

OR A CHEMIST

Thinking Like a Geologist
About Nuclear Change III

UNIT 7 DAY 3

What are we going to learn today?

Quantify Nuclear Decay

Rate of Change

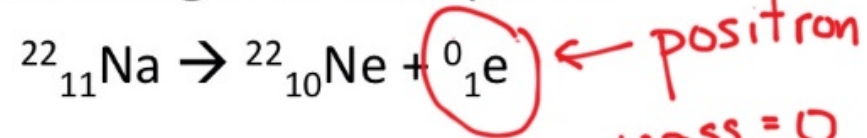
How "FAST" is the reaction

IMPORTANT INFORMATION

Applications
LM 26 due Tue 9AM
HW8 due Tue 9 AM
Sepling

QUIZ: Clicker Question

The following is an example of:



- a) Fission
 - b) Fusion
 - c) Alpha decay
 - d) Beta decay
 - e) positron decay
- if it doesn't say +/- THEN it is (-)

Radioactive Decay – just happens



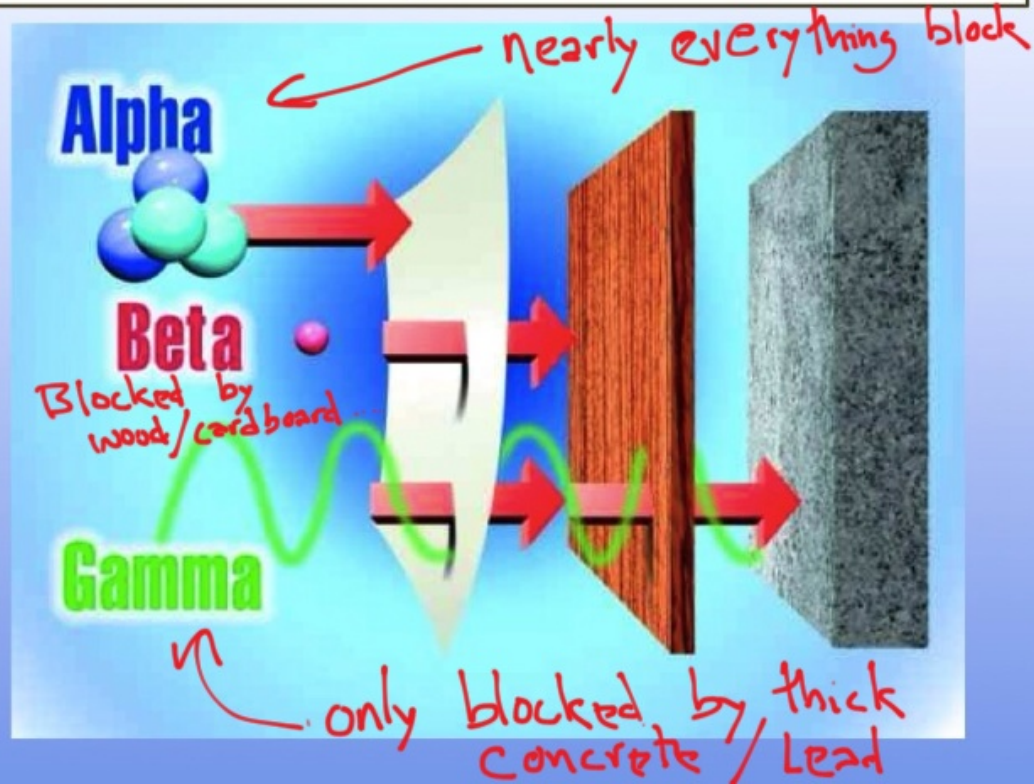
REVIEW BAND OF STABILITY

<http://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML.html>

Use this to review what we did on Tuesday

CHECK OUT
THIS LINK!

