NAME: ____________________________________ PERIOD: __

1. Write a balanced nuclear equation for each decay process indicated.

a. The isotope Th-234 decays by an alpha emission.

b. The isotope Fe-59 decays by a beta emission.

c. The isotope Tc-99 decays by a gamma emission.

d. The isotope C-11 decays by a positron emission.

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2. Complete each of the missing symbol in the following nuclear equation.

a. ${}^{35}_{16}S \rightarrow {}^{0}_{-1}\beta + ?$

b. $? + {}^{1}_{0}n \rightarrow {}^{14}_{6}C + {}^{1}_{1}H$

c. ${}^{210}_{83}Bi \rightarrow {}^{4}_{2}\alpha + ?$

d. ${}^{40}_{18}Ar + ? \rightarrow {}^{43}_{19}K + {}^{1}_{1}H$

CHEMISTRY 101 - WORKSHEET
DISCOVERING THE SECRETS OF THE NUCLEUS

1. Using the form $^{A}_{Z}X$, give the symbol for each of the following

   a. an alpha particle ______
   b. a beta (-) particle ______
   c. a gamma ______
   d. carbon-14 ______
   e. uranium-235 ______
   f. a proton ______
   g. a neutron ______
   h. a positron ______

2. Write a nuclear equation for each of the following processes

   a. the alpha decay of Uranium-238

   b. the beta decay (negatron) of Cobalt-60

   c. the gamma decay of Krypton-81

3. Complete the following nuclear equations

   a. $^{234}Pa \rightarrow {}^{234}U$ + _______

   b. $^{214}Po \rightarrow \alpha$ + _______

   c. $^{154}Sm + n \rightarrow 2\ n$ + ______

   d. $^{106}Pd + \alpha \rightarrow$ _______ + p

IV. BALANCING NUCLEAR EQUATIONS:

❖ *Total atomic numbers and mass numbers must be EQUAL on both sides!*

1. Write a nuclear equation showing the radioactive decay of polonium-218 if the decay produces an alpha particle.

$$^{218}_{84}\mathbf{Po} \rightarrow \underline{\qquad\quad} + {}^{4}_{2}\mathbf{He}$$

2. What type of nuclear radiation is produced when polonium-212 decays to produce lead-208?

$$^{212}_{84}\mathbf{Po} \rightarrow {}^{208}_{82}\mathbf{Pb} + \underline{\qquad\quad}$$

3. What will decay to produce lead-206 and an alpha particle?

$$\underline{\qquad\quad} \rightarrow {}^{206}_{82}\mathbf{Pb} + {}^{4}_{2}\mathbf{He}$$

4. Write a nuclear equation showing the radioactive decay of carbon-14 if the decay produces a beta particle.

$$^{14}_{6}\mathbf{C} \rightarrow \underline{\qquad\quad} + {}^{0}_{-1}\mathbf{e}$$

5. What type of nuclear radiation is produced when potassium-43 decays to produce calcium-43?

$$^{43}_{19}\mathbf{K} \rightarrow \underline{\qquad} + {}^{43}_{20}\mathbf{Ca}$$

6. What will decay to produce protactinium-234 and a beta particle?

$$\underline{\qquad\quad} \rightarrow {}^{234}_{91}\mathbf{Pa} + {}^{0}_{-1}\mathbf{e}$$

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Balancing Nuclear Equations Worksheet

1) $^{14}_{6}C \rightarrow ^{14}_{7}N +$ ______

2) ______ $\rightarrow ^{228}_{88}Ra + ^{4}_{2}He$

3) $^{228}_{89}Ac \rightarrow$ ______ $+ ^{0}_{-1}e$

4) ______ $\rightarrow ^{220}_{86}Rn + ^{4}_{2}He$

5) $^{234}_{91}Pa \rightarrow ^{234}_{92}U +$ ______

6) $^{232}_{90}Th \rightarrow ^{228}_{88}Ra +$ ______

7) $^{60}_{27}Co \rightarrow$ ______ $+ ^{0}_{-1}e$

8) ______ $\rightarrow ^{40}_{20}Ca + ^{0}_{-1}e$

9) $^{241}_{95}Am \rightarrow$ ______ $+ ^{4}_{2}He$

10) $^{222}_{86}Ra \rightarrow ^{218}_{84}Po +$ ______

11) $^{40}_{19}K \rightarrow ^{40}_{20}Ca +$ ______

12) $^{237}_{93}Np \rightarrow$ ______ $+ ^{4}_{2}He$

13) ______ $\rightarrow ^{0}_{-1}e + ^{60}_{28}Ni$

14) $^{228}_{88}Ra \rightarrow$ ______ $+ ^{228}_{89}Ac$

15) $^{233}_{92}U \rightarrow ^{4}_{2}He +$ ______

16) $^{239}_{92}U \rightarrow$ ______ $+ ^{239}_{93}Np$

17) ______ $\rightarrow ^{4}_{2}He + ^{208}_{82}Pb$

18) ______ $\rightarrow ^{32}_{15}P + ^{0}_{-1}e$

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What Types of Radiation Are There?

