

**PHY · PHYSICS**

07. Thermodynamics

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

© 51 Solved Questions

👤 2013 to 2024 Archive

🏛 Boards: BUMHS, DUHS, KMU, KU, MDCAT, NUMS

📄 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

SZABMU 2024

Which one of the following is the best condition for performing maximum work by any thermodynamic system? [SZABMU 2024]

- (A) Isobaric condition
- (B) Adiabatic condition
- (C) Isothermal condition
- (D) Isochoric condition

Q2.

SZABMU 2024

In an isothermal condition of any thermodynamic system, the change in internal energy: [SZABMU 2024]

- (A) Becomes maximum
- (B) Remains constant
- (C) Becomes zero
- (D) Becomes minimum but greater than zero

Q3.

SZABMU 2024

In which of the following condition, the thermodynamics system does not perform any work? [SZABMU 2024]

- (A) Isothermal condition
- (B) Adiabatic condition
- (C) Isochoric condition
- (D) Isobaric condition

Q4.

KU 2024

In an adiabatic process, how does the temperature of a gas change as its volume decreases? [KU 2024]

- (A) The temperature decreases
- (B) The temperature remains constant
- (C) The temperature first increases then decreases
- (D) The temperature increases

Q5.

KU 2024

During an isothermal expansion of an ideal gas, which of the following statement is true? [KU 2024]

- (A) The temperature of the gas remains constant
- (B) Pressure and temperature of the gas increase
- (C) The internal energy of the gas increases
- (D) The work done by the gas is zero

Q6.

KU 2024

Consider an ideal gas confined to the cylinder with a fixed position, on heating the gas, all the heat supplied increases [KU 2024]

- (A) Kinetic energy of the molecules
- (B) The intermolecular forces between gas molecules
- (C) Potential energy of the molecules
- (D) The number of gas molecules

Q7.

UHS 2024

During the isothermal process, the temperature [UHS 2024]

- (A) Remains constant during the initial phase of the process
- (B) Remains constant throughout the process
- (C) Increases throughout the process
- (D) Alters throughout the process

Q8.

UHS 2024

What is the value of heat (Q) in an adiabatic process? [UHS 2024]

- (A) +1
- (B) -1
- (C) 0
- (D) +2

Q9.

NUMS 2024

A process in which all the heat energy is used for increasing internal energy of the system is known as: [NUMS 2024]

- (A) Adiabatic
- (B) Isobaric
- (C) Isothermal
- (D) Isochoric

Q10.

BUMHS 2024

When a gas is expanded at constant temperature then it [BUMHS 2024]

- (A) Absorbs heat
- (B) None of these
- (C) Releases heat
- (D) Neither absorbs nor releases heat

Q11.

BUMHS 2024

Which of the following condition must be true for transfer of energy from an object at temperature T_1 to another object at temperature T_2 ? [BUMHS 2024]

- (A) $T_1 < T_2$
- (B) $T_1 = T_2$
- (C) None of these
- (D) $T_1 > T_2$

Q12.

BUMHS 2024

If heat equal to 0.1 J is provided to the gas contained in a cylinder and it expands through 0.1 m^3 at 1 N/m^2 then its internal energy: [BUMHS 2024]

- (A) Decreases by 0.1 J
- (B) Remains same
- (C) Increases
- (D) Decreases

Q13.

UHS 2023

For an ideal gas equation $PV = nRT$, the dimensions of real gas constant R are: [UHS 2023]

- (A) $[ML^{-2}T^{-1}K^{-1}]$
- (B) $[ML^2T^{-2}K^{-1}]$
- (C) $[ML^{-3}T^{-2}K^{-1}]$
- (D) $[ML^{-3}T^{-1}K^{-1}]$

Q14.

UHS 2023

First law of thermodynamics concerns with the conservation of [UHS 2023]

- (A) Energy
- (B) Work
- (C) Momentum
- (D) Heat

Q15.

UHS 2023

An ideal gas has molar specific heat C_p at constant pressure. When the temperature of n moles is increased by ΔT the increase in the internal energy is: [UHS 2023]

- (A) $nC_p\Delta T$
- (B) $n(C_p - R)\Delta T$
- (C) $n(C_p + R)\Delta T$
- (D) $n(2C_p + R)\Delta T$

Q16.

SZABMU 2023

The relation between C_p and C_v is given as: [SZABMU 2023]

- (A) $C_p + C_v = R$
- (B) $R - C_v = C_p$
- (C) $C_p - C_v = R$
- (D) $C_v - C_p = R$

Q17.

SZABMU 2023

The equation of 1st law of thermodynamics is:
[SZABMU 2023]

- (A) $Q = W$
- (B) $Q = \Delta U + W$
- (C) $W = Q + \Delta U$
- (D) $\Delta U = Q + W$

Q18.

SZABMU 2023

The thermodynamics process during which the pressure is kept constant is called: [SZABMU 2023]

- (A) Isobaric process
- (B) Isochoric process
- (C) Adiabatic process
- (D) Isothermal process

Q19.

KMU 2023

The expression, $C_p - R$ is equal to: [ETEA 2023]

- (A) $C_p - C_v$
- (B) $R + C_p$
- (C) C_v
- (D) R

Q20.

KMU 2023

In a certain process, 200 J of heat energy is supplied to a system and the same time 50 J of work is done by the system. The increase in the internal energy of the system is: [ETEA 2023]

- (A) 150 J
- (B) 250 J
- (C) 25 J
- (D) 100 J

Q21.

KMU 2023

Work done during isochoric process is: [ETEA 2023]

- (A) Zero
- (B) Maximum positive
- (C) Negative
- (D) Maximum negative

Q22.

DUHS 2023

Which law has a graph similar to the graph of isothermal process? [SINDH 2023]

- (A) Charle's law
- (B) Law of heat exchange
- (C) Avagadro's law
- (D) Boyle's law

Q23.

DUHS 2023

The property of the system that does not change during an adiabatic change [SINDH 2023]

- (A) Pressure
- (B) Amount of heat
- (C) Temperature
- (D) Volume

Q24.

DUHS 2023

The process in which no external work is performed is called: [SINDH 2023]

- (A) Adiabatic
- (B) Isobaric
- (C) Isochoric
- (D) Isothermal

Q25.

NUMS 2023

In isochoric process: [NUMS 2023]

- (A) Temperature is kept constant
- (B) Volume is kept constant
- (C) Exchange of heat is zero
- (D) Pressure is kept constant

Q26.

NUMS 2023

If 42 J heat is transferred to the system during expansion, what is the change in internal energy when work done is 32 J? [NUMS 2023]

- (A) 106 J
- (B) 10 J
- (C) 116 J
- (D) 74 J

Q27.

NUMS 2023

The 1st law of thermodynamic is the generalization of the law of conservation of: [NUMS 2023]

- (A) Energy
- (B) Momentum
- (C) Charge
- (D) Mass

Q28.

UHS 2022

Thermodynamics is that branch of Physics in which we study [UHS 2022]

- (A) Relations between heat and ionization energies
- (B) Relations between kinetic and potential energies
- (C) Relations between chemical and mechanical energies
- (D) Relations between heat and mechanical energies

Q29.