Effects Are Different
RATE of Decay is also IMPORTANT

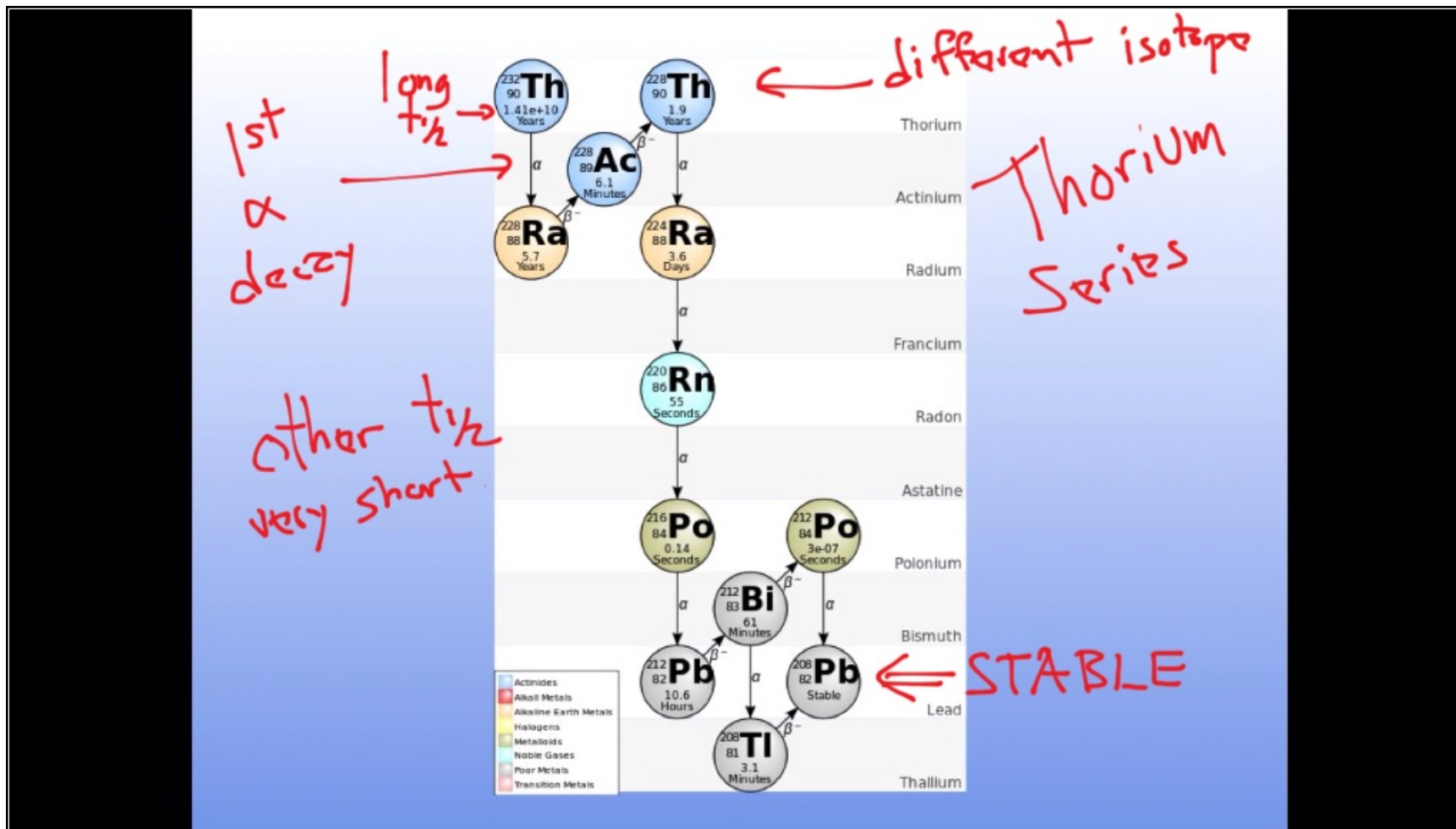


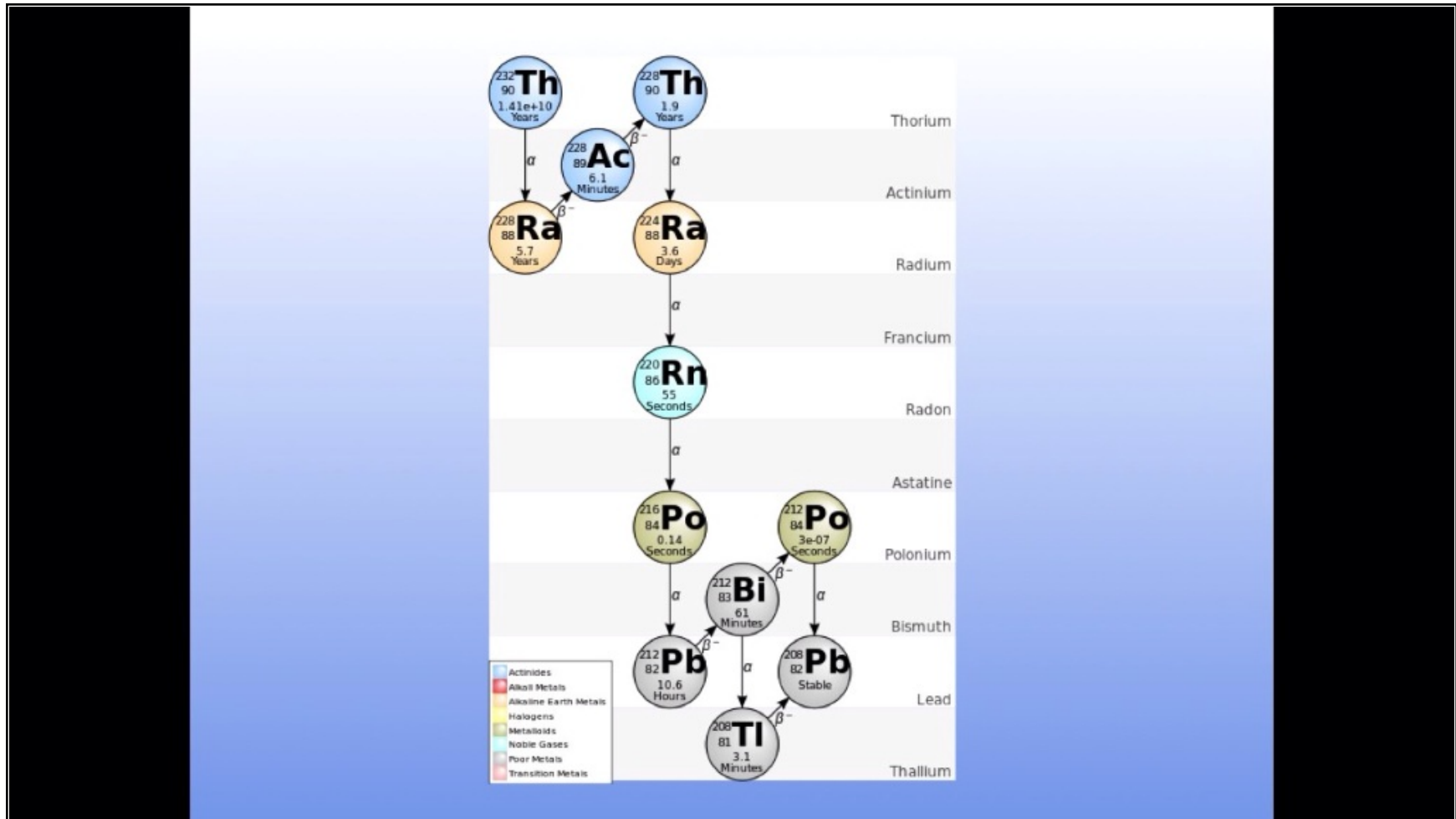
RADIOACTIVITY DEMO

KCl salt:	K-40, g
Lantern mantle:	Th-232 and daughters, a b g
Monazite Rock:	Th-232 and daughters, a b g
Demo Button 1:	Cs-137, g
Demo Button 2:	Ra-226, g

