Nuclear Decay and Radiation

I. In the space provided, write the letter of the term or phrase that best answers the question.

_____ 1. What does the 96 in $^{244}_{96}$Cm in represent?
   a. mass number  
   b. atomic number  
   c. number of nucleons  
   d. number of neutrons

_____ 2. What does the 254 in fermium-254 represent?
   a. mass number  
   b. atomic number  
   c. number of neutrons  
   d. number of protons

_____ 3. Isotopes of an element have the same
   a. mass number.  
   b. atomic number.  
   c. number of nucleons.  
   d. number of neutrons.

_____ 4. Which of the following general statements would account for instability of the nuclide $^{214}_{82}$Pb?
   a. Except for $^1_1$H and $^3_2$He, a stable nucleus has $N$ equal to or greater than $Z$.
   b. A stable nucleus has an $\frac{N}{Z}$ value between 1 and 1.5.
   c. A stable nucleus has the number of protons equaling an even number and the number of neutrons equaling an even number.
   d. All nuclides that have atomic number greater than 83 and a mass number greater than 209 are unstable.

_____ 5. The nuclear reaction $^{21}_{11}$Na $\rightarrow ^{21}_{10}$Ne + $^0_{1}$e occurs through the process of
   a. annihilation.  
   b. positron emission  
   c. electron capture  
   d. fission
6. Which of the following statements is true about nuclear fission?
   a. Fission occurs most often naturally.
   b. Fission produces nuclei that are each more massive than the original nuclei.
   c. Fission produces nuclei that are more stable than the original nuclei.
   d. Fission is the primary process that produces energy in stars.

II. Questions 7–10 refer to Table 1.

TABLE 1: HALF-LIVES OF SEVERAL RADIOACTIVE NUCLIDES

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese-56</td>
<td>3 h</td>
</tr>
<tr>
<td>Palladium-148</td>
<td>5 days</td>
</tr>
<tr>
<td>Silver-102</td>
<td>70 min</td>
</tr>
<tr>
<td>Zinc-62</td>
<td>9 h</td>
</tr>
</tbody>
</table>

7. Which nuclide has a half-life of slightly more than 1 hr?
   a. manganese-56
   b. palladium-148
   c. silver-102
   d. zinc-62

8. Which of the following nuclides is likely the most stable?
   a. manganese-56
   b. palladium-148
   c. silver-102
   d. zinc-62

9. For equal masses of nuclides at the start, which nuclide would have the least mass after 5 hr?
   a. manganese-56
   b. palladium-148
   c. silver-102
   d. zinc-62

10. What fraction of the original mass of palladium-148 will remain after 10 days?
    a. 1/2
    b. 1/3
    c. 1/4
    d. 1/5
11. The equation \( \text{^{40}K} + \text{e}^{-} \rightarrow \text{^{40}Ar} \) represents the decay of potassium-40 by to argon-40.
   a. beta emission
   b. electron capture
   c. positron emission
   d. alpha decay

12. If an original sample of carbon-14 has a mass of 10 g, at the end of 11,430 years, the amount of carbon-14 remaining would be g (half life carbon-14 is 5,730±40 years).
   a. 2.5
   b. 5
   c. 10
   d. 50

III. Answer the following in the space provided.
13. What is radioactivity?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

14. Define half-life.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

15. How can half-lives be used to determine an object’s age?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
IV. Solve the following problem, and write your answer in the spaces in the table.

16. Complete the following table about different types of radioactive decay.

<table>
<thead>
<tr>
<th>Type of Radioactive Decay</th>
<th>What happens to the atomic number?</th>
<th>What happens to the mass number?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-particle emission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>electron capture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>positron emission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>alpha particle emission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. The half-life of radon-222 is approximately 4 days. If a tube containing 1.00 microgram of radon were stored in a hospital clinic for 12 days, how much radon would remain in the tube? Use the table below to determine successive half-life amounts during the 12-day period.

<table>
<thead>
<tr>
<th>Days</th>
<th>0</th>
<th>4</th>
<th>8</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radon remaining</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. Solve the following problems, and write your answer in the space provided.

18. The half-life of iodine-131 is approximately 8 days. How much of an original sample will be left after 24 days?

19. Thorium-234 has a half-life of 24 days. If 1 gram remains in a sealed container after 72 days, how much was there to begin with?

20. The half-life of polonium-218 is 3.0 minutes. What percentage of the original sample remains after 4 half-lives?
VI. Categorize each nuclear equation below by writing the correct term from the following list. Terms may be used more than once.

- beta particle emission
- electron capture
- alpha particle emission
- positron emission

21. $^{51}_{24}\text{Cr} + ^0_{-1}\text{e} \rightarrow \underline{\text{___________}} + \gamma$ 
   type: _______________

22. $^{226}_{88}\text{Ra} \rightarrow \underline{\text{___________}} + ^4_2\text{He}$ 
   type: _______________

23. $^{239}_{93}\text{Np} \rightarrow \underline{\text{___________}} + ^0_{+1}\text{e}$ 
   type: _______________

24. $^1_1\text{p} \rightarrow ^0_0\text{n} + ^0_{+1}\text{e}$ 
   type: _______________

25. $^{37}_{18}\text{Ar} + ^0_{-1}\text{e} \rightarrow ^{37}_{17}\text{Cl}$ 
   type: _______________

26. $^{238}_{92}\text{U} \rightarrow ^{234}_{90}\text{Th} + ^4_2\text{He}$ 
   type: _______________