8. (a) The atomic number Z = 39 corresponds to the element yttrium (see Appendix F and/or Appendix G).

(b) The atomic number Z = 53 corresponds to iodine.

(c) A detailed listing of stable nuclides (such as the website http://nucleardata.nuclear.lu.se/nucleardata) shows that the stable isotope of yttrium has 50 neutrons (this can also be inferred from the Molar Mass values listed in Appendix F).

(d) Similarly, the stable isotope of iodine has 74 neutrons

(e) The number of neutrons left over is 235 – 127 – 89 = 19.

14. The binding energy is given by

$$\Delta E_{\text{be}} = \left[Z m_H + (A - Z) m_n - M_{\text{Am}} \right] c^2 ,$$

where Z is the atomic number (number of protons), A is the mass number (number of nucleons), m_H is the mass of a hydrogen atom, m_n is the mass of a neutron, and M_{Am} is the mass of a ${}^{244}_{95}\text{Am}$ atom. In principle, nuclear masses should be used, but the mass of the Z electrons included in ZM_H is canceled by the mass of the Z electrons included in M_{Am}, so the result is the same. First, we calculate the mass difference in atomic mass units:

$$\Delta m = (95)(1.007825 \text{ u}) + (244 - 95)(1.008665 \text{ u}) - (244.064279 \text{ u}) = 1.970181 \text{ u}.$$

Since 1 u is equivalent to 931.494013 MeV,

$$\Delta E_{\text{be}} = (1.970181 \text{ u})(931.494013 \text{ MeV/u}) = 1835.212 \text{ MeV}.$$

Since there are 244 nucleons, the binding energy per nucleon is

$$\Delta E_{\text{ben}} = E/A = (1835.212 \text{ MeV})/244 = 7.52 \text{ MeV}.$$

17. It should be noted that when the problem statement says the "masses of the proton and the deuteron are …" they are actually referring to the corresponding atomic masses (given to very high precision). That is, the given masses include the "orbital" electrons. As in many computations in this chapter, this circumstance (of implicitly including electron masses in what should be a purely nuclear calculation) does not cause extra difficulty in the calculation. Setting the gamma ray energy equal to ΔE_{be}, we solve for the neutron mass (with each term understood to be in u units):

$$m_n = M_d - m_H + \frac{E_\gamma}{c^2} = 2.013553212 - 1.007276467 + \frac{2.2233}{931.502}$$
$$= 1.0062769 + 0.0023868$$

which yields m_n = 1.0086637 u ≈ 1.0087 u.

83. We note that hc = 1240 MeV·fm, and that the classical kinetic energy $\frac{1}{2}mv^2$ can be written directly in terms of the classical momentum $p = mv$ (see below). Letting

$$p \simeq \Delta p \simeq \Delta h / \Delta x \simeq h / r,$$

we get

$$E = \frac{p^2}{2m} \simeq \frac{(hc)^2}{2(mc^2)r^2} = \frac{(1240\,\text{MeV} \cdot \text{fm})^2}{2(938\,\text{MeV})\left[(1.2\,\text{fm})(100)^{1/3}\right]^2} \simeq 30\,\text{MeV}.$$