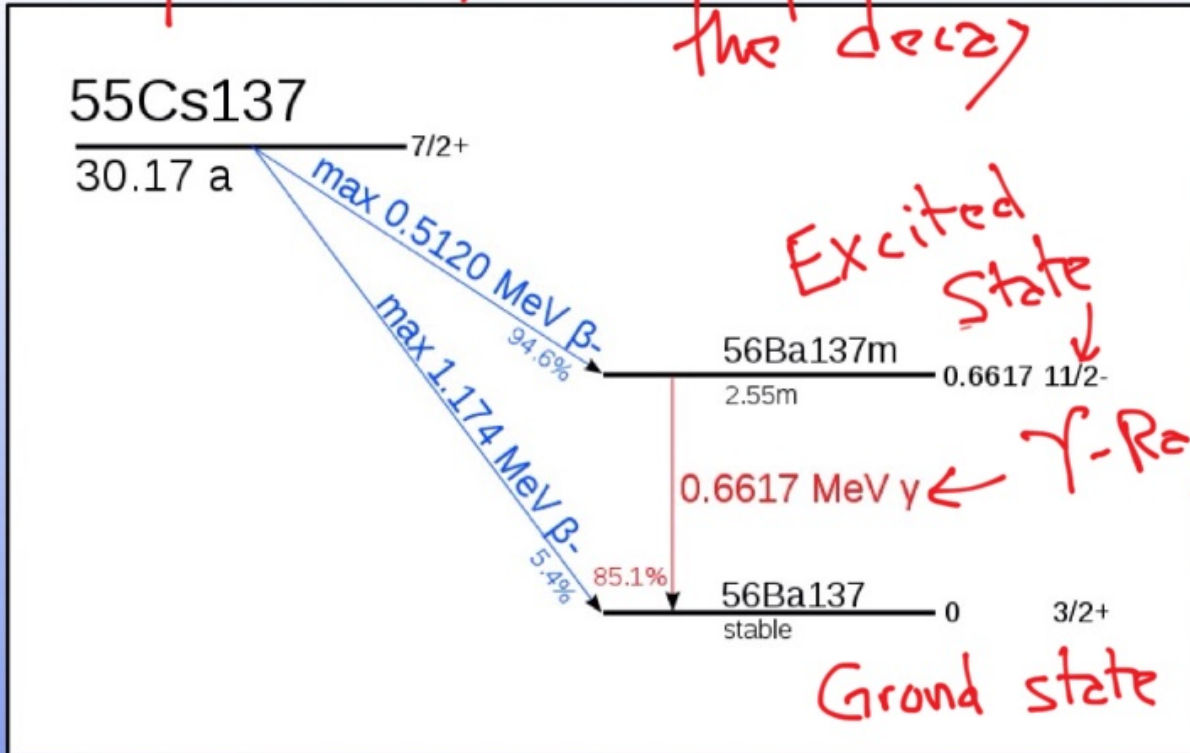
← γ (β)

Big Series
] γ out of source as others are blocked





γ usually accompanies the decay



POLL: Clicker Question

A Geiger counter shows that a sample is emitting radiation. Placing a piece of paper or wood between the sample and the device does not diminish the counts, but placing a piece of lead between the sample and device stops the detection of radiation. What type of radiation is being emitted?

A. α

B. β

C. γ

← Not blocked by paper wood

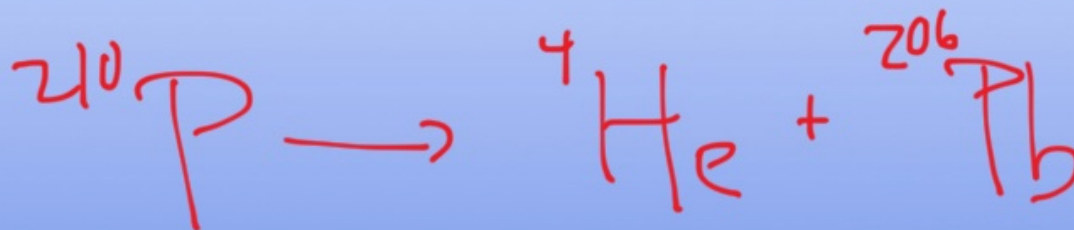
POLL: LOTS OF CLICKERING!

Radioactive Decay Activity!

Read Introduction. Gather activity sheet, coin and I-clicker.

A) Standing (Po-210)

B) Sitting (Pb-206)



POLL: Clicker Question

8. Most of the Po is lost:

- A) during first event
- B) same at each event
- C) during the last event

First event is the BIGGEST
there is the most to change

POLL: Clicker Question

10. What is the relationship between the amount of Po that decays in a given time period with the amount of Po that you have at the beginning of that time period.

