UNIT7-DAY2-LaB1230

Tuesday, March 19, 2013
7:59 AM

Thinking Like a Chemist
About Nuclear Change II

UNIT7 DAY2

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What are we going to learn today?

Types of Nuclear Changes
Isotopic Stability
Ionizing Radiation

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IMPORTANT INFORMATION

LM25 & LM26 due Th 9AM

Check out nuclear reaction and decay worksheets.

EXAM AVERAGES WERE GOOD. RANGE BETWEEN 69 and 72 DEPENDING ON CLASS.

POLL: CLICKER QUESTION 1

I HAVE:

A) CHECKED my grade for UNIT 6 EXAM
B) CHECKED my grade for UNIT 6 EXAM, and looked at what I missed.
→ C) CHECKED my grade for UNIT 6 EXAM, looked at what I missed, and tried to figure out what the correct answers should be ← Cumulative Final
D) NOT CHECKED my grade for UNIT 6 EXAM
E) NOT REALIZED that we already taken that EXAM

Review From Last Class: Nuclear Change vs Chemical Change

1. Compare energy released upon change
2. Compare what is conserved across the change
3. Types of change and how to recognize type of change

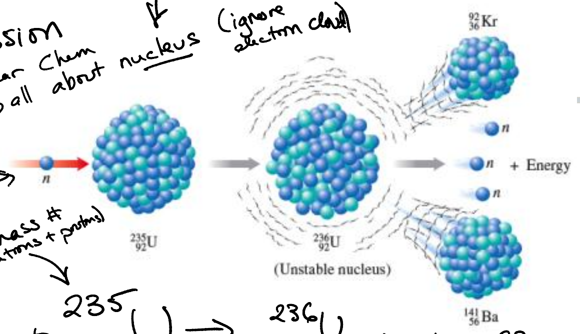
"nuclide"

"nuclide"

Fission

Nuclear Chem → all about nucleus (ignore electron cloud)

"nucleons" → neutrons, protons



mass # (neutrons + protons)

$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{236}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$

atomic # → # protons OR nuclear charge

Chemical Change vs Nuclear Change

$4C_7H_2(NO_2)_3CH_3(s) + 25O_2(g) \rightarrow 32CO_2(g) + 10H_2O(g) + 6\,N_2(g)$ $\Delta E \sim$ 100's kJ

Chemical – atoms rearrange, but do not change atomic identity. = all about e⁻'s

$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$

Nuclear – nuclear change, change in atomic identity likely across nuclear change, $\Delta E \sim 10^{10}$ kJ

matter converted to energy or energy converted to matter.

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Conserved: mass numbers
on Rt hand side vs Lft hand side
atomic numbers
on Rt hand side vs. Lft hand side

START WORKSHEET

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Recognize Different Types of Nuclear Change: How are the following similar and different?

Decay: Big → Big + Tiny

$^{238}_{92}U \rightarrow \, ^{234}_{90}Th + \, ^{4}_{2}He$ — helium nucleus, alpha particle

Fission: $^{1}_{0}n + \, ^{235}_{92}U \rightarrow \, ^{141}_{56}Ba + \, ^{92}_{36}Kr + 3 \, ^{1}_{0}n$

Big → 2 decent sized particles

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Fission vs Fusion – make it happen

→ release energy

Fission (Nuclide larger, Heavy): $^{1}_{0}n + \, ^{235}_{92}U \rightarrow \, ^{141}_{56}Ba + \, ^{92}_{36}Kr + 3 \, ^{1}_{0}n$

Fusion: $^{1}_{1}H + \, ^{2}_{1}H \rightarrow \, ^{3}_{2}He$

2 light → heavy (fuse together)

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Transmutation – make it happen

NOT spontaneous

Bombard w/ α particles

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

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

Need particle accelerator

Medicine → cancer treatment

&

Research

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Radioactive Decay – just happens

$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He + 2^{0}_{0}\gamma$ ← gamma, usually left off of balanced eqn since it has no mass & no charge, just electromagnetic radiation

Alpha $^{4}_{2}\alpha$; $^{0}_{0}\gamma$

$^{234}_{90}Th \rightarrow ^{234}_{91}Pa + ^{0}_{-1}e$

beta particle $^{0}_{-1}\beta$; electron →

$^{22}_{11}Na \rightarrow ^{22}_{10}Ne + ^{0}_{1}e$ positron $^{0}_{1}\beta$ (also β)

$^{201}_{80}Hg + ^{0}_{-1}e \rightarrow ^{201}_{79}Au + ^{0}_{0}\gamma$

→ electron capture (from electron cloud, spontaneously) — turns proton into neutron

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Where does the energy come from?

BINDING ENERGY – WHAT IS IT? HOW IS IT RELEASED?

like bond energy in chemical Rxns

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$\Delta m = -1.9 \times 10^{-2}$

amu → -3.226×10^{-29} kg

$\Delta E = (-3.226 \times 10^{-29}\ kg)(2.998 \times 10^{8}\ \frac{m}{s})^2$

$\Delta E = -2.9 \times 10^{-12}$ J

$kg\ \frac{m^2}{s^2} = 1J$

$\frac{-2.9 \times 10^{-12}}{\text{individual}} \Big| \frac{6.022 \times 10^{23}\ \text{individual}}{1\ \text{mole}} = -1.75 \times 10^{12}$ J/mole

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$^{12}_{6}C \rightarrow 6\,^{1}_{0}n + 6\,^{1}_{1}p$ + Binding Energy

$^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$ ← Products lower energy side

