

Contents

Preface	VII
1 Introduction	1
2 Units of Radiation Protection	4
2.1 Supplementary Information	14
2.2 Problems	18
3 Basic Nuclear Physics	19
3.1 Supplementary Information	28
3.2 Problems	30
4 Interaction of Ionizing Radiation with Matter	31
4.1 Detection of Charged Particles	31
4.2 Detection of Neutrons	39
4.3 Detection of Photons	41
4.4 Supplementary Information	46
4.5 Problems	56
5 Detectors for Radiation Protection	57
5.1 Ionization Chamber	57
5.2 Proportional Counters and Geiger–Müller Counters	59
5.3 Scintillation Counters	62
5.4 Semiconductor Counters	66
5.5 Neutron Dosimeters	70
5.6 Personal Dosimeters	71
5.7 Measurement of Incorporations and Contaminations	80
5.8 Supplementary Information	82
5.9 Problems	89

6	International Safety Standards for Radiation Protection	90
6.1	European Directive	91
6.2	American Directive	93
6.3	Other Countries	98
6.3.1	Australia	98
6.3.2	Brazil	99
6.3.3	Canada	100
6.3.4	China	101
6.3.5	India	101
6.3.6	Japan	102
6.3.7	Mexico	103
6.3.8	Russia	104
6.3.9	South Africa	105
6.4	Supplementary Information	106
6.5	Problems	109
7	Organization of Radiation Protection	110
7.1	Supplementary Information	116
7.2	Problems	117
8	Practical Safety Measures	119
8.1	Licensing	120
8.2	Design Approval	122
8.3	Arrangements for Fire Fighting	123
8.4	Arrangements for Mitigating the Consequences of Severe or Design-Basis Accidents	124
8.5	Instruction and Training	124
8.6	Protection of Air, Water, and Soil	125
8.7	Special Reasons for Radiation Exposure	126
8.8	Handling of Unsealed Radioactive Sources	126
8.9	Medical Supervision	128
8.10	Storage and Security of Radioactive Substances	129
8.11	Bookkeeping	129
8.12	Waste Treatment and Storage of Radioactive Waste	130
8.13	Packaging and Transport	133
8.14	Supplementary Information	137
8.15	Problems	141

9	Radiation Sources	143
9.1	Particle Radiation	143
9.2	Photon Sources	146
9.3	Neutron Sources	148
9.4	Cosmic-Ray Sources	149
9.5	Supplementary Information	151
9.6	Problems	158
10	X Rays and X-Ray Regulations	160
10.1	Supplementary Information	163
10.2	Problems	168
11	Environmental Radioactivity	169
11.1	Cosmic Rays	169
11.2	Terrestrial Radiation	172
11.3	Incorporation of Radioisotopes	173
11.4	Radiation Exposure by Technical Installations ...	176
11.5	Supplementary Information	185
11.6	Problems	189
12	Nuclear Power Plants	190
12.1	Nuclear-Fission Reactors	191
12.2	Fusion Reactors	198
	12.2.1 Inertial Fusion	200
	12.2.2 Fusion by Magnetic Containment	203
12.3	Supplementary Information	206
12.4	Problems	210
13	Biological Effects of Ionizing Radiation	212
13.1	Supplementary Information	219
13.2	Problems	227
14	Radiation Accidents	229
14.1	Supplementary Information	235
14.2	Problems	237
15	Non-Ionizing Radiation	238
15.1	Supplementary Information	241
15.2	Problems	246

16	Solutions to the Problems	247
16.1	Solutions to the Problems of Chapter 2	247
16.2	Solutions to the Problems of Chapter 3	249
16.3	Solutions to the Problems of Chapter 4	251
16.4	Solutions to the Problems of Chapter 5	253
16.5	Solutions to the Problems of Chapter 6	254
16.6	Solutions to the Problems of Chapter 7	256
16.7	Solutions to the Problems of Chapter 8	257
16.8	Solutions to the Problems of Chapter 9	258
16.9	Solutions to the Problems of Chapter 10	260
16.10	Solutions to the Problems of Chapter 11	261
16.11	Solutions to the Problems of Chapter 12	262
16.12	Solutions to the Problems of Chapter 13	263
16.13	Solutions to the Problems of Chapter 14	266
16.14	Solutions to the Problems of Chapter 15	268
	Formulary	270
17	Written Test on Radiation Protection	272
17.1	Problems	272
17.2	Solutions for the Written Test	278
18	Radiation-Protection Glossary	279
	Appendixes	323
A	Table of Frequently Used Radioisotopes	323
B	Exemption Limits for Absolute and Specific Activities ..	326
C	Maximum Permitted Activity Concentrations Discharged from Radiation Areas	329
D	Examples of Limits for Surface Contaminations	333
E	Definition of Radiation Areas	335
F	Radiation Weighting Factors w_R	336
G	Tissue Weighting Factors w_T	337
H	Physical Constants	338
I	Useful Conversions	339
J	List of Abbreviations	340

K	List of Elements	345
L	Decay Chains	348
M	List of Isotopes Frequently Used in Nuclear Medicine and Radiology	350
N	Critical Organs for Various Radioisotopes	355
O	Simplified Table of Isotopes and Periodic Table of Elements	360
P	Decay-Level Schemes	368
Q	Introduction into the Basics of Mathematics	374
	Q.1 Derivatives and Integrals	374
	Q.2 Exponential Function	377
	Q.3 Natural Logarithm	378
	Further Reading	381
	Photo Credit for Commercial Products	390
	Index	399