Warm Up

1. What is the difference between $^{238}_{92}U$ and $^{234}_{92}U$

Following directions check:

Go get a calculator. You will need it today.

Carbon-14 emits beta radiation and decays with a half-life of 5730 years. Assume you start with a mass of 2.00×10^{-12} g of Carbon-14.

a) How long is three half-lives?

b) How much of the sample is left after 3 half-lives?

Analyze ***List the knowns and the unknowns.***

Knowns

- $t_{1/2} = 5730$ years
- initial mass 2.00×10^{-12} g
- number of half-lives = 3

Unknowns

- 3 half-lives = ? years
- mass after 3 half-lives = ? g

First, calculate the time for three half-lives by multiplying the length of each half-life by three. Find the mass remaining by multiplying the original mass by $\frac{1}{2}$ three times.

Calculate ***Solve for the unknowns.***

a. 3 half-lives = 3 × 5730 years = 17,190 years

b. The initial mass of carbon-14 is reduced by one half for each of the three half-lives, so for three half-lives

$$\text{Remaining mass} = 2.00 \times 10^{-12}\text{g} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 0.250 \times 10^{-12}\text{g}$$

or 2.50×10^{-13}

Evaluate ***Do the results make sense?***

The mass of carbon-14 after three half-lives should be much lower than the original mass. The final answer has the proper units and the proper number of significant figures.

7. Manganese-56 is a beta emitter with a half-life of 2.6 h. What is the mass of manganese-56 in a 1.0-mg sample of the isotope at the end of 10.4 h?

Practice:

If there were 128 grams of radioactive material initially, what mass remains after four half-lives?

a) 4 grams
b) 32 grams
c) 16 grams
d) 8 grams

Warm Up

If you have a radioisotope with a half-life of 5 days how much of a 14.4 g sample will be left after 25 days?

Warm Up

If you have a radioisotope with a half-life of 7 days how much of a 4.44 g sample will be left after 49 days?

Get a calculator!! You need it for the quiz!!

Warm Up:

A radioisotope has a half life of 4 years. How many years must pass before 6 half-lives have passed?

Objectives:

TSWBAT:

Compare fission and fusion to chemical reactions (include the part of the atom involved and the relative amount of energy released.)

Explain the concept of half-life, its use in determining the age of materials, and its significance to nuclear waste disposal.

Warm Up

If a radioisotope has a half-life of 8 years, how many years have gone by when only half the sample is left?

Warm Up

How many grams of a 12.5 g radioisotope sample will be left after ~~25~~ 10 years if the half life is 5 years?

0.5 0.5 0.5 0.5 0.5

$12.5 \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 0.391\ g$

$12.5 \times \frac{1}{2} \times \frac{1}{2} = 3.13\ g$

Pop Quiz

For a sample weighing 45.0 g, how much sample will be left after 49 years if the half-life of this isotope is 7 years?

