CHAPTER

13 Thermodynamics

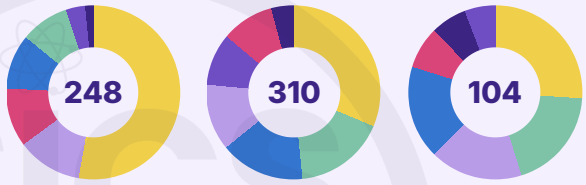
MHT CET · JEE · NEET Physics

PHYSICS CIRCLE

CONTENTS

13.1	Gas Laws & Ideal Gas Equation	2
13.2	Degrees of Freedom & Internal Energy	6
13.3	Specific Heats of Gases	9
13.4	Heat, Work & First Law	12
13.5	Isobaric & Isochoric Processes	15
13.6	Isothermal & Adiabatic Processes	18
13.7	Polytropic & Other Processes	21
13.8	P-V Diagrams & Cyclic Processes	24
13.9	Heat Engines, Second Law & Refrigerators	27
★	**Exam-Day Card & Formula Sheet**	30

EXAM WEIGHTAGE



	CET	JEE	NEET
Thermodynamic Processes	131 53%	97 31%	27 26%
Heat Engines & Refrigerators	22 9%	53 17%	20 19%
P-V Diagrams & Cyclic Processes	25 10%	49 16%	18 17%
Gas Laws & Ideal Gas Equation	30 12%	38 12%	18 17%
Specific Heats of Gases	27 11%	30 10%	8 8%
Degrees of Freedom & Internal Energy	9 4%	30 10%	6 6%
Heat, Work & First Law	4 2%	13 4%	7 7%

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

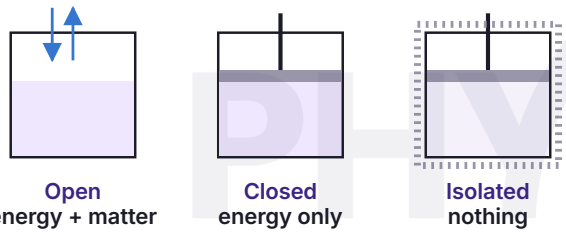
01 CONCEPT Gas Laws & Ideal Gas Equation

IN ONE LINE

A gas is described by four quantities: **P, V, T and amount n**. The gas laws link them, and together they give **PV = nRT**.

13.1.1 Thermodynamic system

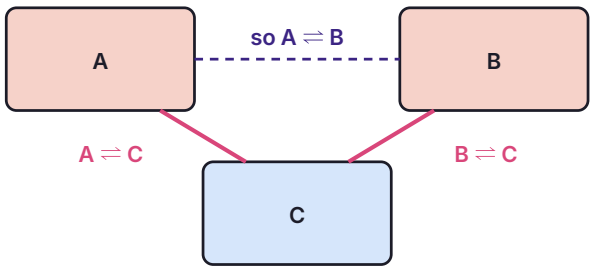
- **System**: the part (usually a gas) we study; everything outside is the **surroundings**.
- **Open**: exchanges energy and matter. **Closed**: energy only. **Isolated**: neither.
- **State variables**: P, V, T, U, n. They fix the state of the system.



Open, closed and isolated systems

13.1.2 Zeroth law of thermodynamics

- If A and B are each in thermal equilibrium with C, then A and B are in thermal equilibrium with each other.
- This law defines **temperature**: bodies in equilibrium have the same T.



13.1.3 Boyle's law (T constant)

$$PV = \text{constant} \cdot P_1V_1 = P_2V_2$$

- Also $\frac{P}{\rho}$ = constant, since $\rho \propto \frac{1}{V}$.
- P–V graph: rectangular hyperbola. PV–P graph: horizontal line.
- Volume falls by x% ⇒ pressure rises by $\frac{100x}{100 - x}$ % (not x%).

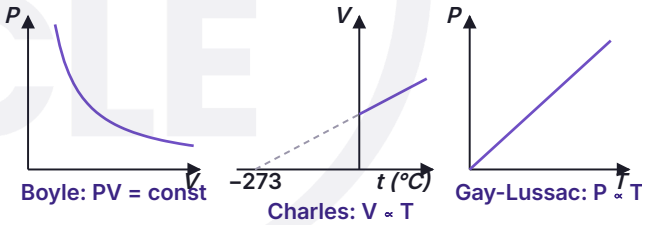
13.1.4 Charles's law (P constant)

$$V \propto T \cdot \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

- In °C: $V_t = V_0(1 + \frac{t}{273.15})$.
- V–t line meets the t-axis at −273.15°C. Always use kelvin in the formula.

13.1.5 Gay-Lussac's law (V constant)

$$P \propto T \cdot \frac{P_1}{T_1} = \frac{P_2}{T_2}$$



Boyle, Charles and Gay-Lussac graphs

13.1.6 Avogadro's and Dalton's laws

- **Avogadro**: equal volumes of all gases at the same P and T have equal numbers of molecules.
- 1 mole of any gas at STP occupies 22.4 L and has $N_A = 6.023 \times 10^{23}$ molecules.
- **Dalton**: total pressure of non-reacting gases = sum of partial pressures.

$$P = P_1 + P_2 + P_3 + \ldots$$

13.1.7 Ideal gas equation

$$PV = nRT$$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

Amount of gas	Equation	Constant
n moles	$PV = nRT$	$R = 8.31\ J\ mol^{-1}\ K^{-1}$
N molecules	$PV = Nk_BT$	$k_B = \frac{R}{N_A} = 1.38 \times 10^{-23}\ J\ K^{-1}$
mass m	$PV = \frac{m}{M}RT$	M = molar mass

- $R \approx 8.31\ J\ mol^{-1}\ K^{-1} \approx 2\ cal\ mol^{-1}\ K^{-1}$.
- PV has the unit of **energy** (N m = J).

13.1.8 Density and number of molecules

$$\rho = \frac{PM}{RT} \cdot \frac{\rho}{P} \propto \frac{1}{T}$$

$$N \propto \frac{PV}{T} \cdot n_V = \frac{N}{V} = \frac{P}{k_BT}$$

- Same P, V, T ⇒ same number of molecules, whatever the gas.
- Gas leaking from a fixed vessel: mass left $\propto \frac{P}{T}$.
- Two vessels joined, total internal energy kept: $P(V_1 + V_2) = P_1V_1 + P_2V_2$ (same T) and n is conserved.

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

Solved Examples 01 Gas Laws & Ideal Gas Equation

SOLVED 1 MHT CET 2026 · 14 May · Shift 2

At constant temperature, the volume of a gas is to be decreased by 4%. The pressure must be increased by

(a) 4% (b) 4.16%
(c) 8% (d) 3.86%

STEP 1 Boyle's law: $P_1V_1 = P_2V_2$, with $V_2 = 0.96\ V_1$
STEP 2 $P_2 = \frac{P_1}{0.96} = 1.0417\ P_1$
STEP 3 Increase = **4.16%**

Answer: **(b)**

SOLVED 2 MHT CET 2026 · 12 May · Shift 1

The pressure of a given mass of a gas is decreased by 20% at constant temperature, then its volume will

(a) decrease by 20%
(b) increase by 20%
(c) decrease by 25%
(d) increase by 25%

STEP 1 PV = constant, $P_2 = 0.8\ P_1$
STEP 2 $V_2 = \frac{V_1}{0.8} = 1.25\ V_1$
STEP 3 Volume **increases by 25%**

Answer: **(d)**

SOLVED 3 MHT CET 2026 · 18 Apr · Shift 1

An ideal gas is heated from 27°C to 627°C at constant pressure. If initial volume of gas is 4 m^3, then the new volume of the gas will be

(a) 12 m^3 (b) 6 m^3
(c) 3 m^3 (d) 2 m^3

STEP 1 Charles's law: $V \propto T$ (in kelvin)
STEP 2 $T_1 = 300$ K, $T_2 = 900$ K
STEP 3 $V_2 = 4 \times \frac{900}{300} =$ **12 m^3**

Answer: **(a)**

SOLVED 4 MHT CET 2025 · 20 Apr · Shift 1

A tyre of a vehicle is filled with air having pressure 270 kPa at 27°C. The air pressure in the tyre when the temperature increases to 37°C is

(a) 282 kPa (b) 270 kPa
(c) 265 kPa (d) 279 kPa

STEP 1 Volume of the tyre is constant $\Rightarrow P \propto T$
STEP 2 $P_2 = 270 \times \frac{310}{300}$
STEP 3 $P_2 =$ **279 kPa**

Answer: **(d)**

SOLVED 5 MHT CET 2026 · 13 May · Shift 2

A balloon contains 500 m^3 of He at 27°C and 1 atmospheric pressure. Then, volume of He at −3°C and 0.5 atmospheric pressure will be

(a) 700 m^3 (b) 900 m^3
(c) 1000 m^3 (d) 500 m^3

STEP 1 $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
STEP 2 $V_2 = 500 \times \frac{1}{0.5} \times \frac{270}{300}$
STEP 3 $V_2 =$ **900 m^3**

Answer: **(b)**

SOLVED 6 MHT CET 2026 · 15 May · Shift 1

The gas in a vessel is subjected to a pressure of 20 atm at 27°C. Now half of the gas is released from the vessel and the temperature is raised by 50°C. The pressure of the gas in the vessel is nearly

(a) 8 atm (b) 11 atm
(c) 12 atm (d) 17 atm

STEP 1 Fixed volume: $P \propto nT$
STEP 2 $P_2 = 20 \times \frac{1}{2} \times \frac{350}{300}$
STEP 3 $P_2 = 11.7 \approx$ **12 atm**

Answer: **(c)**

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

Solved Examples 01 Gas Laws & Ideal Gas Equation (contd.)

