 1996)**

(*a*) The work done by the gas in the process A to B exceeds the work that would be done by it if the system were taken from A to B along an isotherm

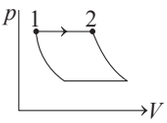
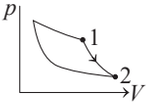
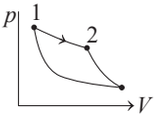
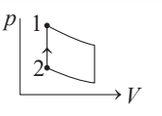
(*b*) In the $T - V$ diagram, the path AB becomes a part of a parabola

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

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

Comprehension Based/Passage Based

Directions (Q.Nos. 131 to 133): Matching the information given in the three columns of the following table.

Column 1		Column 2		Column 3	
(I)	$W_{1\to2} = \frac{1}{\gamma - 1}(p_2V_2 - p_1V_1)$	(*i*)	Isothermal	(P)	
(II)	$W_{1\to2} = -pV_2 + pV_1$	(*ii*)	Isochoric	(Q)	
(III)	$W_{1\to2} = 0$	(*iii*)	Isobaric	(R)	
(IV)	$W_{1\to2} = -nRT \ln\left(\frac{V_2}{V_1}\right)$	(*iv*)	Adiabatic	(S)	

An ideal gas is undergoing a cyclic thermodynamic process in different ways as shown in the corresponding p-V diagrams in column 3 of the table. Consider only the path from state 1 to state 2. W denotes the corresponding work done on the system. The equations and plots in the table have standards notations and used in thermodynamic processes. Here r is the ratio of heat capacities at constant pressure and constant volume. The number of moles in the gas is n.

23. Which one of the following options correctly represents a thermodynamic process that is used as a correction in the determination of the speed of sound in an ideal gas? **(JEE Adv. 2017)**

(*a*) (IV)(*ii*)(R) (*b*) (I)(*ii*)(Q) (*c*) (I)(*iv*)(Q) (*d*) (III)(*iv*)(R)

24. Which of the following options is the only correct representation of a process in which $\Delta U = \Delta Q - p\Delta V$? **(JEE Adv. 2017)**

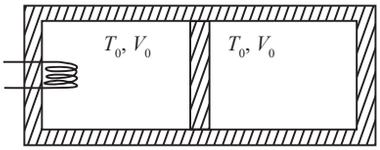
(*a*) (II)(*iii*)(S) (*b*) (II)(*iii*)(P) (*c*) (III)(*iii*)(P) (*d*) (II)(*iv*)(R)

25. Which one of the following options is the correct combination? **(JEE Adv. 2017)**

(*a*) (II)(*iv*)(P) (*b*) (III)(*ii*)(S) (*c*) (II)(*iv*)(R) (*d*) (IV)(*ii*)(S)

Paragraph

A thermally insulating cylinder has a thermally insulating and frictionless movable partition in the middle, as shown in the figure below. On each side of the partition, there is one mole of an ideal gas, with specific heat at constant volume, $C_V = 2R$. Here, R is the gas constant. Initially, each side has a volume V_0 and temperature T_0. The left side has an electric heater, which is turned on at very low power to transfer heat Q to the gas on the left side. As a result the partition moves slowly towards the right reducing the right side volume to $V_0/2$. Consequently, the gas temperatures on the left and the right sides become T_L and T_R, respectively. Ignore the changes in the temperatures of the cylinder, heater and the partition. **(JEE Adv. 2021)**



26. The value of $\frac{T_R}{T_o}$ is ____ **C-24.15 W-25.64 UA-50.21**

(*a*) $\sqrt{2}$ (*b*) $\sqrt{3}$ (*c*) 2 (*d*) 3

27. The value of $\frac{Q}{RT_0}$ is_____ **C-13.74 W-20.84 UA-65.42**

(*a*) $4(2\sqrt{2}+1)$ (*b*) $4(2\sqrt{2}-1)$ (*c*) $(5\sqrt{2}+1)$ (*d*) $(5\sqrt{2}-1)$

Match the column

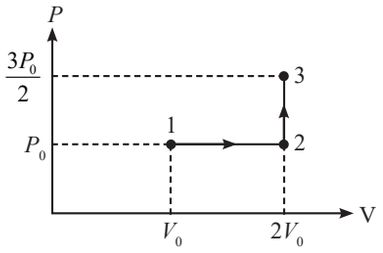
Directions (Q.Nos. 3 to 4): Answer the following by appropriately matching the list based on the information given in the paragraph.

