1. $m = (15.999\ \text{u})(1.66 \times 10^{-27}\ \text{kg}/1\ \text{u}) = 2.66 \times 10^{-26}\ \text{kg}$, so choice (c) is the correct answer.

3. Nuclei are approximately spherical with average radii of $r = r_0 A^{1/3}$, where r_0 = constant. Thus, the ratio of the volume of a ^{20}Ne nucleus to that of a ^{4}He is

$$\frac{V_{\text{Ne}}}{V_{\text{He}}} = \frac{\frac{4}{3}\pi r_{\text{Ne}}^3}{\frac{4}{3}\pi r_{\text{He}}^3} = \frac{r_0^3 A_{\text{Ne}}}{r_0^3 A_{\text{He}}} = \frac{20}{4} = 5$$

and (d) is the correct choice.

4. From the binding energy curve shown in Figure 29.4 of the textbook, the approximate binding energies per nucleon in the isotopes ^{35}Cl, ^{62}Ni, and ^{197}Au are seen to be 8.4 MeV, 8.8 MeV, and 7.9 MeV, respectively. Therefore, the correct ranking, from smallest to largest, is gold, chlorine, nickel, which is choice (a).

5. The half-life of a substance is related to its decay constant by $T_{1/2} = \ln 2/\lambda$. The desired ratio is then

$$\frac{\left(T_{1/2}\right)_A}{\left(T_{1/2}\right)_B} = \frac{\ln 2/\lambda_A}{\ln 2/\lambda_B} = \frac{\lambda_B}{\lambda_A} = \frac{1}{3}$$

so (c) is the correct choice.

6. In a large sample, one half of the radioactive nuclei initially present remain in the sample after one half-life has elapsed. Hence, the fraction of the original number of radioactive nuclei remaining after n half-lives have elapsed is $(1/2)^n = 1/2^n$. In this case the number of half-lives that have elapsed is $\Delta t/T_{1/2} = 14\ \text{d}/3.6\ \text{d} \approx 4$. Therefore, the approximate fraction of the original sample that remains undecayed is $1/2^4 = 1/16$, and the correct answer is choice (d).

7. The nucleus $^{40}_{18}\text{X}$ contains $A = 40$ total nucleons, of which $Z = 18$ are protons. The remaining $A - Z = 40 - 18 = 22$ are neutrons, and choice (c) is correct.

8. In the beta decay of $^{95}_{36}\text{Kr}$, the emitted particles are an electron, $^{0}_{-1}\text{e}$, and an antineutrino, $\overline{\nu}_e$. The emitted particles contain a total charge of $-e$ and zero nucleons. Thus, to conserve both charge and nucleon number, the daughter nucleus must be $^{95}_{37}\text{Rb}$, which contains $Z = 37$ protons and $A - Z = 95 - 37 = 58$ neutrons, making (a) the correct choice.

9. In gamma decay, an unstable nucleus gives off excess energy by emitting a high energy photon. The daughter nucleus is the same as the parent, with both the charge and nucleon number unchanged, simply in a lower energy state. Thus, the correct choice is (b).

10. To conserve the total number of nucleons, it is necessary that $A + 4 = 234$, or $A = 230$. Conservation of charge demands that $Z + 2 = 90$, or $Z = 88$. We then see that the correct answer is choice (c).

11. $^{32}_{15}\text{P}$ decays to $^{32}_{16}\text{S}$ by means of beta decay, with the decay equation being

$$^{32}_{15}\text{P} \rightarrow {}^{32}_{16}\text{S} + {}^{0}_{-1}\text{e} + \overline{\nu}_e$$

As will be discussed in Chapter 30, the antineutrino must be emitted along with the electron in order to conserve electron-lepton number. The correct choices are (c) and (e).

6. Beta particles have greater penetrating ability than do alpha particles.

29.1 The average nuclear radii are $r = r_0 A^{1/3}$, where $r_0 = 1.2 \times 10^{-15}\ \text{m} = 1.2\ \text{fm}$ and A is the mass number.

For $^{2}_{1}\text{H}$, $r = (1.2\ \text{fm})(2)^{1/3} = \boxed{1.5\ \text{fm}}$

For $^{60}_{27}\text{Co}$, $r = (1.2\ \text{fm})(60)^{1/3} = \boxed{4.7\ \text{fm}}$

For $^{197}_{79}\text{Au}$, $r = (1.2\ \text{fm})(197)^{1/3} = \boxed{7.0\ \text{fm}}$

For $^{239}_{94}\text{Pu}$, $r = (1.2\ \text{fm})(239)^{1/3} = \boxed{7.4\ \text{fm}}$

29.4 (a) $r \approx r_0 A^{1/3} = (1.2\ \text{fm})(65)^{1/3} = \boxed{4.8\ \text{fm}}$

(b) $V = \dfrac{4}{3}\pi r^3 \approx \dfrac{4}{3}\pi\left(4.8 \times 10^{-15}\ \text{m}\right)^3 = \boxed{4.6 \times 10^{-43}\ \text{m}^3}$

(c) $\rho = \dfrac{m}{V} \approx \dfrac{65\ \text{u}}{V} = \dfrac{65\left(1.66 \times 10^{-27}\ \text{kg}\right)}{4.6 \times 10^{-43}\ \text{m}^3} = \boxed{2.3 \times 10^{17}\ \text{kg/m}^3}$

