1. Consider a radioactive nuclide of element X with mass number A and atomic number Z. Write a general nuclear equation for each type of decay in the table below.

Decay Type	General Nuclear Equation	Description
β decay	${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}\beta$	Neutron-rich
positron emission	${}^{A}_{Z}X \rightarrow$	Neutron-poor
electron capture	${}^{A}_{Z}X \rightarrow$	Neutron-poor
α decay	${}^{A}_{Z}X \rightarrow$	Neutron-rich (Z>83)

2. Complete each nuclear reaction given below.

A) ${}^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + \boxed{?_A}$

B) ${}^{131}_{53}I \rightarrow {}^{131}_{54}Xe + \boxed{?_B}$

C) ${}^{11}_{6}C \rightarrow \boxed{?_C} + {}^{0}_{+1}\beta$

D) Electron capture by cadmium-104 (${}^{104}_{48}Cd$)

E) ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow \boxed{?_{E1}} \rightarrow {}^{137}_{52}Te + \boxed{?_{E2}} + 2\,{}^{1}_{0}n$

3. Both carbon-14 and potassium-40 can be used for radiometric dating. The half-life of ^{14}C is 5730 years and the half-life of ^{40}K is 1.28×10^9 years.

$$\text{Rate} = kN \quad t_{1/2} = \frac{\ln 2}{k} \quad t = -\frac{1}{k}\ln\frac{N_t}{N_0}$$

A) Which radioisotope is preferred for radiodating a rock that is 20,000 years old?

B) Neither method is good for a 200,000-year-old rock. Calculate the fraction of ^{14}C and ^{40}K remaining in the rock to determine why this is so.

4. Mercury-197 has a half-life of 65 hours. What fraction of a mercury sample remains after 6 days?

$$\text{Rate} = k\text{N} \quad t_{1/2} = \frac{\ln 2}{k} \quad t = -\frac{1}{k}\ln\frac{\text{N}_t}{\text{N}_0}$$

5. Iron-56 is often considered the most stable nuclide although it is actually the third-most stable. Nickel-62 is the most stable nuclide. Given the mass of a proton, neutron, and measured mass of ${}^{62}_{28}\text{Ni}$ below, calculate the binding energy *per* nucleon for ${}^{62}_{28}\text{Ni}$.

$m_{\text{proton}} = 1.0073$ amu $m_{\text{neutron}} = 1.0087$ amu $m_{{}^{62}_{28}\text{Ni}} = 61.9283$ amu

Recall $\Delta E = \Delta mc^2$ where $c = 3.00 \times 10^8$ m/s, 1 amu $= 1.66 \times 10^{-27}$ kg, and 1 J $= 1$ kg $\cdot$ $(\text{m}/\text{s})^2$.

6. Silicon-28 can be made by many different nuclear fusion reactions. Which of the two fusion reactions, A or B, releases the greater amount of energy?

A) ${}^{14}\text{N} + {}^{14}\text{N} \rightarrow {}^{28}\text{Si}$

B) ${}^{16}\text{O} + {}^{12}\text{C} \rightarrow {}^{28}\text{Si}$

where: ${}^{14}\text{N}$ = 14.00307 amu ${}^{28}\text{Si}$ = 27.97693 amu

${}^{16}\text{O}$ = 15.99491 amu ${}^{12}\text{C}$ = 12.00000 amu

Propose an alternative fusion reaction to produce ${}^{28}\text{Si}$.