UHS 2022

When a gas is compressed isothermally, the product of its pressure and volume during the process is: **[UHS 2022]**

- (A) Proportional to entropy
- (B) Constant
- (C) Zero
- (D) Not constant

Q30.

UHS 2022

Temperature of given mass of a gas is changed from 150°C to 300°C during an isobaric process, volume of the gas will become: **[UHS 2022]**

- (A) Double
- (B) Half
- (C) Remains same
- (D) Less than double

Q31.

SZABMU 2022

The thermodynamic process during which volume of the system remains constant is called: **[SZABMU 2022]**

- (A) Isochoric
- (B) Isobaric
- (C) Adiabatic
- (D) Isothermal

Q32.

SZABMU 2022

The conditions for application of Boyle's law holds good in: **[SZABMU 2022]**

- (A) Isobaric process
- (B) Isothermal process
- (C) Adiabatic process
- (D) Isochoric process

Q33.

SZABMU 2022

The internal energy of a system during an isothermal process: **[SZABMU 2022]**

- (A) Remain constant
- (B) Decreases
- (C) Become zero
- (D) Increases

Q34.

SZABMU 2022

Two bodies A and B of temperature $T_A = 100^{\circ}\text{C}$ and $T_B = 0^{\circ}\text{C}$ are brought in thermal contact with each other. Which one in the followings is possible at thermal equilibrium? **[SZABMU 2022]**

- (A) $T_A = 0^{\circ}\text{C}, T_B = 100^{\circ}\text{C}$
- (B) $T_A = 60^{\circ}\text{C}, T_B = 50^{\circ}\text{C}$
- (C) $T_A = 60^{\circ}\text{C}, T_B = 40^{\circ}\text{C}$
- (D) $T_A = 45^{\circ}\text{C}, T_B = 45^{\circ}\text{C}$

Q35.

KMU 2022

In an isolated thermodynamic system: **[ETEA 2022]**

- (A) No dissipated energy and heat are transferred to the environment
- (B) Neither heat nor any mass are transferred to the environment
- (C) No mass transfers to the environment
- (D) No heat transfers to the environment

Q36.

BUMHS 2022

Thermal equilibrium in environment occurs due to: **[BMU 2022]**

- (A) Heat flow
- (B) Heat dissipation
- (C) Heat absorption
- (D) Heat generation

Q37.

DUHS 2022

Specific heat capacity of a gas is measured in: **[DUHS 2022]**

- (A) $\text{J kg}^{-1}\text{K}^{-1}$
- (B) J kg K^{-1}
- (C) $\text{J kg}^{-1}\text{K}$
- (D) $\text{J kg}^{\circ}\text{K}$

Q38.

DUHS 2022

First law of thermodynamics is mathematically represented as: **[DUHS 2022]**

- (A) $\Delta U = \Delta Q - \Delta W$
- (B) $\Delta Q = \Delta W - \Delta U$
- (C) $\Delta U = \Delta W - \Delta Q$
- (D) $\Delta W = \Delta Q + \Delta U$

Q39.

NUMS 2022

First law of thermodynamic is based on: **[NUMS 2022]**

- (A) Law of conservation of charge
- (B) Law of conservation of energy
- (C) Law of conservation of mass
- (D) Law of conservation of momentum

Q40.

NUMS 2022

The thermodynamics process during which the pressure is kept constant is called: [NUMS 2022]

- (A) Adiabatic process
- (B) Isothermal process
- (C) Isochoric process
- (D) Isobaric process

Q41.

PMDC 2021

$C_p - C_v$ value, find if 3 moles of gas is given [NMDCAT 2021]

- (A) 7R
- (B) 5R
- (C) 2R
- (D) 3R

Q42.

PMDC 2020

In which process the entire of heat supplied to the gas is converted to the internal energy of the gas? [NMDCAT 2020]

- (A) Adiabatic process
- (B) Isobaric process
- (C) Isothermal process
- (D) Isochoric process

Q43.

PMDC 2020

The internal energy of a system during an isothermal process: [NMDCAT 2020]

- (A) Decreases
- (B) Remain constant
- (C) Become zero
- (D) Increases

Q44.

NUMS 2020

In a certain process, 400J of heat energy is supplied to a system and at the same time 150J of work is done by the system. The increase in internal energy of system is [NUMS 2020]

- (A) 150J
- (B) 500J
- (C) 300J
- (D) 250J

Q45.

NUMS 2020

The rapid escape of air from a burst tyre is an example of: [NUMS 2020]

- (A) Isobaric
- (B) Isochoric
- (C) Adiabatic
- (D) Isothermal

Q46.

MDCAT 2019

The sum of all forms of molecular energies (kinetic and potential) of a substance is termed as? [MDCAT 2019]

- (A) Heat energy
- (B) Absolute energy
- (C) Internal energy
- (D) Elastic energy

Q47.

MDCAT 2018

If one mole of an ideal gas is heated at constant pressure, then the first law of thermodynamics can be written as: [MDCAT 2018]

- (A) $C_v \Delta T = C_p \Delta T + P \Delta T$
- (B) $C_p \Delta T = C_v \Delta T + V \Delta P$
- (C) $C_p \Delta T = C_v \Delta T + P \Delta V$
- (D) $\Delta C_v T = \Delta C_p T + P \Delta V$

Q48.

MDCAT 2018

If $C_v = \frac{5}{2}R$, C_p will be [MDCAT 2018]

- (A) $\frac{5}{5}R$
- (B) $\frac{7}{2}R$
- (C) $\frac{5}{2}R$
- (D) $\frac{2}{7}R$

Q49.

KMU 2018

The amount of heat required to raise the temperature of 10 moles of water from 70K to 80K (molar heat capacity of water 75.24J) is: [ETEA 2018]

- (A) 572.4J
- (B) 0.7524J
- (C) 95.24J
- (D) 7524J

Q50.

KMU 2014

The amount of heat required to raise the temperature of 1kg of substance through 1 K is called; [ETEA 2014]

- (A) Specific heat
- (B) One calorie
- (C) Heat capacity
- (D) 1 Joule

Q51.