In a thermodynamic process on an ideal monatomic gas, the infinitesimal heat absorbed by the gas is given by $T\Delta X$, where T is temperature of the system and ΔX is the infinitesimal change in a thermodynamic quantity X of the system. For a mole of monatomic ideal gas $X = \frac{3}{2}R\ln\left(\frac{T}{T_A}\right) + R\ln\left(\frac{V}{V_A}\right)$. Here, R is gas constant, V is volume of gas. T_A and V_A are constants.

The List –I below gives some quantities involved in a process and List –II gives some possible values of these quantities.

List-I	List-II
I. Work done by the system in process $1 \to 2 \to 3$	(P) $\frac{1}{3}RT_0\ln 2$
II. Change in internal energy in process $1 \to 2 \to 3$	(Q) $\frac{1}{3}RT_0$
III. Heat absorbed by the system in process $1 \to 2 \to 3$	(R) RT_0
IV. Heat absorbed by the system in process $1 \to 2$	(S) $\frac{4}{3}RT_0$
	(T) $\frac{1}{3}RT_0(3+\ln 2)$
	(U) $\frac{5}{6}RT_0$

28. If the process carried out on one mole of monatomic ideal gas is as shown in figure in the P-V-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is



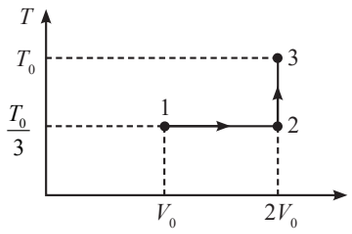
(*a*) I → Q; II → R; III → S; IV → U

(*b*) I → Q; II → S; III → R; IV → U

(*c*) I → Q; II → R; III → P; IV → U

(*d*) I → S; II → R; III → Q; IV → T

29. If the process on one mole of monatomic ideal gas is as shown in the TV-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is,



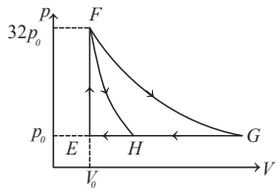
(*a*) I → P; II → T; III → Q; IV → T

(*b*) I → S; II → T; III → Q; IV → U

(*c*) I → P; II → R; III → T; IV → S

(*d*) I → P; II → R; III → T; IV → P

30. One mole of a monatomic ideal gas is taken along two cyclic processes $E \to F \to G \to E$ and $E \to F \to H \to E$ as shown in the P-V - diagram. **C-57.47, W-22.32, UA-20.22 (JEE Adv. 2013)**



The processes involved are purely isochoric, isobaric, isothermal or adiabatic.

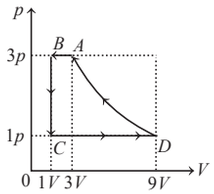
Match the paths in List-I with the magnitudes of the work done in List-II and select the correct answer using the codes given below the lists.

List-I	List-II
P. $G \to E$	1. $160\,p_0V_0\ln 2$
Q. $G \to H$	2. $36\,p_0V_0$
R. $F \to H$	3. $24\,p_0V_0$
S. $F \to G$	4. $31\,p_0V_0$

Codes

P Q R S	P Q R S
(*a*) 4 3 2 1	(*b*) 4 3 1 2
(*c*) 3 1 2 4	(*d*) 1 3 2 4

31. One mole of a monoatomic ideal gas is taken through a cycle *ABCDA* as shown in the p-V diagram. **Column-II** gives the characteristics involved in the cycle. Match them with each of the processes given in **Column-I**. **(IIT-JEE 2011)**