SOLVED 7 MHT CET 2023 · 11 May · Shift 2

According to Boyle's law, the product PV remains constant. The unit of PV is same as that of

(a) energy (b) force
(c) impulse (d) momentum

STEP 1 Unit of P = N m^{-2}, unit of V = m^3
STEP 2 PV → N m^{-2} × m^3 = N m
STEP 3 N m = J ⇒ **energy**

Answer: **(a)**

SOLVED 8 MHT CET 2026 · 18 Apr · Shift 2

At a pressure P and temperature T, 7 gram of oxygen occupies a volume V. The equation of state will be (molecular weight of oxygen = 32)

(a) $PV = (\frac{2}{7})RT$ (b) $PV = (\frac{7}{2})RT$
(c) $PV = (\frac{7}{16})RT$ (d) $PV = (\frac{7}{32})RT$

STEP 1 PV = nRT with n = mass ÷ molar mass
STEP 2 $n = \frac{7}{32}$
STEP 3 $PV = (\frac{7}{32})RT$

Answer: **(d)**

SOLVED 9 MHT CET 2024 · 2 May · Shift 1

A sample of oxygen gas and a sample of hydrogen gas both have the same mass, same volume and the same pressure. The ratio of their absolute temperatures (O_2 : H_2) is (molecular weights 32 and 2)

(a) 1 : 4 (b) 1 : 8
(c) 16 : 1 (d) 12 : 1

STEP 1 $PV = \frac{m}{M}RT \Rightarrow T = \frac{PVM}{mR}$
STEP 2 Same P, V, m ⇒ T ∝ M
STEP 3 $\frac{T_O}{T_H} = \frac{32}{2} =$ **16 : 1**

Answer: **(c)**

SOLVED 10 MHT CET 2026 · 20 Apr · Shift 1

Gas at pressure P, temperature T and volume V is filled in jar A. Another jar B is filled with gas having parameters 2P, $\frac{V}{4}$, 2T. The ratio of the number of molecules of jar B to those of jar A is

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

STEP 1 $PV = NkT \Rightarrow N \propto \frac{PV}{T}$
STEP 2 $\frac{N_B}{N_A} = \frac{2P \times V}{4 \times 2T} \times \frac{T}{PV}$
STEP 3 $= \frac{1}{4} \Rightarrow$ **1 : 4**

Answer: **(b)**

SOLVED 11 MHT CET 2026 · 19 Apr · Shift 2

An ideal gas at pressure P and temperature T is enclosed in a vessel of volume V. Some gas leaks through a hole and the pressure of the enclosed gas falls to P′. Assuming the temperature stays constant, the number of moles of gas that have leaked is

(a) $\frac{P'V}{RT}$ (b) $\frac{V}{RT}(P - P')$
(c) $\frac{2V}{RT}(P + P')$ (d) $\frac{V}{RT}(P + P')$

STEP 1 $n = \frac{PV}{RT}$ before, $n' = \frac{P'V}{RT}$ after
STEP 2 Leaked = n − n′
STEP 3 $= \frac{V}{RT}(P - P')$

Answer: **(b)**

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

02 CONCEPT Degrees of Freedom & Internal Energy

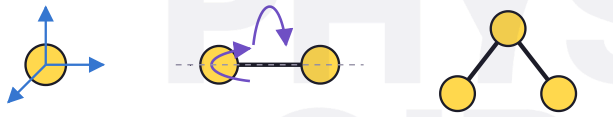
IN ONE LINE

Degrees of freedom count the independent ways a molecule can move. Each one stores energy, so they decide the **internal energy** of a gas.

13.2.1 Degrees of freedom

Degrees of freedom

- A = number of atoms, B = number of fixed bonds (constraints).
- Translational f is always 3 (motion along x, y, z).
- Rotation about the axis of a linear molecule is not counted (negligible moment of inertia).



monoatomic f = 3 | diatomic f = 3 + 2 = 5 | non-linear triatomic f = 3 + 3 = 6

Monoatomic, diatomic and non-linear triatomic molecules

Gas	Example	f (room temperature)
monoatomic	He, Ne, Ar	3 (trans)
diatomic	H_2, O_2, N_2	5 (3 trans + 2 rot)
triatomic linear	CO_2	5 (rigid)
triatomic non-linear	H_2O, CH_4	6 (3 trans + 3 rot)
diatomic, vibrating	high T	7 (+2 vibrational)

- One vibrational mode adds **2** degrees of freedom (kinetic + potential energy).

13.2.2 Internal energy

- U = kinetic energy + potential energy of the molecules.
- Ideal gas: no intermolecular force ⇒ U is **wholly kinetic** and depends on T only.
- Each degree of freedom carries $\frac{1}{2}k_BT$ per molecule (law of equipartition, proved in Kinetic Theory of Gases).

$$U = \frac{f}{2}nRT \cdot \Delta U = \frac{f}{2}nR\Delta T = nC_V\Delta T$$

$$U = \frac{f}{2}PV$$

- U is a **state function**: ΔU depends only on the initial and final states, not on the path.
- For a cyclic process ΔU = 0.

13.2.3 Internal energy of a mixture

$$U = \frac{f_1}{2}n_1RT + \frac{f_2}{2}n_2RT$$

$$f_{mix} = \frac{n_1f_1 + n_2f_2}{n_1 + n_2} \cdot T_{mix} = \frac{n_1f_1T_1 + n_2f_2T_2}{n_1f_1 + n_2f_2}$$

13.2.4 Moving container stopped suddenly

$$\frac{1}{2}Mv^2 = \frac{f}{2}R\Delta T \Rightarrow \Delta T = \frac{Mv^2}{fR} = \frac{(\gamma - 1)Mv^2}{2R}$$

- M = molar mass. Insulated container: no heat is lost.
- Monoatomic: $\Delta T = Mv^2 \div 3R$. Diatomic: $\Delta T = Mv^2 \div 5R$.

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

DIWALI HOMEWORK

Thermodynamics

LEVEL 1 · EASY

Topic-wise Previous Year Questions

MHT CET · NEET · JEE Main

192	18	7
questions	concepts	topics

CONTENTS

01	Gas Laws & Ideal Gas Equation	Q 1–26	26 Qs
02	Degrees of Freedom & Internal Energy	Q 1–11	11 Qs
03	Specific Heats of Gases - Cp, Cv, γ & Mayer's Relation	Q 1–28	28 Qs
04	Heat, Work & First Law of Thermodynamics	Q 1–10	10 Qs
05	Thermodynamic Processes	Q 1–65	65 Qs
06	P-V Diagrams & Cyclic Processes	Q 1–24	24 Qs
07	Heat Engines, Refrigerators & Second Law	Q 1–28	28 Qs
	Answer key		

WATCH THE CONCEPT VIDEOS

Every chapter explained on YouTube. Subscribe to **Physics Circle**

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 01

Gas Laws & Ideal Gas Equation

26 PYQs · Easy 26 · Medium 0 · Difficult 0 | MHT CET 12 · NEET 6 · JEE 8

Concepts covered: Gas laws & ideal gas equation (23) · Number of molecules & density (3)

LEVEL 1 · EASY 26 questions

◆ Gas laws & ideal gas equation 23 Qs

1. At constant temperature, the volume of a gas is to be decreased by 4%. The pressure must be increased by
MHT CET 2026 · 14 MAY · SHIFT 2
(a) 4% (b) 4.16% (c) 8% (d) 3.86%

2. A balloon contains 500 m^3 of He at 27 °C and 1 atmospheric pressure. Then, volume of He at −3°C and 0.5 atmospheric pressure will be
MHT CET 2026 · 13 MAY · SHIFT 2
(a) 700 m^3 (b) 900 m^3 (c) 1000 m^3 (d) 500 m^3

3. The pressure of a given mass of a gas is decreased by 20 % at constant temperature, then its volume will
MHT CET 2026 · 12 MAY · SHIFT 1
(a) decrease by 20 %. (b) increase by 20 %.
(c) decrease by 25 %. (d) increase by 25 %

4. An ideal gas is heated from 27°C to 627°C at constant pressure. If initial volume of gas is 4 m^3, then the new volume of the gas will be
MHT CET 2026 · 18 APR · SHIFT 1
(a) 12 m^3 (b) 6 m^3 (c) 3 m^3 (d) 2 m^3

5. A balloon is filled at 27°C and 1 atmospheric pressure by volume 500 m^3 helium gas. At −3°C and 0.5 atmospheric pressure, the volume of helium gas will be
MHT CET 2025 · 25 APR · SHIFT 2
(a) 500 m^3 (b) 700 m^3 (c) 900 m^3 (d) 1000 m^3

6. The volume of given mass of a gas is decreased by 7% at constant temperature. The pressure should be increased by
MHT CET 2025 · 25 APR · SHIFT 1
(a) 7% (b) 14% (c) 7.52% (d) 14.52%

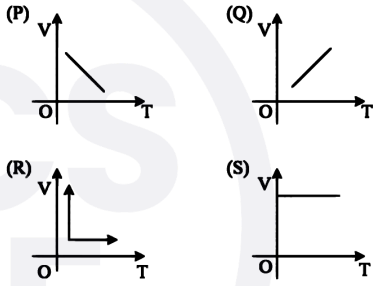
7. How much should the pressure be increased in order to reduce the volume of a given mass of gas by 5% at the constant temperature?
MHT CET 2025 · 23 APR · SHIFT 1
(a) 5% (b) 10% (c) 5.26% (d) 4%

8. A tyre of a vehicle is filled with air having pressure 270 kPa at 27°C. The air pressure in the tyre when the temperature increases to 37°C is
MHT CET 2025 · 20 APR · SHIFT 1
(a) 282 kPa (b) 270 kPa (c) 265 kPa (d) 279 kPa

9. Temperature remaining constant, the pressure of gas is decreased by 20%. The percentage change in volume is
MHT CET 2024 · 16 MAY · SHIFT 2
(a) increases by 29% (b) decreases by 20%
(c) increases by 25% (d) decreases by 25%

10. At constant temperature, increasing the pressure of a gas by 5% its volume will decrease by
MHT CET 2023 · 14 MAY · SHIFT 2
(a) 5% (b) 5.26% (c) 4.20% (d) 4.70%

11. Which one of the following represents correctly the variation of volume (V) of an ideal gas with temperature (T) under constant pressure conditions?
MHT CET 2023 · 13 MAY · SHIFT 1



(a) P (b) Q (c) R (d) S

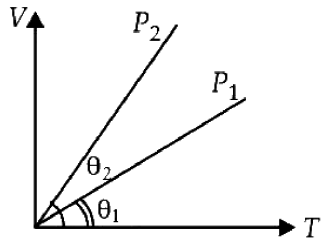
12. According to Boyle's law, the product PV remains constant. The unit of PV is same as that of
MHT CET 2023 · 11 MAY · SHIFT 2
(a) energy (b) force (c) impulse (d) momentum

13. The average thermal energy for a mono-atomic gas is: (kB is Boltzmann constant and T absolute temperature)
NEET 2020 · PHASE 1
(a) $\frac{3}{2}k_BT$ (b) $\frac{5}{2}k_BT$ (c) $\frac{7}{2}k_BT$ (d) $\frac{1}{2}k_BT$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

14. In the given (V – T) diagram, what is the relation between pressure P1 and P2?

NEET 2013



(a) P2 < P1 (b) Cannot be predicted
(c) P2 = P1 (d) P2 > P1

15. The equation of state for 5 g of oxygen at a pressure P and temperature T, when occupying a volume V, will be
(where R is the gas constant)

AIPMT 2004

(a) PV = (5/32)RT (b) PV = 5RT
(c) PV = (5/2)RT (d) PV = (5/16) RT

16. The gases carbon-monoxide (CO) and nitrogen at the same temperature have kinetic energies E_1 and E_2 respectively. Then

AIPMT 2000

(a) $E_1 = E_2$
(b) $E_1 > E_2$
(c) $E_1 < E_2$
(d) E_1 and E_2 cannot be compared

17. Relation between pressure (P) and energy (E) of a gas is

AIPMT 1991

(a) $P = \frac{2}{3}E$ (b) $P = \frac{1}{3}E$
(c) $P = E$ (d) $P = 3E$

18. The helium and argon are put in the flask at the same room temperature (300 K). The ratio of average kinetic energies (per molecule) of helium and argon is:
(Give: Molar mass of helium = 4 g/mol, Molar mass of argon = 40 g/mol)

JEE MAIN 2025 · 7 APR · SHIFT 2

(a) 1: $\sqrt{10}$ (b) 10: 1 (c) 1: 10 (d) 1: 1

19. Pressure of an ideal gas, contained in a closed vessel, is increased by 0.4% when heated by 1°C. Its initial temperature must be:

JEE MAIN 2025 · 3 APR · SHIFT 2

(a) 2500 K (b) 25°C (c) 250°C (d) 250 K

20. A bicycle tyre is filled with air having pressure of 270 kPa at 27°C. The approximate pressure of the air in the tyre when the temperature increases to 36°C is

JEE MAIN 2023 · 29 JAN · SHIFT 1

(a) 262 kPa (b) 360 kPa (c) 270 kPa (d) 278 kPa

21. A gas of certain mass filled in a closed cylinder at a pressure of 3.23 kPa has temperature 50°C. The gas is now heated to double its temperature. The modified pressure is ____ Pa.

