

Contents

■ RADIOACTIVITY

1. Origins and Discovery	1
The Greek Elements and the Indivisible Atom	1
Twentieth Century Science and the Multi-Corpuscular Atom	4
Discovery of Radioactivity	5
Structure of the Atom: Kelvin-Thomson “Plum Pudding” Atom	6
Bohr-Sommerfeld Model of the Atom	8
The Neutron	11
Wave/Particle Duality: The de Broglie Relation and Wave Mechanics	12
Classification of the Elements	14
Synthesis of the Elements in Nature	15
2. Nuclear Energetics	19
Nuclear Units – Atomic Mass Unit and the Electron Volt	19
Nuclear and Atomic Masses	19
Atomic and Molecular Weights	20
Avogadro’s Number	21
Mass of an Atom and Atomic Number Density	22
Relativistic Mechanics and Einstein’s Mass/Energy Equivalence	23
Binding Energy of the Nucleus	24
Nucleon Separation Energy	26
<i>Q</i> -Value for a Reaction	28
Energy Level Diagrams	29
Nuclear Spin and Parity	30
Nuclear Isomerism	31
Nuclide Charts	31
3. Radioactivity and Nuclear Reactions	43
Simple Radioactive Decay: Half-life and Decay Constant	44
Activity	44
Average (Mean) Lifetime	45
Branching Ratios and Number of Decay Modes	45
Decay Chains	46
Radioactive Equilibria	49

Decay Energy	52
Nuclear Reactions	53
Cross-sections	54
Neutron Reactions	56
Burnout Time	56
4. Types of Radioactive Decay	59
Decay Modes	59
Alpha (α) Decay	62
Beta-minus (β^-) Decay	64
Gamma Emission and Isomeric Transition (IT)	67
Internal Conversion (IC)	68
Beta-plus (β^+) Decay (Positron Emission)	69
Electron Capture (ϵ or ec)	71
Spontaneous Fission (SF)	73
Proton Decay	77
Special Beta-Decay Processes	79
Heavy-Ion or Cluster Radioactivity	81
Magic Radioactivity	82
Decay of Bare Nuclei – Bound Beta Decay	83
Halo Nuclides	86
 ■ RADIONUCLIDES	
5. Transmutation Research	89
How Constant is the Decay Constant?	89
Natural Transmutation by Radioactive Decay	90
Synthesis of Superheavy Elements by Transmutation	91
Laser Transmutation	92
6. Archaeology and Dating	105
Radioactive Dating	105
An Astrophysical Clock	108
Age of the Earth	109
Prehistoric Cave Art at Altamira, Northern Spain	111
The Age of Groundwater – The Oasis Ballad Seet	112
Nuclear Forensic Science – Age of Plutonium Particles	114
7. Radioisotopes in Medicine	117
Imaging	117
External Beam Radiotherapy	119
Brachytherapy	119
Immunotherapy	119
Ion Beam Therapy	119
Boron Neutron Capture Therapy	120
Radioactive “Bullets” – Alpha-Immunotherapy	121

8. Scientific and Industrial Applications	125
Radioisotope Tracers	126
Radiography and Gauging	128
Radiation Processing	133
Nuclear Batteries	135
■ RADIATION	
9. Radiation and the Environment	139
Biological Effects of Ionising Radiation	139
Radiotoxicity and Annual Limits of Intake	142
Radiation Hormesis and the Linear Non-Threshold (LNT) Model	144
High Background Radiation Areas Around the World	146
Radon: A Test for the LNT Hypothesis?	147
Radiation Exposure in High-Flying Aircraft	149
Conan the Bacterium	152
Packaging and Transport of Radioactive Materials	153
Nuclear Waste Disposal	155
Nuclear Tests in the South Pacific	158
The Chernobyl Accident	161
The Goiânia Radiation Incident – a Benchmark for Radiological Dispersion Devices (RDDs)	162
References	167
Recommended Reading and Weblinks	175
Reading	175
Weblinks	176
Glossary	177
Appendices	189
Appendix A: Physical Constants, Conversion Factors, Prefixes, Greek Alphabet	189
Appendix B: Table of the Elements	191
Appendix C: Properties of the Elements	194
Appendix D: Table of Atomic Masses	197
Appendix E: Universal Nuclide Chart	229
Computer System Requirements	229
User Interface	230
Radioactive Decay Chain Simulator	233
Neutron Reaction Path Simulator	236
Appendix F: Periodic Table of the Elements	239
Appendix G: Karlsruhe Chart of the Nuclides – Karlsruher Nuklidkarte	243
Index	249

<http://www.springer.com/978-3-540-21116-7>

Radioactivity Radionuclides Radiation

Magill, J.; Galy, J.

2005, VII, 264 p. With online files/update., Hardcover

ISBN: 978-3-540-21116-7