Thermodynamics – Exam 1 (JEE)

System, Properties, Process, First Law

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Q1. Assertion – Reason (Adiabatic Process)

Conceptual Approach

> Adiabatic matlab system aur surroundings ke beech koi heat exchange nahi hota ($q = 0$). Temperature change ho bhi sakta hai, zaruri nahi ki constant rahe.

Stepwise Solution

- Assertion: True (Adiabatic = no heat exchange).
- Reason: False (temperature can increase/decrease in adiabatic).

Final Answer: Option (c) – Assertion true, Reason false.

Q2. Isothermal Expansion in Vacuum (1 L → 20 L)

Conceptual Approach

> Isothermal free expansion in vacuum → no external pressure → work done $w = 0$. Also, $q = \Delta U + w = 0$.

Solution

$$q = 0, \quad w = 0$$

Final Answer: Heat absorbed = 0 (Option a).

Q3. Path Variable

Conceptual Approach

> Path functions depend on process followed (e.g. heat q, work w). State functions depend only on initial and final states (U, H, V).

Final Answer: Heat (q) is path variable → Option (c).

Q4. Internal Energy in Cyclic Process

Conceptual Approach

> Internal energy (U) is state function → depends only on initial and final state. Cyclic process → system returns to same state → $\Delta U = 0$.

Final Answer: Zero (Option d).

Q5. Heat absorbed 20 kJ, Work = 10 kJ

Conceptual Approach

First law: $\Delta U = q - w$.

Calculation

$$\Delta U = 20 - 10 = +10\,\text{kJ}$$

Final Answer: Internal energy increases by 10 kJ (Option a).

Q6. $q = 300$ **cal,** $w = 200$ **cal**
Conceptual Approach

Apply first law: $\Delta U = q - w$.

Calculation

$$\Delta U = 300 - 200 = 100\,\text{cal}$$

Final Answer: 100 cal (Option c).

Q7. Isothermal expansion of ideal gas (1 L → 10 L)
Conceptual Approach

Isothermal process → $\Delta U = 0$.

Final Answer: Zero (Option b).

Q8. Free expansion (Adiabatic)
Conceptual Approach

Free expansion: $w = 0$. Adiabatic: $q = 0$. Ideal gas → no temperature change → $\Delta T = 0$.

Final Answer: (c) $q = 0, w = 0, \Delta T = 0$.

Q9. Expansion from 4 dm^3 to 6 dm^3 against 3 atm
Conceptual Approach

Work $w = -P\Delta V$. Convert L·atm to J.

Calculation

$$\Delta V = 2\,\text{L}, \quad w = -3 \times 2 = -6\,L \cdot atm$$

$$w = -6 \times 101.32 = -608\,J$$

Final Answer: –608 J (Option b).

Q10. Isothermal expansion (15 L → 50 L)
Conceptual Approach

Work done (isothermal,)$w = -P\Delta V$.

Calculation w= -1×(50 − 15)$Latm$

$w = -35 \times 24.2 cal w = -847 cal$
Final Answer: –843.3 cal (Option b).

I1. Free expansion from 2 L, 10 atm → 10 L
Conceptual Approach

> Isothermal free expansion in vacuum: $q = 0, w = 0, \Delta U = 0$.

Final Answer: Heat = 0, Work = 0.

I2. Work = 10 kJ, heat loss = 2 kJ
Conceptual Approach

> First law: $\Delta U = q - w$. Heat $q = -2$ (lost).

Calculation

$$\Delta U = -2 - 10 = -12\,kJ$$

Final Answer: –12 kJ.

I3. Expansion 1 L → 10 L against 1 bar
Conceptual Approach

> Work $w = -P\Delta V$.

Calculation

$$\Delta V = 9\,L, \quad P = 1\,bar$$

$$w = -1 \times 9 = -9\,L \cdot bar$$

Final Answer: –9 L·bar.