JEE MAIN 2026 · 24 JAN · SHIFT 1 *(Numerical)*

22. A container of fixed volume contains a gas at 27°C. To double the pressure of the gas, the temperature of gas should be raised to _____ °C.

JEE MAIN 2025 · 29 JAN · SHIFT 1 *(Numerical)*

23. When a gas filled in a closed vessel is heated by raising the temperature by 1°C, its pressure increases by 0.4%. The initial temperature of the gas is _____ K.

JEE MAIN 2022 · 25 JUN · SHIFT 2 *(Numerical)*

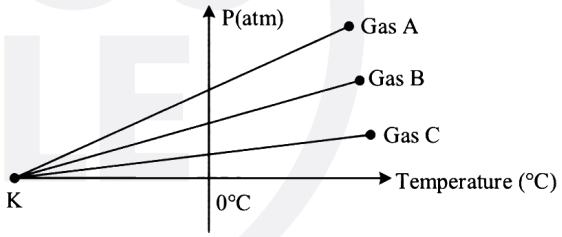
◆ Number of molecules & density 3 Qs

24. A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule of the gas is m. Which of the following gives the density of the gas?

NEET 2016 · PHASE 2

(a) P/(kT) (b) Pm/(kT) (c) P/(KTV) (d) mkT

25. For three low density gases A, B, C pressure versus temperature graphs are plotted while keeping them at constant volume, as shown in the figure.



The temperature corresponding to the point 'K' is:

JEE MAIN 2023 · 1 FEB · SHIFT 2

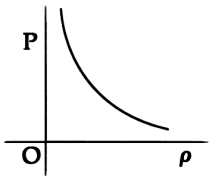
(a) −273°C (b) −373°C (c) −100°C (d) −40°C

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

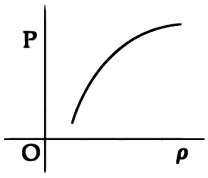
26. Which of the following shows the correct relationship between the pressure 'P' and density ρ of an ideal gas at constant temperature?

JEE MAIN 2016 · 10 APR · SHIFT 1

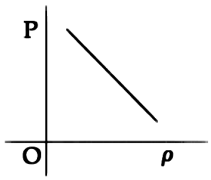
(a)



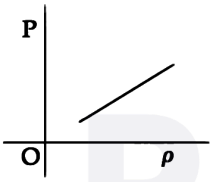
(b)



(c)



(d)



© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 02

Degrees of Freedom & Internal Energy

11 PYQs · Easy 11 · Medium 0 · Difficult 0 | MHT CET 1 · NEET 4 · JEE 6

Concepts covered: Degrees of freedom (7) · Internal energy of gases & mixtures (4)

LEVEL 1 · EASY 11 questions

◆ Degrees of freedom 7 Qs

1. Three vessels of equal capacity have gases at the same temperature and pressure. The first vessel contains helium (monoatomic), the second contains fluorine (diatomic) and the third contains sulfur hexafluoride (polyatomic). The correct statement, among the following is:

NEET 2022 · PHASE 2

(a) The root mean square speed of sulfur hexafluoride is the largest
(b) All vessels contain unequal number of respective molecules
(c) The root mean square speed of molecules is same in all three cases
(d) The root mean square speed of helium is the largest

2. To find out degree of freedom, the expansion is

AIPMT 2000

(a) $f = \frac{2}{\gamma-1}$ (b) $f = \frac{\gamma+1}{2}$ (c) $f = \frac{2}{\gamma+1}$ (d) $f = \frac{1}{\gamma+1}$

3. The degrees of freedom of a molecule of a triatomic gas are

AIPMT 1999

(a) 2 (b) 4 (c) 6 (d) 8

4. The number of translational degrees of freedom for a diatomic gas is

AIPMT 1993

(a) 2 (b) 3 (c) 5 (d) 6

5. The translational degrees of freedom (f_t) and rotational degrees of freedom (f_r) of CH_4 molecule are:

JEE MAIN 2024 · 4 APR · SHIFT 2

(a) $f_t = 2$ and $f_r = 2$ (b) $f_t = 3$ and $f_r = 3$
(c) $f_t = 3$ and $f_r = 2$ (d) $f_t = 2$ and $f_r = 3$

6. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed (v_{rms}) and choose the correct answer from the options given below:

JEE MAIN 2023 · 11 APR · SHIFT 1

(a) $v_{rms}(\text{mono}) = v_{rms}(\text{dia}) = v_{rms}(\text{poly})$
(b) $v_{rms}(\text{mono}) > v_{rms}(\text{dia}) > v_{rms}(\text{poly})$
(c) $v_{rms}(\text{dia}) < v_{rms}(\text{poly}) < v_{rms}(\text{mono})$
(d) $v_{rms}(\text{mono}) < v_{rms}(\text{dia}) < v_{rms}(\text{poly})$

7. Match List I with List II:

	List I		List II
(A)	3 Translational degrees of freedom	(I)	Monoatomic gases
(B)	3 Translational, 2 rotational degrees of freedom	(II)	Polyatomic gases
(C)	3 Translational, 2 rotational and 1 vibrational degrees of freedom	(III)	Rigid diatomic gases
(D)	3 Translational, 3 rotational and more than one vibrational degrees of freedom	(IV)	Nonrigid diatomic gases

Choose the correct answer from the options given below:

JEE MAIN 2023 · 10 APR · SHIFT 1

(a) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(b) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
(c) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)
(d) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

◆ Internal energy of gases & mixtures 4 Qs

8. The internal energy of a monoatomic ideal gas molecule is

MHT CET 2023 · 13 MAY · SHIFT 2

(a) partly kinetic and partly potential
(b) totally kinetic
(c) totally potential
(d) Neither kinetic nor potential

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

9. Molecules of an ideal gas are known to have three translational degrees of freedom and two rotational degrees of freedom.The gas is maintained at a temperature of T. The total internal energy, U of a mole of this gas, and the value of $\gamma\left(=\frac{C_p}{C_v}\right)$ are given, respectively by:

JEE MAIN 2020 · 6 SEP · SHIFT 1

(a) U = $\frac{5}{2}RT$ and $\gamma = \frac{7}{5}$ (b) U = 5RT and $\gamma = \frac{6}{5}$

(c) U = 5RT and $\gamma = \frac{7}{5}$ (d) U = $\frac{5}{2}RT$ and $\gamma = \frac{6}{5}$

10. This question has Statement-1 and Statement-2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: The internal energy of a perfect gas is entirely kinetic and depends only on absolute temperature of the gas and not on its pressure or volume.

Statement 2: A perfect gas is heated keeping pressure constant and later at constant volume. For the same amount of heat the temperature of the gas at constant pressure is lower than that at constant volume.

JEE MAIN 2013 · 23 APR · SHIFT 1

(a) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1.

(b) Statement-1 is true, Statement-2 is false.

(c) Statement-1 is true, Statement-2 is true but Statement-2 is not the correct explanation of Statement-1.

(d) Statement-1 is false, Statement-2 is true.

11. The total internal energy of two mole monoatomic ideal gas at temperature T = 300 K will be _____ J. (Given R = 8.31 J/mol.K)

JEE MAIN 2022 · 28 JUN · SHIFT 1 *(Numerical)*

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 03

Specific Heats of Gases - Cp, Cv, γ & Mayer's Relation

28 PYQs · Easy 28 · Medium 0 · Difficult 0 | MHT CET 20 · NEET 3 · JEE 5

Concepts covered: Cp – Cv: Mayer's relation (1) · γ, Cv & degrees of freedom (27)

LEVEL 1 · EASY 28 questions

◆ Cp – Cv: Mayer's relation 1 Q

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

JEE MAIN 2021 · 20 JUL · SHIFT 1

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

◆ γ, Cv & degrees of freedom 27 Qs

2. The molar specific heat at constant pressure of an ideal gas is $\frac{7}{2}R$. The gas is made up of molecules which are

MHT CET 2026 · 19 MAY · SHIFT 1

(a) polyatomic (b) non-rigid diatomic
(c) rigid diamotic (d) monoatomic

3. For a gas, if the ratio of specific heats at constant pressure and volume is γ then the value of degree of freedom is

MHT CET 2026 · 15 MAY · SHIFT 2

(a) $\frac{(3\gamma-1)}{(2\gamma-1)}$ (b) $\frac{2}{\gamma-1}$
(c) $\frac{9(\gamma-1)}{2}$ (d) $\frac{25(\gamma-1)}{2}$

4. The ratio of C_p to C_v for a non-rigid diatomic gas is

MHT CET 2026 · 12 MAY · SHIFT 2

(a) $\frac{5}{3}$ (b) $\frac{7}{5}$ (c) $\frac{4}{3}$ (d) $\frac{9}{7}$

5. According to law of equipartition of energy the molar specific heat of a non rigid diatomic gas at constant volume is

MHT CET 2026 · 13 APR · SHIFT 2

(a) $(9/2)R$ (b) $(5/2)R$ (c) $(3/2)R$ (d) $(7/2)R$

6. For a gas, $\frac{R}{C_v} = 0.4$ where R is the universal gas constant and C_v is the molar specific heat at constant volume. The gas is made up of molecules which are

MHT CET 2026 · 11 APR · SHIFT 2

(a) monoatomic (b) polyatomic
(c) non rigid diatomic (d) rigid diatomic

7. For ideal non-rigid diatomic gas, the value of $\frac{R}{C_V}$ is nearly $\left(\gamma = \frac{C_P}{C_V} = \frac{9}{7}\right)$

MHT CET 2025 · 19 APR · SHIFT 1

(a) 0.4 (b) 0.66 (c) 0.28 (d) 1.28

8. The ratio of the specific heats $\frac{C_p}{C_v} = \gamma$, in terms of degrees of freedom (n) is

MHT CET 2024 · 16 MAY · SHIFT 2

(a) $\left(1+\frac{1}{n}\right)$ (b) $\left(1+\frac{2}{n}\right)$ (c) $\left(1+\frac{n}{3}\right)$ (d) $\left(1+\frac{n}{2}\right)$

9. For a gas, $\frac{R}{C_v} = 0.4$ where R is the universal gas constant and ' C_V ' is molar specific heat at constant volume. The gas is made up of molecules which are

MHT CET 2024 · 10 MAY · SHIFT 2

(a) rigid diatomic. (b) monoatomic.
(c) non-rigid diatomic. (d) polyatomic.

