

Thermodynamics

What is Thermodynamics? Thermodynamics is the field of physics that deals with the relationship between heat and other properties (such as pressure , density , temperature , etc .) in a substance . Specifically , thermodynamics focuses largely on how a heat transfer is related to various energy changes within a physical system undergoing a thermodynamic process . Such processes usually result in work being done by the system and are guided by the laws of thermodynamics .

Basic Concepts of Heat Transfer:

Thermal Contact is when two substances can affect each other's temperature .

Thermal Equilibrium is when two substances in thermal contact no longer transfer heat .

Thermal Expansion takes place when a substance expands in volume as it gains heat . Thermal contraction also exists .

Conduction is when heat flows through a heated solid .

Convection is when heated particles transfer heat to another substance , such as cooking something in boiling water .

Radiation is when heat is transferred through electromagnetic waves , such as from the sun .

Insulation is when a low-conducting material is used to prevent heat transfer .

Thermodynamic Processes:

A system undergoes a thermodynamic process when there is some sort of energetic change within the system , generally associated with changes in pressure , volume , internal energy (i . e .

temperature) , or any sort of heat transfer . There are several specific types of thermodynamic processes that have special

properties: · Adiabatic process - a process with no heat transfer into or out of the system . · Isochoric process - a process with no change in volume , in which case the system does no work . ·

· Isobaric process - a process with no change in pressure . ·

· Isothermal process - a process with no change in temperature .

Zeroeth Law of Thermodynamics:

Two systems in thermal equilibrium with a third system are in

thermal equilibrium to each other . [This zeroeth](#) law is sort of a [transitive](#) property of thermal equilibrium . The [transitive](#) property of mathematics says that if $A \equiv B$ and $B \equiv C$, then $A \equiv C$. The same is true of thermodynamic [systems](#) that are in thermal equilibrium . [One](#) consequence of the [zeroeth](#) law is the idea that measuring temperature has any meaning [whatsoever](#) . In order to measure a temperature , thermal equilibrium must be reached between the thermometer as a whole , the mercury inside the thermometer , and the substance being measured . This , in turn , results in being able to accurately tell what the temperature of the substance is . [This](#) law was understood without being explicitly stated through much of the history of [thermodynamics](#) study , and it was only [realized](#) that it was a law in its own right at the beginning of the [20th](#) century . It was British [physicist Ralph H . Fowler](#) who first [coined](#) the term "[zeroeth](#) law , " based on a belief that it was more fundamental even than the other SSPS textZeroeth IL ov Thermodynamics tu systems in

First Law of [Thermodynamics](#) The change in a [system's](#) internal energy is equal to the difference between heat added to the system from its [surroundings](#) and work done by the system on its [surroundings](#) . [Though](#) this may sound complex , it's really a very simple idea . If you add heat to a system , there are only two things that can be done -- change the internal energy of the system or cause the system to do work (or , of course , some combination of the two) . All of the heat energy must go into doing these things . [Mathematical](#) Representation of the First [Law](#) [Physicists](#) typically use uniform conventions for representing the quantities in the first law of [thermodynamics](#) . They are: U_1 (or U_i) \equiv initial internal energy at the start of the process U_2 (or U_f) \equiv final internal energy at the end of the process $\Delta U \equiv U_2 - U_1 \equiv$ Change in internal energy (used in cases where the [specifics](#) of beginning and ending internal energies are irrelevant) $Q \equiv$ heat [transferred](#) into ($Q > 0$) or out of ($Q < 0$) the system $W \equiv$ work performed by the system ($W > 0$) or on the system ($W < 0$) . [This](#) yields a mathematical representation of the first law which [proves](#) very useful and can be [rewritten](#) in a couple of useful [ways](#): $U_2 - U_1 \equiv \Delta U \equiv Q - W$ $Q \equiv \Delta U + W$

The analysis of a thermodynamic process , at least within a physics

classroom situation , generally involves analyzing a situation where one of these quantities is either 0 or at least controllable in a reasonable manner . For example , in an adiabatic process , the heat transfer (Q) is equal to 0 while in an isochoric process the work (W) is equal to 0 .

The First Law & Conservation of Energy

The first law of thermodynamics is seen by many as the foundation of the concept of conservation of energy . It basically says that the energy that goes into a system cannot be lost along the way , but has to be used to do something . . . in this case , either change internal energy or perform work . Taken in this view , the first law of thermodynamics is one of the most far-reaching scientific concepts ever discovered .

Second Law of Thermodynamics:

It is impossible for a process to have as its sole result the transfer of heat from a cooler body to a hotter one . The second law of thermodynamics is formulated in many ways , as will be addressed shortly , but is basically a law which - unlike most other laws in physics - deals not with how to do something , but rather deals entirely with placing a restriction on what can be done . It is a law that says nature constrains us from getting certain kinds of outcomes without putting a lot of work into it , and as such is also closely tied to the concept of the conservation of energy , much as the first law of thermodynamics is .