MDCAT 2013

What is the factor upon which change in internal energy of an ideal gas depends? [MCAT 2013]

- ☐ (A) Change in volume
 - ☐ (B) Path followed to change internal energy
 - ☐ (C) Change in volume and temperature
 - ☐ (D) Change in temperature
-

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 07. Thermodynamics.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	A	SZABMU 2024	12	B	BUMHS 2024	23	B	DUHS 2023	34	D	SZABMU 2022	45	C	NUMS 2020
2	C	SZABMU 2024	13	B	UHS 2023	24	C	DUHS 2023	35	B	KMU 2022	46	C	MDCAT 2019
3	C	SZABMU 2024	14	A	UHS 2023	25	B	NUMS 2023	36	A	BUMHS 2022	47	C	MDCAT 2018
4	D	KU 2024	15	B	UHS 2023	26	B	NUMS 2023	37	A	DUHS 2022	48	B	MDCAT 2018
5	A	KU 2024	16	C	SZABMU 2023	27	A	NUMS 2023	38	A	DUHS 2022	49	D	KMU 2018
6	A	KU 2024	17	B	SZABMU 2023	28	D	UHS 2022	39	B	NUMS 2022	50	A	KMU 2014
7	B	UHS 2024	18	A	SZABMU 2023	29	B	UHS 2022	40	D	NUMS 2022	51	D	MDCAT 2013
8	C	UHS 2024	19	C	KMU 2023	30	D	UHS 2022	41	D	PMDC 2021			
9	D	NUMS 2024	20	A	KMU 2023	31	A	SZABMU 2022	42	D	PMDC 2020			
10	A	BUMHS 2024	21	A	KMU 2023	32	B	SZABMU 2022	43	B	PMDC 2020			
11	D	BUMHS 2024	22	D	DUHS 2023	33	A	SZABMU 2022	44	D	NUMS 2020			

TOTAL
MCQS

51

CORRECT

INCORRECT

BLANK

ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (A)

SZABMU 2024

Which one of the following is the best condition for performing maximum work by any thermodynamic system? [SZA...

1.

CORE CONCEPT AND DERIVATION

The mechanical work done by a gas expanding from V_1 to V_2 is exactly equal to the area under its curve on a Pressure–Volume (P–V) diagram.

2. Formula:

$$W = \int_{V_1}^{V_2} P dV$$

3. Solution:

- In an Isobaric expansion, pressure remains constantly high at its maximum initial value, generating a rectangular area ($P \times \Delta V$).
- In Isothermal expansion, pressure slowly drops as volume increases, creating a curved area smaller than the rectangle.
- In Adiabatic expansion, pressure drops even more steeply, yielding the smallest area.
- Therefore, for given identical volume limits, the Isobaric process yields the maximum mathematical area, and thus maximum work.

4. Why other options are incorrect:

Isochoric process produces exactly zero work. Isothermal and adiabatic processes produce progressively less work due to dropping pressures.

Question #2 Key: (C)

SZABMU 2024

In an isothermal condition of any thermodynamic system, the change in internal energy: [SZABMU 2024]

1.

CORE CONCEPT AND DERIVATION

The internal energy of an ideal gas is a strict function of its temperature. If the temperature does not change, neither does the internal energy.

2. Formula:

$$\Delta U = nC_v \Delta T$$

3. Solution:

- An isothermal condition mandates that temperature remains exactly constant throughout the entire expansion or compression.
- Therefore, the change in temperature is zero ($\Delta T = 0$).
- Substituting this into the energy formula, the CHANGE in internal energy ΔU becomes mathematically exactly zero.

4. Why other options are incorrect:

While the total absolute internal energy U remains constant, the question specifically asks for the *change* in internal energy (ΔU), which is strictly zero.

Question #3 Key: (C)

SZABMU 2024

In which of the following condition, the thermodynamics system does not perform any work? [SZABMU 2024]

1.

CORE CONCEPT AND DERIVATION

In physics, thermodynamic work requires a spatial change. Without a change in boundary (volume), no physical work can be transferred to the environment.

2. Formula:

$$W = P\Delta V$$

3. Solution:

- To perform zero work, the formula requires $\Delta V = 0$.
- A process where the volume is artificially or physically locked (such as heating a gas inside a thick, unyielding metal sphere) guarantees $\Delta V = 0$.
- This rigidly constrained process is officially termed an Isochoric condition.

4. Why other options are incorrect:

All other listed processes (isothermal, isobaric, adiabatic) inherently involve a changing volume, meaning they mathematically will produce non-zero work.

Question #4 Key: (D)

KU 2024

In an adiabatic process, how does the temperature of a gas change as its volume decreases? [KU 2024]

1.

CORE CONCEPT AND DERIVATION

In an adiabatic process, the system is perfectly insulated so no heat escapes. Any work done ON the system directly compresses the gas and fuels an increase in internal energy.

2. Formula:

$$W_{\text{on system}} = \Delta U \implies T \propto U$$

3. Solution:

- When volume decreases (compression), the environment is physically doing work ON the gas.
- Because no heat can escape to the surroundings ($Q = 0$), all of this mechanical energy is absorbed entirely into the internal kinetic energy of the gas molecules.
- An increase in internal kinetic energy directly manifests as an increase in the absolute temperature of the gas.

4. Why other options are incorrect:

Temperature decreases only during an adiabatic expansion (volume increases). It cannot remain constant unless it is an isothermal process.

Question #5 **Key: (A)**

KU 2024

During an isothermal expansion of an ideal gas, which of the following statement is true? [KU 2024]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic nomenclature strictly dictates the physical parameters of the process. 'Isothermal' directly defines the thermal state.

2. Formula:

$$\Delta T = 0$$

3. Solution:

- The prefix 'iso' denotes equality or constancy. 'Thermal' relates to temperature.
- Therefore, by strict definition, an isothermal expansion occurs in such a slow, heat-exchanging manner that the temperature of the gas is maintained absolutely constant.

4. Why other options are incorrect:

In isothermal expansion, pressure drops (not increases), work is definitely done (not zero), and internal energy remains constant (does not increase).

Question #6 **Key: (A)**

KU 2024

Consider an ideal gas confined to the cylinder with a fixed position, on heating the gas, all the heat supplie...

1.

CORE CONCEPT AND DERIVATION

A 'fixed position' piston creates an Isochoric (constant volume) process. Furthermore, an 'ideal gas' has no intermolecular forces, meaning it possesses zero potential energy.

2. Formula:

$$Q = \Delta U \quad (\text{where } U = K.E_{\text{translational}})$$

3. Solution:

- Because the volume is fixed, work done is zero ($W = 0$). Thus, First Law states $Q = \Delta U$.
- All supplied heat goes directly into increasing the internal energy.
- By the kinetic theory of gases, the internal energy of a purely ideal gas consists exclusively of the translational kinetic energy of its molecules.

4. Why other options are incorrect:

An ideal gas is theoretically defined as having absolutely no intermolecular forces, therefore zero potential energy. Heating a gas cannot create new molecules.

Question #7 Key: (B)

UHS 2024

During the isothermal process, the temperature [UHS 2024]

1.

CORE CONCEPT AND DERIVATION

An isothermal process is defined by strict thermal equilibrium with a massive external heat reservoir, ensuring the system's temperature never drifts.

2. Formula:

$$T(t) = \text{constant}$$

3. Solution:

- For a process to be mathematically classified as isothermal, the temperature T must not vary at any singular moment.
- The heat reservoir actively supplies or removes heat exactly as needed throughout the entire duration of the volume change to strictly hold T constant from start to finish.

4. Why other options are incorrect:

If temperature alters or only remains constant initially, the mathematical integration for isothermal work ($W = nRT \ln(V_2/V_1)$) becomes invalid. It must be constant the entire time.

Question #8 Key: (C)

UHS 2024

What is the value of heat (Q) in an adiabatic process? [UHS 2024]

1.