10. If C_p and C_v are molar specific heats of an ideal gas at constant pressure and volume respectively and ' γ ' is C_p/C_v then C_p = (R = universal gas constant)

MHT CET 2024 · 4 MAY · SHIFT 2

(a) $\frac{\gamma R}{\gamma-1}$ (b) γR (c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{R}{\gamma-1}$

11. For polyatomic gases, the ratio of molar specific heat at constant pressure to constant volume is (f = degrees of freedom)

MHT CET 2023 · 12 MAY · SHIFT 2

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

12. The molar specific heat of an ideal gas at constant pressure and constant volume is C_p and C_v respectively. If R is universal gas constant and $\gamma = \frac{C_p}{C_v}$ then C_v =

MHT CET 2023 · 12 MAY · SHIFT 1

(a) $\frac{1-\gamma}{1+\gamma}$ (b) $\frac{1+\gamma}{1-\gamma}$ (c) $\frac{\gamma-1}{R}$ (d) $\frac{R}{\gamma-1}$

13. For a gas, $\frac{R}{C_v} = 0\cdot4$, where R is universal gas constant and C_v is molar specific heat at constant volume. The gas is made up of molecules which are

MHT CET 2023 · 11 MAY · SHIFT 2

(a) rigid diatomic (b) monoatomic
(c) non-rigid diatomic (d) polyatomic

14. For a gas having 'X' degrees of freedom, 'γ' is (γ = ratio of specific heats = C_P/C_V)

MHT CET 2023 · 9 MAY · SHIFT 1

(a) $\frac{1+X}{2}$ (b) $1+\frac{X}{2}$ (c) $1+\frac{2}{x}$ (d) $1+\frac{1}{x}$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

15. Which one of the following is NOT a correct expression for an ideal gas?
[C_p = Molar specific heat of a gas at constant pressure,
C_v = Molar specific heat of a gas at constant volume,
γ = Ratio of two specific heats of a gas,
R = Universal gas constant]
MHT CET 2021 · 24 SEP · SHIFT 2
(a) $C_v = C_p + R$ (b) $R = C_v(\gamma - 1)$
(c) $\frac{C_v}{C_p} = \frac{1}{\gamma}$ (d) $R = \frac{C_p(\gamma-1)}{\gamma}$

16. For an ideal gas, $R = \frac{2}{3}C_v$. This suggests that the gas consists of molecules, which are [R = universal gas constant]
MHT CET 2021 · 23 SEP · SHIFT 2
(a) polyatomic
(b) diatomic
(c) monoatomic
(d) a mixture of diatomic and polyatomic molecules

17. For a gas molecule with 6 degrees of freedom, which one of the following relation between gas constant 'R' and molar specific heat 'C_v' is correct?
MHT CET 2021 · 22 SEP · SHIFT 1
(a) $R = \frac{C_v}{3}$ (b) $R = \frac{5C_v}{4}$ (c) $R = \frac{C_v}{2}$ (d) $R = \frac{3C_v}{4}$

18. The molar specific heats of an ideal gas at constant pressure and volume are denoted by 'C_p' and 'C_v' respectively. If $\gamma = \frac{C_p}{C_v}$ and 'R' is universal gas constant, then C_v is equal to
MHT CET 2021 · 21 SEP · SHIFT 1
(a) $\frac{R}{\gamma-1}$ (b) γR (c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{\gamma-1}{R}$

19. Specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v respectively. If $\gamma = \frac{C_p}{C_v}$ and R it's the universal gas constant then C_v is equal to
MHT CET 2021 · 20 SEP · SHIFT 1
(a) $\frac{(\gamma-1)}{(\gamma+1)}$ (b) $\frac{(\gamma-1)}{R}$ (c) $R\gamma$ (d) $\frac{R}{(\gamma-1)}$

20. For a gas, $\frac{R}{C_V} = 0.4$, where R is universal gas constant and C_V is the molar specific heat at constant volume. The gas is made up of molecules, which are
MHT CET 2020 · 16 OCT · SHIFT 1
(a) polyatomic (b) rigid diatomic
(c) monoatomic (d) non-rigid diatomic

21. If 'C_P' and 'C_V' are molar specific heats of an ideal gas at constant pressure and volume respectively. If 'λ' is the ratio of two specific heats and 'R' is universal gas constant then 'C_p' is equal to
MHT CET 2019 · 2 MAY · SHIFT 1
(a) $\frac{R\gamma}{\gamma-1}$ (b) γR (c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{R}{\gamma-1}$

22. The ratio of the specific heats $\frac{C_p}{C_v} = \gamma$ in terms of degrees of freedom (n) is given by
AIPMT 2015 · CANCELLED PAPER
(a) $\left(1+\frac{2}{n}\right)$ (b) $\left(1+\frac{n}{2}\right)$ (c) $\left(1+\frac{1}{n}\right)$ (d) $\left(1+\frac{n}{3}\right)$

23. The molar specific heat at constant pressure of an ideal gas is (7/2) R. The ratio of specific heat at constant pressure to that at constant volume is
AIPMT 2006
(a) 9/7 (b) 7/5 (c) 8/7 (d) 5/7

24. If for a gas, $\frac{R}{C_V} = 0.67$, this gas is made up of molecules which are
AIPMT 1992
(a) diatomic
(b) mixture of diatomic and polyatomic molecules
(c) monoatomic
(d) polyatomic

25. A gas has n degrees of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be:
JEE MAIN 2022 · 26 JUL · SHIFT 2
(a) $\frac{n}{n+2}$ (b) $\frac{n+2}{n}$ (c) $\frac{n}{2n+2}$ (d) $\frac{n}{n-2}$

26. The ratio of specific heats $\left(\frac{C_P}{C_V}\right)$ in terms of degree of freedom (f) is given by:
JEE MAIN 2022 · 25 JUN · SHIFT 2
(a) $\left(1+\frac{f}{3}\right)$ (b) $\left(1+\frac{2}{f}\right)$ (c) $\left(1+\frac{f}{2}\right)$ (d) $\left(1+\frac{1}{f}\right)$

27. The correct relation between the degrees of freedom f and the ratio of specific heat γ is:
JEE MAIN 2021 · 20 JUL · SHIFT 2
(a) $f = \frac{2}{\gamma-1}$ (b) $f = \frac{2}{\gamma+1}$ (c) $f = \frac{\gamma+1}{2}$ (d) $f = \frac{1}{\gamma+1}$

28. An ideal gas has molecules with 5 degrees of freedom. The ratio of specific heats at constant pressure (Cp) and at constant volume (Cv) is:
JEE MAIN 2017 · 8 APR · SHIFT 1
(a) 6 (b) $\frac{7}{2}$ (c) $\frac{5}{2}$ (d) $\frac{7}{5}$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 04

Heat, Work & First Law of Thermodynamics

10 PYQs · Easy 10 · Medium 0 · Difficult 0 | MHT CET 0 · NEET 5 · JEE 5

Concepts covered: Heat, work & first law (10)

LEVEL 1 · EASY 10 questions

1. An electric heater supplies heat to a system at a rate of 100 W. If the system performs work at a rate of $75\ \mathrm{J/s}$, then the rate at which internal energy increases will be:

NEET 2026

(a) 75 W (b) 100 W (c) 125 W (d) 25 W

2. The internal energy change in a system that has absorbed 2 kcal of heat and done 500 J of work is

AIPMT 2009

(a) 6400 J (b) 5400 J (c) 7900 J (d) 8900 J

3. Which of the following is not thermodynamical function?

AIPMT 1993

(a) Enthalpy (b) Work done
(c) Gibbs energy (d) Internal energy

4. 110 joule of heat is added to a gaseous system whose internal energy is 40 J, then the amount of external work done is

AIPMT 1993

(a) 150 J (b) 70 J (c) 110 J (d) 40 J

5. First law of thermodynamics is consequence of conservation of

AIPMT 1988

(a) work (b) energy
(c) heat (d) all of these

6. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason **R**

Statement I: Change in internal energy of a system containing n mole of ideal gas can be written as $\Delta \mathrm{U} = n\mathrm{C}_v\,(T_\mathrm{f} - T_i) = \frac{nR}{\gamma - 1}(T_\mathrm{f} - T_i)$, where $\gamma = \frac{C_p}{C_v}$, $T_i =$ initial temperature, $T_\mathrm{f} =$ final temperature. Statement II: Relation between degree of freedom f and $\gamma\,(= C'_p/C'_v)$ is $\left(\gamma = 1 + \frac{2}{f}\right)$ Choose the correct answer from the options given below

JEE MAIN 2026 · 5 APR · SHIFT 1

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

7. Given are statements for certain thermodynamic variables,

(A) Internal energy, volume (V) and mass (M) are extensive variables.

(B) Pressure (P), temperature (T) and density (ρ) are intensive variables.

(C) Volume (V), temperature (T) and density (ρ) are intensive variables.

(D) Mass (M), temperature (T) and internal energy are extensive variables.

