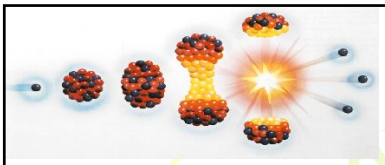
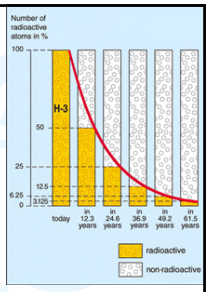




Nuclear Chemistry:

Ref. Tables N / O

Nuclear Energy

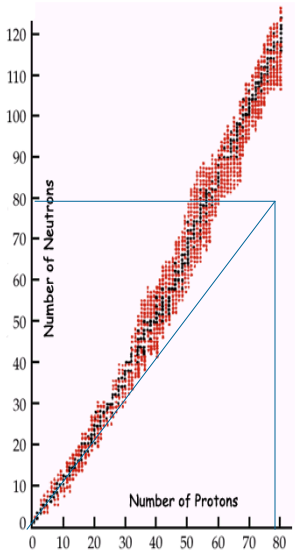
- Energy _____ as a result of a change in the _____ of an atom
- Transmutation: The atomic nucleus of one element is changed into the nucleus of a _____ element (# of protons change, thus atomic _____ changes.)
- Nucleus made of Nucleons

Protons Neutrons

2

Radioisotopes and the Band of Stability

- an isotope that is _____ and thus radioactive (usually element above #___) (Table __)
- n/P ratios above one are often unstable
- Band of stability exists showing areas of stable/unstable isotopes



3

Types of Particles

- Table __
- _____, _____, _____, _____, _____, _____

Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	$^{4}_{2}He$ or $^{4}_{2}\alpha$	α
beta particle (electron)	$^{0}_{-1}e$ or $^{0}_{-1}\beta$	β^-
gamma radiation	$^{0}_{0}\gamma$	γ
neutron	$^{1}_{0}n$	n
proton	$^{1}_{1}H$ or $^{1}_{1}p$	p
positron	$^{0}_{+1}e$ or $^{0}_{+1}\beta$	β^+

4

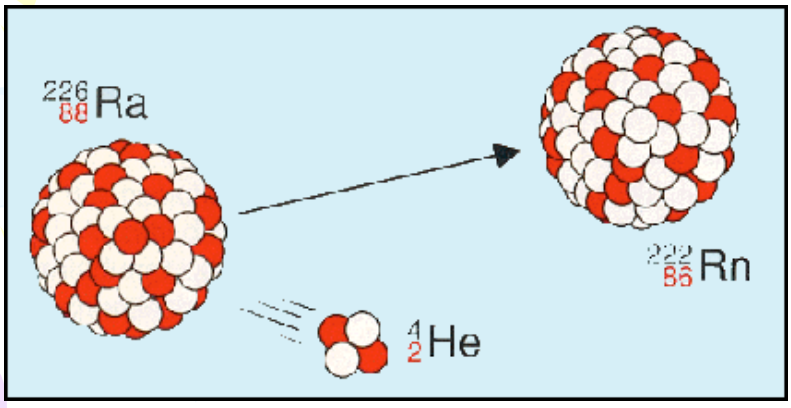
Alpha radiation: symbol→ α

- particle is __ protons/__ neutrons= __ amu and has a ____ charge.
- notation is similar to a Helium nucleus

  $^{4}_{2}$ _____ or $^{4}_{2}\alpha$
- least harmful radiation:
  i- blocked by _____
  ii- _____ penetrating power
  iii- travels _____ distances ~3ft/1m
  iv- speed is _____

