23. We first "separate" all the nucleons in one copper nucleus (which amounts to simply calculating the nuclear binding energy) and then figure the number of nuclei in the penny (so that we can multiply the two numbers and obtain the result). To begin, we note that (using Eq. 43-1 with Appendix F and/or G) the copper-63 nucleus has 29 protons and 34 neutrons. We use the more accurate values given in Sample Problem 43-3:

$$\Delta E_{\text{be}} = (29(1.007825\,\text{u}) + 34(1.008665\,\text{u}) - 62.92960\,\text{u})\,(931.5\,\text{MeV/u}) = 551.4\ \text{MeV}\ .$$

To figure the number of nuclei (or, equivalently, the number of atoms), we adapt Eq. 43-20:

$$N_{\text{Cu}} = \left(\frac{3.0\,\text{g}}{62.92960\,\text{g/mol}}\right)\left(6.02 \times 10^{23}\,\text{atoms/mol}\right) \approx 2.9 \times 10^{22}\ \text{atoms}\ .$$

Therefore, the total energy needed is

$$N_{\text{Cu}}\Delta E_{\text{be}} = (551.4\,\text{MeV})\left(2.9 \times 10^{22}\right) = 1.6 \times 10^{25}\ \text{MeV}\ .$$