The radiation one typically encounters is one of four types: alpha radiation, beta radiation, gamma radiation, and x radiation. Neutron radiation is also encountered in nuclear power plants and high-altitude flight and emitted from some industrial radioactive sources.

1. **Alpha Radiation**

Alpha radiation is a heavy, very short-range particle and is actually an ejected helium nucleus. Some characteristics of alpha radiation are:

- Most alpha radiation is not able to penetrate human skin.
- Alpha-emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.
- A variety of instruments has been designed to measure alpha radiation. Special training in the use of these instruments is essential for making accurate measurements.
- Instruments cannot detect alpha radiation through even a thin layer of water, dust, paper, or other material, because alpha radiation is not penetrating.
- Alpha radiation travels only a short distance (a few inches) in air, but is not an external hazard.
- Alpha radiation is not able to penetrate clothing.

Examples of some alpha emitters: radium, radon, uranium, thorium.

2. **Beta Radiation**

Beta radiation is a light, short-range particle and is actually an ejected electron. Some characteristics of beta radiation are:

- Beta radiation may travel several feet in air and is moderately penetrating.
- Beta radiation can penetrate human skin to the "germinal layer," where new skin cells are produced. If high levels of beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury.
- Beta-emitting contaminants may be harmful if deposited internally.
- Most beta emitters can be detected with a survey instrument and a thin-window GM probe (e.g., "pancake" type). Some beta emitters, however, produce very low-energy, poorly penetrating radiation that may be difficult or impossible to detect. Examples of these difficult-to-detect beta emitters are hydrogen-3 (tritium), carbon-14, and sulfur-35.
- Clothing provides some protection against beta radiation.

Examples of some pure beta emitters: strontium-90, carbon-14, tritium, and sulfur-35.

3. **Gamma and X Radiation**

Gamma radiation and x rays are highly penetrating electromagnetic radiation. Some characteristics of these radiations are:

- Gamma radiation or x rays are able to travel many feet in air and many inches in human tissue. They readily penetrate most materials and are sometimes called "penetrating" radiation.
- X rays are like gamma rays. X rays, too, are penetrating radiation. Sealed radioactive sources and machines that emit gamma radiation and X rays respectively constitute mainly an external hazard to humans.
- Gamma radiation and x rays are electromagnetic radiation like visible light, radio waves, and ultraviolet light. These electromagnetic radiations differ only in the amount of energy they have. Gamma rays and x rays are the most energetic of these.
- Dense materials are needed for shielding from gamma radiation. Clothing provides little shielding from penetrating radiation, but will prevent contamination of the skin by gamma-emitting radioactive materials.
- Gamma radiation is easily detected by survey meters with a sodium iodide detector probe.
- Gamma radiation and/or characteristic x rays frequently accompany the emission of alpha and beta radiation during radioactive decay.

Examples of some gamma emitters: iodine-131, cesium-137, cobalt-60, radium-226, and technetium-99m.

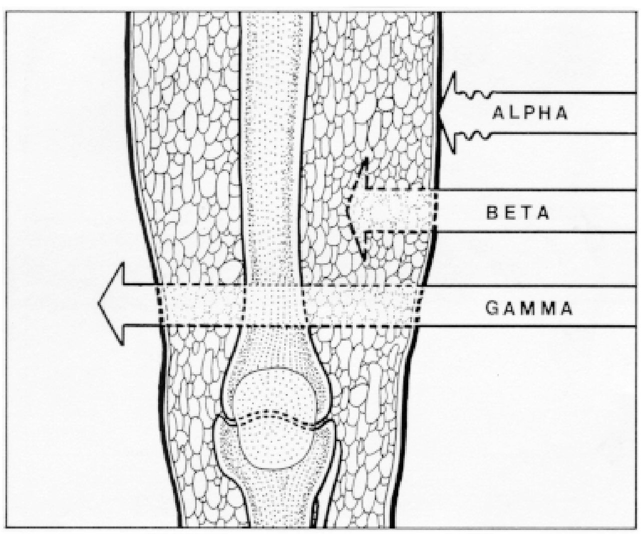

Figure 3. Radiation travelling through human tissue