

## Chapter 16: Selected Radioactive Isotopes

Decay modes are  $\alpha$ ,  $\beta^-$ ,  $\beta^+$ , electron capture (EC) and isomeric transition (IT). EC results in the same daughter nucleus as would  $\beta^+$  decay. IT is a transition from a metastable excited state. Energies for  $\beta^\pm$  decays are the maxima; average energies are roughly one-half the maxima.

Table *Chapter*16.1: Selected Radioactive Isotopes

| Isotope          | $t_{1/2}$                    | DecayMode(s)        | Energy(MeV) | Percent |                  | $\gamma$ -Ray<br>Energy(MeV) | Percent |
|------------------|------------------------------|---------------------|-------------|---------|------------------|------------------------------|---------|
| $^3\text{H}$     | 12.33 y                      | $\beta^-$           | 0.0186      | 100%    |                  |                              |         |
| $^{14}\text{C}$  | 5730 y                       | $\beta^-$           | 0.156       | 100%    |                  |                              |         |
| $^{13}\text{N}$  | 9.96 min                     | $\beta^+$           | 1.20        | 100%    |                  |                              |         |
| $^{22}\text{Na}$ | 2.602 y                      | $\beta^+$           | 0.55        | 90%     | $\gamma$         | 1.27                         | 100%    |
| $^{32}\text{P}$  | 14.28 d                      | $\beta^-$           | 1.71        | 100%    |                  |                              |         |
| $^{35}\text{S}$  | 87.4 d                       | $\beta^-$           | 0.167       | 100%    |                  |                              |         |
| $^{36}\text{Cl}$ | $3.00 \times 10^5 \text{ y}$ | $\beta^-$           | 0.710       | 100%    |                  |                              |         |
| $^{40}\text{K}$  | $1.28 \times 10^9 \text{ y}$ | $\beta^-$           | 1.31        | 89%     |                  |                              |         |
| $^{43}\text{K}$  | 22.3 h                       | $\beta^-$           | 0.827       | 87%     | $\gamma\text{s}$ | 0.373                        | 87%     |
|                  |                              |                     |             |         |                  | 0.618                        | 87%     |
| $^{45}\text{Ca}$ | 165 d                        | $\beta^-$           | 0.257       | 100%    |                  |                              |         |
| $^{51}\text{Cr}$ | 27.70 d                      | EC                  |             |         | $\gamma$         | 0.320                        | 10%     |
| $^{52}\text{Mn}$ | 5.59d                        | $\beta^+$           | 3.69        | 28%     | $\gamma\text{s}$ | 1.33                         | 28%     |
|                  |                              |                     |             |         |                  | 1.43                         | 28%     |
| $^{52}\text{Fe}$ | 8.27 h                       | $\beta^+$           | 1.80        | 43%     |                  | 0.169                        | 43%     |
|                  |                              |                     |             |         |                  | 0.378                        | 43%     |
| $^{59}\text{Fe}$ | 44.6 d                       | $\beta^- \text{ s}$ | 0.273       | 45%     | $\gamma\text{s}$ | 1.10                         | 57%     |
|                  |                              |                     | 0.466       | 55%     |                  | 1.29                         | 43%     |
| $^{60}\text{Co}$ | 5.271 y                      | $\beta^-$           | 0.318       | 100%    | $\gamma\text{s}$ | 1.17                         | 100%    |
|                  |                              |                     |             |         |                  | 1.33                         | 100%    |
| $^{65}\text{Zn}$ | 244.1 d                      | EC                  |             |         | $\gamma$         | 1.12                         | 51%     |
| $^{67}\text{Ga}$ | 78.3 h                       | EC                  |             |         | $\gamma\text{s}$ | 0.0933                       | 70%     |
|                  |                              |                     |             |         |                  | 0.185                        | 35%     |
|                  |                              |                     |             |         |                  | 0.300                        | 19%     |
|                  |                              |                     |             |         |                  | others                       |         |
| $^{75}\text{Se}$ | 118.5 d                      | EC                  |             |         | $\gamma\text{s}$ | 0.121                        | 20%     |
|                  |                              |                     |             |         |                  | 0.136                        | 65%     |
|                  |                              |                     |             |         |                  | 0.265                        | 68%     |
|                  |                              |                     |             |         |                  | 0.280                        | 20%     |

