SHOW ALL YOUR WORK in the space provided and clearly mark your final answers.

1. You have 120 grams of Uranium-238 in a sample. The half-life of U-238 is 4.5 billion years.



1. How many grams will you have after one half-life has expired?
2. How many years will it take for the U-238 sample to decay down to only 15 grams?

2. The half-life of iodine-131 is about eight days. Calculate how much of a 40-g sample will be left after eight days, after 16 days, and after 32 days. Fill in the chart below:



Half-life

|  |
| --- |
| Iodine-131 sample Decay |
| Day 0 | 40 grams |
| Day 8 |  |
| Day 16 |  |
| Day 24 |  |
| Day 32 |  |

3. Finish the Natural Transmutation equations below: [***make sure the atomic # & masses are equal on both sides of the arrow***]

a. Alpha Transmutation

214

218

At Bi **+** He

83

85

b. Beta Transmutation



Nuclear Scientist

210

210

Tl Pb **+** e

822

81

c. Alpha Transmutation

226

Ra Rn **+** He

88

d. Beta Transmutation

234

Pa U **+** e

91

4. Finish the Artificial Transmutation equations below. [***make sure the atomic # & masses are equal on both sides of the arrow***]

a. The artificial element Neptunium is produced by bombarding Uranium-238 with an alpha particle.

4

2

1

238

He **+** U Np **+** H

1

9222

b. The artificial element Californium is produced by bombarding Berkelium-247 with an alpha particle.

1

1

247

He **+** Bk Cf **+** H

97

5. Finish the Isotopic Dating equations below AND the fill in information for each problem.

a. Carbon-14 Dating (used to calculate the age of once living organisms)

14

14

C N **+** e

6

* The amount of \_\_\_\_\_\_\_ (non-radioactive) is compared to the amount of radioactive \_\_\_\_\_\_\_ in a specimen to determine its age.
* Suppose an archeologist extracts 10 g of carbon from an ancient bone of a bird. She then determines that a modern day bone of 10 g has twice as much radioactivity as the ancient one. How old is the ancient bone?



b. Uranium Dating (used to estimate the age of rocks)

**?**

206

23814

U Pb **+** X

**?**

82

92

* Replace “?” of unknown element. Why is the broken arrow above different than the previous equations? In other words, what does that arrow represent?



c. What is the alpha particle? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d. What is beta radiation?

 *All this talk of nuclear energy gives me “atomic” ache*

6. What is the common particle involved in a nuclear chain reaction? \_\_\_\_\_\_\_\_\_\_\_\_

7. Write the nuclear fusion reaction formula & name reactants and products.

**ANSWERS**

1. You have 120 grams of Uranium-238 in a sample.

a. How many grams will you have after one half-life has expired?

* **60 grams**

b. How many years will it take for the U-238 sample to decay down to only 15 grams?

* **the half life of U-238 is 4.5 billion years**
* **it takes 3 half lives to reduce to 15 grams [ 120 g 🡪 60 g 🡪 30 g 🡪 15 g ]**
* **(3 half lives)(4.5 billion years) = 13.5 billion years**

2. The half-life of iodine-131 is about eight days. Calculate how much of a 40-g sample will be left after eight days, after 16 days, and after 32 days. Fill in the chart below:

|  |
| --- |
| Iodine-131 sample Decay |
| Day 0 | 40 grams |
| Day 8 | **20 g** |
| Day 16 | **10 g** |
| Day 24 | **5 g** |
| Day 32 | **2.5 g** |

3. Finish the Natural Transmutation equations below: [***make sure the atomic # & masses are equal on both sides of the arrow***]

a. Alpha Transmutation

**4**

214

218

At Bi **+** He

**86**

**222**

**2**

**4**

**-1**

**2**

83

85

b. Beta Transmutation

**0**

210

210

Tl Pb **+** e

822

81

c. Alpha Transmutation

226

Ra Rn **+** He

**2342**

88

d. Beta Transmutation

**0**

234

Pa U **+** e

**-1**

**92**

91

4. Finish the Artificial Transmutation equations below. [***make sure the atomic # & masses are equal on both sides of the arrow***]

a. The artificial element Neptunium is produced by bombarding Uranium-238 with an alpha particle.

**241**

1

238

4

He **+** U Np **+** H

**93**

1

9222

2

b. The artificial element Californium is produced by bombarding Berkelium-247 with an alpha particle.

**250**

1

247

He **+** Bk Cf **+** H

**4**

**2**

**98**

1

97

5. Finish the Isotopic Dating equations below AND the fill in information for each problem.

a. Carbon-14 Dating (used to calculate the age of once living organisms)

**0**

14

14

C N **+** e

**-1**

**7**

6

* The amount of **Carbon-12** (non-radioactive) is compared to the amount of radioactive **Carbon-14** in a specimen to determine its age.
* Suppose an archeologist extracts 10 g of carbon from an ancient bone of a bird. She then determines that a modern day bone of 10 g has twice as much radioactivity as the ancient one. How old is the ancient bone?
* **The half life of carbon-14 (radioactive) is 5730 years**
* **Twice as much radioactivity implies 1 half life**
* **Therefore, the bone is 5730 years old**

b. Uranium Dating (used to estimate the age of rocks)

**32**

206

23814

U Pb **+** X

**10**

82

92

* **Element “X” is an isotope of Ne**. Why is the broken arrow above different than the previous equations? In other words, what does that arrow represent?

**The “broken arrow” represents several steps in the nuclear transmutation of Uranium to Lead**

c. What is the alpha particle? **A helium nucleus 2He4**

d. What is beta radiation? **Giving off of an electron**

6. What is the common particle involved in a chain reaction? **neutron**

7. Write the fusion reaction formula & name reactants and products.

**1**

**0**

**4**

**2**

**3**

**1**

**2**

**1**

H **+** H He **+** n + ENERGY!!!!

neutron

helium

tritium

deuterium