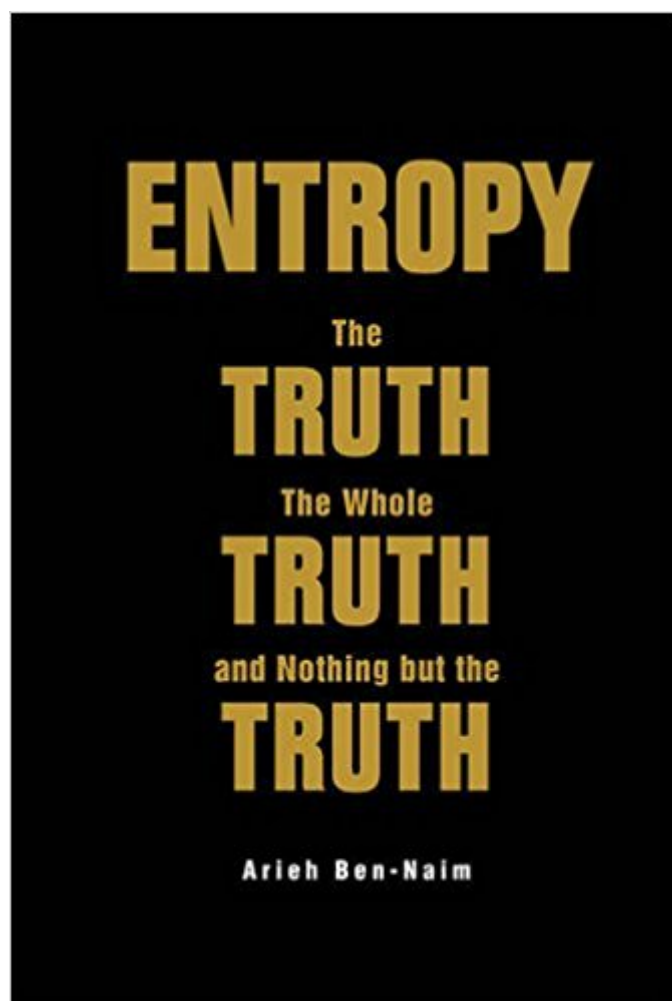


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Entropy: The Truth, The Whole Truth, And Nothing But The Truth



Synopsis

This book discusses the proper definitions of entropy, the valid interpretation of entropy and some useful applications of the concept of entropy. Unlike many books which apply the concept of entropy to systems for which it is not even defined (such as living systems, black holes and the entire universe), these applications will help the reader to understand the meaning of entropy. It also emphasizes the limitations of the applicability of the concept of entropy and the Second Law of Thermodynamics. As with the previous books by the author, this book aims at a clear and mystery-free presentation of the central concept in thermodynamics the entropy. In this book, the concepts of entropy and the Second Law are presented in a friendly, simple language. It is devoid of all kinds of fancy and pompous statements made by authors of popular science books who write on this subject.

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all kinds of fancy and pompous statements made by authors of popular science books who write on this subject.

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Entropy, The Truth, is a wonderful book, but my remarks will be more helpful if I comment on my background first. My background is in mathematics and probability theory, decades old, where I came across Shannon's channel coding theorem in a grad school course in coding. Shannon's measure of information, called entropy, was always interesting to me, but my subsequent life's work was only peripherally mathematical. Of course now every telecommunications engineer knows of Shannon's entropy and the thermodynamics concept of entropy has taken on a life of its own in popular science books and in the press. The website the Edge.com claims to canvas the best minds in the world to answer questions. The 2017 question was "What scientific term or concept ought to be more widely known?" The Harvard psychology professor Steven Pinker wrote that it was the Second Law of Thermodynamics. But he goes on to repeat many of the nutty things that Professor Ben-Naim has tried for decades to extirpate from science books and the public mind. But it's not just nutty things that are said. In fact, there is enough subtlety, variation and complexity in the Second Law and entropy that have resulted in wide variation in their definition and application. Ben-Naim has dedicated this book, and perhaps decades of work, to clarifying and explaining these concepts. And even more than that, he's explained and unified not only entropy but also Gibbs free energy and Helmholtz energy. His unification of the information entropy with the thermodynamics entropy in a carefully derived mathematical formula puts a probability explanation of the second law front and center where it belongs. It's truly a historic contribution to one of the most troubled central tenants of science. Now I admit that my only knowledge of physics is based on my own private reading, and I knew even less about thermodynamics. But I started by reading several of his earlier books, such as Farewell to Entropy (2008) and Information, Entropy, Life and the Universe (2015) which are much more mathematical and probabilistic than this book (Entropy, The Truth), and thus I could follow with my almost nonexistent thermodynamics background. Entropy, The Truth is much less mathematical, but it requires, like his other books, that you read carefully. He's a careful writer using many "simple" examples and exhibits, and his book is aimed at a general, but scientifically educated, audience. But still, as good as he is at writing and explaining the

concepts, the confusion over entropy and the second law would not have persisted so long in the heart of thermodynamics if it was easy to sort out. He divides the book into the three broad chapters.