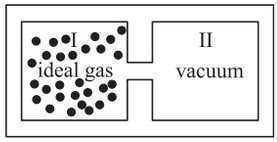


Column-I	Column-II
(A) Process A → B	(p) Internal energy decreases
(B) Process B → C	(q) Internal energy increases
(C) Process C → D	(r) Heat is lost
(D) Process D → A	(s) Heat is gained
	(t) Work is done on the gas

32. Column-I contains a list of processes involving expansion of an ideal gas. Match this with Column-II describing the thermodynamic change during this process. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS. **(IIT-JEE 2008)**

Column-I

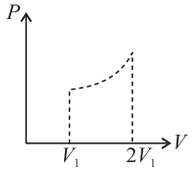
(A) An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and Chamber II has vacuum. The valve is opened.



(B) An ideal monatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$, where V is the volume of the gas.

(C) An ideal monatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$, where V is its volume gas.

(D) An ideal monatomic gas expands such that its pressure *p* and volume V follows the behaviour shown in the graph.



Column-II

(*p*) The temperature of the gas decreases

(*q*) The temperature of the gas increases or remains constant

(*r*) The gas loses heat

(*s*) The gas gains heat

(*a*) $A \to p, B \to q, r, C \to p,s, D \to p,s$

(*b*) $A \to r, B \to p, C \to s, D \to q$

(*c*) $A \to q, B \to p,r, C \to p,s, D \to q,s$

(*d*) $A \to s, B \to q, C \to p, D \to r$

Multiple Correct

33. A bubble has surface tension *S*. The ideal gas inside the bubble has ratio of specific heats $\gamma = \frac{5}{3}$. The bubble is exposed to the atmosphere and it always retains its spherical shape. When the atmospheric pressure is P_{a1}, the radius of the bubble is found to be r_1 and the temperature of the enclosed gas is T_1. When the atmospheric pressure is P_{a_2}, the radius of the bubble and the temperature of the enclosed gas are r_2 and T_2, respectively. **C-3.94 W-26.6 UA-61.45 (JEE Adv. 2022)**

Which of the following statement(s) is(are) correct?

(*a*) If the surface of the bubble is a perfect heat insulator, then

$$\left(\frac{r_1}{r_2}\right)^5 = \frac{P_{a_2} + \frac{2S}{r_2}}{P_{a_1} + \frac{2S}{r_1}}$$

(*b*) If the surface of the bubble is a perfect heat insulator, then the total internal energy of the bubble including its surface energy does not change with the external atmospheric pressure.

(*c*) If the surface of the bubble is a perfect heat conductor and the change in atmospheric temperature is negligible, then

$$\left(\frac{r_1}{r_2}\right)^3 = \frac{P_{a2} + \frac{4S}{r_2}}{P_{a1} + \frac{4S}{r_1}}.$$

(*d*) If the surface of the bubble is a perfect heat insulator, then

$$\left(\frac{T_2}{T_1}\right)^{\frac{5}{2}} = \frac{P_{a_2} + \frac{4S}{r_2}}{P_{a_1} + \frac{4S}{r_1}}.$$

34. A mixture of ideal gas containing 5 moles of monatomic gas and 1 mole of rigid diatomic gas is initially at pressure P_0, volume V_0, and temperature T_0. If the gas mixture is adiabatically compressed to a volume $V_0/4$, then the correct statement(s) is/are,

C-10.25 W-15.51 UA-39.87 PC-34.37(JEE Adv. 2019)

(Given $2^{1.2} = 2.3; 2^{3.2} = 9.2$; *R* is gas constant)

(*a*) The work $|W|$ done during the process is $13RT_0$

(*b*) The average kinetic energy of the gas mixture after compression is in between $18RT_0$ and $19RT_0$

(*c*) The final pressure of the gas mixture after compression is in between $9P_0$ and $10P_0$

(*d*) Adiabatic constant of the gas mixture is 1.6

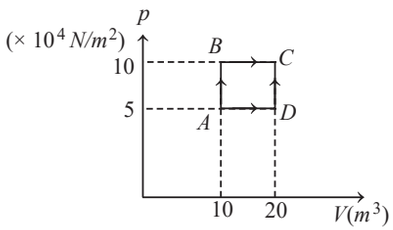
Subjective

35. One mole of a monoatomic ideal gas undergoes an adiabatic expansion in which its volume becomes eight times its initial value. If the initial temperature of the gas is 100 K and the universal gas constant $R = 8.0$ j mol^{-1} K^{-1}, the decrease in its internal energy in joule, is _____ . **(JEE Adv. 2018)**