Choose the correct answer from the options given below:

JEE MAIN 2025 · 22 JAN · SHIFT 2

(a) (C) and (D) Only (b) (A) and (B) Only
(c) (D) and (A) Only (d) (B) and (C) Only

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 is

JEE MAIN 2023 · 6 APR · SHIFT 1

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

9. 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 options given below:

JEE MAIN 2023 · 29 JAN · SHIFT 1

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

10. Which of the following parameters does not characterize the thermodynamic state of mattter?

AIEEE 2003

(a) Temperature (b) Pressure
(c) Work (d) Volume

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 05

Thermodynamic Processes

65 PYQs · Easy 65 · Medium 0 · Difficult 0 | MHT CET 32 · NEET 12 · JEE 21

Concepts covered: Types of processes: identify & compare (32) · Isobaric & isochoric processes (9) · Isothermal process (10) · Adiabatic process (10) · Polytropic & other processes (4)

LEVEL 1 · EASY 65 questions

◆ Types of processes: identify & compare 32 Qs

1. We consider a thermodynamic system. If ΔU is the increase in internal energy and W is the work done by the system, which one of the following statement is true?
MHT CET 2026 · 15 MAY · SHIFT 1
(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

2. Out of the following relations which one is true in the case of an adiabatic process, where $\gamma = C_p/C_v$?
MHT CET 2026 · 13 MAY · SHIFT 1
(a) $P^{(1-\gamma)}T^{\gamma} =$ constant (b) $P^{\gamma}T^{(1-\gamma)} =$ constant
(c) $PT^{\gamma} =$ constant (d) $P^{\gamma}T =$ constant

3. The thermodynamic process in which no work is done by the gas or on the gas is
MHT CET 2026 · 19 APR · SHIFT 1
(a) isothermal process (b) adiabatic process
(c) isobaric process (d) isochoric process

4. In the thermodynamic processes, which of the following statements is NOT true?
MHT CET 2025 · 26 APR · SHIFT 2
(a) In an isothermal process, the temperature remains constant.
(b) In an adiabatic process, the system is insulated from surroundings.
(c) In an isochoric process, pressure remains constant.
(d) In an adiabatic process, $PV^{\gamma} =$ constant.

5. Heat supplied $dQ =$ increase in internal energy dU is true for
MHT CET 2025 · 25 APR · SHIFT 2
(a) isothermal process. (b) adiabatic process.
(c) isobaric process. (d) isochoric process.

6. During thermodynamic process, the increase in internal energy of a system is equal to the w_{0rk} done on the system. Which process does the system undergo?
MHT CET 2025 · 23 APR · SHIFT 2
(a) Isothermal (b) Adiabatic
(c) Isochoric (d) Isobaric

7. In a thermodynamic system ' ΔU ' represents the increase in internal energy and ' W ' the work done by the system. Which of the following statement is true?
MHT CET 2024 · 10 MAY · SHIFT 2
(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.

8. The internal energy of a gas will increase when it
MHT CET 2024 · 9 MAY · SHIFT 1
(a) expands adiabatically.
(b) is compressed adiabatically.
(c) expands isothermally.
(d) is compressed isothermally.

9. In a thermodynamic system, ΔU represents the increases in its internal energy and dW is the work done by the system then correct statement out of the following is
MHT CET 2023 · 14 MAY · SHIFT 1
(a) $\Delta U = dW$ is an isothermal process
(b) $\Delta U = -dW$ is an adiabatic process
(c) $\Delta U = -dW$ is an isothermal process
(d) $\Delta U = dW$ is an adiabatic process

10. Select the WRONG statement from the following. For an isothermal process
MHT CET 2023 · 12 MAY · SHIFT 2
(a) Energy exchanged is used to do work
(b) Perfect thermal equilibrium with environment
(c) Equation of state PV is not constant.
(d) No change internal energy.

11. In a thermodynamic process, there is no exchange of heat between the system and surroundings. Then the thermodynamic process is
MHT CET 2023 · 9 MAY · SHIFT 1
(a) isothermal (b) isobaric
(c) isochoric (d) adiabatic

12. The thermodynamic process in which no work is done on or by the gas is
MHT CET 2022 · 11 AUG · SHIFT 2
(a) isochoric process (b) adiabatic process
(c) isothermal process (d) isobaric process

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

13. Which one of the following statements is wrong for an isobaric process?
MHT CET 2021 · 23 SEP · SHIFT 1
(a) The pressure of the system remains constant
(b) There is change in volume, when work is done
(c) Temperature of the system remains constant
(d) Energy exchanged is used to do work to change internal energy

14. Which of the following statements is true?
(ΔU = increase in internal energy, dW = work done by the system)
MHT CET 2021 · 22 SEP · SHIFT 1
(a) In an adiabatic process $\Delta U = dW$
(b) In an adiabatic process $\Delta U = -dW$
(c) In an isothermal process $\Delta U = -dW$.
(d) In an isothermal process $\Delta U = dW$

15. Which one of the following equations specifies an isobaric process? [Q = heat supplied $\Delta P, \Delta V$ and ΔT are change in pressure, volume and temperature respectively]
MHT CET 2021 · 21 SEP · SHIFT 1
(a) $Q = 0$ (b) $\Delta T = 0$ (c) $\Delta V = 0$ (d) $\Delta P = 0$

16. Two cylinders A and B of equal capacity are connected to each other via a stop cock. A contains an ideal gas at standard temperature and pressure. B is completely evacuated. The entire systems is thermally insulated. The stop cock is suddenly opened. The Process is:
NEET 2020 · PHASE 1
(a) adiabatic (b) isochoric
(c) isobaric (d) isothermal

17. In which of the following processes, heat is neither absorbed nor released by a system?
NEET 2019
(a) adiabatic (b) isobaric
(c) isochoric (d) isothermal

18. Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning?
NEET 2013
(a) $P1^{-\gamma}\, T^{\gamma}$ = constant (b) PV^{γ} = constant
(c) $TV^{\gamma-1}$ = constant (d) $P^{\gamma}\, T1^{-\gamma}$ = constant

19. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?
AIPMT 2010 · PRELIMS
(a) $\Delta U = -\Delta W$, in an adiabtic process
(b) $\Delta U = \Delta W$, in an isothermal process
(c) $\Delta U = \Delta W$, in an adiabatic process
(d) $\Delta U = -\Delta W$, in an isothermal process

20. In thermodynamic processes which of the following statements is not true?
AIPMT 2009
(a) In an isochoric process pressure remains constant.
(b) In an isothermal process the temperature remains constant.
(c) In an adiabatic process PV^{γ} = constant.
(d) In an adiabatic process the system is insulated from the surroundings.

21. 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?
AIPMT 1998
(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

22. 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
AIPMT 1997
(a) adiabatic (b) equal in all cases
(c) isothermal (d) isobaric

23. Match List - I with List - II.

List - I	List - II
(A) Isothermal	(I) ΔW (work done) = 0
(B) Adiabatic	(II) ΔQ (supplied heat) = 0
(C) Isobaric	(III) ΔU (change in internal energy) ≠ 0
(D) Isochoric	(IV) ΔU = 0

Choose the correct answer from the options given below:
JEE MAIN 2025 · 7 APR · SHIFT 2
(a) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
(b) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)
(c) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)
(d) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

24. Identify the characteristics of an adiabatic process in a monoatomic gas.
(A) Internal energy is constant.
(B) Work done in the process is equal to the change in internal energy.
(C) The product of temperature and volume is a constant.
(D) The product of pressure and volume is a constant.
(E) The work done to change the temperature from T_1 to T_2 is proportional to $(T_2 - T_1)$. Choose the correct answer from the options given below:
JEE MAIN 2025 · 2 APR · SHIFT 2
(a) (B), (D) only (b) (B), (E) only
(c) (A), (C), (E) only (d) (A), (C), (D) only

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

25. Match the List - I with List - II

	List - I		List - II
(A)	Pressure varies inversely with volume of an ideal gas.	(I)	Adiabatic process
(B)	Heat absorbed goes partly to increase internal energy and partly to do work.	(II)	Isochoric process
(C)	Heat is neither absorbed nor released by a system.	(III)	Isothermal process
(D)	No work is done on or by a gas.	(IV)	Isobaric process

Choose the correct answer from the options given below:

JEE MAIN 2025 · 23 JAN · SHIFT 1

(a) A-I, B-III, C-II, D-IV
(b) A-I, B-IV, C-II, D-III
(c) A-III, B-I, C-IV, D-II
(d) A-III, B-IV, C-I, D-II

26. The Thermodynamic process, in which internal energy of the system remains constant is

JEE MAIN 2023 · 11 APR · SHIFT 2

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

27. 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:

JEE MAIN 2023 · 25 JAN · SHIFT 2

(a) A-I, B-II, C-IV, D-III
(b) A-II, B-I, C-III, D-IV
(c) A-II, B-I, C-IV, D-III
(d) A-I, B-II, C-III, D-IV

28. Match List I with List II.

	List I		List II
(a)	Isothermal	(i)	Pressure constant
(b)	Isochoric	(ii)	Temperature constant
(c)	Adiabatic	(iii)	Volume constant
(d)	Isobaric	(iv)	Heat content is constant

Choose the correct answer from the options given below:

(1) (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)
(2) (a) - (ii), (b) - (iv), (c) - (iii), (d) - (i)
(3) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)
(4) (a) - (i), (b) - (iii), (c) - (ii), (d) - (iv)

JEE MAIN 2021 · 24 FEB · SHIFT 1

29. Match the thermodynamic 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.

JEE MAIN 2020 · 4 SEP · SHIFT 2

Process	Condition
(I) Adiabatic	(1) $\Delta W = 0$
(II) Isothermal	(2) $\Delta Q = 0$
(III) Isochoric	(3) $\Delta U \neq 0, \Delta W \neq 0, \Delta Q \neq 0$
(IV) Isobaric	(4) $\Delta U = 0$

(a) (I) - (1), (II) - (1), (III) - (2), (IV) - (3)
(b) (I) - (2), (II) - (4), (III) - (1), (IV) - (3)
(c) (I) - (1), (II) - (2), (III) - (4), (IV) - (4)
(d) (I) - (2), (II) - (1), (III) - (4), (IV) - (3)

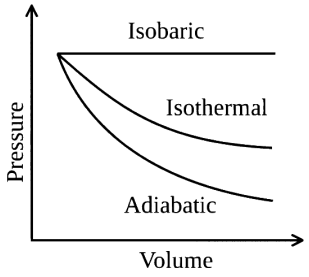
30. A balloon filled with helium (32oC and 1.7 atm.) bursts. Immediately afterwards the expansion of helium can be considered as

JEE MAIN 2020 · 3 SEP · SHIFT 1

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

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

31. A sample of gas expands from V_1 to V_2. In which of the following, the work done will be greatest?
JEE MAIN 2013 · 25 APR · SHIFT 1



(a) Same in all processes (b) Isobaric process
(c) Isothermal process (d) Adiabatic process

32. A diatomic gas ($\gamma = 1.4$) does 400J of work when it is expanded isobarically. The heat given to the gas in the process is _____ J.
JEE MAIN 2022 · 27 JUN · SHIFT 2 *(Numerical)*

◆ Isobaric & isochoric processes 9 Qs

33. When the temperature of 4 moles of a gas was increased from 70°C to 90°C, at constant volume, the change in internal energy was 60 J. The total heat capacity of the gas at constant volume is
MHT CET 2026 · 19 MAY · SHIFT 1
(a) 0.5 J/K (b) 2 J/K (c) 3 J/K (d) 4 J/K

34. In thermodynamic isobaric process
MHT CET 2026 · 15 APR · SHIFT 1
(a) change in internal energy is zero
(b) work done is zero
(c) change in internal energy is not zero
(d) heat supplied is zero

35. In an isobaric process
MHT CET 2024 · 2 MAY · SHIFT 2
(a) pressure is constant.
(b) volume is constant.
(c) temperature is constant.
(d) internal energy is constant.