CORE CONCEPT AND DERIVATION

The cornerstone definition of an adiabatic thermodynamic process is absolute thermal isolation from the surrounding environment.

2. Formula:

$$Q = 0$$

3. Solution:

- In an adiabatic process, the boundary of the system is considered perfectly insulated (like a perfect thermos flask).
- Because no heat can permeate this boundary, the net heat transfer entering or leaving the system is strictly zero.
- Consequently, $Q = 0$.

4. Why other options are incorrect:

Values like +1, -1, or +2 imply a finite, quantifiable heat transfer, which directly contradicts the physical definition of 'adiabatic'.

Question #9 Key: (D)

NUMS 2024

A process in which all the heat energy is used for increasing internal energy of the system is known as: [NUMS...]

1.

CORE CONCEPT AND DERIVATION

If all incoming heat strictly increases internal energy, it means none of the energy is being spent performing mechanical work on the environment.

2. Formula:

$$Q = \Delta U + W \implies Q = \Delta U \text{ if } W = 0$$

3. Solution:

- For work to be absolute zero, the system's boundary must not move (i.e., volume remains perfectly constant).
- A process occurring strictly at constant volume is formally termed an Isochoric process.
- Therefore, in an isochoric heating process, 100% of the input heat converts into internal kinetic energy.

4. Why other options are incorrect:

In isobaric, part of the heat does work. In isothermal, all heat does work. In adiabatic, no heat enters at all.

Question #10 Key: (A)

BUMHS 2024

When a gas is expanded at constant temperature then it [BUMHS 2024]

1.

CORE CONCEPT AND DERIVATION

During an expansion, a gas uses its own internal energy to push outward against external pressure. If it wants to maintain a constant temperature, it must replenish that lost energy.

2. Formula:

$$\Delta U = 0 \implies Q = W$$

3. Solution:

- An expansion strictly means work is done BY the gas ($W > 0$).
- Since the temperature is rigidly constant (isothermal), internal energy cannot change ($\Delta U = 0$).
- Applying the First Law: $Q = 0 + W$. Since W is positive, Q must be positive.
- A positive Q indicates that the gas actively absorbs heat from the thermal reservoir to compensate for the work it is doing.

4. Why other options are incorrect:

If it released heat or absorbed nothing, its internal energy would plummet during expansion, causing a massive drop in temperature, violating the isothermal constraint.

Question #11 Key: (D)

BUMHS 2024

Which of the following condition must be true for transfer of energy from an object at temperature [Formula] t...

1.

CORE CONCEPT AND DERIVATION

The Second Law of Thermodynamics (Clausius statement) dictates the absolute natural direction of spontaneous heat flow.

2. Formula:

$$Q_{\text{spontaneous}} \rightarrow \text{from High } T \text{ to Low } T$$

3. Solution:

- Heat energy inherently flows down a thermal gradient, much like water flowing downhill.
- For heat to naturally transfer from Object 1 to Object 2, Object 1 MUST possess a higher average kinetic temperature than Object 2.
- Therefore, the absolute required mathematical condition is $T_1 > T_2$.

4. Why other options are incorrect:

If $T_1 = T_2$, they are in thermal equilibrium and net heat transfer is exactly zero. If $T_1 < T_2$, heat would naturally flow in the reverse direction (from 2 to 1).

Question #12 Key: (B)

BUMHS 2024

If heat equal to 0.1 J is provided to the gas contained in a cylinder and it expands through [Formula] at [For...

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics dictates that the change in a system's internal energy is the difference between the heat added to it and the mechanical work it performs on its surroundings.

2. Formula:

$$W = P\Delta V \quad \text{and} \quad \Delta U = Q - W$$

3. Solution:

- First, calculate the mechanical work done by the gas during expansion: $W = P \times \Delta V$.
- Substitute the given values: $W = (1 \text{ N/m}^2) \times (0.1 \text{ m}^3) = 0.1 \text{ Joules}$.
- Next, apply the First Law of Thermodynamics. The heat provided to the gas is $Q = +0.1 \text{ J}$.
- Calculate the change in internal energy: $\Delta U = 0.1 \text{ J} - 0.1 \text{ J} = 0 \text{ J}$.
- Since the net change in internal energy is exactly zero, the internal energy strictly **remains the same**.

4. Why other options are incorrect:

If a student incorrectly added the work instead of subtracting it (assuming work was done ON the gas instead of BY the gas), they would get an increase of 0.2 J. If they ignored the work entirely, they would assume it increases by 0.1 J. Proper sign convention is required to see they cancel out perfectly.

Question #13 Key: (B)

UHS 2023

For an ideal gas equation [Formula], the dimensions of real gas constant R are: [UHS 2023]

1.

CORE CONCEPT AND DERIVATION

Dimensional analysis is used to find the base SI units of a constant by isolating it in a known physical equation.

2. Formula:

$$R = \frac{PV}{nT}$$

3. Solution:

- The product of Pressure and Volume (PV) has the exact same dimensions as Energy or Work (Joules).
- The dimension of Energy is $[ML^2T^{-2}]$.
- Temperature (T) has the dimension of $[K]$. Moles (n) are dimensionless or defined as $[mol]$, but often omitted in basic dimensional brackets.
- Dividing Energy by Temperature yields: $[ML^2T^{-2}K^{-1}]$.

4. Why other options are incorrect:

Other dimensional formulas represent incorrect physics, such as dividing by volume instead of multiplying (yielding negative length dimensions).

Question #14 Key: (A)

UHS 2023

First law of thermodynamics concerns with the conservation of [UHS 2023]

1.

CORE CONCEPT AND DERIVATION

The First Law explicitly states that the total energy of an isolated system remains strictly constant; it only changes physical forms.

2. Formula:

$$\Delta U = Q - W$$

3. Solution:

- The law mathematically accounts for all energy entering or leaving a thermodynamic system.
- It states that heat is a form of energy transfer, which converts into internal energy and mechanical work, proving energy is conserved.

4. Why other options are incorrect:

Work and Heat are merely specific forms of energy transfer; they are not conserved individually (e.g., work can convert entirely to heat). It is total Energy that is conserved.

Question #15 Key: (B)

UHS 2023

An ideal gas has molar specific heat [Formula] at constant pressure. When the temperature of n moles is increa...

1.

CORE CONCEPT AND DERIVATION

The change in internal energy of an ideal gas strictly relies on its molar specific heat at constant volume (C_v), regardless of the thermodynamic process it undergoes.

2. Formula:

$$\Delta U = nC_v\Delta T \quad \text{and} \quad C_p - C_v = R$$

3. Solution:

- We know internal energy depends on C_v , so $\Delta U = nC_v\Delta T$.
- Using Mayer's relation, we can express C_v in terms of C_p :
 $C_v = C_p - R$.
- Substituting this back into the internal energy equation gives: $\Delta U = n(C_p - R)\Delta T$.

4. Why other options are incorrect:

Option $nC_p\Delta T$ represents the total heat supplied (Q) at constant pressure, not just internal energy. Other options use incorrect mathematical variations of Mayer's relation.

