

Contents

Preface	ix
Programs for Simulating Some of the Games in the Book	xxiii
1 Introduction, and a Short History of the Second Law of Thermodynamics	1
1.1. The <i>Non-Atomistic</i> Formulation of the Second Law	1
1.2. The Atomistic Formulation of the Second Law	9
2 A Brief Introduction to Probability Theory, Information Theory, and all the Rest	19
2.1. The Classical Definition	31
2.2. The Relative Frequency Definition	33
2.3. Independent Events and Conditional Probability	37
2.4. Three Caveats	42
2.4.1. Conditional probability and subjective probability	42
2.4.2. Conditional probability and cause and effect	46

2.4.3.	Conditional probability and joint probability	49
2.5.	A Teaspoon of Information Theory	51
2.6.	A Tip of a Teaspoon of Mathematics, Physics and Chemistry	60
2.7.	A Matter of Lottery	67
2.8.	A Matter of Order-Disorder	69
2.9.	A Challenging Problem	70
2.10.	Answers to the Problems	73
2.10.1.	Answers to the roulette problems . . .	73
2.10.2.	Answer to “a matter of lottery”	74
2.10.3.	Answer to “a matter of order-disorder”	75
2.10.4.	Answer to “a challenging problem” . .	76
3	First Let Us Play with Real Dice	78
3.1.	One Die	78
3.2.	Two Dice	79
3.3.	Three Dice	84
3.4.	Four Dice and More	86
4	Let’s Play with Simplified Dice and have a Preliminary Grasp of the Second Law	92
4.1.	Two Dice; $N = 2$	95
4.2.	Four Dice; $N = 4$	98
4.3.	Ten Dice; $N = 10$	100
4.4.	Hundred Dice; $N = 100$	106
4.5.	Thousand Dice; $N = 1000$	108
4.6.	Ten Thousand Dice; $N = 10^4$ and Beyond . . .	110
5	Experience the Second Law with all Your Five Senses	116
5.1.	See it with your Visual Sense	117
5.2.	Smell it with your Olfactory Sense	119

5.3. Taste it with your Gustatory Sense 122

5.4. Hear it with your Auditory Sense 123

5.5. Feel it with your Touch (Tactile) Sense 125

6 Finally, Grasp it with Your Common Sense 129

7 Translating from the Dice-World to the Real World 146

7.1. The Correspondence with the Expansion Process 147

7.2. The Correspondence with the Deassimilation Process 157

7.3. Summary of the Evolution of the System towards the Equilibrium State 164

7.4. Mixing of Three Components 172

7.5. Heat Transfer from a Hot to a Cold Gas 174

7.6. Test Your Understanding of the Second Law . . 180

8 Reflections on the Status of the Second Law of Thermodynamics as a Law of Physics 186

8.1. What is the Source of the Mystery? 189

8.2. The Association of Entropy with “Disorder” . 196

8.3. The Association of Entropy with Missing Information 199

8.4. Is the Second Law Intimately Associated with the Arrow of Time? 208

8.5. Is the Second Law of Thermodynamics a Law of Physics? 213

8.6. Can We Do Away with the Second Law? 216

References and Suggested Reading 219

Index 223