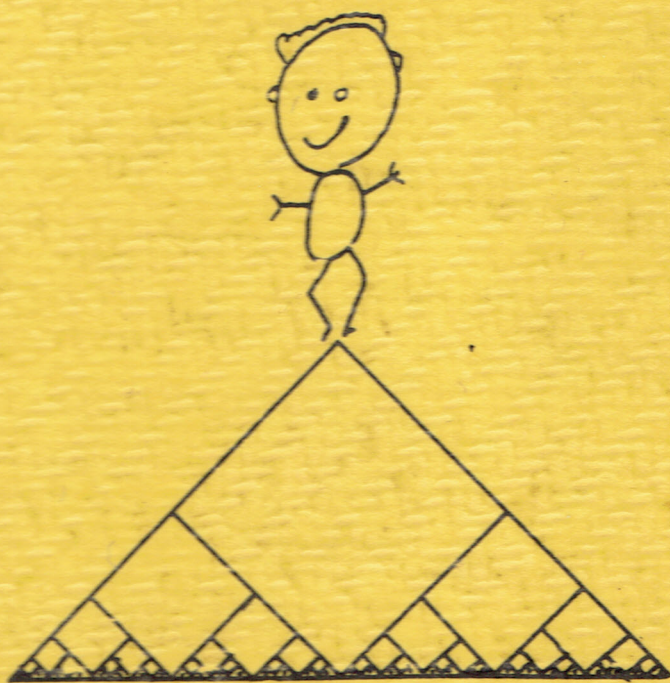


# FROM ABOVE THE WEB

**A NEW LOOK AT PHYSICS  
AND ITS EXTENSIONS**



## ABOUT THE AUTHORS

The authors wrote this book during the summer after their second year at the University of British Columbia. Together, they have studied physics, mathematics, chemistry, psychology, biology, astronomy, and philosophy. Their position as students makes them fully aware of the difficulties and rewards of learning, and for this reason they feel competent in writing this book.

Certainly these students are not professional authors, and as a result they possess quite varied writing styles. As an aid to the reader, then, we present the following table of the contributions of the individual authors. This is not an indication of the relative amounts of work performed by these individuals, as the work load varies tremendously from subject to subject. Its purpose is to account for changes of style which may otherwise reflect upon the subjects in question.

|                             | Preliminary Writing | Final Writing |
|-----------------------------|---------------------|---------------|
| Mathematics                 | L.W.                | L.W.          |
| Newtonian Mechanics         | J.A., L.W.          | L.W.          |
| Thermodynamics              | J.A.                | L.W.          |
| Special Relativity          | L.W.                | L.W.          |
| Atomic & Sub-Atomic Physics | S.A., M.T.          | L.W.          |
| Chemistry                   | S.A.                | S.A.          |
| Biology                     | S.A.                | S.A.          |
| Astronomy                   | M.T.                | M.T.          |

## ON THE COVER

The drawing on the cover symbolizes the pleasure of viewing the relationships of the universe in a simplified manner. The ascending lines, beginning from infinite detail at the bottom and finally forming a single point at the top, represent the way in which a person can bring various thoughts together in order to perceive the universe as a beautiful whole.

## ACKNOWLEDGEMENTS

The authors are indebted to the Canadian Government Opportunities for Youth Program, for financing the writing of this book.

In addition, they would like to thank the following individuals for their kind support and advice:

Doug Black  
Dr. A. Bree  
Donald Dashwood-Jones  
Lorenz von Ferson  
P. C. Gregory  
Bill Little  
Jura Loudon  
Dr. K. C. Mann  
Dr. H. B. Richer  
Dr. R. C. Riddel  
Manfred Schmidt  
Dr. D. Suzuki  
Dr. B. G. Turrel  
Dr. E. W. Vogt

Finally, we give our special thanks to Martha Whitehead for her patient, competent help in the editing, proof reading, and typing of this book.