36. A solid body X of heat capacity C is kept in an atmosphere whose temperature is T_A = 300 K. At time t = 0, the temperature of X is T_0 = 400 K. It cools according to Newton's law of cooling. At time t_1 its temperature is found to be 350 K.

At this time (t_1) the body X is connected to a large body Y at atmospheric temperature T_A through a conducting rod of length L, cross-sectional area A and thermal conductivity K. The heat capacity of Y is so large that any variation in its temperature may be neglected. The cross-sectional area A of the connecting rod is small compared to the surface area of X. Find the temperature of X at time $t = 3t_1$. **(IIT-JEE 1998)**

37. A sample of 2 kg monoatomic helium (assumed ideal) is taken through the process ABC and another sample of 2 kg of the same gas is taken through the process ADC (see fig). Given molecular mass of helium = 4. **(IIT-JEE 1997)**



(*a*) What is the temperature of helium in each of the states A, B,C and D?

(*b*) Is there any way of telling afterwards which sample of helium went through the process ABC and which went through the process ADC? Write Yes or No.

(*c*) How much is the heat involved in the process ABC and ADC?

38. One mole of a diatomic ideal gas (γ = 1.4) is taken through a cyclic process starting from point A. The process $A \rightarrow B$ is an adiabatic compression. $B \rightarrow C$ is isobaric expansion, $C \rightarrow D$ an adiabatic expansion and $D \rightarrow A$ is isochoric.

The volume ratio are V_A/V_B = 16 and V_C/V_B = 2 and the temperature at A is T_A = 300K. Calculate the temperature of the gas at the points B and D and find the efficiency of the cycle. **(IIT-JEE 1997)**

39. A gaseous mixture enclosed in a vessel of volume V consists of one gram mole of gas A with $\gamma = C_p/C_V$ = 5/3 and another gas B with γ = 7/5 at a certain temperature T. The gram molecular weights of the gases A and B are 4 and 32 respectively. The gases A and B do not react with each other and are assumed to be ideal. The gaseous mixture follows the equation $pV^{19/13}$ = Constant, in adiabatic process. **(IIT-JEE 1995)**

(*a*) Find the number of gram moles of the gas B in the gaseous mixture.

(*b*) Compute the speed of sound in the gaseous mixture at 300 K.

(*c*) If T is raised by 1 K from 300 K, find the percentage change in the speed of sound in the gaseous mixture.

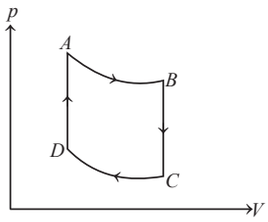
(*d*) The mixture is compressed adiabatically to 1/5 of its initial volume V. Find the change in its adiabatic compressibility in terms of the given quantities.

40. An ideal gas is taken through a cyclic thermodynamic process through four steps. The amounts of heat involved in these steps are Q_1 = 5960J, Q_2 = –5585J, Q_3 = – 2980J and Q_4 = 3645 J respectively. The corresponding quantities of work involved are W_1 = 2200 J, W_2 = –825 J, W_3 = –1100 J and W_4 respectively. **(IIT-JEE 1994)**

(*a*) Find the value of W_4.

(*b*) What is the efficiency of the cycle?

41. One mole of a monoatomic ideal gas is taken through the cycle shown in figure **(IIT-JEE 1993)**



$A \rightarrow B$: adiabatic expansion

$B \rightarrow C$: cooling at constant volume

$C \rightarrow D$: adiabatic compression

$D \rightarrow A$: heating at constant volume.