- A) not predictable from data
- B) the more Po you have, the more Po decays
- C) the less Po you have, the faster it decays

That is why the first event is biggest change

POLL: Clicker Question

11. The relationship between the amount of Po lost and the amount of Pb gained is:

- A) not predictable from data
- B) Po decreases by the same amount that Pb increases
- C) cannot make an interpretation

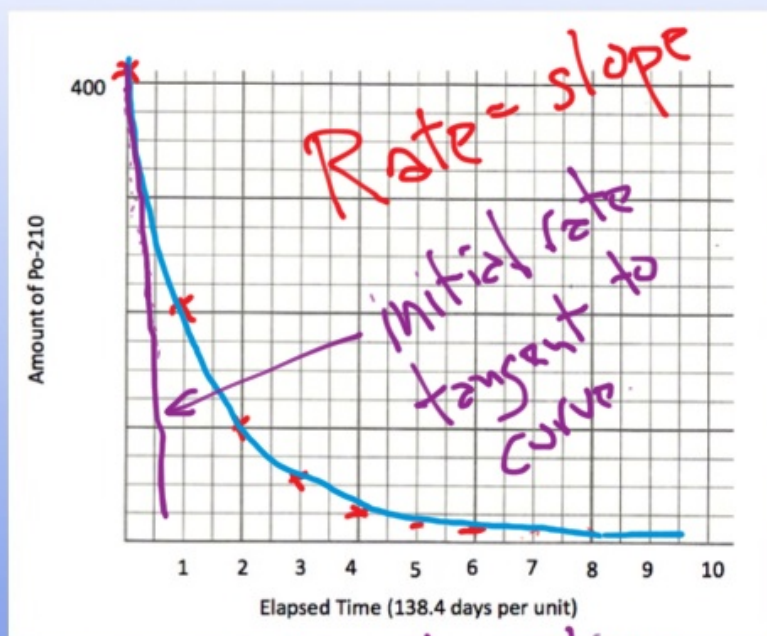


What is "REACTION RATE"?

Rate is change in amount per change in unit time

Rate is the slope of the graph of amount vs. time

If you know the rate of one reactant or product you know them all



$$\text{Rate} = \frac{\Delta P_o}{\Delta t}$$

rate = derivative

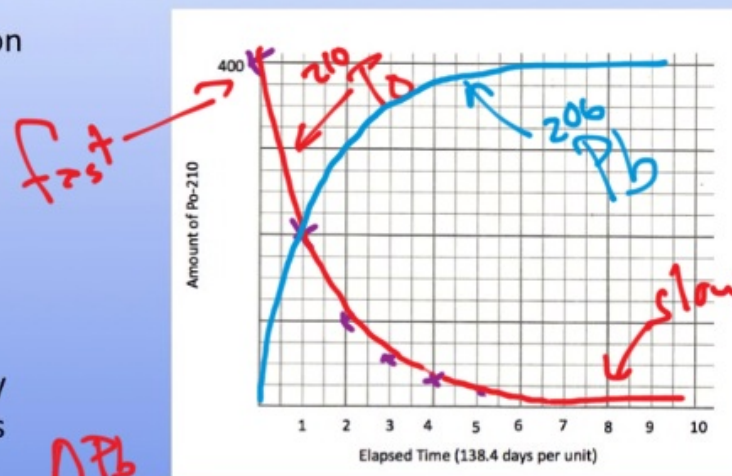
How does Rate Depend on Amount? RATE LAW

Note on your graph: Rate is changing with concentration

How does the rate depend on the amount of Po-210?