Question #16 Key: (C)

SZABMU 2023

The relation between [Formula] and [Formula] is given as: [SZABMU 2023]

1.

CORE CONCEPT AND DERIVATION

Mayer's relation dictates that a gas heated at constant pressure requires more heat to raise its temperature than at constant volume because extra energy is needed to do expansion work against atmospheric pressure.

2. Formula:

$$C_p = C_v + R$$

3. Solution:

- C_p (heat capacity at constant pressure) must account for both internal energy and work done.
- C_v (heat capacity at constant volume) only accounts for internal energy.
- The difference is exactly the work done per mole per Kelvin, which is the universal gas constant R .
- Thus, algebraically: $C_p - C_v = R$.

4. Why other options are incorrect:

$C_v - C_p = R$ would falsely imply that C_v is larger. Adding them together has no physical thermodynamic significance.

Question #17 Key: (B)

SZABMU 2023

The equation of [Formula] law of thermodynamics is: [SZABMU 2023]

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics serves as the energy conservation ledger for thermal systems, tracking heat input, energy storage, and work output.

2. Formula:

$$Q = \Delta U + W$$

3. Solution:

- By standard convention (where work done BY the gas is positive), the heat energy supplied to the system (Q) serves two simultaneous purposes:
- First, it increases the kinetic energy of the molecules, thus raising the internal energy (ΔU).
- Second, any remaining energy pushes the piston outward, performing mechanical work (W) on the environment.
- Therefore, the total input equals the sum of the outcomes:
 $Q = \Delta U + W$.

4. Why other options are incorrect:

Equations like $W = Q + \Delta U$ would violate energy conservation by suggesting work output is greater than heat input when internal energy also increases.

Question #18 Key: (A)

SZABMU 2023

The thermodynamics process during which the pressure is kept constant is called: [SZABMU 2023]

1.

CORE CONCEPT AND DERIVATION

A thermodynamic process that involves changing state variables (V, T) while explicitly maintaining a constant pressure constraint is known as an isobaric process.

2. Formula:

$$P = \text{constant} \implies \Delta P = 0$$

3. Solution:

- 'Iso' stands for equal/constant. 'Baric' refers to pressure (originating from 'baros' meaning weight, related to barometers).
- When a gas expands but the external pressure (like a freely moving piston under constant atmospheric weight) doesn't change, the process is Isobaric.

4. Why other options are incorrect:

Isochoric means constant volume. Isothermal means constant temperature. Adiabatic means zero heat exchange.

Question #19 Key: (C)

KMU 2023

The expression, [Formula] is equal to: [ETEA 2023]

1.

CORE CONCEPT AND DERIVATION

Mayer's equation establishes the absolute mathematical relationship between the specific heats of ideal gases.

2. Formula:

$$C_p - C_v = R$$

3. Solution:

- Start with the standard equation: $C_p - C_v = R$.
- The question asks for the equivalent of $C_p - R$.
- By algebraically rearranging the terms (subtracting R from both sides and adding C_v to both sides), we yield: $C_p - R = C_v$.

4. Why other options are incorrect:

All other options fail simple algebraic rearrangement. R is the difference itself, not the resulting specific heat.

Question #20 Key: (A)

KMU 2023

In a certain process, 200J of heat energy is supplied to a system and the same time 50 J of work is done by th...

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics tracks energy conservation. Net energy stored in the system is the energy added minus the energy expelled as work.

2. Formula:

$$\Delta U = Q - W$$

3. Solution:

- Given heat supplied to the system, $Q = +200 \text{ J}$.
- Given work done by the system, $W = +50 \text{ J}$.
- Substitute into the First Law: $\Delta U = 200 - 50$.
- The resulting increase in internal energy is 150 J.

4. Why other options are incorrect:

Adding 200 and 50 yields 250J (incorrectly assuming work was done ON the system). Other answers result from arbitrary division or ignoring the work completely.

Question #21 **Key: (A)**

KMU 2023

Work done during isochoric process is: [ETEA 2023]

1.

CORE CONCEPT AND DERIVATION

In thermodynamics, physical work is only accomplished when a boundary is moved against a force, which manifests as a change in volume.

2. Formula:

$$W = P\Delta V$$

3. Solution:

- An isochoric process strictly means the volume remains perfectly constant throughout the state change.
- Mathematically, this means the change in volume $\Delta V = 0$.
- Substituting this into the work equation yields $W = P(0) = 0$.
- Thus, absolutely zero work is done.

4. Why other options are incorrect:

Work cannot be positive or negative if the piston physically does not move. Maximum work is typically associated with isobaric processes (for the same volume expansion limits).

Question #22 **Key: (D)**

DUHS 2023

Which law has a graph similar to the graph of isothermal process? [SINDH 2023]

1.

CORE CONCEPT AND DERIVATION

The visual representation (P-V graph) of a thermodynamic process is governed by its mathematical proportionality.

2. Formula:

$$PV = \text{constant} \quad (\text{Isothermal})$$

3. Solution:

- An isothermal process operates at a strictly constant temperature.
- Boyle's Law states that at a constant temperature, Pressure and Volume are inversely proportional ($P \propto \frac{1}{V}$).
- Both an isothermal process and Boyle's Law mathematically graph as a hyperbola (a downward curving line) on a P-V diagram.

4. Why other options are incorrect:

Charles's Law graphs as a straight line (V directly proportional to T). Avogadro's Law relates V and n (straight line). Neither matches the hyperbolic curve of an isothermal expansion.

Question #23 **Key: (B)**

DUHS 2023

The property of the system that does not change during an adiabatic change [SINDH 2023]

1.

CORE CONCEPT AND DERIVATION

An adiabatic process is strictly defined by extreme thermal insulation or extremely rapid expansion/compression, completely preventing heat exchange.

2. Formula:

$$\Delta Q = 0$$

3. Solution:

- Because the boundary is perfectly insulated, thermal energy (heat) can neither enter nor escape the system.
- Therefore, the total amount of heat (Q) transferred remains zero; the heat content is unchanged from outside sources.
- In contrast, because work is done, the internal energy, temperature, pressure, and volume all dynamically change.

4. Why other options are incorrect:

In an adiabatic compression, work is done ON the gas, so volume decreases, pressure spikes, and temperature rises. Only the heat transfer strictly remains zero.

Question #24 **Key: (C)**

DUHS 2023

The process in which no external work is performed is called: [SINDH 2023]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic work is strictly the product of external pressure and the change in the physical boundaries (volume) of the system.

2. Formula:

$$W = P\Delta V$$

3. Solution:

- For work to be absolute zero, one of the components of the work equation must be zero.
- Since absolute pressure P of a gas is never zero, the volume change ΔV must be zero.
- A process where $\Delta V = 0$ is termed an Isochoric process (constant volume).

4. Why other options are incorrect:

Isothermal, isobaric, and adiabatic processes all permit the volume of the gas to expand or compress, meaning external work is definitively performed in all of them.

