

Name _____ Class _____

Nuclear Chemistry

Activity Natural Radioactivity Radioactivity

| SELECTED RADIOISOTOPES | | |
|------------------------|----------------------|-------------------|
| Nuclide | Half-Life | Particle Emission |
| ^{14}C | 5730 y | β^- |
| ^{60}Co | 5.27 y | β^- |
| ^{137}Cs | 30.2 y | β^- |
| ^{220}Fr | 27.4 s | α |
| ^3H | 12.3 y | β^- |
| ^{131}I | 8.04 d | β^- |
| ^{40}K | 1.28×10^9 y | β^- |
| ^{42}K | 12.4 h | β^- |
| ^{32}P | 14.3 d | β^- |
| ^{226}Ra | 1600 y | α |
| ^{90}Sr | 29 y | β^- |
| ^{235}U | 7.04×10^8 y | α |
| ^{238}U | 4.46×10^9 y | α |

y = years; d = days; h = hours; s = seconds

1. What are isotopes? _____

2. What is a radioisotope? _____

3. Choose words from the word list to complete the following paragraphs relating to radioactivity. The list groups words that have contrasting or related meanings.

Word List

- | | |
|------------------|----------------------------|
| alpha/beta/gamma | number(s) |
| breakdown | particles |
| energy | protons/electrons/neutrons |
| isotope(s) | stable/unstable |
| nucleus | transmutation(s) |

Radioactivity is the spontaneous _____ of the _____ of an atom. This breakdown is accompanied by the emission of _____ and/or radiant _____. This breakdown changes the makeup of the _____. When the number of _____ in the nucleus changes, one element has been changed to another element. If only the number of _____ changes, one isotope of an element has been changed to another _____ of the same element. The first kind of change—one element to another—is called _____.

Some naturally occurring _____ are radioactive. All known _____ of elements with atomic _____ greater than 83 are unstable. These isotopes undergo transmutation such that they are eventually converted to _____ with atomic _____ less than 83. One well-studied series of _____ is that of uranium-238. This unstable radioisotope, $^{238}_{92}\text{U}$, undergoes transmutation to $^{206}_{82}\text{Pb}$, a _____ isotope. The breakdown products formed during _____ are called nuclear emissions. These include _____ decay, _____ decay, and _____ radiation.

Nuclear emissions

Nuclei of radioisotopes emit energy and subatomic particles. These emissions, or emanations, differ from each other in mass, charge, penetrating power, and ionizing power.

4. Complete the following table to show the properties of some subatomic particles. You may refer to table H in the Appendix.

| Name | Symbol used in equations | Other symbol | Mass number | Charge |
|----------------|--------------------------|--------------|-------------|--------|
| electron | | | | |
| positron | | | | |
| proton | | | | |
| alpha particle | | | | |
| neutron | | | | |

5. Choose words from the word list below to fill in the blanks in the following paragraphs relating to the properties of nuclear emissions. Words with contrasting meanings have been paired in the list.

Word List

| | |
|-----------------------|-----------------------|
| deflected/undeflected | positive/negative |
| electric | positively/negatively |
| emissions | zero |
| particles/rays | |

Some _____ are deflected as they pass through an _____ field. Emissions such as positrons, protons, and alpha particles that are _____ charged are deflected toward the _____ electrode. Beta particles, which are _____ charged, are deflected toward the _____ electrode. Neutrons and gamma radiation pass _____ through an electric field since they possess no charge.

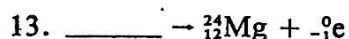
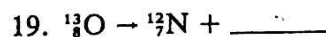
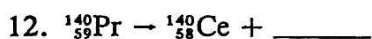
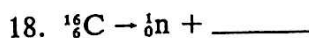
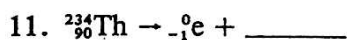
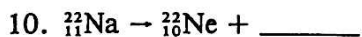
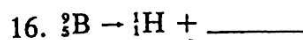
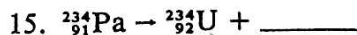
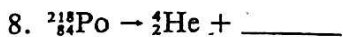
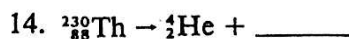
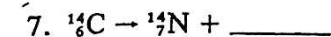
Gamma radiation is in the form of _____, not _____. Gamma radiation is not included in the list of emissions above because gamma rays have a mass of nearly _____ and a charge of _____.

Nuclear equations

6. Complete the following statements:

In balanced nuclear equations, the sum of the superscripts on the left is _____ (greater than/equal to/less than) the sum of the _____ (subscripts/superscripts) on the right. This illustrates the principle of conservation of _____ (mass/charge). Similarly the sum of the subscripts on the left is _____ (greater than/equal to/less than) the sum of the _____ (subscripts/superscripts) on the right. This illustrates the principle of conservation of _____ (mass/charge).

Nuclear equations show transmutations of one kind of nucleus into another. Complete and balance the equations for the following nuclear transmutations.



