True or False

- Atoms of elements are electrically neutral.
- The mass of an electron is equal to the mass of a neutron.
- The number of neutrons in the nucleus can be calculated by subtracting the atomic number from the mass number.
- Every atom of nitrogen has 7 protons and 7 neutrons.
- The charge of all protons is the same.
- The atomic number of an element is the sum of the protons and electrons in the atom.
- Radiation decreases with the distance between you and the source.

Check your answers

- Atoms of elements are electrically neutral. *True*
- The mass of an electron is equal to the mass of a neutron. *False*
- The number of neutrons in the nucleus can be calculated by subtracting the atomic number from the mass number. *True*
- Every atom of nitrogen has 7 protons and 7 neutrons. *False*
- The charge of all protons is the same. *True*
- The atomic number of an element is the sum of the protons and electrons in the atom. *False*
- Radiation decreases with the distance between you and the source. *True*

Topic of the lesson

The phenomenon of radioactivity.

Radioisotopes.

The nuclear reaction.

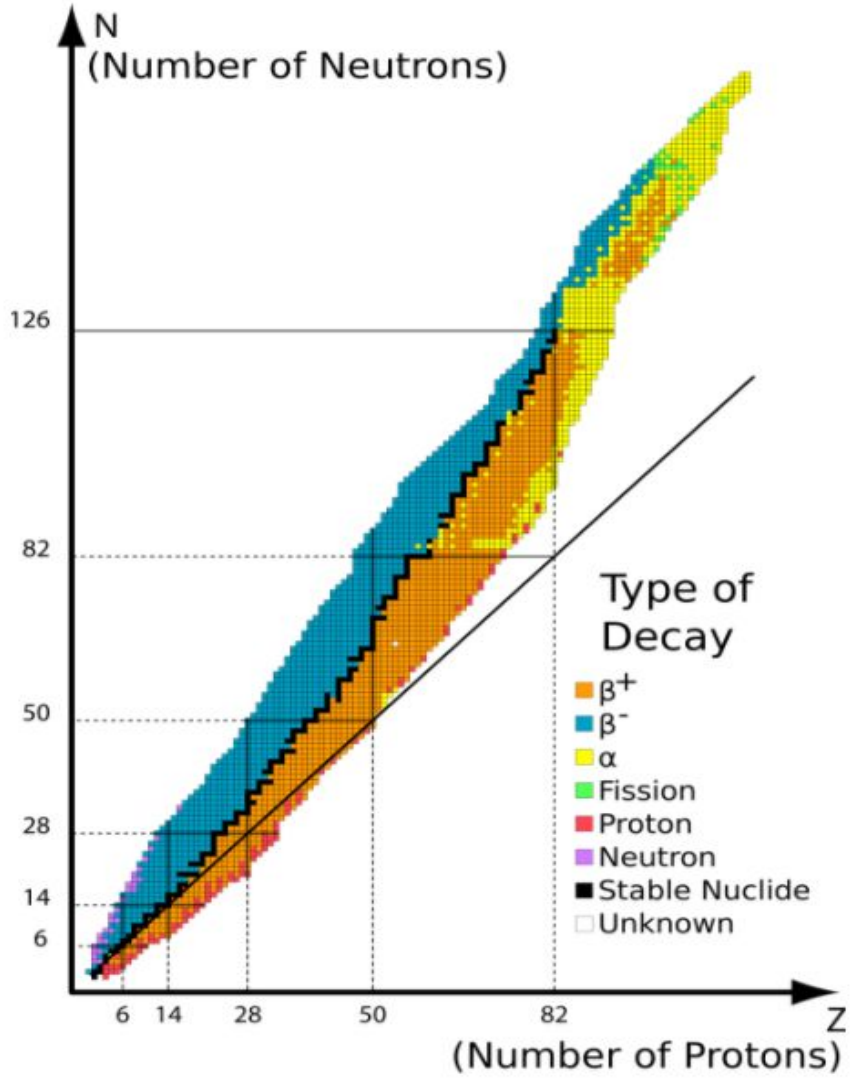
Learning objectives:

- understand why isotopes occur and the nature of radioactivity
- ability to write simple equation of nuclear reaction
- the ability to predict the impact of radioactive decay on the number of protons, neutrons, and nucleons in the nucleus

Frontal questions:

- What is radiation?
- How can you prove that element is radioactive?
- How to determine whether a nucleus is stable or not?

Look at the graph of stable elements which is commonly referred to as the Band (or Belt) of Stability and describe it



Q1. Identify the following as Alpha, beta, gamma or neutron:

a. ${}^{1}_{0}\mathrm{n}$

b. ${}^{0}_{-1}\mathrm{e}$

c. ${}^{4}_{2}\mathrm{He}^{2+}$

d. ${}^{0}_{0}\gamma$

e. Nuclear decay with no mass nor charge:

f. An electron

g. Least penetrating nuclear decay

h. Most damaging nuclear decay to the human body

i. Nuclear decay that can be stopped by skin paper

j. Nuclear decay that can be stopped by aluminum

Q2. Complete the following nuclear equations (the question marks)

a. ${}^{42}_{19}\mathrm{K} \rightarrow {}^{0}_{-1}\mathrm{e}^{-} + ?$

b. ${}^{239}_{94}\mathrm{Pu} \rightarrow {}^{4}_{2}\mathrm{He}^{2+} + ?$

c. ${}^{9}_{4}\mathrm{Be} \rightarrow {}^{9}_{4}\mathrm{Be} + ?$

d. ${}^{235}_{92}\mathrm{U} \rightarrow ? + {}^{231}_{90}\mathrm{Th}$

e. ${}^{6}_{3}\mathrm{Li} \rightarrow {}^{4}_{2}\mathrm{He}^{2+} + ?$

f. $? \rightarrow {}^{142}_{56}\mathrm{Ba} + {}^{91}_{36}\mathrm{Kr} + 3\ {}^{1}_{0}\mathrm{n}$

Q3. Throium-232 undergoes radioactive decay until a stable isotope is reached. Write the nuclear reaction for each of the 11 steps in the decay of Th-238 with each product becoming the reactant of the next decay. What is the final stable isotope?

- Step 1: Alpha decay
- Step 2: Beta decay
- Step 3: Beta decay
- Step 4: Alpha decay
- Step 5: Alpha decay
- Step 6: Alpha decay
- Step 7: Alpha decay
- Step 8: Beta decay
- Step 9: Beta decay
- Step 10: Alpha decay
- Step 11: Beta decay

Summing up the lesson

Problems

1. Using the above chart state if this isotope is alpha-emitter, stable, or unstable:
   a. $^{40}_{20}\mathrm{Ca}$
   b. $^{54}_{25}\mathrm{Mn}$
   c. $^{210}_{84}\mathrm{Po}$
2. If the isotope is located above the band of stability what type of radioactivity is it? what if it was below?
3. Between elements bromide and carbon which is more stable when using magic numbers?
4. Name one of the isotopes that consist of odd-odd combination in the nuclei?

Summing up the lesson

Solutions

1. Based off the belt of stability:
    a. Stable, because this Ca isotope has 20 neutrons, which is on of the magic numbers
    b. Unstable, because there is an odd number (25 and 29) of protons and neutrons
    c. Alpha-emitter, because Z=84, which follows rule/step one on the chart
2. Beta decay, positron emission, or electron capture
3. Carbon is stable
4. Hydrogen-2, Lithium-6, Boron-10, nitrogen-14