5

Alpha radiation continued



6

Beta radiation: symbol→ β-

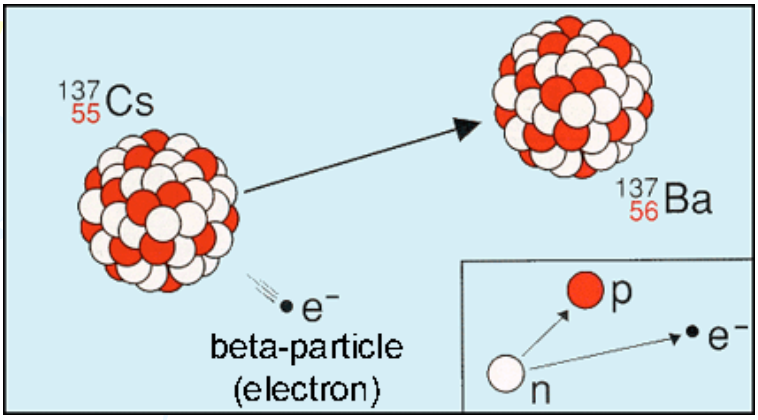
- particle is basically an _____= 0 amu and has a _____ charge
- notation

$^{0}_{-1}e$ or $^{0}_{-1}\beta$

- More dangerous than alpha
  - i- blocked by _____
  - ii- _____ penetrating power
  - iii- travels about _____
  - iv- speed _____

7

Beta radiation continued



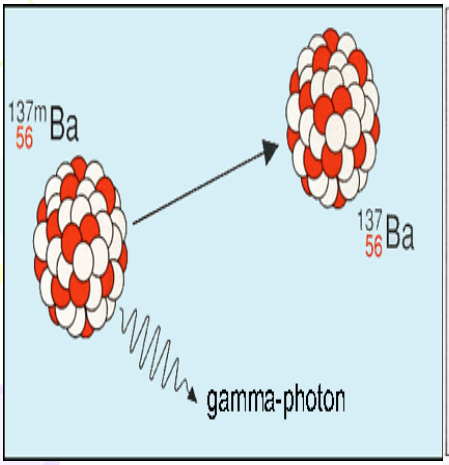
8

Gamma radiation: symbol→ γ

- is _____ (but is energy) that has no _____ and no _____
- notation $^{0}_{0}\gamma$
- most harmful-similar to x-rays
  - i-blocked by _____ (5-10cm), _____ (2-4ft) or _____ (10-15ft)
  - ii- travels _____ than α and β
  - iii- travels _____
  - iv- causes _____ to be destroyed