Half-life

21. What is the definition of half-life for a radioisotope? _____

22. Write the balanced equation for the transmutation of ${}^{131}\text{I}$ as described in Table F in the Appendix. _____

23. a. From a starting mass of 100 g of ${}^{131}\text{I}$, what mass will remain after 8 days? _____

After 16 days? _____ After 24 days? _____

b. Which of the following will be the remaining mass of ${}^{131}\text{I}$ after 4 days? (See the graph on page 330.) Circle your answer.

greater than 75 g 75 g less than 75 g

Explain your answer. _____

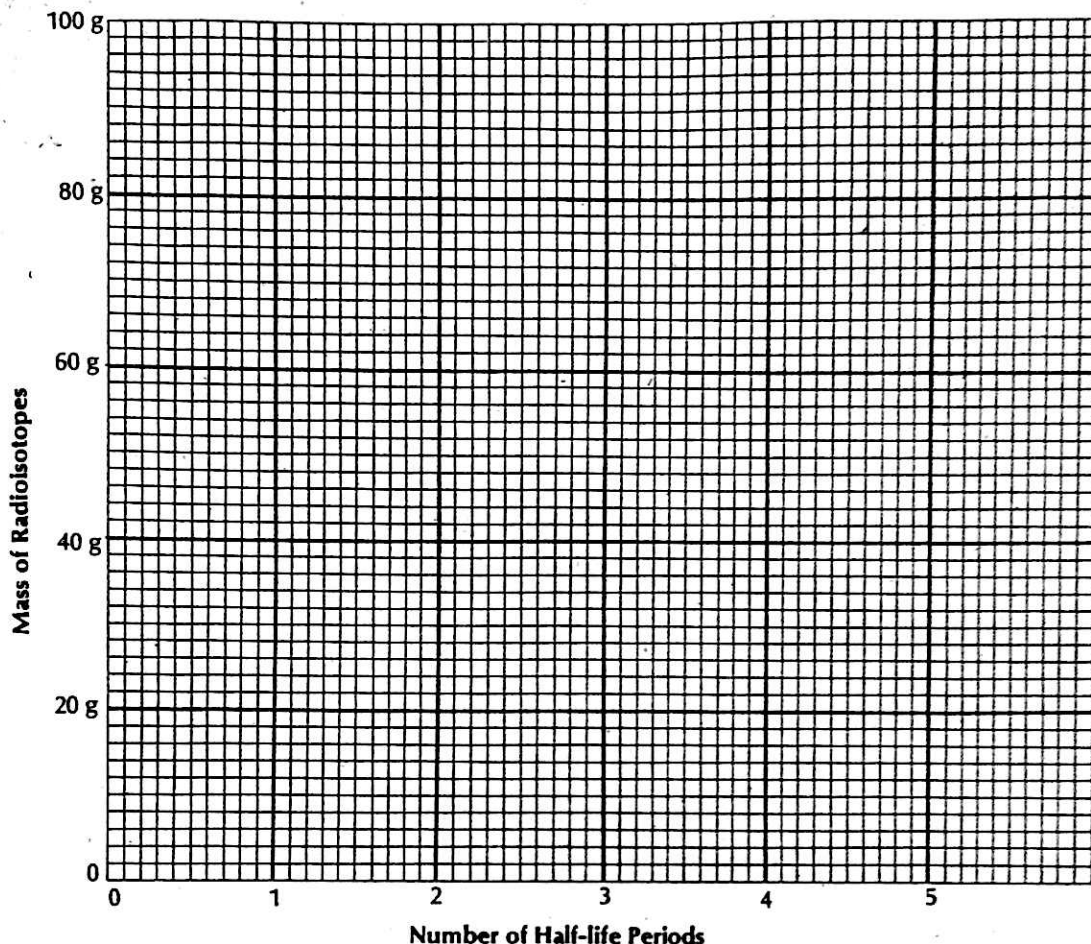
24. Write the balanced equation for the transmutation of ${}^{220}\text{Fr}$ as described in Table F in the Appendix. _____

25. Starting with a sample of 4.0×10^{-7} mole of Fr atoms, how many Fr atoms will remain

After 27.4 sec? _____ After 54.8 sec? _____ After 82.2 sec? _____

In the space below, show your calculations.

26. Using the following grid, make a graph to show the quantity of radioisotope remaining unchanged after the passage of successive half-life periods. The original mass of the radioisotope is 100 grams.



For each of the following, write the equation for the nuclear transformation, the number of half-life periods that has elapsed, and the quantity of radioisotope remaining unchanged after the given period of time. Refer to Table F in the Appendix for information you need.

27. Radioisotope: $^{42}_{19}\text{K}$. Original quantity: 100 grams. Time elapsed: 62 hours.

Equation _____

Number of half-life periods _____

Mass of radioisotope remaining unchanged _____ grams

28. Radioisotope: $^{226}_{88}\text{Ra}$. Original quantity: 8.0×10^{19} atoms. Time elapsed: 16 000 years.

Equation _____

Number of half-life periods _____

Number of atoms of radioisotope remaining unchanged _____ atoms