36. dQ is the heat energy supplied to an ideal gas under isochoric conditions. If dU and dW denote the change in internal energy and the work done respectively then
MHT CET 2023 · 13 MAY · SHIFT 1
(a) dQ = dW (b) dQ > dU
(c) dQ < dU (d) dQ = dU

37. In thermodynamics, for an isochoric process, which one of the following statement is INCORRECT?
MHT CET 2021 · 21 SEP · SHIFT 2
(a) Energy exchanged is used to do work and also to change internal energy.
(b) No work is done in the process.
(c) It is a constant volume process.
(d) Temperature of the system changes during the process.

38. Heat is supplied to a diatomic gas at constant pressure. Then the ratio of $\Delta Q : \Delta U : \Delta W$ is _____.
JEE MAIN 2026 · 2 APR · SHIFT 1
(a) 2: 3: 5 (b) 5: 3: 2 (c) 2: 5: 7 (d) 7: 5: 2

39. A diatomic gas, having $C_p = \frac{7}{2}R$ and $C_v = \frac{5}{2}R$, is heated at constant pressure. The ratio dU: dQ: dW:
JEE MAIN 2021 · 25 FEB · SHIFT 1
(a) 5: 7: 3 (b) 3: 7: 2 (c) 5: 7: 2 (d) 3: 5: 2

40. The ratio of work done by an ideal monoatomic gas to the heat supplied to it in an isobaric process is:
JEE MAIN 2016 · 9 APR · SHIFT 1
(a) $\frac{3}{5}$ (b) $\frac{2}{3}$ (c) $\frac{3}{2}$ (d) $\frac{2}{5}$

41. A gas is compressed from a volume of 2 m3 to a volume of 1 m3 at a constant pressure of 100 N/m2. Then it is heated at constant volume by supplying 150 J of energy. As a result, the internal energy of the gas:
JEE MAIN 2014 · 19 APR · SHIFT 1
(a) Increases by 250 J (b) Decreases by 250 J
(c) Increases by 50 J (d) Decreases by 50 J

◆ Isothermal process 10 Qs

42. If a gas is compressed isothermally then the r.m.s. velocity of the molecules
MHT CET 2026 · 16 APR · SHIFT 2
(a) increases
(b) remains the same
(c) decreases
(d) first increases and then decreases

43. Heat is given to an ideal gas in an isothermal process. Then
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 negative work.
MHT CET 2025 · 21 APR · SHIFT 2
(a) B (b) C (c) D (d) A

44. If a gas is compressed isothermally then the r.m.s. velocity of its molecules
MHT CET 2025 · 20 APR · SHIFT 2
(a) increases.
(b) decreases.
(c) remains the same.
(d) first increases and then decreases.

45. When the heat is given to a gas in an Isothermal process, then there will be
MHT CET 2025 · 19 APR · SHIFT 1
(a) external work done.
(b) rise in temperature.
(c) increase in internal energy.
(d) external work done and also rise in temperature.

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

46. A perfect gas of volume 5 litre is compressed isothermally to volume of 1 litre. The r.m.s. speed of the molecules will

MHT CET 2024 · 4 MAY · SHIFT 2

(a) increase by 10 times (b) decrease by 10 times
(c) increase by 5 times (d) remain unchanged

47. If a gas is compressed isothermally then the r.m.s. velocity of the molecules

MHT CET 2023 · 11 MAY · SHIFT 1

(a) decreases.
(b) increases.
(c) remains the same.
(d) first decreases and then increases.

48. If the pressure of an ideal gas is decreased by 10% isothermally, then its volume will

MHT CET 2021 · 22 SEP · SHIFT 2

(a) decrease by 8% (b) decrease by 9%
(c) increase by 8% (d) increase by 11.1%

49. A perfect gas of volume 10 litre n compressed isothermally to a volume of 1 litre. The rms speed of the molecules will

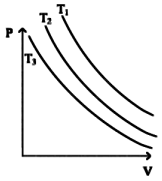
MHT CET 2021 · 20 SEP · SHIFT 2

(a) decrease 5 times (b) remain unchanged
(c) increase 5 times (d) increase 10 times

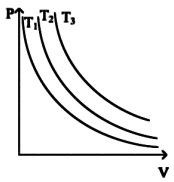
50. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperatures; $T_3 > T_2 > T_1$ as:

JEE MAIN 2023 · 24 JAN · SHIFT 2

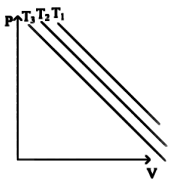
(a)



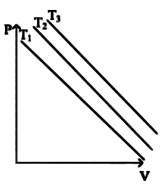
(b)



(c)



(d)



51. One mole of an ideal monoatomic gas is compressed isothermally in a rigid vessel to double its pressure at room temperature, $27^{\circ}C$. The work done on the gas will be:

JEE MAIN 2018 · 15 APR · SHIFT 1

(a) $300\ R$ (b) $300\ R\ ln\ 6$
(c) $300\ R\ ln\ 2$ (d) $300\ R\ ln\ 7$

◆ Adiabatic process 10 Qs

52. A thermodynamic system is compressed adiabatically, then its temperature

MHT CET 2026 · 17 APR · SHIFT 2

(a) becomes zero. (b) remains constant.
(c) increases. (d) decreases.

53. During the isothermal expansion, a confined ideal gas does (-150)J of work against its surroundings. This means that

MHT CET 2025 · 25 APR · SHIFT 1

(a) 150 J of heat has been added to the gas
(b) 150 J of heat has been removed from the gas
(c) 300 J of heat has been added to the gas
(d) no heat is transferred because the process is isothermal

54. For an adiabatic process, which one of the following is wrong statement?

MHT CET 2023 · 13 MAY · SHIFT 2

(a) Equation of state is $pV^{\gamma} =$ constant
(b) There is exchange of heat with surrounding
(c) All the work is utilised to change the internal energy of the system
(d) Temperature of the system changes i.e. $\Delta T \neq 0$

55. In an adiabatic expansion, the temperature of one mole of an ideal monatomic gas ($\gamma = 5/3$) decreases from 60 K to 50 K. The work done by the gas in the process is:

(Take the universal gas constant as $R = 8.3\ \text{J mol}^{-1}\ \text{K}^{-1}$)

RE-NEET 2026

(a) 166 J (b) 41.5 J (c) 83 J (d) 124.5 J

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

AIPMT 2011 · PRELIMS

(a) 150 J of heat has been removed from the gas
(b) 300 J of heat has been added to the gas
(c) no heat is transferred because the process is isothermal
(d) 150 J of heat has been added to the gas

57. A monatomic gas at pressure P1 and volume V1 is compressed adiabatically to $\frac{1}{8}^{th}$ of its original volume. What is the final pressure of the gas?

AIPMT 2010 · MAINS

(a) 64P1 (b) P1 (c) 16P1 (d) 32P1

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

58. An ideal gas, undergoing adiabatic change, has which of the following pressure temperature relationship?
AIPMT 1996
(a) $P^{\gamma}T^{1-\gamma}$ = constant (b) $P^{1-\gamma}T^{\gamma}$ = constant
(c) $P^{\gamma-1}T^{\gamma}$ = constant (d) $P^{\gamma}T^{\gamma-1}$ = constant

59. The work done in an adiabatic change in an ideal gas depends upon only:
JEE MAIN 2025 · 29 JAN · SHIFT 1
(a) change in its pressure
(b) change in its temperature
(c) change in its specific heat
(d) change in its volume

60. 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)
JEE MAIN 2023 · 13 APR · SHIFT 2
(a) $P_0(4)^{\frac{1}{\gamma}}$ (b) P_0
(c) $4P_0$ (d) $P_0(4)^{\gamma}$

61. A gas is compressed adiabatically, which one of the following statements is NOT true?
JEE MAIN 2023 · 10 APR · SHIFT 2
(a) There is no heat supplied to the system
(b) The temperature of the gas increases.
(c) There is no change in the internal energy
(d) The change in the internal energy is equal to the work done on the gas.

◆ Polytropic & other processes 4 Qs

62. In an adiabatic process, which one of the following statement is true?
MHT CET 2026 · 15 MAY · SHIFT 2
(a) The molar heat capacity is infinite
(b) Work done by the gas equals the increase in internal energy
(c) The molar heat capacity is zero
(d) The internal energy of the gas decreases as the temperature increases

63. The equilibrium state of a thermodynamic system is described by
A. Pressure
B. Total heat
C. Temperature
D. Volume
E. Work done
Choose the most appropriate answer from the options given below.
NEET 2024
(a) A, B and E only (b) B, C and D only
(c) A, B and C only (d) A, C and D only

64. In an adiabatic process, which of the following statements is true?
JEE MAIN 2025 · 2 APR · SHIFT 1
(a) The internal energy of the gas decreases as the temperature increases
(b) The molar heat capacity is zero
(c) Work done by the gas equals the increase in internal energy
(d) The molar heat capacity is infinite

65. A rigid diatomic ideal gas undergoes an adiabatic process at room temperature. The relation between temperature and volume for this process is TVx = constant, then x is:
JEE MAIN 2019 · 11 JAN · SHIFT 1
(a) $\frac{5}{3}$ (b) $\frac{2}{5}$ (c) $\frac{3}{5}$ (d) $\frac{2}{3}$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 06

P-V Diagrams & Cyclic Processes

24 PYQs · Easy 24 · Medium 0 · Difficult 0 | MHT CET 14 · NEET 6 · JEE 4

Concepts covered: Work done & area under P-V (4) · Graphs of processes: P-V, P-T, V-T (8) · Cyclic processes (8) · Free expansion (4)

LEVEL 1 · EASY 24 questions

◆ Work done & area under P-V 4 Qs

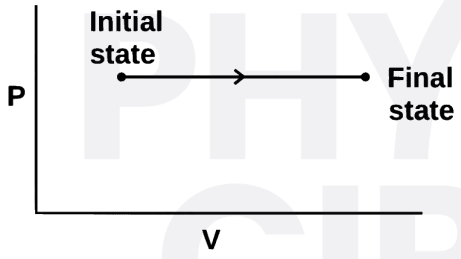
1. For any thermodynamic process, the work done by the system depends

MHT CET 2026 · 12 MAY · SHIFT 1

(a) only on intial state of the system.
(b) both on initial and final state of the system.
(c) on the initial state and final state and on the path along which the change takes place.
(d) only on intermediate state.