9

Gamma radiation continued



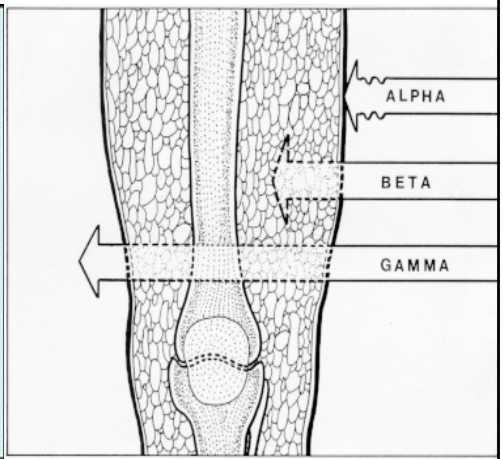


Figure 3. Radiation travelling through human tissue

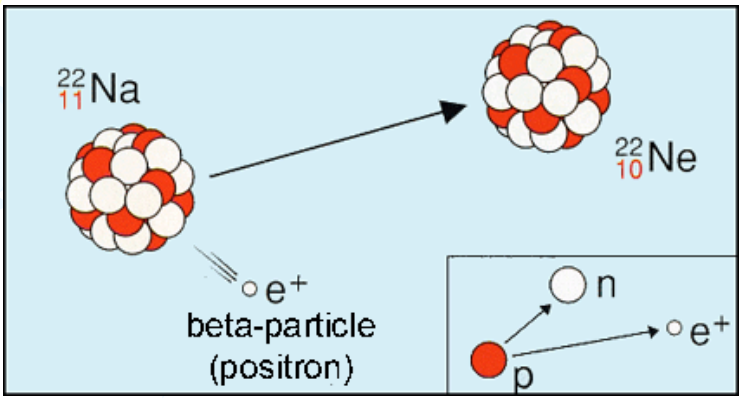
10

Neutron, Proton, Positrons

- Neutron ${}_{0}^{1}n$ mass of ___ with ___ charge
- Proton ${}_{1}^{1}H$ *or* ${}_{1}^{1}P$ Mass of _/charge of ___
- Positron ${}_{+1}^{0}e$ *or* β^{+} Mass of _/charge of ___
  - results when a _____ converts to a _____

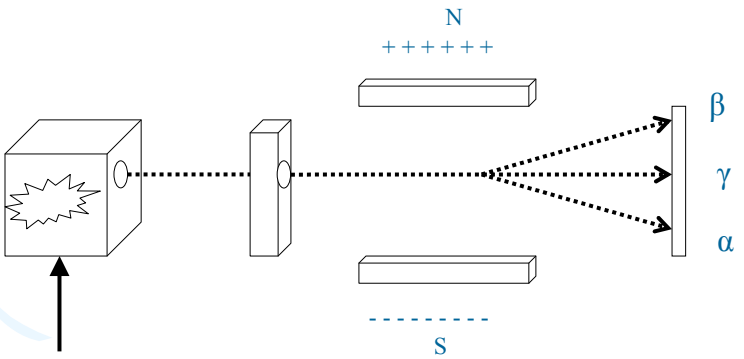
11

Positron formation



12

Effect of magnetic field on α, β, γ



13

Radioactive Decay: By transmutation

- Natural/spontaneous transmutation
  - Particles given off
  - Happens _____
  - Elements _____ than 83 will go through a series of transmutations until they form _____ by _____ or _____ decay
  - Alpha decay: $^{226}Ra \rightarrow$ _____ + _____
    $^{210}Po \rightarrow$ _____ + _____
  - Beta decay: $^{60}Co \rightarrow$ _____ + _____
    $^{234}Pa \rightarrow$ _____ + _____

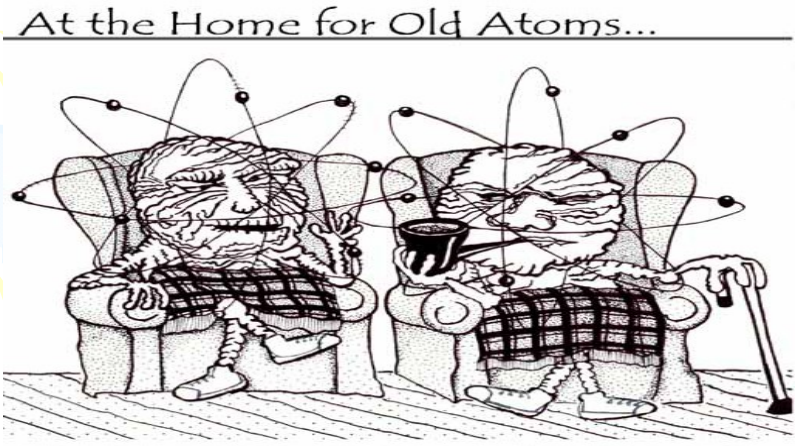
14

Transmutation continued

- Artificial transmutation
  - Particles are _____ to an existing atom
    - $^{1}H + {}^{9}Be \rightarrow$ _____ + ^{6}Li
    - $^{238}U + {}^{12}C \rightarrow 6($_____$) + {}^{244}Cf$
    - $^{249}Cf + {}^{10}B \rightarrow {}^{257}Lr + 2($_____$)$
- **In nuclear equations, both _____ and _____ must be conserved and equal**

15

Nuclear Humor



"When I was young I used to feel so alive, so dangerous! In fact, would you believe I started life as a Uranium-238? Then one day I accidentally ejected an alpha particle....now look at me, a spent old atom of Lead-206. Seems that all my life since then has been nothing but decay, decay, decay..."