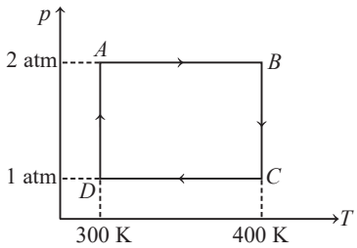
The pressure and temperature at A, B, etc., are denoted by p_A , T_A, p_B, T_B etc., respectively. Given that, T_A = 1000 K, $p_B = (2/3)p_A$ and $p_C = (1/3)\,p_A$, calculate the following quantities

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

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

(*c*) The temperature T_D . (Given : $(2/3)^{2/5}$ = 0.85)

42. Two moles of helium gas undergo a cyclic process as shown in figure. Assuming the gas to be ideal, calculate the following quantities in this process. **(IIT-JEE 1992)**



(*a*) The net change in the heat energy.

(*b*) The net work done.

(*c*) The net change in internal energy.

43. Three moles of an ideal gas $\left(C_p = \frac{7}{2}R\right)$ at pressure, p_A and temperature T_A is isothermally expanded to twice its initial volume. It is then compressed at constant pressure to its original volume. Finally gas is compressed at constant volume to its original pressure p_A. **(IIT-JEE 1991)**

(*a*) Sketch p-V and p-T diagrams for the complete process.

(*b*) Calculate the net work done by the gas, and net heat supplied to the gas during the complete process.

44. An ideal gas having initial pressure p, volume V and temperature T is allowed to expand adiabatically until its volume becomes 5.66 V while its temperature falls to T/2. **(IIT-JEE 1990)**

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

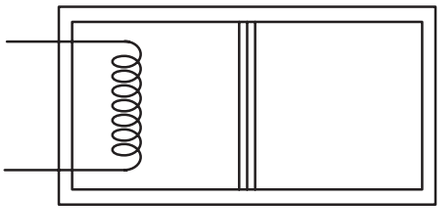
(*b*) Obtain the work done by the gas during the expansion as a function of the initial pressure p and volume V.

45. Two moles of helium gas $\left(\gamma = \frac{5}{3}\right)$ are initially at temperature 27°C and occupy a volume of 20 L. The gas is first expanded at constant pressure until the volume is doubled. Then it undergoes an adiabatic change until the temperature returns to its initial value.

What are the final volume and pressure of the gas? Sketch the process on P – V diagram and find the work done by the gas

(IIT-JEE 1988)

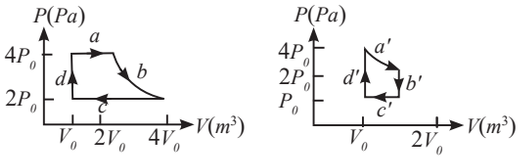
46. The rectangular box shown in figure has a partition which can slide without friction along the length of the box. **(IIT-JEE 1984)**



Initially each of the two chambers of the box has one mole of a monatomic ideal gas ($\gamma = 5/3$) at a pressure P_0, volume V_0 and temperature T_0. The chamber on the left is slowly heated by an electric heater. The walls of the box and the partition are thermally insulated. Heat loss through the lead wires of the heater is negligible. The gas in the left chamber expands pushing the partition until the final pressure in both chambers becomes $\frac{243p_0}{32}$. Determine (*a*) the final temperature of the gas in each chamber and (*b*) the work done by the gas in the right chamber.

Fill in the Blanks

47. One mole of an ideal gas undergoes two different cyclic processes I and II, as shown in the *P–V* diagrams below. In cycle I, processes *a, b, c* and *d* are isobaric, isothermal, isobaric and isochoric, respectively. In cycle II, processes a′, b′, c′ and d′ are isothermal, isochoric, isobaric and isochoric, respectively. The total work done during cycle I is W_I and that during cycle II is W_{II}. The ratio W_I / W_{II} is _____. **C-44.24 W-42.59 UA-13.17 (JEE Adv, 2023)**



48. Consider one mole of helium gas enclosed in a container at initial pressure P_1 and volume V_1. It expands isothermally to volume $4V_1$. After this, the gas expands adiabatically and its volume becomes $32V_1$. The work done by the gas during isothermal and adiabatic expansion processes are W_{iso} and W_{adia}, respectively. If the ratio $\frac{W_{iso}}{W_{adia}} = f \ln 2$, then f is _____.