2. The P-V diagram for an ideal gas in a piston cylinder assembly undergoing a thermodynamic process is shown in the figure. The process is

NEET 2020 · PHASE 2



(a) isothermal (b) adiabatic
(c) isochoric (d) isobaric

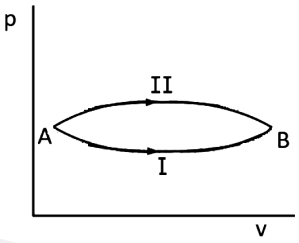
3. In thermodynamics, heat and work are:

JEE MAIN 2021 · 16 MAR · SHIFT 1

(a) Path functions
(b) Point functions
(c) Extensive thermodynamics state variables
(d) Intensive thermodynamic state variables

4. 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

AIEEE 2005

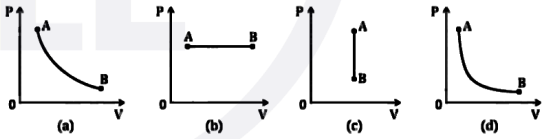


(a) relation between ΔU_1 and ΔU_2 can not be determined
(b) $\Delta U_1 = \Delta U_2$
(c) $\Delta U_2 < \Delta U_1$
(d) $\Delta U_2 > \Delta U_1$

◆ Graphs of processes: P-V, P-T, V-T 8 Qs

5. Arrange the correct order of P-V diagrams in thermodynamics for an isothermal process, isobaric process, isochoric process and adiabatic process

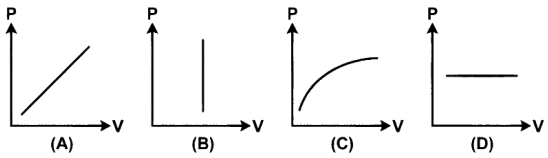
MHT CET 2026 · 14 MAY · SHIFT 2



(a) a,b,c,d (b) a,c,b,d (c) d,c,b,a (d) d,b,c,a

6. Which of the following graphs between pressure and volume of a gas correctly shows isochoric process in thermodynamics?

MHT CET 2026 · 18 APR · SHIFT 1

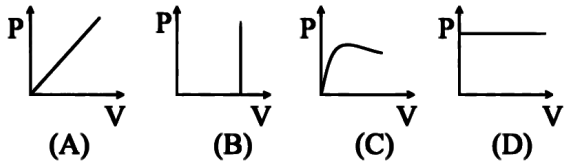


(a) (D) (b) (A) (c) (C) (d) (B)

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

7. Which of the following graphs between pressure and volume correctly show isochoric process?

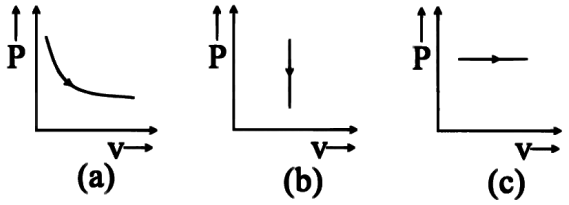
MHT CET 2024 · 10 MAY · SHIFT 1



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

8. The P-V diagrams for particular gas of different thermodynamic processes are given by

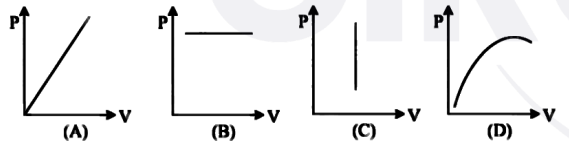
MHT CET 2024 · 9 MAY · SHIFT 2



(a) Figure (a) and (b) show isobaric curve and isothermal curve respectively.
(b) Figure (a) and (c) show isothermal curve and isochoric curve respectively.
(c) Figure (b) and (c) show isobaric curve and isochoric curve respectively.
(d) Figure (a) and (c) show isothermal curve and isobaric curve respectively.

9. Which of the following graphs between pressure (P) and volume (V) correctly shows isochoric changes?

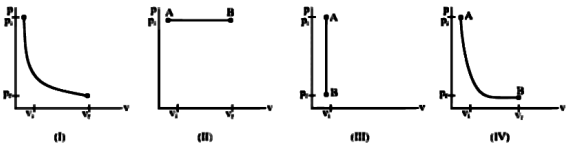
MHT CET 2023 · 10 MAY · SHIFT 2



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

10. Which one of the following p-V diagram is correct for an isochoric process:

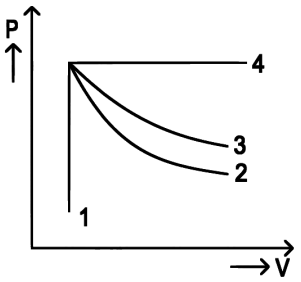
MHT CET 2021 · 24 SEP · SHIFT 2



(a) IV (b) II (c) III (d) I

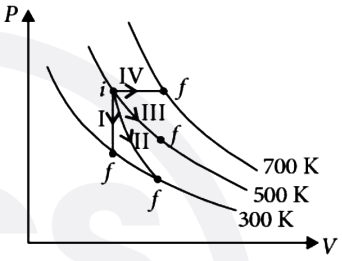
11. An ideal gas undergoes four different processes from the same initial state as shown in the figure below. Those processes are adiabatic, isothermal, isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is

NEET 2022 · PHASE 1



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

12. Thermodynamic processes are indicated in the following diagram.



Match the following

NEET 2017

Column-1		Column-2	
P.	Process I	A.	Adiabatic
Q.	Process II	B.	Isobaric
R.	Process III	C.	Isochoric
S.	Process IV	D.	Isothermal

(a) P → C, Q → A, R → D, S → B
(b) P → C, Q → D, R → B, S → A
(c) P → D, Q → B, R → A, S → C
(d) P → A, Q → C, R → D, S → B

◆ Cyclic processes 8 Qs

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

MHT CET 2026 · 15 APR · SHIFT 2

(a) zero.
(b) equal to the heat given to system.
(c) more than the heat given to system.
(d) independent of heat given to system.

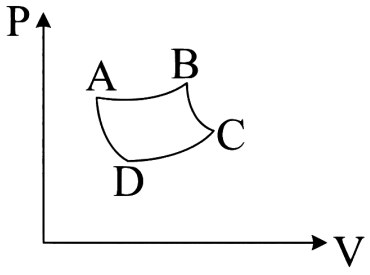
14. In a cyclic process, work done by the system is

MHT CET 2025 · 20 APR · SHIFT 2

(a) more than the heat given to the system.
(b) equal to the heat given to the system.
(c) zero.
(d) independent of the heat given to the system.

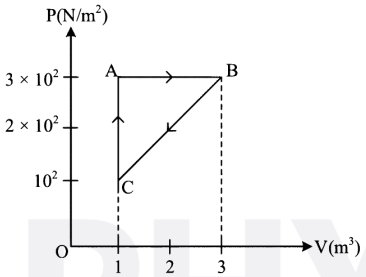
© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

15. The P-V graph of an ideal gas, cycle is shown. The adiabatic process is described by the region
MHT CET 2024 · 2 MAY · SHIFT 1



(a) AB and BC (b) AB and CD (c) AD and BC (d) BC and CD

16. For the given cycle, the work done during isobaric process is:
NEET 2023

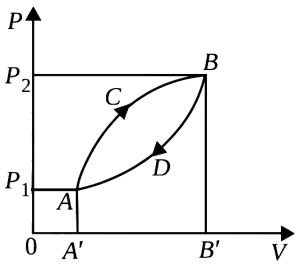


(a) 200 J (b) Zero (c) 400 J (d) 600 J

17. If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then
AIPMT 2008

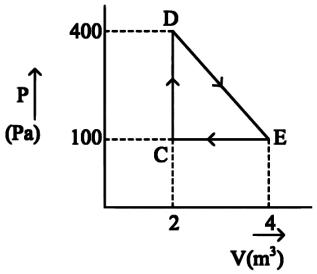
(a) E = 0 (b) Q = 0 (c) W = 0 (d) Q = W = 0

18. 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
AIPMT 1992



(a) $P_1ACBP_2P_1$ (b) $ACBB'A'A$
(c) $ACBDA$ (d) $ADBB'A'A$

19. A thermodynamic system is taken through cyclic process. The total work done in the process is:
JEE MAIN 2023 · 15 APR · SHIFT 1



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

20. Which of the following is incorrect regarding the first law of thermodynamics?
AIEEE 2005 *(One or more correct)*

(a) It is a restatement of the principle of conservation of energy
(b) It is not applicable to any cyclic process
(c) It introduces the concept of the entropy
(d) It introduces the concept of the internal energy

◆ Free expansion 4 Qs

21. In case of 'free expansion', which one of the following statements is 'WRONG'?
MHT CET 2026 · 20 MAY · SHIFT 1

(a) It is an instantaneous change.
(b) The system is not in thermodynamic equilibrium.
(c) Free expansion can be plotted in a p-v diagram.
(d) It is an uncontrolled change.

22. There is an expansion of a gas in a thermodynamic system. But this change cannot be plotted on a P-V diagram. Then it is
MHT CET 2026 · 19 MAY · SHIFT 1

(a) an isothermal expansion.
(b) a free expansion
(c) an adiabatic expansion
(d) an isobaric expansion

23. In thermodynamic process for free expansion, select the 'WRONG' statement out of the following options.
MHT CET 2026 · 18 APR · SHIFT 1

(a) Free expansions are adiabatic expansions and there is no exchange of heat between system and environment.
(b) A free expansion can be plotted on a p-V diagram.
(c) There is no work done on the system or by the system.
(d) It is an instantaneous change and the system is not in thermodynamic equilibrium.

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

24. In case of free expansion, which one of the following statements is WRONG?

MHT CET 2025 · 26 APR · SHIFT 1

(a) It is an instantaneous change.
(b) The system is not in thermodynamic equilibrium.
(c) Free expansion can be plotted on a P-V diagram.
(d) It is an uncontrolled change.

PHYSICS CIRCLE

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

TOPIC 07

Heat Engines, Refrigerators & Second Law

28 PYQs · Easy 28 · Medium 0 · Difficult 0 | MHT CET 8 · NEET 9 · JEE 11

Concepts covered: Heat engine & Carnot efficiency (25) · Refrigerators & COP (3)

LEVEL 1 · EASY 28 questions

◆ Heat engine & Carnot efficiency 25 Qs

1. A Carnot engine has an efficiency of 30%. The energy is supplied to the engine at the rate of 3 kW. The output power of the engine is

MHT CET 2026 · 19 MAY · SHIFT 2

(a) 100 W (b) 300 W (c) 900 W (d) 1200 W

2. An ideal gas heat engine operate in Carnot cycle between $327^{\circ}C$ and $227^{\circ}C$. It absorbs 6×10^4 cal of heat at higher temperature. How much is the amount of heat converted in to work?

