Answers to selected problems from Essential Physics, Chapter 29

1. (a) 26 (b) 30 (c) 56

3. 9×10^{16} J

5. (a) a beta-plus decay (b) $+e = +1.6 \times 10^{-19}$ C (c) an electron

7. About 3%.

9. (a) A (b) B

11. 3

13. (a) 0.13699 u (b) 127.61 MeV (c) 7.9756 MeV/nucleon

15. (a) 0.0023868 u (b) 2.2233 MeV

17. (a) 1.7566 u (b) 1636.3 MeV (c) 7.8668 MeV/nucleon

19. (a) ${}^{239}_{94}\mathrm{Pu} \rightarrow {}^{235}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He}$ (b) 5.245 MeV

21. (a) ${}^{22}_{11}\mathrm{Na} \rightarrow {}^{22}_{10}\mathrm{Ne} + {}^{0}_{+1}\mathrm{e}^{+} + \nu_e$ (b) 1.820 MeV

23. (a) For a spontaneous decay to occur, the total mass of the products must be less than the mass of the original atom, with the missing mass being converted to energy – this energy is the kinetic energy of the products after the decay process. One of the candidate atoms given in the problem has a larger mass than the original silver atom, so the silver atom will not spontaneously decay into that larger mass atoms. The rhodium is quite a bit lower in mass, so let's investigate that possibility – that would be an alpha decay. To verify whether this decay will occur spontaneously, we need to add the mass of the rhodium and the alpha to see whether the total mass after the alpha decay is less than the mass of the original silver atom. The total mass afterwards in that case would be 106.906748 u + 4.00260325 u = 110.909351 u, which is larger than the 110.905291 u of the silver atom – that reaction will not occur spontaneously either. The only possibility left is the cadmium, which would be a beta-minus decay. In a beta-minus decay, the mass of the electron emitted is already included in the mass of the product atom, so all we have to do is to see that the mass of the cadmium atom is less than the mass of the silver atom to know that this is the reaction that the silver atom will undergo.

(b) ${}^{111}_{47}\mathrm{Ag} \rightarrow {}^{111}_{48}\mathrm{Cd} + {}^{0}_{-1}\mathrm{e}^{-} + \overline{\nu}_e$

25. (a) 88 g (b) 18 g (c) 2.7 g

27. Yes. That's how radioactive decay works – for equal time intervals, the number of atoms is reduced by the same factor.

29. (a) $^{1}_{1}H$ (b) 5.025 MeV

31. 12.860 MeV

35. (a) 1.1×10^{-12} (b) 0.94×10^{-12}

37. 1/256th of the original activity

41. (a) 64 (b) 4 (c) 4.8×10^{-15} m

43. (a) 511 keV (b) 511 keV (c) 511 keV (d) 2.4×10^{-12} m

45. (a) The momenta are equal-and-opposite. (b) 50 : 1

47. (a) one throw (b) 3.8 throws

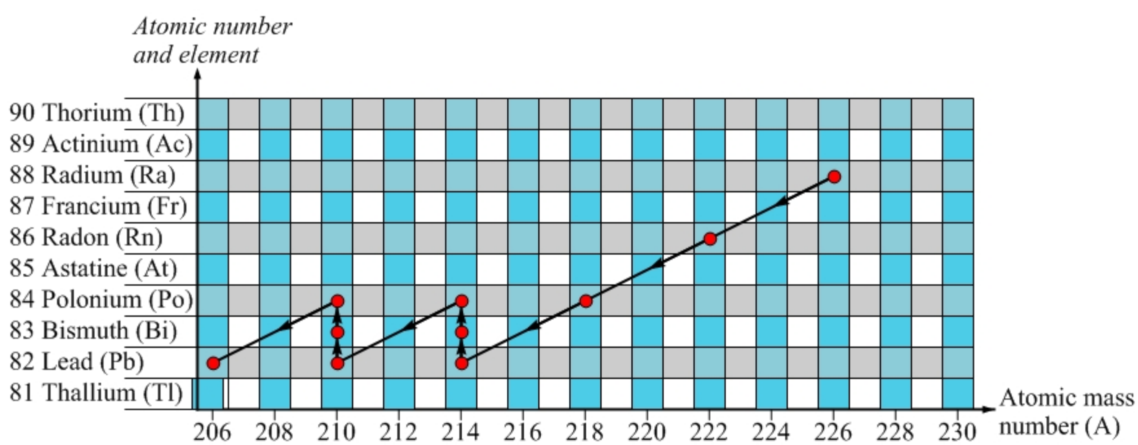
49. (a) 0.5 N (b) 2N/3.

51. 120 s

53. 16%

55. (a) 9.3×10^{19} (b) 3.1×10^{19} (c) -3.9×10^{19}
(d) 9.3×10^{19} (e) 5.0×10^{19} (f) 2.5×10^{19}
(g) The second method, using Equation 29.12, is correct. The problem with the first method is that it assumes the rate of loss of nuclei is constant, but the rate of loss of nuclei decreases as time goes by, because the number of radioactive nuclei decreases as time goes by.

57.



59. 6.8×10^{-13}