## CONTENTS

|  |     |
|--|-----|
| INTRODUCTION TO BOOK   | 11  |
| A BRIEF OUTLINE  | 14  |
| MATHEMATICS  |     |
| Introduction   | 19  |
| The Logic of Mathematics   | 19  |
| Numbers and Their Meaning  | 21  |
| Geometry   | 28  |
| The Combination of Geometry and the Study of Numbers                                 | 33  |
| Probability  | 37  |
| Conclusion   | 39  |
| Bibliography for Mathematics   | 40  |
| NEWTONIAN MECHANICS - CHART  |     |
| Introduction   | 41  |
| #1: The Concept of Time  | 42  |
| #2: The Concept of Length  | 43  |
| #3: The Geometry of Nature   | 45  |
| #4: The Concept of Force   | 46  |
| #5: Position and the Vector Concept  | 47  |
| #6: The Concepts of Velocity and Acceleration  | 52  |
| #7: Newton's First Law of Motion - The Concept of the<br>Inertial Reference Frame    | 61  |
| #8: Experimental Evidence Regarding Force and Acceleration                           | 63  |
| #9: The Proportionality of Acceleration and Force                                    | 65  |
| #10: Momentum  | 68  |
| #11: Experimental Considerations of Pairs and Forces                                 | 69  |
| #12: Newton's Third Law of Motion  | 71  |
| #13: The Principle of Conservation of Momentum                                       | 72  |
| #14: The Experimental Basis for the Definition of Work                               | 74  |
| #15: The Definition of Mechanical Work   | 77  |
| #16: The Definition of Kinetic Energy  | 79  |
| #17: The Definition of Potential Energy and the Conservation<br>of Mechanical Energy | 83  |
| A Final Overview of Newtonian Mechanics  | 86  |
| Appendix: 1) Gravitation   | 91  |
| 2) Multi-particle Systems  | 93  |
| 3) Electricity and Magnetism   | 97  |
| 4) Wave Motion   | 101 |
| 5) Maxwell's Theory of Electromagnetic Radiation                                     | 106 |
| Bibliography for Newtonian Mechanics   | 109 |

|  |     |
|--|-----|
| THERMODYNAMICS - CHART   | 111 |
| Introduction   | 112 |
| Part A. Classical Thermodynamics   |     |
| #1: Systems and States   | 113 |
| #2: Equilibrium and Processes  | 114 |
| #3: Pressure   | 117 |
| #4: Volume   | 120 |
| #5: The Sense of Temperature   | 121 |
| #6: Experimental Basis for Temperature Measurement   | 122 |
| #7: The Law of Thermal Equilibrium and Temperature Measurement   | 123 |
| #8: The Experimental Observations of Heat  | 127 |
| #9: Work, In Terms of Pressure and Volume  | 130 |
| #10: The First Law of Thermodynamics   | 132 |
| #11: The Existence of Phenomena Which Occur in Only One Direction in Time  | 136 |
| #12: The Second Law of Thermodynamics  | 137 |
| #13: Entropy   | 139 |
| #14: Equations of State and the Ideal Gas Law  | 145 |
| #15: The Carnot Cycle - the Efficiency of a Reversible Ideal Gas Engine  | 147 |
| #16: General Statements of Engine Efficiency   | 151 |
| #17: Another Definition of Temperature   | 153 |
| #18: The End of the Classical Thermodynamic Road - Absolute Zero   | 154 |
| Part B. Microscopic Thermodynamics   |     |
| #19: The Basic Assumptions of the Kinetic Particle Theory  | 156 |
| #20: The Kinetic Particle Theory Predictions of Gas Properties   | 158 |
| #21: Statistical Ideas in Thermodynamics   | 164 |
| #22: A Statistical Description of Heat Flow and the Related Ideas of Equilibrium, Reversibility, Entropy, and Time | 165 |
| #23: Maxwell-Boltzmann Velocity Distribution   | 171 |
| #24: Prediction of the Properties of Gases   | 173 |
| A Final Overview of the Development of Thermodynamics  | 175 |
| Bibliography for Thermodynamics  | 181 |
| SPECIAL RELATIVITY - CHART   | 183 |
| Introduction   | 184 |
| #1: The Constancy of the Speed of Light  | 185 |
| #2: The Equivalence of all Inertial Frames   | 188 |
| #3: A Clear Definition of a Reference Frame  | 189 |
| #4: The Lorentz Transformations - The Heart of Special Relativity  | 191 |
| #5: Relativistic Momentum  | 208 |
| #6: The Meaning of Relativistic Mass   | 211 |
| #7: Relativistic Force   | 213 |
| #8: The Definition of Mechanical Work  | 216 |
| #9: The Relationship Between Kinetic Energy and Relativistic Mass  | 217 |

