

Thermodynamics — Assignment 1

Class 11 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Thermal Equilibrium and the Zeroth Law

MCQ Questions (choose the correct option)

- Two bodies are in thermal equilibrium when they have —
 - the same temperature
 - the same heat content
 - the same mass
 - the same specific heat
- The zeroth law of thermodynamics is the basis of —
 - temperature measurement
 - work measurement
 - heat-engine efficiency
 - the gas laws
- If A and B are each in thermal equilibrium with C, then A and B are —
 - in thermal equilibrium with each other
 - never in equilibrium
 - hotter than C
 - colder than C
- Heat flows between two bodies only when —
 - their temperatures differ
 - their masses differ
 - they are both solid
 - they are both at the same temperature

1 Mark Questions

- Define thermal equilibrium.
- State the zeroth law of thermodynamics.
- Why is the zeroth law the basis of thermometry?

2 Mark Questions

- State the zeroth law of thermodynamics and explain how it justifies the use of a thermometer.
- Explain the meaning of thermal equilibrium and give two examples.
- A and B are each in thermal equilibrium with C. What can you conclude about A and B?

3 Mark Questions

- State and explain the zeroth law of thermodynamics, and show how it leads to the definition of temperature.
- Discuss the conditions for thermal equilibrium between two bodies and explain why heat flows only when temperatures differ.

Heat, Work and Internal Energy

MCQ Questions (choose the correct option)

- Which of the following is a path function? —
(A) Heat (Q)
(B) Internal energy (U)
(C) Temperature (T)
(D) Volume (V)
- For an ideal gas, the internal energy depends only on —
(A) temperature
(B) pressure
(C) volume
(D) the external force
- The work done by a gas expanding at constant pressure P through volume ΔV is —
(A) $P\Delta V$
(B) $\frac{1}{2}P\Delta V$
(C) $P/\Delta V$
(D) $\Delta V/P$
- Which of the following is a state function? —
(A) Internal energy
(B) Work
(C) Heat
(D) None of these

1 Mark Questions

- Distinguish between heat and work as forms of energy transfer.
- Define internal energy.
- Write the expression for the work done by a gas at constant pressure.

2 Mark Questions

- Distinguish between path functions and state functions, giving examples.
- A gas expands from 2 m^3 to 5 m^3 at a constant pressure of $4 \times 10^5 \text{ Pa}$. Find the work done by the gas.
- Explain why the internal energy of an ideal gas depends only on temperature.

3 Mark Questions

- Explain the difference between heat, work and internal energy, and classify them as path or state functions with justification.
- A gas is compressed at constant pressure of $2 \times 10^5 \text{ Pa}$ from 4 m^3 to 2 m^3 . Find the work done on the gas and state its sign.

The First Law of Thermodynamics

MCQ Questions (choose the correct option)

- The first law of thermodynamics is a statement of —
(A) conservation of energy

- (B) conservation of mass
 - (C) conservation of momentum
 - (D) conservation of charge
2. For a process at constant volume, the heat supplied equals —
- (A) the change in internal energy
 - (B) the work done by the gas
 - (C) zero
 - (D) the change in pressure
3. In an isothermal process, ΔU for an ideal gas is —
- (A) zero
 - (B) positive
 - (C) negative
 - (D) equal to the heat supplied
4. In a cyclic process, the net change in internal energy of the system is —
- (A) zero
 - (B) positive
 - (C) negative
 - (D) equal to the net heat

1 Mark Questions

1. State the first law of thermodynamics.
2. Write the mathematical form of the first law with the sign convention.
3. What is the value of ΔU in an isothermal process for an ideal gas?

2 Mark Questions

1. In a certain process 1000 J of heat is supplied to a gas and it does 600 J of work. Find the change in its internal energy.
2. Explain the first law for an isothermal and an adiabatic process.
3. State the sign conventions for heat and work in the first law.

3 Mark Questions

1. State and explain the first law of thermodynamics, and apply it to isothermal, isobaric and adiabatic processes.
2. A gas absorbs 400 J of heat and does 250 J of work. Find the change in internal energy. If the gas instead expands doing 400 J of work while absorbing 600 J, find the new ΔU .