Nuclear Fission

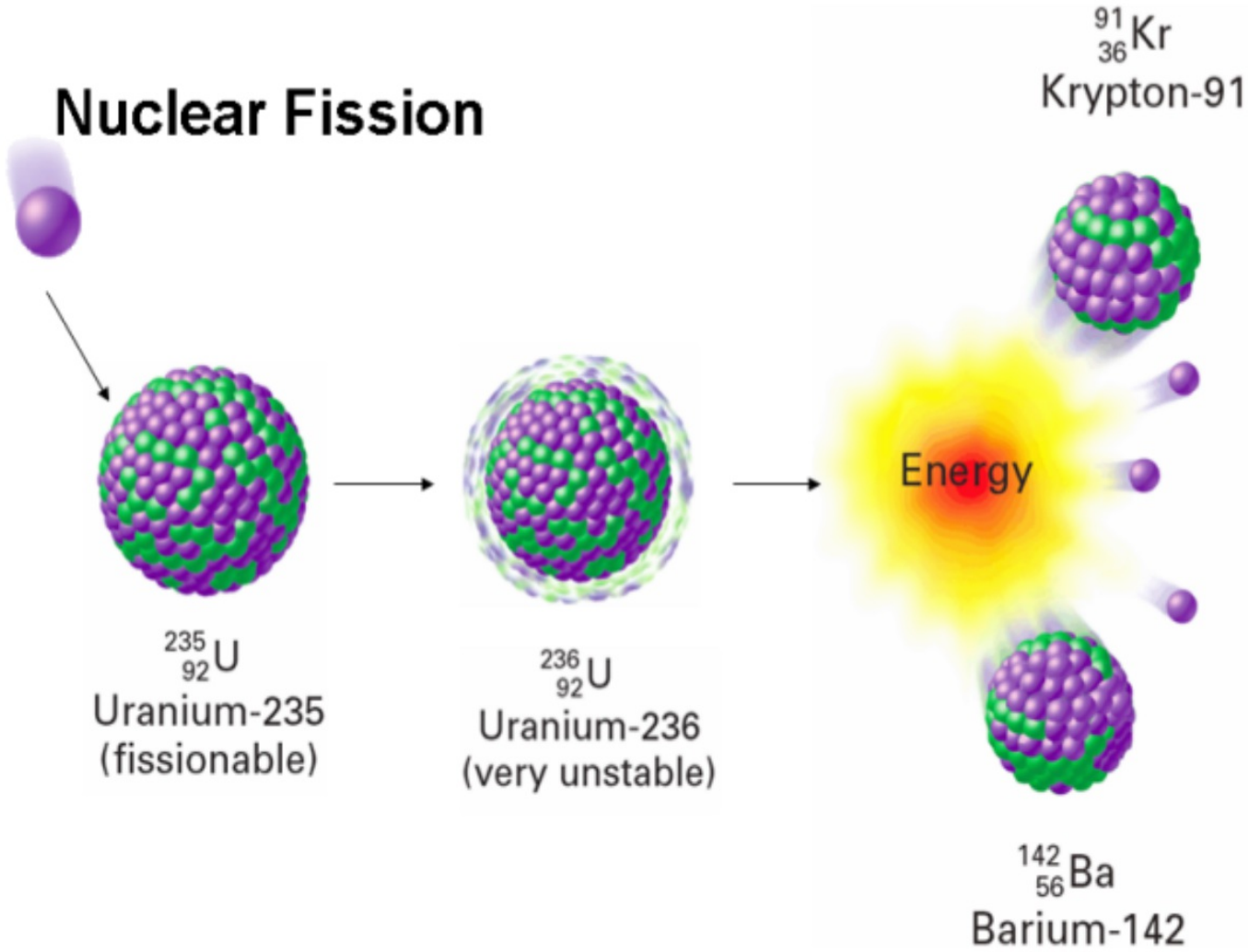
What happens in a nuclear chain reaction?

When the nuclei of certain isotopes are bombarded with neutrons, they undergo **fission**, the splitting of a nucleus into smaller fragments.