29.10 (a) For $^{2}_{1}\text{H}$,

$$\Delta m = 1(1.007\ 825\ \text{u}) + 1(1.008\ 665\ \text{u}) - (2.014\ 102\ \text{u}) = 0.002\ 388\ \text{u}$$

and $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(0.002\ 388\ \text{u})(931.5\ \text{MeV/u})}{2} = \boxed{1.11\ \text{MeV/nucleon}}$$

(b) For $^{4}_{2}\text{He}$,

$$\Delta m = 2(1.007\ 825\ \text{u}) + 2(1.008\ 665\ \text{u}) - (4.002\ 603\ \text{u}) = 0.030\ 377\ \text{u}$$

and $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(0.030\ 377\ \text{u})(931.5\ \text{MeV/u})}{4} = \boxed{7.07\ \text{MeV/nucleon}}$$

(c) For $^{56}_{26}\text{Fe}$,

$$\Delta m = 26(1.007\ 825\ \text{u}) + 30(1.008\ 665\ \text{u}) - (55.934\ 942) = 0.528\ 458\ \text{u}$$

and $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(0.528\ 458\ \text{u})(931.5\ \text{MeV/u})}{56} = \boxed{8.79\ \text{MeV/nucleon}}$$

(d) For $^{238}_{92}\text{U}$,

$$\Delta m = 92(1.007\ 825\ \text{u}) + 146(1.008\ 665\ \text{u}) - (238.050\ 783) = 1.934\ 207\ \text{u}$$

and $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(1.934\ 207\ \text{u})(931.5\ \text{MeV/u})}{238} = \boxed{7.57\ \text{MeV/nucleon}}$$

29.13 For $^{23}_{11}\text{Na}$,

$$\Delta m = 11(1.007\ 825\,\text{u}) + 12(1.008\ 665\,\text{u}) - (22.989\ 770\,\text{u}) = 0.200\ 285\,\text{u}$$

and $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(0.200\ 285\,\text{u})(931.5\ \text{MeV/u})}{23} = 8.111\ \text{MeV/nucleon}$$

For $^{23}_{12}\text{Mg}$,

$$\Delta m = 12(1.007\ 825\,\text{u}) + 11(1.008\ 665\,\text{u}) - (22.994\ 127\,\text{u}) = 0.195\ 088\,\text{u}$$

so $$\frac{E_b}{A} = \frac{(\Delta m)c^2}{A} = \frac{(0.195\ 088\,\text{u})(931.5\ \text{MeV/u})}{23} = 7.901\ \text{MeV/nucleon}$$

The binding energy per nucleon is greater for $^{23}_{11}\text{Na}$ by $\boxed{0.210\ \text{MeV/nucleon}}$.

This is attributable to $\boxed{\text{less proton repulsion in } ^{23}_{11}\text{Na}}$.

29.19 From $R = R_0\, e^{-\lambda t}$, with $R = (1.00 \times 10^{-3})R_0$, we find $e^{-\lambda t} = R/R_0$, and

$$t = -\frac{\ln(R/R_0)}{\lambda} = -T_{1/2}\left[\frac{\ln(R/R_0)}{\ln 2}\right]$$

$$= -(432\ \text{yr})\left[\frac{\ln(1.00 \times 10^{-3})}{\ln 2}\right] = \boxed{4.31 \times 10^3\ \text{yr}}$$

29.20 Using $R = R_0\, e^{-\lambda t}$, with $R/R_0 = 0.125$, gives $\lambda t = -\ln(R/R_0)$, or

$$t = -\frac{\ln(R/R_0)}{\lambda} = -T_{1/2}\left[\frac{\ln(R/R_0)}{\ln 2}\right] = -(5\ 730\ \text{yr})\left[\frac{\ln(0.125)}{\ln 2}\right] = \boxed{1.72 \times 10^4\ \text{yr}}$$

29.24 In each of the given events, both the total number of nucleons and the total charge must be the same afterwards as it was before. Using these two rules, we find:

(a) $^{109}_{48}\text{Cd} + \boxed{^{0}_{-1}\text{e}} \rightarrow {}^{109}_{47}\text{Ag} + \nu_e$

(b) $^{14}_{7}\text{N} + {}^{4}_{2}\text{He} \rightarrow \boxed{^{1}_{1}\text{H}} + {}^{17}_{8}\text{O}$

29.25 The more massive ${}^{56}_{27}\text{Co}$ decays into the less massive ${}^{56}_{26}\text{Fe}$. To conserve charge, the charge of the emitted particle must be +1e. Since the parent and the daughter have the same mass number, the emitted particle must have essentially zero mass. Thus, the decay must be positron emission or $\boxed{e^+ \text{ decay}}$. The decay equation is

$$\boxed{{}^{56}_{27}\text{Co} \rightarrow {}^{56}_{26}\text{Fe} + e^+ + \nu_e}$$

29.33 (a) $\boxed{{}^{21}_{10}\text{Ne}} + {}^{4}_{2}\text{He} \rightarrow {}^{24}_{12}\text{Mn} + {}^{1}_{0}\text{n}$

(b) ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{90}_{38}\text{Sr} + \boxed{{}^{144}_{54}\text{Xe}} + 2\,{}^{1}_{0}\text{n}$

(c) $2\,{}^{1}_{1}\text{H} \rightarrow {}^{2}_{1}\text{H} + \boxed{{}^{0}_{+1}\text{e}} + \boxed{\nu_e}$