1. Balance the following nuclear reactions by filling in the missing particle and indicate the type of nuclear process:
   a. $^{73}\text{Ga} \rightarrow ^{73}\text{Ge} + ____$
   b. $^{238}\text{U} \rightarrow ^{234}\text{Th} + ____$
   c. $^{201}\text{Hg} + ____ \rightarrow ^{201}\text{Au} + \gamma$
   d. $^1_0\text{n} + ^{235}\text{U} \rightarrow ^{141}\text{Ba} + ______ + 3^1_0\text{n}$
   e. $^{13}\text{N} \rightarrow ^{13}\text{C} + ____$

2. The isotope $^{247}\text{Bk}$ decays by a series of $\alpha$-particle and $\beta$–particle emissions, eventually ending up as $^{207}\text{Pb}$. In the complete decay series, how many $\alpha$ and $\beta$–particles are produced?

3. Fill in the table:

<table>
<thead>
<tr>
<th>Type of decay</th>
<th>Effect on nucleus</th>
</tr>
</thead>
<tbody>
<tr>
<td>alpha ($\alpha$)</td>
<td></td>
</tr>
<tr>
<td>beta ($\beta$)</td>
<td></td>
</tr>
<tr>
<td>positron</td>
<td></td>
</tr>
<tr>
<td>electron capture</td>
<td></td>
</tr>
<tr>
<td>gamma ($\gamma$)</td>
<td></td>
</tr>
</tbody>
</table>
4. The only stable isotope of fluorine is fluorine-19. Predict possible modes of decay for $^{18}\text{F}$ and $^{21}\text{F}$.

5. Phosphorous-32 is used in biochemical research, and it’s half-life is 14.3 days.
   a. What mass of $^{32}\text{P}$ is left from an original sample of 175 mg after 35 days?
   b. How long will it take for 15% of a sample of $^{32}\text{P}$ to decay?

6. The easiest fusion reaction to initiate is 
   \begin{equation}
   ^2\text{H} + ^3\text{H} \rightarrow ^4\text{He} + ^1\text{n}
   \end{equation}
   Calculate the energy released per mole of helium produced given the following atomic masses:
   $^2\text{H} = 2.01410$ amu, $^3\text{H} = 3.01605$ amu, $^4\text{He} = 4.00260$ amu, neutron = 1.00866 amu.

7. The most stable nucleus in terms of binding energy is $^{56}\text{Fe}$. If the atomic mass of iron-56 is 55.9349 amu, calculate the binding energy per nucleon for $^{56}\text{Fe}$.
   ($m_e = 5.486 \times 10^{-4}$ amu, $m_p = 1.00728$ amu, $m_n = 1.00866$ amu)