## SPECIAL RELATIVITY cont'd

|   |     |
|---|-----|
| #10: The Relationship Between Internal Energy and Rest Mass | 221 |
| #11: $E = mc^2$   | 226 |
| A Final Overview of the Logic of Special Relativity         | 228 |
| Bibliography for Special Relativity                         | 233 |

## ATOMIC &amp; SUB-ATOMIC PHYSICS - CHART 234

|   |     |
|---|-----|
| Introduction  | 235 |
| #1: The Existence of Atoms                                      | 236 |
| #2: Mass Ratios of Chemical Observations                        | 239 |
| #3: The Relative Volumes of Reacting Gases                      | 240 |
| #4: Relative Atomic Weights                                     | 242 |
| #5: The Discovery of the Electron                               | 244 |
| #6: Mass Spectroscopy and Isotopes                              | 247 |
| #7: The Rutherford Nucleus                                      | 249 |
| #8: The Nuclear Particles - The Proton and the Neutron          | 251 |
| #9: Our Over-all Picture of the Atom                            | 256 |
| #10: Experiments Regarding the Nature of Radiation              | 259 |
| #11: The Wave-like Nature of the Sub-Atomic Particles           | 263 |
| #12: The Nature of the Wave Particle Duality                    | 265 |
| #13: Heisenburg's Uncertainty Principle                         | 268 |
| #14: Radiation Spectra  | 271 |
| #15: The Quantum Description of the Atom                        | 273 |
| #16: Chemical Properties and the Periodic Chart of the Elements | 281 |
| #17: Experimental Techniques for Observing Nuclear Particles    | 289 |
| #18: Detailed Study of the Sub-Atomic Particles                 | 295 |
| #19: The Structure of the Nucleus                               | 299 |
| #20: Nuclear Forces and Energy Levels                           | 301 |
| #21: Nuclear Fission, Nuclear Fusion, and Radioactivity         | 304 |
| #22: The Nature of Forces                                       | 308 |
| A Final Overview of Atomic and Sub-Atomic Physics               | 310 |
| Bibliography for Atomic & Sub-Atomic Physics                    | 314 |

## CHEMISTRY - CHART (part 6) 316

|   |     |
|---|-----|
| Periodic Chart of the Elements          | 317 |
| Introduction to Chemistry and Biology   | 318 |
| #1: Periodic Properties of the Elements | 319 |
| #2: Bonding                             | 321 |
| #3: Reactions                           | 329 |
| #4: Solutions and Electrolytes          | 342 |
| #5: Organic Chemistry and Biomolecules  | 348 |
| Bibliography for Chemistry              | 362 |

## BIOLOGY - CHART (part 7) 316

|                               |     |
|-------------------------------|-----|
| #6: The Functions of Life     | 364 |
| #7: Cell Compartmentalization | 373 |

## BIOLOGY cont'd

|   |     |
|---|-----|
| #8: Utilization of Energy                 | 379 |
| #9: Control                               | 390 |
| #10: Enzymes                              | 404 |
| #11: Genetics and Evolution               | 408 |
| #12: Diversity                            | 418 |
| A Final Overview of Chemistry and Biology | 436 |
| Bibliography for Biology                  | 437 |

## ASTRONOMY - CHART (part 8)

|  |     |
|--|-----|
| Introduction                                     | 440 |
| #1: Planet Earth                                 | 441 |
| #2: Earth-Sun Relations                          | 446 |
| #3: The Solar System                             | 448 |
| #4: Distance and Spectra of Stars                | 450 |
| #5: Stars' Energy Processes                      | 455 |
| #6: Stellar Evolution, Pulsars, and Black Holes  | 459 |
| #7: Cosmogony and Life                           | 464 |
| #8: Galactic Distances                           | 467 |
| #9: The Red Shift                                | 469 |
| #10: Galaxy and Quasar Properties                | 471 |
| #11: $3^{\circ}\text{K}$ Radiation and Cosmology | 474 |
| A Final Overview of Astronomy                    | 476 |
| Bibliography for Astronomy                       | 479 |

## CONCLUSION

481

|  |     |
|--|-----|
| APPENDIX 1: A Discussion of Dimensional Analysis | 483 |
| 2: A List of Useful Formulas                     | 489 |
| 3: Physical Constants                            | 492 |