Question #25 Key: (B)

NUMS 2023

In isochoric process: [NUMS 2023]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic process names reflect the specific physical parameter that is rigidly locked in place during the state change.

2. Formula:

$$\Delta V = 0$$

3. Solution:

- 'Iso' means constant.
- 'Choric' derives from the Greek 'chora', meaning space or volume.
- Therefore, an Isochoric process is one where the volume of the system is forced to be kept strictly constant, usually by heating a gas in a sealed, rigid steel container.

4. Why other options are incorrect:

Constant pressure describes an isobaric process. Constant temperature describes an isothermal process. Zero heat exchange describes an adiabatic process.

Question #26 Key: (B)

NUMS 2023

If 42 J heat is transferred to the system during expansion, what is the change in internal energy when work do...

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics operates as an energy balance sheet: Energy In (Heat) minus Energy Out (Work) equals Energy Stored (Internal Energy).

2. Formula:

$$\Delta U = Q - W$$

3. Solution:

- Heat transferred INTO the system is positive: $Q = +42 \text{ J}$.
- Work done BY the system during expansion is positive: $W = +32 \text{ J}$.
- Apply the equation: $\Delta U = 42 - 32$.
- The net change in internal energy is $\Delta U = +10 \text{ J}$.

4. Why other options are incorrect:

Adding the numbers yields 74 J, which incorrectly assumes work was done ON the system (compression) rather than BY the system (expansion).

Question #27 **Key: (A)**

NUMS 2023

The [Formula] law of thermodynamic is the generalization of the law of conservation of: [NUMS 2023]

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics bridges the gap between mechanics and thermal physics by proving that heat is simply another transferable form of energy.

2. Formula:

$$\Delta U = Q - W$$

3. Solution:

- Before this law, heat and mechanical work were thought to be completely separate entities.
- The First Law dictates that the total energy (accounting for both heat and work) in an isolated universe remains strictly constant.
- Thus, it is the direct thermal generalization of the universal Law of Conservation of Energy.

4. Why other options are incorrect:

Conservation of momentum applies strictly to forces and collisions. Conservation of charge applies to electromagnetism. Thermodynamics inherently deals with energy.

Question #28 **Key: (D)**

UHS 2022

Thermodynamics is that branch of Physics in which we study [UHS 2022]

1.

CORE CONCEPT AND DERIVATION

Thermodynamics is fundamentally the study of heat, work, temperature, and energy dynamics. The term itself combines 'thermo' (heat) and 'dynamics' (mechanical power/motion).

2. Formula:

$$W = JQ \text{ (Mechanical equivalent of heat)}$$

3. Solution:

- The primary focus of classical thermodynamics is understanding how thermal energy (heat) is converted to and from other forms of energy, particularly mechanical energy (work).
- This is perfectly described by the First and Second Laws of Thermodynamics.

4. Why other options are incorrect:

Kinetic/potential energy is classical mechanics. Chemical energy is thermochemistry. Ionization energy belongs to atomic physics.

Question #29 Key: (B)

UHS 2022

When a gas is compressed isothermally, the product of its pressure and volume during the process is: [UHS 2022...]

1.

CORE CONCEPT AND DERIVATION

According to Boyle's Law, for a fixed mass of an ideal gas kept at a steady temperature, the pressure is inversely proportional to the volume.

2. Formula:

$$PV = \text{constant}$$

3. Solution:

- An isothermal compression means temperature T remains completely unchanged.
- Based on the ideal gas law $PV = nRT$, since n , R , and T are all constants, their product nRT must be a constant.
- Consequently, the product of pressure and volume (PV) remains constant throughout the entire compression.

4. Why other options are incorrect:

The product cannot be zero because matter exists ($P, V > 0$). It is strictly constant as dictated by the ideal gas equation, not variable.

Question #30 Key: (D)

UHS 2022

Temperature of given mass of a gas is changed from [Formula] to [Formula] during an isobaric process, volume o...

1.

CORE CONCEPT AND DERIVATION

Charles's Law dictates that at constant pressure, volume is directly proportional to absolute temperature (Kelvin), NOT Celsius.

2. Formula:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

3. Solution:

- Convert initial temperature to Kelvin: $T_1 = 150 + 273 = 423 \text{ K}$.
- Convert final temperature to Kelvin: $T_2 = 300 + 273 = 573 \text{ K}$.
- The ratio $\frac{T_2}{T_1} = \frac{573}{423} \approx 1.35$.
- Since $V_2 = 1.35V_1$, the volume increases but does not double. It is strictly less than double.

4. Why other options are incorrect:

A common student error is to look at 150°C and 300°C and assume the temperature doubled. Thermodynamics requires all ratios to be computed in absolute Kelvin.

Question #31 Key: (A)

SZABMU 2022

The thermodynamic process during which volume of the system remains constant is called: [SZABMU 2022]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic processes are named based on the property that remains rigid or unchanging throughout the physical transformation.

2. Formula:

$$\Delta V = 0 \implies W = 0$$

3. Solution:

- The prefix 'iso-' means equal or constant.
- The suffix '-choric' pertains to space or volume.
- Therefore, an Isochoric process is defined strictly as a thermodynamic change where the container's volume remains completely unchanged.

4. Why other options are incorrect:

Isobaric means constant pressure. Isothermal means constant temperature. Adiabatic means zero heat transfer.

Question #32 Key: (B)

SZABMU 2022

The conditions for application of Boyle's law holds good in: [SZABMU 2022]

1.

CORE CONCEPT AND DERIVATION

Boyle's Law states that the pressure of a given mass of an ideal gas is inversely proportional to its volume, provided the temperature remains absolutely constant.

2. Formula:

$$P \propto \frac{1}{V} \quad (\text{at constant } T)$$

3. Solution:

- Because Boyle's law strictly requires a constant temperature to be mathematically valid ($PV = \text{constant}$), the thermodynamic environment must enforce this.
- A process that maintains a constant temperature is defined as an isothermal process.

4. Why other options are incorrect:

Isobaric processes enforce constant pressure (Charles's Law). Isochoric processes enforce constant volume (Gay-Lussac's Law). Adiabatic processes allow temperature to fluctuate.

Question #33 Key: (A)

SZABMU 2022

The internal energy of a system during an isothermal process:
[SZABMU 2022]

1.

CORE CONCEPT AND DERIVATION

For an ideal gas, internal energy is purely a function of its absolute kinetic temperature. If the temperature does not change, the internal kinetic energy cannot change.

2. Formula:

$$\Delta U = nC_v \Delta T$$

3. Solution:

- An isothermal process is characterized by $\Delta T = 0$.
- Plugging this into the internal energy equation yields $\Delta U = 0$.
- Because the change is zero, the total internal energy remains constant throughout the entire process.

4. Why other options are incorrect:

Internal energy cannot decrease or increase unless the temperature changes. It cannot become zero unless the gas reaches absolute zero (0 K), which is not the case for a standard isothermal process.

Question #34 Key: (D)

SZABMU 2022

Two bodies A and B of temperature [Formula] and [Formula] are brought in thermal contact with each other. Whic...