MHT CET 2026 · 12 MAY · SHIFT 2

(a) $2 \times 10^4\ cal$ (b) $1 \times 10^4\ cal$
(c) $4 \times 10^4\ cal$ (d) $3 \times 10^4\ cal$

3. The efficiency of Carnot engine which operates between the two temperatures $T_1 = 500$ K and $T_2 = 300$ K is

MHT CET 2026 · 20 APR · SHIFT 2

(a) 75 % (b) 50 % (c) 25 % (d) 40 %

4. The first operation involved in a Carnot cycle is

MHT CET 2024 · 16 MAY · SHIFT 2

(a) isothermal expansion.
(b) adiabatic expansion.
(c) isothermal compression.
(d) adiabatic compression.

5. The first operation involved in a carnot cycle is

MHT CET 2024 · 2 MAY · SHIFT 2

(a) isothermal expansion.
(b) adiabatic expansion.
(c) isothermal compression.
(d) adiabatic compression.

6. A carnot engine operates with source at 227°C and sink at 27°C. If the source supplies 50 kJ of heat energy, the work done by the engine is

MHT CET 2023 · 13 MAY · SHIFT 2

(a) 2 kJ (b) 5 kJ (c) 10 kJ (d) 20 kJ

7. A Carnot engine has an efficiency of 50% when its source is at a temperature 327°C. The temperature of the sink is :-

NEET 2023

(a) 15°C (b) 100°C (c) 200°C (d) 27°C

8. The efficiency of a Carnot engine depends upon

NEET 2020 · PHASE 2

(a) the temperature of the source only
(b) the temperature of the sink only
(c) the temperatures of the source and sink
(d) the volume of the cylinder of the engine

9. The efficiency of an ideal heat engine working between the freezing point and boiling point of water, is

NEET 2018

(a) 26.8% (b) 20% (c) 6.25% (d) 12.5%

10. An ideal gas heat engine operates in Carnot cycle between 227oC and 127oC. It absorbs 6 × 104 cal of heat at higher temperature. Amount of heat converted to work is

AIPMT 2005

(a) 4.8 × 104 cal (b) 6 × 104 cal
(c) 2.4 × 104 cal (d) 1.2 × 104 cal.

11. Which of the following processes is reversible?

AIPMT 2005

(a) Transfer of heat by conduction
(b) Transfer of heat by radiation
(c) Isothermal compression
(d) Electrical heating of a nichrome wire.

12. An ideal gas heat engine operates in a Carnot cycle between 227oC and 127oC. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to

AIPMT 2003

(a) 4.8 (b) 3.5 (c) 1.6 (d) 1.2

13. A scientist says that the efficiency of his heat engine which work at source temperature 127oC and sink temperature 27oC is 26%, then

AIPMT 2001

(a) it is impossible
(b) it is possible but less probable
(c) it is quite probable
(d) data are incomplete.

14. The efficiency of a Carnot engine operating with reservoir temperature of 100°C and −23°C will be

AIPMT 1997

(a) $\frac{373+250}{373}$ (b) $\frac{373-250}{373}$
(c) $\frac{100+23}{100}$ (d) $\frac{100-23}{100}$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

15. Which of the following statements is correct for any thermodynamic system?
AIEEE 2004
(a) The change in entropy can never be zero
(b) Internal energy and entropy are state functions
(c) The internal energy changes in all processes
(d) The work done in an adiabatic process is always zero

16. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of:
AIEEE 2003
(a) second law of thermodynamics
(b) conservation of momentum
(c) conservation of mass
(d) first law of thermodynamics

17. Work done by a Carnot engine operating between temperatures $127^{\circ}C$ and $27^{\circ}C$ is 2 kJ. The amount of heat transferred to the engine by the reservoir is:
JEE MAIN 2023 · 8 APR · SHIFT 2 *(Not in current JEE/NEET syllabus)*
(a) 8 kJ (b) 2 kJ (c) 4 kJ (d) 2.67 kJ

18. A Carnot engine with efficiency 50% takes heat from a source at 600 K. In order to increase the efficiency to 70%, keeping the temperature of sink same, the new temperature of the source will be:
JEE MAIN 2023 · 25 JAN · SHIFT 1 *(Not in current JEE/NEET syllabus)*
(a) 300 K (b) 1000 K (c) 900 K (d) 360 K

19. A Carnot engine is operating between the two reservoirs of temperature $227\,^{\circ}C$ and $127\,^{\circ}C$ respectively. If the engine performs 1.04×10^5 J work per cycle. Then, the heat absorbed from hot reservoir per cycle will be:
JEE MAIN 2022 · 30 JUL · SHIFT 2 *(Not in current JEE/NEET syllabus)*
(a) 2.08×10^4 J (b) 1.04×10^5 J
(c) 5.20×10^5 J (d) 2.36×10^5 J

20. The efficiency of a Carnot's engine, working between steam point and ice point, will be:
JEE MAIN 2022 · 26 JUN · SHIFT 1 *(Not in current JEE/NEET syllabus)*
(a) 26.81% (b) 37.81% (c) 47.81% (d) 57.81%

21. A Carnot's engine working between 400 K and 800 K has a work output of 1200 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is:
JEE MAIN 2021 · 17 MAR · SHIFT 1 *(Not in current JEE/NEET syllabus)*
(a) 2400 J (b) 1600 J (c) 1800 J (d) 3200 J

22. Which statement is incorrect?
AIEEE 2002 *(Not in current JEE/NEET syllabus)*
(a) all reversible cycles have same efficiency
(b) reversible cycle has more efficiency than an irreversible one
(c) Carnot cycle is a reversible one
(d) Carnot cycle has the maximum efficiency in all cycles.

23. Even Carnot engine cannot give 100% efficiency because we cannot
AIEEE 2002 *(Not in current JEE/NEET syllabus)*
(a) prevent radiation
(b) find ideal sources
(c) reach absolute zero temperature
(d) eliminate friction.

24. For an ideal heat engine, the temperature of the source is 127° C. In order to have 60% efficiency the temperature of the sink should be _____ $^{\circ}$C. (Round off to the Nearest Integer)
JEE MAIN 2021 · 16 MAR · SHIFT 2 *(Numerical)* *(Not in current JEE/NEET syllabus)*

25. A Carnot engine operates between two reservoirs of temperatures 900 K and 300 K. The engine performs 1200 J of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is _____.
JEE MAIN 2020 · 7 JAN · SHIFT 1 *(Numerical)* *(Not in current JEE/NEET syllabus)*

◆ Refrigerators & COP 3 Qs

26. The relation between efficiency (η) of Carnot engine and coefficient of performance (η_1) of refrigerator is
MHT CET 2025 · 5 MAY · SHIFT 2
(a) $\eta = \frac{1}{1+\eta_1}$ (b) $\eta = \frac{1}{1-\eta_1}$
(c) $\eta = \frac{\eta_1}{1-\eta_1}$ (d) $\eta = \frac{1+\eta_1}{\eta_1}$

27. If α is the coefficient of performance of a refrigerator and ' Q ' is heat released to the hot reservoir, then the heat extracted from the cold reservoir ' Q_2 ' is
MHT CET 2019 · 2 MAY · SHIFT 1
(a) $\frac{\alpha Q_1}{\alpha-1}$ (b) $\frac{\alpha-1}{\alpha}Q_1$ (c) $\frac{\alpha Q_1}{1+\alpha}$ (d) $\frac{1+\alpha}{\alpha}Q_1$

28. The temperature inside a refrigerator is t2 oC and the room temperature is t1 oC. The amount of heat delivered to the room for each joule of electrical energy consumed ideally will be
NEET 2016 · PHASE 2
(a) $\frac{t_1}{t_1-t_2}$ (b) $\frac{t_1+273}{t_1-t_2}$ (c) $\frac{t_2+273}{t_1-t_2}$ (d) $\frac{t_1+t_2}{t_1+273}$

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying

ANSWER KEY

Shaded by level: **Easy**

01 Gas Laws & Ideal Gas Equation

1. (b)	2. (b)	3. (d)	4. (a)	5. (c)	6. (c)	7. (c)	8. (d)	9. (c)	10. (d)
11. (b)	12. (a)	13. (a)	14. (a)	15. (a)	16. (a)	17. (a)	18. (d)	19. (d)	20. (d)
21. 3730	22. 327	23. 250	24. (b)	25. (a)	26. (d)				

02 Degrees of Freedom & Internal Energy

1. (d)	2. (a)	3. (c)	4. (b)	5. (b)	6. (b)	7. (a)	8. (b)	9. (a)	10. (c)
11. 7479									

03 Specific Heats of Gases - Cp, Cv, γ & Mayer's Relation

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

04 Heat, Work & First Law of Thermodynamics

1. (d)	2. (c)	3. (b)	4. (b)	5. (b)	6. (b)	7. (b)	8. (d)	9. (b)	10. (c)

05 Thermodynamic Processes

1. (a)	2. (a)	3. (d)	4. (c)	5. (d)	6. (b)	7. (a)	8. (b)	9. (b)	10. (c)
11. (d)	12. (a)	13. (c)	14. (b)	15. (d)	16. (a)	17. (a)	18. (d)	19. (a)	20. (a)
21. (a)	22. (d)	23. (c)	24. (b)	25. (d)	26. (d)	27. (c)	28. 1	29. (b)	30. (a)
31. (b)	32. 1400	33. (c)	34. (c)	35. (a)	36. (d)	37. (a)	38. (d)	39. (c)	40. (d)
41. (a)	42. (b)	43. (b)	44. (c)	45. (a)	46. (d)	47. (c)	48. (d)	49. (b)	50. (b)
51. (c)	52. (c)	53. (b)	54. (b)	55. (d)	56. (d)	57. (d)	58. (b)	59. (b)	60. (d)
61. (c)	62. (c)	63. (d)	64. (b)	65. (b)					

06 P-V Diagrams & Cyclic Processes

1. (c)	2. (d)	3. (a)	4. (b)	5. (a)	6. (d)	7. (d)	8. (d)	9. (c)	10. (c)
11. (b)	12. (a)	13. (b)	14. (b)	15. (c)	16. (d)	17. (a)	18. (c)	19. (c)	20. (b,c)
21. (c)	22. (b)	23. (b)	24. (c)						

07 Heat Engines, Refrigerators & Second Law

1. (c)	2. (b)	3. (d)	4. (a)	5. (a)	6. (d)	7. (d)	8. (c)	9. (a)	10. (d)
11. (c)	12. (d)	13. (a)	14. (b)	15. (b)	16. (a)	17. (a)	18. (b)	19. (c)	20. (a)
21. (a)	22. (a)	23. (c)	24. -113	25. 600	26. (a)	27. (c)	28. (b)		

Note: *"Bonus" = no option is correct as the question is printed (dropped in the official key). Numerical questions show the numerical answer.*

© Physics Circle · Free sample from physicscircle.in · Not for sale or copying