16

Half-Life

- Time required for _____ of the atoms in a radioactive sample to _____ to a stable form
- Formula to determine amount left after each half life is $(1/2)^n$, where n = the # of half lives

$1 \rightarrow (1/2)^1 \rightarrow$ _____

$2 \rightarrow (1/2)^2 \rightarrow$ _____

$3 \rightarrow (1/2)^3 \rightarrow$

$6 \rightarrow (1/2)^6 \rightarrow$ _____

$7 \rightarrow (1/2)^7 \rightarrow$ _____

$8 \rightarrow (1/2)^8 \rightarrow$

17

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
^{198}Au	2.69 d	β^-	gold-198
^{14}C	5730 y	β^-	carbon-14
^{37}Ca	175 ms	β^+	calcium-37
^{60}Co	5.26 y	β^-	cobalt-60
^{137}Cs	30.23 y	β^-	cesium-137
^{53}Fe	8.51 min	β^+	iron-53
^{220}Fr	27.5 s	α	francium-220
^{3}H	12.26 y	β^-	hydrogen-3
^{131}I	8.07 d	β^-	iodine-131
^{37}K	1.23 s	β^+	potassium-37
^{42}K	12.4 h	β^-	potassium-42
^{85}Kr	10.76 y	β^-	krypton-85
^{16}N	7.2 s	β^-	nitrogen-16
^{19}Ne	17.2 s	β^+	neon-19
^{32}P	14.3 d	β^-	phosphorus-32
^{239}Pu	2.44×10^4 y	α	plutonium-239
^{226}Ra	1600 y	α	radium-226
^{222}Rn	3.82 d	α	radon-222
^{90}Sr	28.1 y	β^-	strontium-90
^{99}Tc	2.13×10^5 y	β^-	technetium-99
^{232}Th	1.4×10^{10} y	α	thorium-232
^{233}U	1.62×10^5 y	α	uranium-233
^{235}U	7.1×10^8 y	α	uranium-235
^{238}U	4.51×10^9 y	α	uranium-238

ms = milliseconds; s = seconds; min = minutes;
h = hours; d = days; y = years

To determine # of half-lives passed (n)

- use the following: $\frac{\text{Total Time elapsed}}{\text{Half-Life of isotope}}$

- Ex. Phosphorus -32 has a half life of 14.3 days, How many mg are left after 57.2 days if we started with 4.0 mg?

19

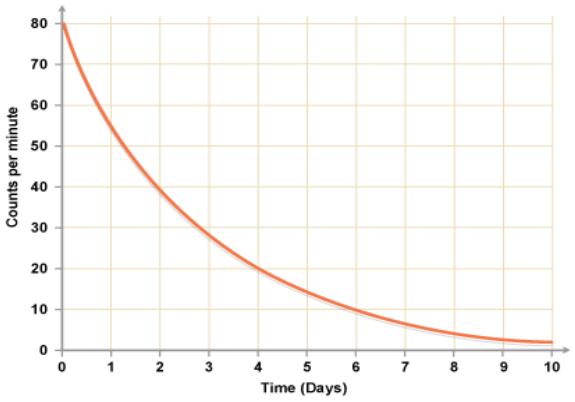
Half Lives continued

- Ex. How many grams of a 34.0g sample of Neon-19 will remain after 1 minute and 43.2 seconds?

