

STUDYNEST | CLASS 11 PHYSICS QUESTION PAPER 1

Chapter 11: Thermodynamics

Maximum Marks: 40 | Suggested time: 60 minutes

Instructions: Answer all questions. Show calculation steps and units. Original practice paper, not an official examination.

Section A 1-mark questions - $8 \times 1 = 8$ marks

1. State the zeroth law. [1]
2. Define internal energy. [1]
3. First law with W done by system? [1]
4. Meaning of adiabatic? [1]
5. Meaning of isothermal? [1]
6. Can a cyclic heat engine be 100% efficient? [1]
7. Ideal gas equation? [1]
8. Carnot efficiency? [1]

Section B 2-mark questions - $6 \times 2 = 12$ marks

9. At constant volume, 500 J heat added: work? [2]
10. Gas absorbs 800 J and does 300 J work: ΔU ? [2]
11. Carnot $T_h=600\text{K}, T_c=300\text{K}$: efficiency? [2]
12. Ideal-gas isothermal process: ΔU ? [2]
13. 1 mol with $C_v=20 \text{ J/mol K}$ and $\Delta T=5 \text{ K}$: ΔU ? [2]
14. Isothermal versus adiabatic? [2]

Section C 3-mark questions - $4 \times 3 = 12$ marks

15. Gas absorbs 1000 J and does 400 J work: ΔU ? [3]
16. Carnot $T_h=500\text{K}, T_c=300\text{K}$: ? [3]
17. Isobaric gas expands .01 to .03 m^3 at 100 kPa. Work? [3]
18. Why no real cyclic engine converts all heat to work? [3]

Section D 4-mark questions - $2 \times 4 = 8$ marks

19. Explain reversible and irreversible processes with examples. [4]
20. Engine absorbs 1500 J from 600K, rejects to 300K; actual work=500J. Find Carnot limit, actual efficiency and Q_{out} . [4]

End of question paper.

FORMULA AND EQUATION REFERENCE

Chapter-specific equations and relations

- First law with W done by the system: $Q = \Delta U + W$; equivalently $\Delta U = Q - W$.
- Boundary work $W = \int p \, dV$; at constant pressure $W = p \Delta V$; at constant volume $W = 0$.
- For an ideal gas, internal energy depends only on temperature; for isothermal change $\Delta U = 0$.
- For n moles: $\Delta U = n C_v \Delta T$; for a monatomic ideal gas $C_v = (3/2)R$.
- Carnot efficiency $\eta = 1 - T_c/T_h$, with temperatures in kelvin; this is the maximum possible efficiency.
- Energy balance over a cycle: $Q_{in} = W + Q_{out}$; actual efficiency $\eta = W/Q_{in}$.
- Adiabatic process: $Q = 0$. Isothermal process: temperature constant. Cyclic process: net $\Delta U = 0$.
- Second law: no cyclic heat engine can convert all absorbed heat into work.

Use equations only when their assumptions apply; keep units consistent.

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STEP-BY-STEP SOLUTIONS

Concept questions are answered directly; numerical problems show the governing equation and substitution.

Question 1

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Thermal equilibrium is transitive.

Final answer: Thermal equilibrium is transitive.

Question 2

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Microscopic energy of molecules and their interactions.

Final answer: Microscopic energy of molecules and their interactions.

Question 3

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $Q = \Delta U + W$.

Final answer: $Q = \Delta U + W$.

Question 4

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $Q = 0$.

Final answer: $Q = 0$.

Question 5

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Temperature constant.

Final answer: Temperature constant.

Question 6

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: No.

Final answer: No.

Question 7

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $pV = nRT$.

Final answer: $pV = nRT$.

Question 8

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $1 - T_c/T_h$.

Final answer: $1 - T_c/T_h$.

Question 9

Working: At constant volume, $\Delta V = 0$. Boundary work $W = \int p \, dV = 0$. This assumes no other kind of work is involved.

Final answer: Zero boundary work.

Question 10

Working: First law gives $\Delta U = Q - W = 800 - 300 = 500 \text{ J}$.

Final answer: 500 J.

Question 11

Working: $\eta = 1 - T_c/T_h = 1 - 300/600 = 0.5 = 50\%$.

Final answer: 50%.

Question 12

Working: For an ideal gas, internal energy depends only on temperature. Isothermal means $\Delta T = 0$, so $\Delta U = 0$.

Final answer: Zero.

Question 13

Working: $\Delta U = nC_v \Delta T = (1 \text{ mol})(20 \text{ J mol}^{-1} \text{ K}^{-1})(5 \text{ K}) = 100 \text{ J}$.

Final answer: 100 J.

Question 14

Working: Isothermal means temperature remains constant and heat may flow to keep it so. Adiabatic means $Q = 0$; temperature may change as work is done.

Final answer: Isothermal: T constant; adiabatic: $Q = 0$.

Question 15

Working: $\Delta U = Q - W = 1000 - 400 = 600 \text{ J}$.

Final answer: 600 J.

Question 16

Working: $\eta = 1 - T_c/T_h = 1 - 300/500 = 0.4 = 40\%$.

Final answer: 40%.

Question 17

Working: For constant pressure, $W = p \Delta V$. $\Delta V = 0.03 - 0.01 = 0.02 \text{ m}^3$; $p = 100 \text{ kPa} = 100,000 \text{ Pa}$. $W = 100,000(0.02) = 2000 \text{ J}$.

Final answer: $W = p\Delta V = 2000 \text{ J}$.

Question 18

Working: The second law requires some heat rejection or another entropy increase for a cyclic engine. Therefore a real cyclic engine cannot convert all absorbed heat into work.

Final answer: Second law requires rejected heat or other entropy increase.

Question 19

Working: A reversible process is an ideal quasi-static process with no dissipative effects and can be reversed by an infinitesimal change. Examples: ideal slow frictionless compression. Irreversible processes involve friction, turbulence or heat flow across a finite temperature difference; real expansion with friction is an example.

Final answer: Reversible: ideal quasi-static frictionless; irreversible: friction or finite-temperature heat flow.

Question 20

Working: Carnot limit $\eta = 1 - 300/600 = 0.50 = 50\%$. Actual efficiency = work/heat input = $500/1500 = 0.333 = 33.3\%$. Energy balance $Q_{in} = W + Q_{out}$, so $Q_{out} = 1500 - 500 = 1000 \text{ J}$.

Final answer: Carnot limit 50%; actual efficiency 33.3%; $Q_{out} = 1000 \text{ J}$.

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