1.

CORE CONCEPT AND DERIVATION

According to the Zeroth Law of Thermodynamics, two systems in thermal contact will exchange heat until they reach thermal equilibrium, at which point their temperatures must be exactly equal.

2. Formula:

$$T_A = T_B = T_{\text{equilibrium}}$$

3. Solution:

- Heat will flow from the hotter body (A) to the colder body (B).
- This flow continues until the temperatures equalize.
- Looking at the options, the only mathematical state where T_A exactly equals T_B is 45°C . The specific final value depends on mass and specific heat, but equality is strictly required.

4. Why other options are incorrect:

Options with unequal temperatures signify that thermal equilibrium has not yet been reached and heat is still flowing.

Question #35 **Key: (B)**

KMU 2022

In an isolated thermodynamic system: [ETEA 2022]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic systems are classified by their boundaries. An 'isolated' system represents the most restrictive boundary possible in physics.

2. Formula:

$$\Delta m = 0 \quad \text{and} \quad Q = 0, W = 0$$

3. Solution:

- An OPEN system allows both mass and energy to cross its boundaries.
- A CLOSED system allows energy (heat/work) to cross, but mass is blocked.
- An ISOLATED system is completely sealed: absolutely no mass can escape, and absolutely no energy (neither heat nor work) can cross the boundary.

4. Why other options are incorrect:

Saying 'no heat transfers' only describes an adiabatic or closed system. Saying 'no mass transfers' only describes a closed system. Only 'neither heat nor mass' accurately defines total isolation.

Question #36 **Key: (A)**

BUMHS 2022

Thermal equilibrium in environment occurs due to: [BMU 2022]

1.

CORE CONCEPT AND DERIVATION

Thermal equilibrium is achieved when two regions in thermal contact cease to have a net exchange of thermal energy, meaning they have reached the exact same temperature.

2. Formula:

$$\Delta Q = mc\Delta T$$

3. Solution:

- If there is a temperature gradient in an environment, nature seeks balance.
- This balance is achieved through the physical flow of heat from the higher temperature region to the lower temperature region.
- Therefore, it is the fundamental mechanism of 'heat flow' that eventually neutralizes the gradient, resulting in equilibrium.

4. Why other options are incorrect:

Heat generation actively disrupts equilibrium. Absorption and dissipation are singular viewpoints of the mechanism; 'heat flow' encompasses the entire interactive transfer process.

Question #37 **Key: (A)**

DUHS 2022

Specific heat capacity of a gas is measured in: [DUHS 2022]

1.

CORE CONCEPT AND DERIVATION

Specific heat capacity determines how much thermal energy is required to raise the temperature of one unit of mass by one unit of absolute temperature.

2. Formula:

$$c = \frac{Q}{m\Delta T}$$

3. Solution:

- Look at the units in the formula: Q is in Joules (J).
- Mass m is in kilograms (kg).
- Temperature change ΔT is in Kelvin (K).
- Combining these gives: $\frac{\text{J}}{\text{kg}\cdot\text{K}}$, which is mathematically written as $\text{J kg}^{-1}\text{K}^{-1}$.

4. Why other options are incorrect:

Other options have incorrect inverse signs (e.g., placing mass in the numerator rather than denominator) or use inappropriate degrees for Kelvin.

Question #38 **Key: (A)**

DUHS 2022

First law of thermodynamics is mathematically represented as: [DUHS 2022]

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics is the law of conservation of energy applied to thermal systems, balancing heat, internal energy, and work.

2. Formula:

$$\Delta Q = \Delta U + \Delta W$$

3. Solution:

- The standard sign convention equation states that heat added to a system (ΔQ) causes a change in internal energy (ΔU) and does work on the surroundings (ΔW).
- Rearranging this algebraically to isolate internal energy gives: $\Delta U = \Delta Q - \Delta W$.

4. Why other options are incorrect:

The other equations fail basic algebraic rearrangement of the First Law or imply incorrect physical phenomena (like work generating heat without changing internal energy).

Question #39 **Key: (B)**

NUMS 2022

First law of thermodynamic is based on: [NUMS 2022]

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics establishes that energy can be transformed from one form to another, but can be neither created nor destroyed.

2. Formula:

$$\Delta Q = \Delta U + \Delta W$$

3. Solution:

- The equation states that whatever thermal energy is added to the system must exactly equal the energy stored within the molecules plus the mechanical energy expended as work.
- This is a direct, macroscopic manifestation of the universal Principle of Conservation of Energy.

4. Why other options are incorrect:

Thermodynamics does not strictly govern particle charge, mass creation (outside nuclear physics), or mechanical momentum in this specific context.

Question #40 **Key: (D)**

NUMS 2022

The thermodynamics process during which the pressure is kept constant is called: [NUMS 2022]

1.

CORE CONCEPT AND DERIVATION

Different thermodynamic processes are characterized by the state variable (P, V, T, Q) that is artificially or naturally constrained to remain unchanged.

2. Formula:

$$\Delta P = 0$$

3. Solution:

- The prefix 'iso-' means equal or unchanged.
- The root 'baric' relates to pressure (e.g., barometer, bars).
- Therefore, a process strictly operating under a fixed, constant pressure is termed an Isobaric process.

4. Why other options are incorrect:

Isochoric locks volume. Isothermal locks temperature. Adiabatic locks heat transfer. None of these guarantee constant pressure.

Question #41 Key: (D)

PMDC 2021

[Formula] value, find if 3 moles of gas is given [NMDCAT 2021]

1.

CORE CONCEPT AND DERIVATION

The difference between the total heat capacity at constant pressure and constant volume for 'n' moles of an ideal gas equals nR .

2. Formula:

$$C_p - C_v = nR$$

3. Solution:

- The standard molar specific heat relation is $c_p - c_v = R$ (for 1 mole).
- The question refers to the total heat capacities C_p and C_v for 3 moles of the gas.
- By substituting $n = 3$ into the extensive property relation, we get $C_p - C_v = 3R$.

4. Why other options are incorrect:

Options like $2R$, $5R$, or $7R$ are purely distractor values and do not map to the number of moles provided in the question stem.

Question #42 Key: (D)

PMDC 2020

In which process the entire of heat supplied to the gas is converted to the internal energy of the gas? [NMDCA...]

1.

CORE CONCEPT AND DERIVATION

If a gas is heated in a rigid container, its volume cannot change. Since work done is pressure multiplied by the change in volume, zero volume change means zero work done.

2. Formula:

$$Q = \Delta U + W$$

3. Solution:

- In an isochoric process, volume is constant ($\Delta V = 0$).
- Work done $W = P\Delta V = 0$.
- Applying the First Law of Thermodynamics: $Q = \Delta U + 0$.
- Therefore, all heat supplied (Q) increases the internal energy (ΔU).

4. Why other options are incorrect:

In isothermal, all heat converts to work. In isobaric, heat splits into internal energy and work. In adiabatic, no heat is supplied at all.

Question #43 **Key: (B)**

PMDC 2020

The internal energy of a system during an isothermal process:
[NMDCAT 2020]

1.

