Mass difference and binding energy

A.C. Norman
anorman@bishopheber.cheshire.sch.uk

Where necessary, take $1\,\mathrm{u} = 931.3\,\mathrm{MeV}$, and $1\,\mathrm{eV} = 1.6 \times 10^{-19}\,\mathrm{J}$.
In each question, calculate the mass differences in u and energies in MeV unless told differently.

1. Explain the meaning of the terms
   (a) mass difference
   (b) binding energy
2. Calculate
   (a) the mass difference
   (b) the binding energy

   of lithium-6. [Atomic mass of lithium-6 = 6.015124]
3. What is the atomic mass of carbon-12 to 4 decimal places.
4. Calculate
   (a) the mass difference
   (b) the binding energy

   of carbon-12.
5. The atomic masses of two stable isotopes of iron are 56.935 39 u (^{57}Fe) and 57.933 27 u (^{58}Fe)
   (a) Calculate the binding energy for each isotope.
   (b) Suggest which isotope may be the more stable, giving a reason.
6. Alpha-particle emission from U-238 may be written as
   $$^{238}_{92}\mathrm{U} \longrightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\alpha$$
   Calculate the energy of the alpha-particle in
   (a) MeV
   (b) J
   (c) Calculate the velocity of the alpha particle, assuming there is no recoil from the nucleus.

   [Atomic masses are 238.0509u and 234.0436u for the isotopes.]
7. Nuclear fission occurs when a heavy nucleus absorbs a neutron, and splits into two small nuclei with the emission of some neutrons. One possible fission reaction is
   $$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{92}_{36}\mathrm{Kr} + {}^{141}_{56}\mathrm{Ba} + 3{}^{1}_{0}\mathrm{n}$$
   Calculate the energy released in this fission.

   [Atomic masses are 235.0439u, 91.8976u and 140.9136u.]