Unit
13
Lesson
4

**AIM**
- What is a half-life and how is it calculated?

**AGENDA**
- U13L4 Lesson video
- Half-Life notes/practice
- Optional Half-Life activity

**YOYO**
- Watch the lesson video on YouTube (U13L4)

**HOMEWORK**
- Nothing due tonight
- Follow calendar

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## Transmutation

- In (natural) transmutation, the nucleus spontaneously decays into a new element.

$$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$$

- In artificial transmutation, the nucleus is first bombarded with high energy particles, then decays and changes into a new element.

$$^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

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## Question Check Point

Which nuclear equation represents a natural transmutation?

(1) $^{9}_{4}\mathrm{Be} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$

(2) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$

(3) $^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}\mathrm{H}$

(4) $^{235}_{92}\mathrm{U} \rightarrow {}^{231}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$

- Uranium is by itself on the reactant side; it does not need to be bombarded with another particle in order to decay. It is spontaneous

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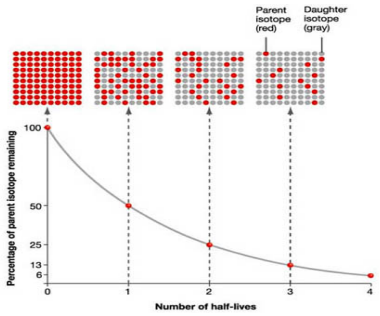
## Half-Life

- Every radioisotope has a rate of decay.
- **Half-life is the time it takes for half of the sample to decay into new elements.**

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## Half-Life

- Table N lists half-life, decay mode (particles emitted during decay), nuclide (radioisotope, and name of nuclide.
- The half-life of Ra-226 is 1600 years; meaning, in 1600 years half of Ra-226 will decay, and in another 1600 years half of what was remaining will decay.
- After 3200 years, how many half-lives has Ra-226 gone through?

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## Common Radioisotopes

- Carbon-14 (C-14) has a half-life of 5700 years and is used to date once living (organic) material
- Uranium-238 (U-238) has a half-life 4.5 billion years and is used to determine the age of rock
- Iodine-131 (I-131) has a half-life 8.021 days and is used for treatment of thyroid disorders
- Cobalt-60 (Co-60) has a half-life 5.271years and is used for cancer treatments

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## Fraction Remaining?

- $^{131}_{53}I$ has a half-life of 8.07 days. A 10 gram sample was allowed to decay for 32 days. What fraction will remain?

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## What is the half-life?

- 100 grams of a radioisotope decayed to 12 ½ grams after 90.7 years. What was the half-life?

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## Initial Amount (Original Amount)

- A radioisotope has a half-life of 10 days. 1 gram remains after 40 days. What was the initial amount of the radioisotope?

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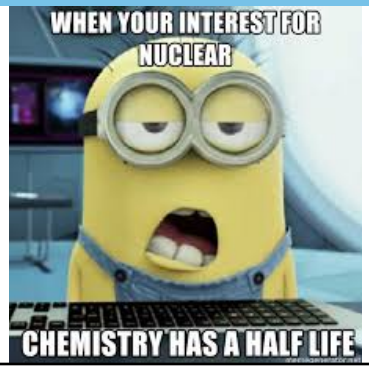
## Mixed Half Life Practice

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## Mixed Half Life Practice

- How long will it take for 30 g of $^{222}Rn$ to decay to 7.5 g?

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## Mixed Half Life Practice

- How many grams of $^{16}N$ will be left from a 16 g sample after 21.6 s?

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## Mixed Half Life Practice

- How many half-lives will it take for 50 g of $^{99}Tc$ to decay to 6.25 g?

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## Mixed Half Life Practice

- What fraction of a sample of $^{32}P$ will be left after 42.9 d?

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## Regents Questions

Which radioisotopes have the same decay mode and have half-lives greater than 1 hour?

a. Au-198 and N-16
b. I-131 and P-32
c. Ca-37 and Fe-53
d. Tc-99 and U-233

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## Regents Questions

After decaying for 48 hours, 1/16 of the original mass of a radioisotope sample remains unchanged. What is the half-life of this radioisotope?

a. 3.0 h
b. 9.6 h
c. 12 h
d. 24 h

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# Twizzler (or any other object) Half Life

- On the graph provided below, label the y-axis "Amount" and the x-axis as "Half-Life," and title your graph
- Number the x-axis from 0 to 10
- You need 2 twizzlers
- Place the first whole twizzler at 0 half lives and mark the top of the piece on the graph
- Cut the 2nd twizzler in half and place one half at Half Life 1 and discard the other half (eat or garbage) and mark off point on graph
- The twizzlers on the graph represent the amount of original material left, and the discard twizzlers represent the decayed material
- Repeat until you can no longer easily divide the twizzlers in half
- Draw a smooth line connecting all your marks

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