

Contents

Acknowledgments	xi
Introduction	xiii
1. Nature's First Law	1
What is Energy?	3
The Emergence of the First Law of Thermodynamics	5
Impossibility of Perpetual Motion Machines	10
Radioactivity and Perpetual Energy	14
2. Nature's Second Law	17
The Beginning of a New Science	19
The Birth of the Second Law of Thermodynamics	22
Nature's Irreversible Trend	25
What Is That Quantity Called Entropy?	27
Maxwell's Demon Attempts to Demolish Nature's Law of Entropy	30
Entropy as "Time's Arrow"	33
Boltzmann's Entropy Relation	38
3. Nature's Laws in Action	43
The Relentless Increase of Entropy	45
From a Clockwork Universe to the Heat Death of the Universe	50
Thermodynamics and Cosmology	53
Entropy as a Measure of Ignorance and Uncertainty	57
Humans as an Open Thermodynamic System	63
Why Do We Age Irreversibly?	67
Is Evolution a Miracle in Violation of the Second Law?	70

4. Knowledge and Entropy	73
Knowledge Undergoes Thermodynamic Transformation	75
Thermodynamic View of the Educational System	79
Disorder in Knowledge	83
5. The United States in High Entropy	89
The High-Entropic Life in the United States	91
Possessions Generate Entropy and Dissipate Time	94
Drowning in a Sea of Words	97
More Choices but Less Time	101
Are We Freeing Ourselves from Machines, at Last?	105
6. The Agricultural-Industrial Complex	109
Modern Agriculture and the Second Law	111
Chemical Control of Insects	115
Soil Erosion and Degradation of the Environment	120
7. What Does the Second Law Really Say?	123
The Availability of Energy and Natural Resources Revisited	125
Entropy: The Supreme Manager of All Natural Processes	129
The Greenhouse Effect	133
High Tech's Environmental Entropy	136
Can We "Control" Natural Processes?	139
8. Economics, the Environment, and the Laws of Thermodynamics	149
Economic Theories	151
The Economics of Computers and Technology	157
The Concept of Environmental Externalities in Economics	161
Economics as an Applied Science	171
9. Why Things Look So Good on the Horizon—Until We Get There	181
Why Great Expectations Turn to Disillusionments	183
Is Nuclear Fusion Our Response to the Second Law?	189
Space: The Unlimited Frontier?	193
Entropy and Growing Global Interdependence	197

10. The World Through the Eyes of Thermodynamics	205
The Concept of “Doing More with Less”	207
Change and Technological “Progress” Re-examined	214
Recognizing Low- and High-Entropic Actions and Life-styles	220
11. The Thermodynamic Imperative	229
Does Science Tell Us How to Live?	231
The Necessity of Projecting a Consistent Scientific Message	234
Making Entropy a Part of Our Daily Language	239
Thermodynamics and the Unity of Knowledge	241
Notes	255
Index	285