| Isotope                                     | $t_{1/2}$                     | DecayMode(s) | Energy(MeV) | Percent         |            | $\gamma$ -Ray<br>Energy(MeV) | Percent         |
|---|-------------------------------|--------------|-------------|-----------------|------------|------------------------------|-----------------|
|   |                               |              |             |                 |            | others                       |                 |
| <b><math>^{86}\text{Rb}</math></b>          | 18.8 d                        | $\beta^-$ s  | 0.69        | 9%              | $\gamma$   | 1.08                         | 9%              |
|   |                               |              | 1.77        | 91%             |            |                              |                 |
| <b><math>^{85}\text{Sr}</math></b>          | 64.8 d                        | EC           |             |                 | $\gamma$   | 0.514                        | 100%            |
| <b><math>^{90}\text{Sr}</math></b>          | 28.8 y                        | $\beta^-$    | 0.546       | 100%            |            |                              |                 |
| <b><math>^{90}\text{Y}</math></b>           | 64.1 h                        | $\beta^-$    | 2.28        | 100%            |            |                              |                 |
| <b><math>^{99\text{m}}\text{Tc}</math></b>  | 6.02 h                        | IT           |             |                 | $\gamma$   | 0.142                        | 100%            |
| <b><math>^{113\text{m}}\text{In}</math></b> | 99.5 min                      | IT           |             |                 | $\gamma$   | 0.392                        | 100%            |
| <b><math>^{123}\text{I}</math></b>          | 13.0 h                        | EC           |             |                 | $\gamma$   | 0.159                        | $\approx 100\%$ |
| <b><math>^{131}\text{I}</math></b>          | 8.040 d                       | $\beta^-$ s  | 0.248       | 7%              | $\gamma$ s | 0.364                        | 85%             |
|   |                               |              | 0.607       | 93%             |            | others                       |                 |
|   |                               |              | others      |                 |            |                              |                 |
| <b><math>^{129}\text{Cs}</math></b>         | 32.3 h                        | EC           |             |                 | $\gamma$ s | 0.0400                       | 35%             |
|   |                               |              |             |                 |            | 0.372                        | 32%             |
|   |                               |              |             |                 |            | 0.411                        | 25%             |
|   |                               |              |             |                 |            | others                       |                 |
| <b><math>^{137}\text{Cs}</math></b>         | 30.17 y                       | $\beta^-$ s  | 0.511       | 95%             | $\gamma$   | 0.662                        | 95%             |
|   |                               |              | 1.17        | 5%              |            |                              |                 |
| <b><math>^{140}\text{Ba}</math></b>         | 12.79 d                       | $\beta^-$    | 1.035       | $\approx 100\%$ | $\gamma$ s | 0.030                        | 25%             |
|   |                               |              |             |                 |            | 0.044                        | 65%             |
|   |                               |              |             |                 |            | 0.537                        | 24%             |
|   |                               |              |             |                 |            | others                       |                 |
| <b><math>^{198}\text{Au}</math></b>         | 2.696 d                       | $\beta^-$    | 1.161       | $\approx 100\%$ | $\gamma$   | 0.412                        | $\approx 100\%$ |
| <b><math>^{197}\text{Hg}</math></b>         | 64.1 h                        | EC           |             |                 | $\gamma$   | 0.0733                       | 100%            |
| <b><math>^{210}\text{Po}</math></b>         | 138.38 d                      | $\alpha$     | 5.41        | 100%            |            |                              |                 |
| <b><math>^{226}\text{Ra}</math></b>         | $1.60 \times 10^3 \text{ y}$  | $\alpha$ s   | 4.68        | 5%              | $\gamma$   | 0.186                        | 100%            |
|   |                               |              | 4.87        | 95%             |            |                              |                 |
| <b><math>^{235}\text{U}</math></b>          | $7.038 \times 10^8 \text{ y}$ | $\alpha$     | 4.68        | $\approx 100\%$ | $\gamma$ s | numerous                     | <0.400%         |
| <b><math>^{238}\text{U}</math></b>          | $4.468 \times 10^9 \text{ y}$ | $\alpha$ s   | 4.22        | 23%             | $\gamma$   | 0.050                        | 23%             |
|   |                               |              | 4.27        | 77%             |            |                              |                 |
| <b><math>^{237}\text{Np}</math></b>         | $2.14 \times 10^6 \text{ y}$  | $\alpha$ s   | numerous    |                 | $\gamma$ s | numerous                     | <0.250%         |
|   |                               |              | 4.96 (max.) |                 |            |                              |                 |
| <b><math>^{239}\text{Pu}</math></b>         | $2.41 \times 10^4 \text{ y}$  | $\alpha$ s   | 5.19        | 11%             | $\gamma$ s | $7.5 \times 10^{-5}$         | 73%             |
|   |                               |              | 5.23        | 15%             |            | 0.013                        | 15%             |

| Isotope                             | $t_{1/2}$                                      | DecayMode(s)                       | Energy(MeV) | Percent |                                    | $\gamma$ -Ray<br>Energy(MeV) | Percent |
|-------------------------------------|--|------------------------------------|-------------|---------|------------------------------------|------------------------------|---------|
|                                     |  |                                    | 5.24        | 73%     |                                    | 0.052                        | 10%     |
|                                     |  |                                    |             |         |                                    | others                       |         |
| <b><math>^{243}\text{Am}</math></b> | <b><math>7.37 \times 10^3 \text{ y}</math></b> | <b><math>\alpha\text{s}</math></b> | Max. 5.44   |         | <b><math>\gamma\text{s}</math></b> | 0.075                        |         |
|                                     |  |                                    | 5.37        | 88%     |                                    | others                       |         |
|                                     |  |                                    | 5.32        | 11%     |                                    |                              |         |
|                                     |  |                                    | others      |         |                                    |                              |         |

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