Rate is some function of the amount of the reactant molecules

Do an experiment to directly measure how the rate varies with amount

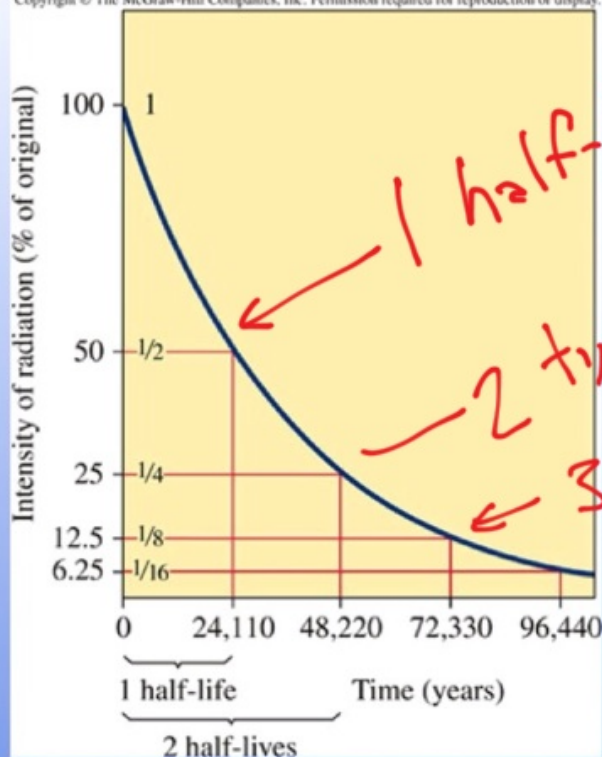


$$\text{rate} = -\frac{\Delta P_o}{\Delta t} = \frac{\Delta P_b}{\Delta t}$$

$$\text{rate} \propto P_o$$

Pu-239 Radioactive Decay – Kinetics of Decay

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



(Handwritten notes in red ink):
 1 half-life = 50% $(\frac{100}{2})$
 2 \times $\frac{1}{2}$ = 25% $(\frac{50}{2})$
 3 \times $\frac{1}{2}$ = 12.5% $(\frac{25}{2})$

POLL: Clicker Question

15. Start with 96 student isotopes. How many events would have to occur to end up with 6 student isotopes?

- A) 1
- B) 2
- C) 3
- D) 4
- E) 5

$$1 \times t_{1/2} = 96/2 = 48$$

$$2 \times t_{1/2} = 48/2 = 24$$

$$3 \times t_{1/2} = 24/2 = 12$$

$$4 \times t_{1/2} = 12/2 = \underline{6}$$

$$\text{or } 6 = \frac{96}{2^x} \quad x = 4$$

Half-life: the time required for the level of radioactivity to fall to one-half of its value. Half-life – indication of stability of isotope.

Table 7.5 Half-Lives for Selected Isotopes

Radioisotope	Half-life
Uranium-238	4.5×10^9 years
Potassium-40	1.3×10^9 years
Plutonium-239	24,110 years
Carbon-14	5715 years
Cesium-137	30.2 years
Strontium-90	29.1 years
Thorium-234	24.1 days
Radon-222	3.82 days
Iodine-131	8.04 days
Plutonium-231	8.5 minutes
Polonium-214	0.00016 seconds

more stable
↓
less stable

$t_{1/2}$ have huge range

POLL: Clicker Question

17. P-32 has a half-life of 14 days. After 3 months what would be the residual radioactivity of 1 millicurie of ATP labeled with P-32?

• Assume each month contains exactly 4 weeks*

- A) 62.5 microcuries
- B) 6.25 microcuries
- C) 15.6 microcuries
- D) 1.56 microcuries

$$3 \text{ month} = 12 \text{ weeks} \\ = 6 t_{1/2}$$

$$1 \text{ mCu} / 2^6 = 1.56 \times 10^{-2} \text{ mCu} \\ = 15.6 \text{ } \mu\text{Cu}$$

Human-Made Radioactive Isotopes: Byproducts of Fission

Cs-137 – $\frac{1}{2}$ life 30 years, beta emitter

I-131 – $\frac{1}{2}$ life 8 days, beta emitter

Sr-90 – $\frac{1}{2}$ life 29 years, beta emitter

Children exposed to Sr-90 can have been shown to have a higher % of bone and blood cancers, because:

- a) Sr is similar to Fe
- b) Sr is radioactive
- c) Sr is similar to Ca
- d) Sr has a $\frac{1}{2}$ life which is longer than that of childhood

Ca in
BONES!

What did we learn today?

Rate of Radioactive Decay

Varies with Isotope

Similar type of Rate – 1st Order

1st Order – Depends on amount of starting reactant

Half Life – $t_{1/2}$

Chemistry is FUN!

