

What are the Laws of Thermodynamics?

Worksheet

There are four laws: the zeroth law defines thermal equilibrium, the first law states energy is conserved ($U = Q - W$), the second law says entropy in an isolated system never decreases, and the third law states entropy approaches zero as temperature approaches absolute zero.

$$\Delta U = Q - W$$

Questions

- Which law states that energy cannot be created or destroyed?
 - Zeroth law
 - First law
 - Second law
 - Third law
- A system absorbs 400 J of heat and does 150 J of work. What is U ?
 - 550 J
 - 250 J
 - 250 J
 - 400 J
- According to the second law, the entropy of an isolated system...
 - Always decreases
 - Always stays exactly constant
 - Never decreases
 - Is undefined
- What does the zeroth law establish?
 - Conservation of energy
 - The concept of temperature via thermal equilibrium
 - That entropy always increases
 - That absolute zero is unreachable
- A gas absorbs 500 J of heat and does 200 J of work on its surroundings. Find U .
- An engine releases 150 J of heat while 400 J of work is done on it. Find U .
- In a fully isolated system undergoing a spontaneous process, what happens to the total entropy?
- Define: What is the first law of thermodynamics?
- Define: What is the second law of thermodynamics?
- Define: What is the zeroth law used for?

Answer Key

1. B) First law - The first law is the conservation of energy: $U = Q + W$.
2. B) 250 J - $U = Q + W = 400 - 150 = 250$ J.
3. C) Never decreases - Entropy of an isolated system never decreases - it increases or stays the same.
4. B) The concept of temperature via thermal equilibrium - The zeroth law defines thermal equilibrium, giving us the concept of temperature.
5. $U = Q + W = 500 - 200 = 300$ J
6. $Q = 150$ J (heat leaves the system) $W = 400$ J (work is done on the system, so work done BY the system is negative) $U = Q + W = 150 + (-400) = -250$ J
7. By the second law, $\Delta S \geq 0$ for an isolated system Entropy increases or stays the same - it never decreases
8. Energy conservation: $U = Q + W$.
9. The entropy of an isolated system never decreases.
10. Defining temperature via thermal equilibrium.

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