↗ make/reassemble

Break ↘ $3\,^{1}_{0}n + 2\,^{1}_{1}p$ gives off energy

takes energy

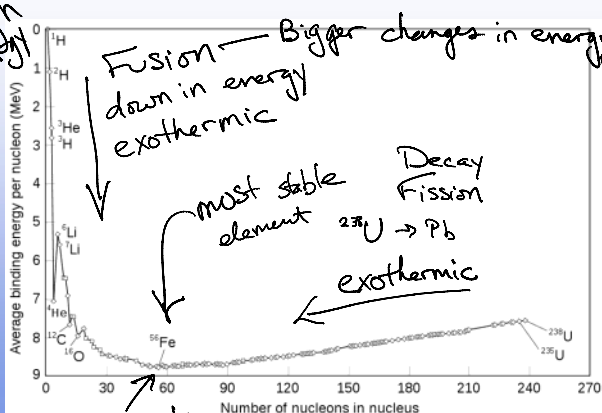
Difference in energies: ΔE

Binding Energy per Nucleon

high energy

Fusion — Bigger changes in energy!

Fusion is a much better way to produce energy!



lowest energy

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POLL: CLICKER QUESTION 2

What is nuclear radiation?

A. High energy electrons
B. High energy small nuclei
C. high energy electromagnetic radiation
D. A & B
E. all of the above

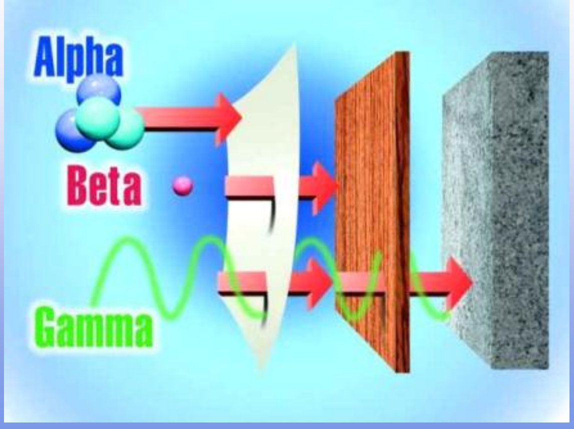
Three basic types of nuclear radiation

alpha radiation	positive and massive
beta radiation	negative and low mass
gamma radiation	uncharged (no mass)

In learning module!

Radioactivity – the spontaneous emission of radiation by certain isotopes of certain elements - Madame Curie

Effects Are Different



Alpha Particles

INSIDE BODY = HARMFUL
bare Helium nucleus will rip electrons off molecules
ionization of biomolecules = unhealthy you

Generally not harmful as they are absorbed by your outer layer of dead skin
(bad news if they get in your lungs!)

http://www.epa.gov/rpdweb00/understand/alpha.html#affecthealth

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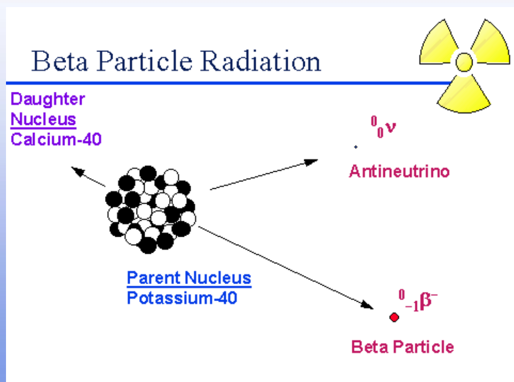
Beta Decay



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Gamma Rays

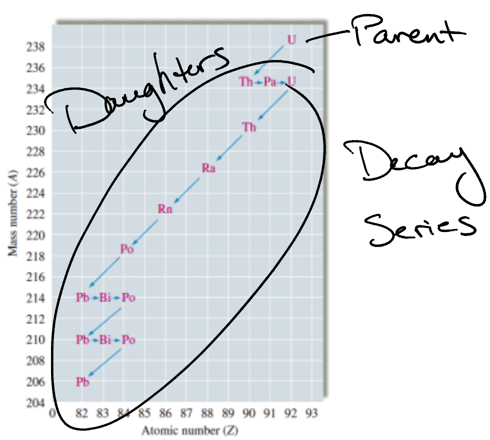
This is what will do you in.
Hard to protect against. Highly ionizing.
Like the world's worst sunburn (except the radiation can penetrate skin)

http://www.epa.gov/rpdweb00/understand/gamma.html#affecthealth

Where does radiation come from?

- Unstable radioisotopes
  - Naturally found in environment
  - Made by humans for medical, energy, defense purposes

Radioactive Decay – just happens



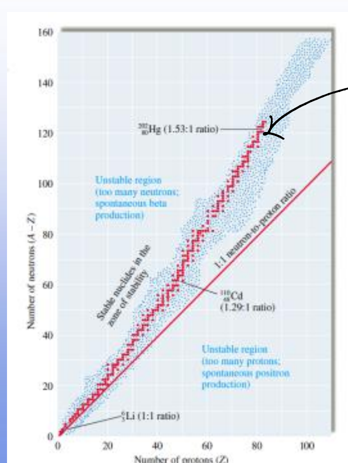
Plot of Neutrons vs Protons

Band of Stability

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

DISCOVER THE TYPES OF RADIATION THAT SHOULD OCCUR FOR EACH PART OF GRAPH

Radioactive Decay – Band of Stability



were black squares on your handout

Red is Band of Stability

BLUE unstable (not on your handout)

What did we learn today?

Types of Nuclear change:

- Fission
- Fusion
- Decay
- Transmutation

Isotopic Stability

- Depends on Neutron to Proton Ratio

Decay "Particles" – Ionizing Radiation

- alpha
- beta
- gamma
- positron

Explanation Space