In practical applications , this law means that any heat engine or similar device based upon the principles of thermodynamics cannot , even in theory , be 100% efficient . This principle was first illuminated by the French physicist and engineer Sadi Carnot , as he developed his Carnot cycle engine in 1824 , and was later formalized as a law of thermodynamics by German physicist Rudolf Clausius .

Entropy and the Second Law of Thermodynamics

The second law of thermodynamics is perhaps the most popular

outside of the realm of physics , because it is closely related to the concept of entropy , or the disorder created during a thermodynamic process . [Reformulated](#) as a statement regarding entropy , the second law [reads: In](#) any closed system , the entropy of the system will either remain constant or increase . [In](#) other words , each time a system goes through a thermodynamic process , the system can never completely return to precisely the same state it was in before . This is one definition used for the arrow of time , since entropy of the universe will always increase over time according to the second law of [thermodynamics](#) .

[Other](#) Second Law Formulations

A [cyclic transformation](#) whose only final result is to transform heat [extracted](#) from a source which is at the same temperature throughout into work is impossible . - Scottish [physicist](#) William [Thompson \(Lord Kelvin\)](#) A [cyclic transformation](#) whose only final result is to transfer heat from a body at a given temperature to a body at a higher temperature is impossible . - German [physicist](#) [Rudolf Clausius](#) All the above formulations of the Second Law of [Thermodynamics](#) are [equivalent statements](#) of the same fundamental principle . [The](#) third law of [thermodynamics](#) is essentially a statement about the ability to create an absolute temperature scale , for which absolute zero is the point at which the internal energy of a solid is precisely [0](#) .

[Various sources](#) show the following three potential formulations of the third law of [thermodynamics](#):

- [1](#) . [It](#) is impossible to reduce any system to absolute zero in a [finite](#) series of [operations](#) .
- [2](#) . [The](#) entropy of a perfect crystal of an element in its most stable form [tends](#) to zero as the temperature [approaches](#) absolute zero .
- [3](#) . [As](#) temperature [approaches](#) absolute zero , the entropy of a system [approaches](#) a [constant](#)

[What](#) the Third Law [Means](#)

[The](#) third law means a few things , and again all of these formulations result in the same outcome depending upon how much you take into [account](#): [Formulation 3](#) contains the least [restraints](#) ,

merely stating that entropy goes to a constant . In fact , this constant is zero entropy (as stated in formulation [2](#)) . However , due to quantum [constraints](#) on any physical system , it will collapse into its [lowest](#) quantum state but never be able to perfectly reduce to [0](#) entropy , therefore it is impossible to reduce a physical system to absolute zero in a [finite](#) number of steps (which yields us formulation [1](#)) .

wot iz TurmōdInōmiks?:

TurmōdInōmiks iz tīa feild ov fizix tīot deilz wiT tīa rilæshinship bit wen het end Ætīa propætēz (sach oz prestīa , densitē , temprichīa , eksechīa .) in æ sǣbstins . sbisifiklē , TurmōdInōmiks fōkisiz lΔjle on hoo æ het chronzfur iz rǣlætēd t● vereis enljē chænjiz wiTlin æ fizikkōl sistim andægōwēg æ TurmōdInōmik prōses . sach prōsesiz yōthlæ rǣzolt in wurk bēg dān bī tīa sistim end Δ gidid bī tīa lǣz ov TurmōdInōmiks .

bæsik konseps ov het chronzfur:

Turmōl kontøkt iz wen t● sǣbstinsiz kōn Æfekt ech Ætīz temprichīa .

Turmōl eqǣlibreim iz wen t● sǣbstinsiz in Turmōl kontøkt nō logǣ chronzfur het . Turmōl exponshin tæx plæes wen æ sǣbstins exponas in volyōm oz it gœnz het . Turmōl kǣndrøkshin ælsō exisas .

kondakshin iz wen het flōz Tr● æ hetid solid .

konvekshin iz wen hetid pΔtǣkōlz chronzfur het t● Ætīa sǣbstins , sach oz kōkēg sǣmTlīg in bælēg wǣrtl .

rædæshin iz wen het iz chronsford Tr● Ælekchrōmōgnetik wœvz , sach oz from tīa sǣn .

insǣshin iz wen æ lō kǣndakteg mǣtereōl iz yōzd t● privent het chronzfur .

first law of Thermodynamics is a change in the system internal energy is equal to the difference between the heat added to the system from its surroundings and work done by the system on its surroundings. This may sound complex, but is really a very simple idea. If you add heat to a system, the Δ will be positive. This can be done by a change in internal energy of the system or work done by the system (or, of course, some combination of the two). All of this heat energy must go into doing work. Mathematical representation of the first law of physics is typically given by the following convention for representing the change in the first law of Thermodynamics. Δ

y_{int} or y_{I} = initial internal energy of the state of the process

y_{f} or y_{f} = final internal energy of the end of the process
 $\Delta y_{\text{int}} = y_{\text{f}} - y_{\text{int}}$ = change in internal energy (used in cases where the specific values of beginning and ending internal energy Δ is relevant)

q = heat transferred into (if q is positive) or out of (if q is negative) the system.

w = work done by the system ($w > 0$) or on the system ($w < 0$).