CORE CONCEPT AND DERIVATION

For an ideal gas, the internal energy is directly proportional to its absolute temperature.

2. Formula:

$$U \propto T \implies \Delta U = nC_v \Delta T$$

3. Solution:

- An isothermal process is defined as a thermodynamic change where the temperature remains constant ($\Delta T = 0$).
- Since the change in temperature is zero, the change in internal energy ΔU is also zero.
- Hence, the internal energy remains completely constant throughout the process.

4. Why other options are incorrect:

Internal energy would increase during heating (temp rise) and decrease during cooling (temp fall), but cannot change if temperature is locked.

Question #44 **Key: (D)**

NUMS 2020

In a certain process, 400J of heat energy is supplied to a system and at the same time 150J of work is done by...

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics dictates that energy is conserved. The heat added to a system splits into changing its internal energy and doing work on the surroundings.

2. Formula:

$$Q = \Delta U + W$$

3. Solution:

- Identify given values with correct sign conventions: Heat supplied $Q = +400$ J, Work done BY the system $W = +150$ J.
- Rearrange the formula to solve for internal energy: $\Delta U = Q - W$.
- Substitute values: $\Delta U = 400 - 150$.
- Result: $\Delta U = 250$ J.

4. Why other options are incorrect:

Adding the numbers instead of subtracting gives 550J. Failing to account for work gives 400J. The correct energy balance requires subtracting the energy lost as work.

Question #45 Key: (C)

NUMS 2020

The rapid escape of air from a burst tyre is an example of: [NUMS 2020]

1.

CORE CONCEPT AND DERIVATION

Thermodynamic processes that happen extremely fast do not leave enough time for heat to exchange with the surrounding environment.

2. Formula:

$$Q = 0 \implies W = -\Delta U$$

3. Solution:

- When a tire bursts, the high-pressure air expands rapidly into the atmosphere.
- Because the expansion is highly sudden, there is practically zero time for heat to flow into or out of the gas ($Q = 0$).
- Any process where heat exchange is zero is strictly defined as an adiabatic process.

4. Why other options are incorrect:

Isothermal processes must happen very slowly to allow heat exchange. Isochoric processes require a constant volume. Isobaric requires constant pressure.

Question #46 Key: (C)

MDCAT 2019

The sum of all forms of molecular energies (kinetic and potential) of a substance is termed as? [MDCAT 2019]

1.

CORE CONCEPT AND DERIVATION

In thermodynamics, the macroscopic properties of a system are defined by the microscopic energies of its particles. The total microscopic energy is called Internal Energy.

2. Formula:

$$U = \Sigma E_k + \Sigma E_p$$

3. Solution:

- By definition, the internal energy (U) of a thermodynamic system is the sum of the random kinetic energies of its molecules and the potential energies associated with intermolecular forces.

4. Why other options are incorrect:

Heat is energy in transit, not energy contained within a system. Absolute energy and elastic energy do not properly describe the sum of all microscopic molecular energies.

Question #47 **Key: (C)**

MDCAT 2018

If one mole of an ideal gas is heated at constant pressure, then the first law of thermodynamics can be written...

1.

CORE CONCEPT AND DERIVATION

The First Law of Thermodynamics states that heat supplied to a system equals the increase in internal energy plus the work done by the system.

2. Formula:

$$Q = \Delta U + W$$

3. Solution:

- At constant pressure, heat supplied for one mole is $Q = C_p \Delta T$.
- The change in internal energy for any process is $\Delta U = C_v \Delta T$.
- The work done at constant pressure is $W = P \Delta V$.
- Substituting these yields: $C_p \Delta T = C_v \Delta T + P \Delta V$.

4. Why other options are incorrect:

Other options misrepresent the basic thermodynamic terms, swapping specific heats or introducing non-standard terms like $V \Delta P$ which applies to steady-flow processes rather than constant pressure expansion.

Question #48 **Key: (B)**

MDCAT 2018

If [Formula], [Formula] will be [MDCAT 2018]

1.

CORE CONCEPT AND DERIVATION

Molar specific heat at constant pressure (C_p) is always greater than molar specific heat at constant volume (C_v) by an amount equal to the universal gas constant (R).

2. Formula:

$$C_p - C_v = R$$

3. Solution:

- Rearrange the relation: $C_p = C_v + R$.
- Substitute the given value: $C_p = \frac{5}{2}R + R$.
- Calculate the sum: $C_p = \frac{5}{2}R + \frac{2}{2}R = \frac{7}{2}R$.

4. Why other options are incorrect:

Other options result from incorrect arithmetic or by erroneously subtracting R instead of adding it.

Question #49 Key: (D)

KMU 2018

The amount of heat required to raise the temperature of 10 moles of water from 70K to 80K (molar heat capacity...

1.

CORE CONCEPT AND DERIVATION

The heat required to raise the temperature of a given number of moles of a substance depends on its molar heat capacity and the change in temperature.

2. Formula:

$$Q = nC\Delta T$$

3. Solution:

- Identify the given values: $n = 10$ moles, $C = 75.24$ J/mol K.
- Calculate temperature change: $\Delta T = 80 \text{ K} - 70 \text{ K} = 10 \text{ K}$.
- Substitute into the formula: $Q = 10 \times 75.24 \times 10$.
- Calculate final value: $Q = 100 \times 75.24 = 7524 \text{ J}$.

4. Why other options are incorrect:

The other options represent decimal errors (forgetting to multiply by the 10 moles or the 10 K temperature difference) or simple calculation mistakes.

Question #50 Key: (A)

KMU 2014

The amount of heat required to raise the temperature of 1kg of substance through 1 K is called; [ETEA 2014]

1.

CORE CONCEPT AND DERIVATION

The specific heat capacity of a material is defined as the amount of heat energy required to raise the temperature of a unit mass (1 kg in SI units) of that substance by 1 Kelvin (or 1°C).

2. Formula:

$$c = \frac{Q}{m\Delta T}$$

3. Solution:

- The question explicitly specifies a mass of 1 kg.
- When mass $m = 1 \text{ kg}$ and $\Delta T = 1 \text{ K}$, the heat Q is exactly equal to the specific heat c .

4. Why other options are incorrect:

Heat capacity (without the word 'specific') refers to the entire body regardless of its mass. Joules and calories are units of energy, not properties of a material.

Question #51 **Key: (D)**

MDCAT 2013

What is the factor upon which change in internal energy of an ideal gas depends? [MCAT 2013]

1.

CORE CONCEPT AND DERIVATION

The internal energy of an ideal gas is purely translational kinetic energy, which depends exclusively on the absolute temperature of the gas.

2. Formula:

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

3. Solution:

- Since the number of moles n and the gas constant R are constant for a fixed system, any change in internal energy ΔU is directly proportional to the change in temperature ΔT .
- Therefore, it does not depend on the path or volume changes.

4. Why other options are incorrect:

Internal energy is a state function, meaning it is completely independent of the path taken. For an ideal gas specifically, intermolecular forces are zero, so volume changes do not alter potential energy.