C-13.66 W-72.49 UA-13.85 (JEE Adv. 2020)

49. An ideal gas with pressure p, volume V and temperature T is expanded isothermally to a volume $2V$ and a final pressure p_i. If the same gas is expanded adiabatically to a volume $2V$, the final pressure is p_a. The ratio of the specific heats of the gas is 1.67. The ratio p_a / p_i is …… . **(IIT-JEE 1994)**

True/False

50. At a given temperature, the specific heat of a gas at a constant pressure is always greater than its specific heat at constant volume. **(IIT-JEE 1987)**

ANSWER KEY

JEE-Main

1. (*d*)	**2.** (*a*)	**3.** [*d*]	**4.** (*a*)	**5.** (*b*)	**6.** (*a*)	**7.** [60.80,60.81]		**8.** (*d*)	**9.** (*d*)
10. (*d*)	**11.** (*d*)	**12.** (*d*)	**13.** (*c*)	**14.** (*b*)	**15.** (*c*)	**16.** (*b*)	**17.** [750]	**18.** [2]	**19.** (*b*)
20. [60]	**21.** [100]	**22.** [25]	**23.** (*a*)	**24.** (*b*)	**25.** (*b*)	**26.** (Bonus)	**27.** (Bonus)	**28.** (*a,c*)	**29.** (*c*)
30. (*d*)	**31.** (*a,b*)	**32.** (*d*)	**33.** (*c*)	**34.** (*b*)	**35.** (*c*)	**36.** (*a*)	**37.** (*c*)	**38.** (*a*)	**39.** (*b*)
40. (*d*)	**41.** [2]	**42.** (*a*)	**43.** (*b*)	**44.** (*d*)	**45.** (*d*)	**46.** (*b*)	**47.** (*b*)	**48.** (*b*)	**49.** (*d*)
50. (*a*)	**51.** (*c*)	**52.** (*c,d*)	**53.** (*b*)	**54.** (*b,c,d*)	**55.** (*c*)	**56.** [25]	**57.** (*d*)	**58.** (*a*)	**59.** (*c*)
60. (*b*)	**61.** [17258]	**62.** [50]	**63.** [1.77 to 1.78]		**64.** [2.05]	**65.** (*a*)	**66.** (*d*)	**67.** (*a*)	**68.** (*a*)
69. (*b*)	**70.** (*a*)	**71.** (*a*)	**72.** (*a*)	**73.** [1819]	**74.** [46]	**75.** (*d*)	**76.** (*c*)	**77.** (*c*)	**78.** (*b*)
79. (*d*)	**80.** (*d*)	**81.** (*a*)	**82.** (*b*)	**83.** [31]	**84.** [540]	**85.** [102]	**86.** (*d*)	**87.** (*c*)	**88.** (*d*)
89. (*b*)	**90.** [500]	**91.** [208]	**92.** (*d*)	**93.** (*d*)	**94.** [8791]	**95.** [19]			

JEE-Advanced

1. (*b, c*)	**2.** [2]	**3.** [–972]	**6.** (*b*)	**7.** (*b*)	**8.** (*a*)	**9.** (*b*)	**10.** (*d*)	**11.** (*c*)	**12.** (*c*)
13. (*b*)	**14.** (*a*)	**15.** (*a*)	**16.** (*c*)	**17.** (*c*)	**18.** (*b,c,d*)	**19.** (*a, c*)	**20.** (*b, c, d*)	**21.** (*a, b, c*)	
22. (*a, b, d*)	**23.** (*c*)	**24.** (*b*)	**25.** (*b*)	**26.** (*a*)	**27.** (*b*)	**28.** (*a*)	**29.** (*d*)	**30.** (*a*)	
31. (A) → (p, r, t); (B) →(p, r); (C) →(q, s);(D) →(r, t)				**32.** (*c*)	**33.** (*c, d*)	**34.** (*a,c,d*)	**35.** [900]	**36.** [2]	**37.** [1.78]
38. [True]									