Thermodynamic Processes

MCQ Questions (choose the correct option)

1. In an isothermal process, the quantity that remains constant is —
 - (A) temperature
 - (B) pressure
 - (C) volume
 - (D) internal energy
2. For an adiabatic process of an ideal gas, —
 - (A) PV^γ is constant
 - (B) PV is constant

- (C) P/V is constant
 (D) T is constant
3. A process with constant volume is called —
 (A) isochoric
 (B) isobaric
 (C) isothermal
 (D) adiabatic
4. The work done by an ideal gas in an isothermal expansion from V_1 to V_2 is —
 (A) $nRT \ln(V_2/V_1)$
 (B) $P\Delta V$
 (C) $nC_V\Delta T$
 (D) $nR(T_2 - T_1)$

1 Mark Questions

1. Define an isothermal process.
2. What is an adiabatic process?
3. Write the equation for an ideal gas under isothermal and adiabatic conditions.

2 Mark Questions

1. Distinguish between isothermal and adiabatic processes.
2. One mole of an ideal gas expands isothermally at 300 K from 1 m^3 to 3 m^3 . Find the work done. ($R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$.)
3. Why is an adiabatic curve steeper than an isothermal curve?

3 Mark Questions

1. Explain isothermal, adiabatic, isobaric and isochoric processes, writing the equation for each.
2. A gas is expanded adiabatically from a pressure of $2 \times 10^5 \text{ Pa}$ and volume 0.5 m^3 so that its pressure becomes $8 \times 10^4 \text{ Pa}$. If $\gamma = 1.4$, find the new volume.

Specific Heats of a Gas

MCQ Questions (choose the correct option)

1. Mayer's relation for an ideal gas is —
 (A) $C_P - C_V = R$
 (B) $C_P + C_V = R$
 (C) $C_P/C_V = R$
 (D) $C_P C_V = R$
2. For a diatomic gas (neglecting vibrations), γ is approximately —
 (A) $7/5$
 (B) $5/3$
 (C) $3/2$
 (D) 1
3. C_P is greater than C_V because —
 (A) at constant pressure the gas does external work
 (B) the gas is compressed at constant volume

- (C) the temperature rises faster
 - (D) of radiation losses
4. For a monatomic gas, C_V is approximately —
- (A) $3R/2$
 - (B) $5R/2$
 - (C) R
 - (D) $2R$

1 Mark Questions

1. Define C_V and C_P for a gas.
2. State Mayer's relation.
3. Write γ for monatomic and diatomic gases.

2 Mark Questions

1. Explain why C_P is greater than C_V for a gas.
2. For a diatomic gas with $C_V = 5R/2$, find C_P and γ .
3. Find the change in internal energy of 2 moles of a monatomic gas heated from 300 K to 400 K. ($R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$.)

3 Mark Questions

1. Derive Mayer's relation $C_P - C_V = R$ for an ideal gas.
2. A diatomic gas of 3 moles is heated at constant pressure from 300 K to 400 K. Find the heat supplied given $C_P = 7R/2$ and $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$.

Heat Engines, Refrigerators and the Second Law

MCQ Questions (choose the correct option)

1. The efficiency of a heat engine is defined as —
 - (A) $W/Q_1 = 1 - Q_2/Q_1$
 - (B) Q_1/W
 - (C) Q_2/W
 - (D) W/Q_2
2. A Carnot engine's efficiency depends on —
 - (A) the temperatures of the two reservoirs
 - (B) the working substance
 - (C) the amount of heat used
 - (D) the speed of the engine
3. A refrigerator operates by —
 - (A) transferring heat from a cold to a hot reservoir using external work
 - (B) creating cold
 - (C) eliminating heat
 - (D) converting work entirely into heat
4. According to the second law of thermodynamics, —
 - (A) heat cannot flow spontaneously from a cold body to a hot body
 - (B) heat always flows from cold to hot
 - (C) energy is never conserved

(D) perpetual motion is possible

1 Mark Questions

1. Define a heat engine.
2. Write the formula for the efficiency of a Carnot engine.
3. State the second law of thermodynamics (Clausius statement).

2 Mark Questions

1. A heat engine absorbs 1000 J from a hot reservoir and rejects 600 J to the cold reservoir. Find its efficiency.
2. Compute the Carnot efficiency of an engine operating between 400 K and 300 K.
3. Explain why a heat engine cannot be 100% efficient.

3 Mark Questions

1. Describe the working of a heat engine and derive its efficiency, and state the Carnot efficiency limit.
2. A Carnot engine works between temperatures 500 K and 300 K. Find (a) its efficiency and (b) the heat rejected per cycle if it absorbs 4000 J per cycle.
3. Explain how a refrigerator works and define its coefficient of performance.