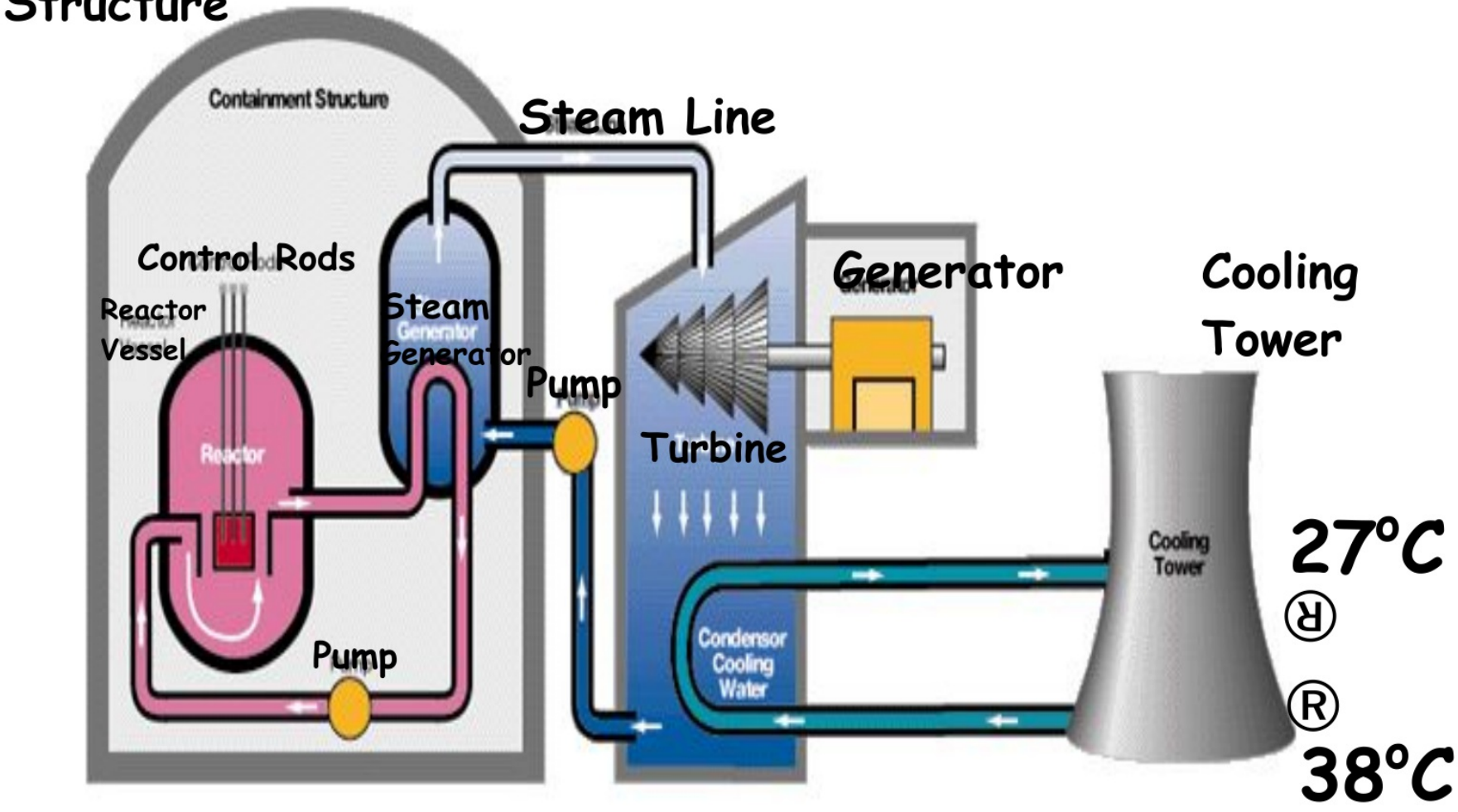
In a chain reaction, some of the neutrons produced react with other fissionable atoms, producing more neutrons which react with still more fissionable atoms.

Stuxnet Virus

Nuclear Fission



A Nuclear Power Plant



Neutron Moderation

Neutron moderation is a process that slows down neutrons so the reactor fuel (uranium-235 or plutonium-239) captures them to continue the chain reaction.

Warm Up

Where does Northwestern HS evacuate to in the case of a "nuclear event?" How long do you stay there? Where do you go next?

Neutron Absorption

Neutron absorption is a process that decreases the number of slow-moving neutrons. Control rods, made of a material such as cadmium, are used to absorb neutrons.

Nuclear Safety (or Lack Thereof)

Three Mile Island, 1979
Chernobyl-1986
Fukushima/Daiichi-2011

Chernobyl

Radiation Effects of Chernobyl

Fukushima Daiichi

Warm Up

A radioisotope has a half life of 5730 years. How many years have gone by if only 2.50 g of a sample originally weighing 10.0 g is left?

Solution: 

To register your cell phone to be notified in case of emergencies:

http://www.yorkcountygov.com/Departments/DepartmentsFP/PublicSafetyCommunications/EmergencyNotificationsRegistration.aspx

Nuclear Waste

Why are spent fuel rods from a nuclear reaction stored in water?

Water cools the spent rods, and also acts as a radiation shield to reduce the radiation levels.

