3. In each case the atomic number equals the number of protons \( Z \), and the atomic charge is \( Z e \).

\( ^2_2\text{He} \): \( Z = 2, N = 1, A = 3, m = 3.02 \text{ u} \)

\( ^4_2\text{He} \): \( Z = 2, N = 2, A = 4, m = 4.00 \text{ u} \)

\( ^8_8\text{O} \): \( Z = 8, N = 9, A = 17, m = 17.0 \text{ u} \)

\( ^{40}_{20}\text{Ca} \): \( Z = 20, N = 22, A = 42, m = 42.0 \text{ u} \)

\( ^{206}_{82}\text{Pb} \): \( Z = 82, N = 128, A = 210, m = 210.0 \text{ u} \)

\( ^{238}_{92}\text{U} \): \( Z = 92, N = 143, A = 235, m = 235.0 \text{ u} \)

4. The required force is

\[
|F_e| = \frac{ke^2}{r^2} = \frac{(8.988 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2) \left(1.602 \times 10^{-19} \text{ C}\right)^2}{(2 \times 10^{-15} \text{ m})^2} = 58 \text{ N}
\]

We can also compare the potential energy:

\[
|V| = \frac{ke^2}{r} = \frac{(8.988 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2) \left(1.602 \times 10^{-19} \text{ C}\right)^2}{(2 \times 10^{-15} \text{ m})(1.602 \times 10^{-13} \text{ J/MeV})} = 0.72 \text{ MeV}
\]

16. a) As in the previous problem, consider the nucleus as the composite of \(^{A-1}_{Z-1}\text{Y} \) and \(^1\text{H} \), so that

\[
B = [M \left(\frac{A-1}{Z-1}\text{Y}\right) + M \left(^1\text{H}\right) - M \left(\frac{2}{X}\right)] c^2
\]

b) \(^8\text{Be}\):

\[
B = [M \left(^7\text{Li}\right) + M \left(^1\text{H}\right) - M \left(^8\text{Be}\right)] c^2
= (7.016004 \text{ u} + 1.007825 \text{ u} - 8.005305 \text{ u}) c^2 \left(931.49 \text{ MeV/}(\text{u} \cdot c^2)\right) = 17.3 \text{ MeV}
\]

\(^{15}\text{O}\):

\[
B = [M \left(^{14}\text{N}\right) + M \left(^1\text{H}\right) - M \left(^{15}\text{O}\right)] c^2 = 7.3 \text{ MeV}
\]

\(^{32}\text{S}\):

\[
B = [M \left(^{31}\text{P}\right) + M \left(^1\text{H}\right) - M \left(^{32}\text{S}\right)] c^2 = 8.9 \text{ MeV}
\]

17. The energy release comes from the mass difference:

\[
\Delta E = \Delta mc^2 = (3M \left(^4\text{He}\right) - M \left(^{12}\text{C}\right)) c^2
= [3 \left(4.002603 \text{ u}\right) - 12.000 \text{ u}] c^2 \left(931.49 \text{ MeV/}(\text{u} \cdot c^2)\right) = 7.27 \text{ MeV}
\]

25. \( \lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{(5.271 \text{ y})(3.156 \times 10^7 \text{ s/y})} = 4.167 \times 10^{-9} \text{ s}^{-1} \)

\[
N = \frac{R}{\lambda} = \frac{2.4 \times 10^7 \text{ s}^{-1}}{4.167 \times 10^{-9} \text{ s}^{-1}} = 5.76 \times 10^{15}
\]

\[
m = (5.76 \times 10^{15}) \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ mol}} = 0.57 \text{ g}
\]

26. \( R = R_0 e^{-\lambda t} \) at \( t = T = 3600 \text{ s} \)

\[
\lambda = \frac{\ln 5}{T}
\]

\[
t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{\ln 5} T = \frac{\ln 2}{\ln 5} (3600 \text{ s}) = 1550 \text{ s} \approx 26 \text{ minutes}
\]
51. From the $A$ values it is clear that there are $28/4 = 7$ alpha decays. Seven alpha decays reduces $Z$ from 92 to 78, so there must be four $\beta^-$ decays in order to bring $Z$ up to 82. There are other possible combinations of beta decays (including $\beta^+$ and electron capture), but the net result must be a change of four charge units. We would have to look at a table of nuclides to determine the exact chain(s).