Chapter 1. *The Various Definitions of Entropy and the Second Law of Thermodynamics* – you might consider to be looking at the forest rather than the trees. By that I mean he presents, not only the historical development of these concepts, but also his development that is presented in much more detail in his earlier books. Here you have to take more things for granted or refer to some of his earlier books. I'm the kind that wants to check every formula so it was good I read some of his earlier books first. But others may prefer to just accept the more technical derivations and look at the broader picture as is done here.

Chapter 2. *Interpretation and Misinterpretations of Entropy* – is a wonderful examination of every possible interpretation of entropy and misinterpretation of entropy. Through examining all the variations you really begin to get a deeper understanding of what entropy is and why Ben-Naim's approach makes sense and all the other variations don't.

Chapter 3. *Applications and Misapplications of Entropy* – is the most thermodynamic chapter. But by now I've developed a respect and better understanding of thermodynamics, and this chapter was perhaps the most interesting for me. His examples are always carefully explained and illustrated and my knowledge of the terminology has improved to the point that I want to do further reading in thermodynamics and physical chemistry. An additional benefit of reading this book is how to think carefully about the concepts and how to construct simple examples to test your reasoning. Ben-Naim has apparently been thinking and teaching about thermodynamics for more than half a century, so just seeing how he does this is interesting. I also liked the historical knowledge that you gradually accumulate as you read.

The World Scientific books of Ben-Naim that I purchased, all paperbacks, have been of the highest quality I've ever seen in paperback. For the low price, every student of physical chemistry or thermodynamics, from undergrad to professor or practitioner, should read this book. But it should also be accessible to a broader audience such as someone with a background like mine (who may want to read an earlier book first as I did) or someone having a strong scientific or analytic background. The Harvard psychologist Steven Pinker would do well to read it.

Arieh Ben-Naim is one of those rare writers who takes a long hard honest look at physical concepts, without letting preconceptions get in his way. His books on entropy present his clear and direct comprehension, allowing the reader to share in his insights. Entropy and the second law have a definite subtlety to them, and as Professor Ben Naim explains there is all too much

misrepresentation out there among popular books. All those who deal with entropy and the second law of thermodynamics can benefit from this book. Also, those who want to understand something about Shannon's information theory and the true relationship between this notion and entropy. Many authors relate the two, but do so in a manner that is vague at best and many are downright misleading. The explosion of interest in information theory in general and quantum information in particular ought to make this book a must-read for many people.

Reading this book by Arie Ben-Naim is first of all a pleasant delightful way to get to know the basic of thermodynamics. Awesome field for many when taught in the academy. Captivating when you learn about thermodynamics through this book. The easy effortless and fascinating way to learn for the beginner even if he has no previous knowledge at all but reading it also deepens the understanding of those who are familiar with this field. That is the magic of the book: excellent for both groups. The learned and those who have not prior knowledge. In this regard this book like others written by Ben Naim resemble the famous course of physics by Richard Feynman. But there is more in this book; Ben-Naim does not accept "common wisdom" related to essential concept in thermodynamic and claims that some concepts are misused even abused or misinterpreted. Particularly in regard to the mystery of life. A bold step of him since some scientists will not love his standing. Ben Naim does not and stick to his conceptions. I do not want to be a "spoiler" and not reveal what it is all about. I will quote one sentence in the book and omit the key words: "The most unjustifiable, unwarranted, unacceptable, outrageous application of the concept of X and Y is undoubtedly in the phenomenon we call life. Read and learn what are X and Y. The price is reading this fascinating book."

Arieh Ben-Naim gives the clearest explanation yet for a general audience of what entropy is and what it is not. Entropy is only defined for systems at equilibrium and can be calculated from probabilities using Shannon's measure of information. He systematically dismantles the definitions and explanations put forward by others, providing counter-examples and pointing out unjustified claims. His targets include that entropy is a function of time, that entropy is a flow of heat, that entropy is subjective or mysterious, or that the entropy of living organisms, the universe, or a child's room are well-defined quantities. He advocates a simple explanation of the second law of thermodynamics without reference to entropy in that a system simply adopts the most probable state according to the relevant constraints. Obvious perhaps, but that is the nature of a clear explanation.

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