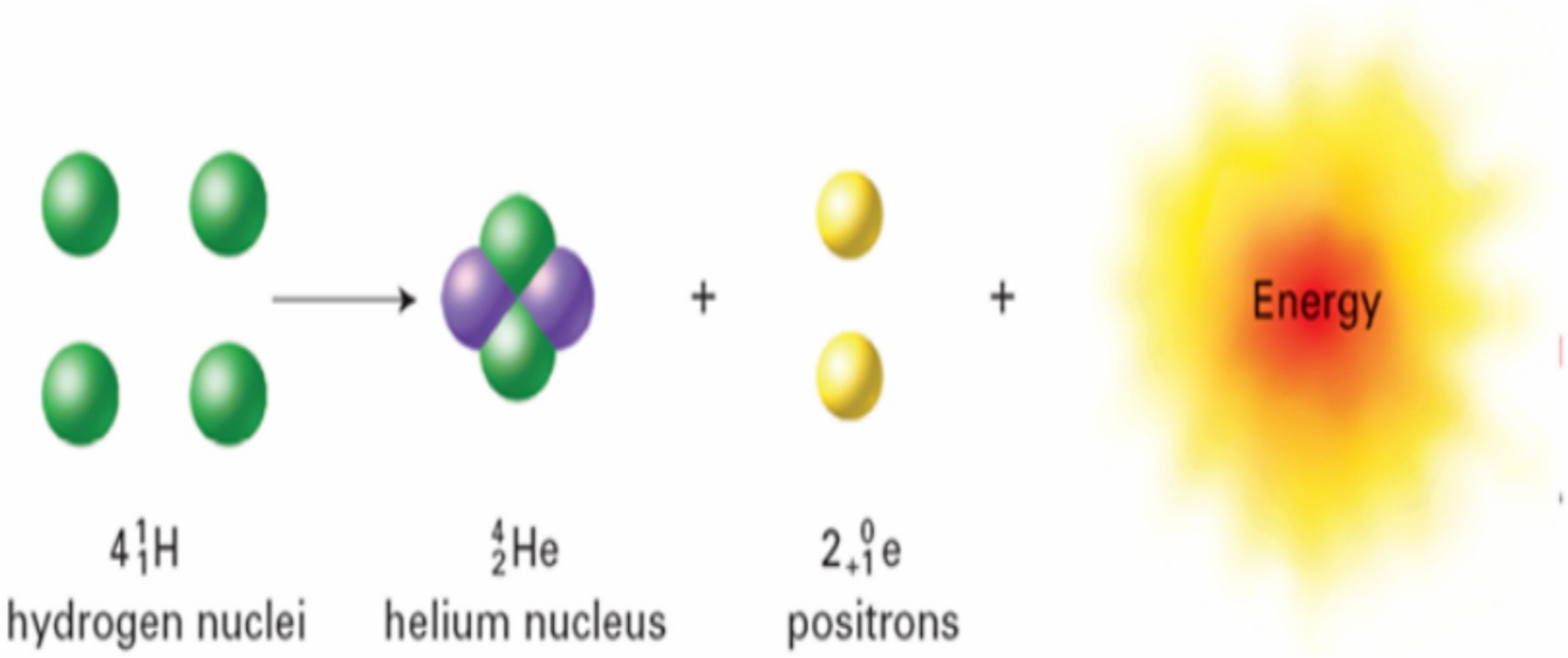
Why are the rods glowing? Hint: Look up "shrink-off radiation."

Nuclear Fusion

How do fission reactions and fusion reactions differ?

Fusion occurs when nuclei combine to produce **a nucleus of greater mass.**

In solar fusion, hydrogen nuclei (protons) fuse to make helium nuclei and two positrons.



Fusion reactions, in which small nuclei combine, release **much more energy** than fission reactions, in which large nuclei split.

The use of controlled fusion as an energy source on Earth is appealing.

- The potential fuels are inexpensive and readily available.
- The problems with fusion lie in achieving the high temperatures necessary to start the reaction and in containing the reaction once it has started.

Practice:

One of the control mechanisms for a sustainable nuclear chain reactor involves **slowing down** the released neutrons so they may be captured by other nuclei. This is done using:

a.moderators.

b.shielding.

c.absorbers.

d.control rods.

2. Spent fuel rods are stored in

a.lead-lined containers.
b.deep pools of water.
c.thick concrete bunkers.
d.cadmium or graphite containers.

3. Choose the correct words for the spaces. In solar fusion, _____ nuclei fuse to form _____ nuclei.

a.helium, hydrogen
b.hydrogen-1, hydrogen-2
c.hydrogen, helium
d.hydrogen-1, hydrogen-3