This equation is a mathematical representation of the first law which provides a very useful and can be written in the following way:

$$y_{\text{f}} - y_{\text{int}} = \Delta y_{\text{int}} - y_{\text{int}} = q - w$$

$$q = \Delta y_{\text{int}} - y_{\text{int}} + w$$

The analysis of a thermodynamic process, or least within a physical closed system, generally involves analyzing the system well and on the other hand is that 0 or at least know the initial and final states. For example, in an adiabatic process, the heat transfer (q) is equal to zero while in an isochoric process the work (w) is equal to zero.

ἡλ first law and conservation of energy

ἡλ first law of Thermodynamics is seen by me as the foundation of the concept of conservation of energy. it basically says that the energy that goes into a system cannot be lost. It is a change in internal energy or performed work. taken in this view, the first law of Thermodynamics is what we most often find in scientific concepts even in a textbook.

second law of Thermodynamics:

it is impossible for a process to have as its sole result the transfer of heat from a colder body to a hotter one. the second law of Thermodynamics is formulated in many ways, but will be easiest to understand, but is basically the law which states that heat does not flow spontaneously from a colder body to a hotter one, but rather heat flows spontaneously from a hotter body to a colder one as from a higher level of entropy to a lower level of entropy. it is the law that says that the entropy of a system cannot decrease, and that is why it is also called the law of increasing entropy. the concept of the conservation of energy, which is the first law of Thermodynamics is.

in practical applications, this law means that one cannot get something for nothing or a perpetual motion machine of the first kind. the principle of conservation of Thermodynamics is not, even in theory, 100% efficient.

this principle was first formulated by the French physicist and engineer Sadi Carnot, who developed his theory of entropy in 1824, and was later formalized as the second law of Thermodynamics by the German physicist Rudolf Clausius.

conclusion and the second law of Thermodynamics

1. The second law of thermodynamics is perhaps the most popular
 outside of the realm of physics, because it is closely related to the
 concept of entropy, and the disorder created by the second
 law of thermodynamics processes. reformulated as the statement that
 entropy, the second law reads: in any closed system, the
 entropy of the system will either remain constant or increase. in
 all cases, each time a system goes through a thermodynamic process
 , the system can never completely return to its original state
 since it was in the first place. this is why the definition of
 entropy is given as the amount of energy that is lost to the
 system, since entropy of the universe will always increase over
 time according to the second law of thermodynamics.

2. The second law of thermodynamics

The cyclic transformation of heat into work is the thermodynamic
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 to the body at the higher temperature is impossible. German physicist
 Rudolf Clausius and the law of conservation of the second law of
 thermodynamics is equivalent to the statement of the second
 fundamental principle. The second law of thermodynamics is
 a statement about the ability to create an absolute
 temperature scale, for which absolute zero is the point at which
 the internal energy of the solid is zero.

various sources show the following three principles of thermodynamics of
 the second law of thermodynamics.

1. it is impossible to raise the temperature of a body to absolute zero in a
 finite series of operations.
2. the entropy of a perfect crystal is zero at absolute zero of the
 most stable form of the substance at absolute zero of the
 equilibrium absolute zero.
3. at absolute zero of the equilibrium absolute zero, the entropy of the
 system is zero, the entropy of the system is zero.

sistim λ pr \ddot{o} chiz \in konstint

wot τ Π rd λ menz

τ Π rd λ menz \in fy \bullet Π igz , ond λ gein α L ov τ iez
f α my \bullet L \in shinz r λ zolt in τ λ s \in m θ otk λ m d λ pende θ λ pon
h θ o m λ ch y \bullet t \in k int \bullet λ k θ ont :

f α my \bullet L \in shin 3 k λ nt \in enz τ λ est r λ sjr \in ns, meile
st \in te θ τ iot enchr λ pe g \ddot{o} z t \bullet \in konstint . in f θ kt , τ is
konstint iz zer \ddot{o} enchr λ pe (θ z st \in tid in f α my \bullet L \in shin 2) .
h θ oev λ , j \bullet t \bullet qontim konsjr \in ns on ene fiz λ k θ λ
sistim , it wil k λ lops int \bullet i α s l \ddot{o} wist qontim st \in t b λ t
nev λ be \in b θ ol t \bullet purfikt λ e r λ jos t \bullet 0 enchr λ pe , τ ie λ f α it
iz impos λ b θ λ t \bullet r λ jos \in fiz λ k θ λ sistim t \bullet θ bs λ lot zer \ddot{o}
in \in fInIt n λ mb λ ov steps (wich yeil α s λ s f α my \bullet L \in shin
1) .