20

Half Life curves

- Shape is generally the same for all half life curves



21

Fission/Fusion

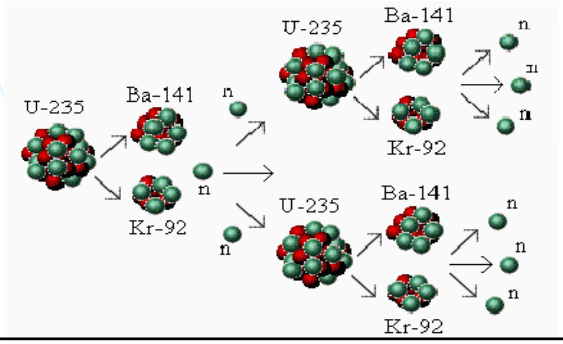
- _____ producing Reactions
- Mass defect= in these Rxn's, the reactants mass is _____ _____ than the resulting product mass.
  - Loss represents a conversion of mass into energy → _____
- Fission: large unstable atom is _____ into smaller ones (a particle is needed to start this _____ reaction)

22

Nuclear Fission of Uranium

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

Starts Reaction — Fuel — Radioactive Products — Allows for chain reactions — Heat



23

Fission: Products may differ

2.10 | 2.11 | 3.1 | 3.2 | RAD AUTO REAL

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{90}_{37}Rb + {}^{144}_{55}Cs + 2\,{}^{1}_{0}n$$

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{93}_{36}Kr + {}^{140}_{56}Ba + 3\,{}^{1}_{0}n$$

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{87}_{35}Br + {}^{146}_{57}La + 3\,{}^{1}_{0}n$$

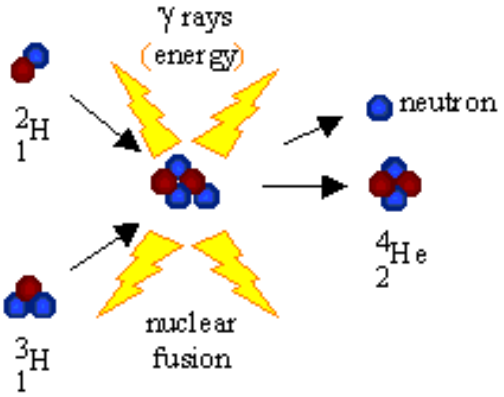
24

Fusion

- 2 small nuclei combine to form _____ _____ or heavier one.
  - $^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He + Q$
  - $4\,{}^{1}_{1}H \rightarrow {}^{4}_{2}He + 2\,{}^{0}_{+1}e$
    - takes place in the _____ under high _____ and _____, producing an immense amount of energy

25

Fusion continued



26

Fusion: Good vs. Bad

- Benefit: tremendous amounts of _____ _____ and no radioactive _____.
- Problem: high _____ _____ needed. Extreme high _____ and _____ to get (+) charged protons to fuse together.

27

Nuclear Reactors

- Fuel sources: _____, _____, _____
- Moderators: maintain _____ of reaction.
  - _____ down reaction
  - _____, _____ and _____ used to slow down _____

28

Nuclear Reactors continued

- Control Rods: controls fission process by adjusting _____available.
  - _____/_____ used to absorb neutrons
  - Can be inserted/withdrawn along a fuel rod to control amount of neutrons available
  - in an emergency they are inserted and _____ all neutrons to kill reaction
- Coolant: absorbs _____→ converted into steam and used as an energy source
  - H_2O, He, CO_2, Liquid Na and Li used
  - Work along with moderator to prevent core meltdown

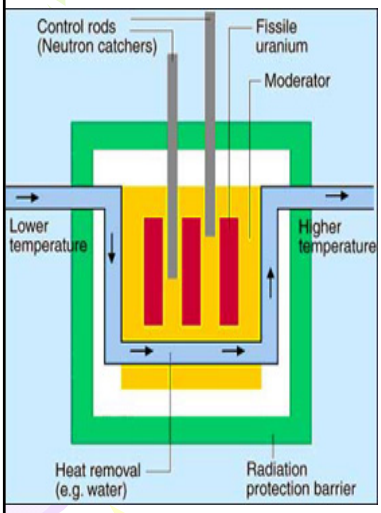
29

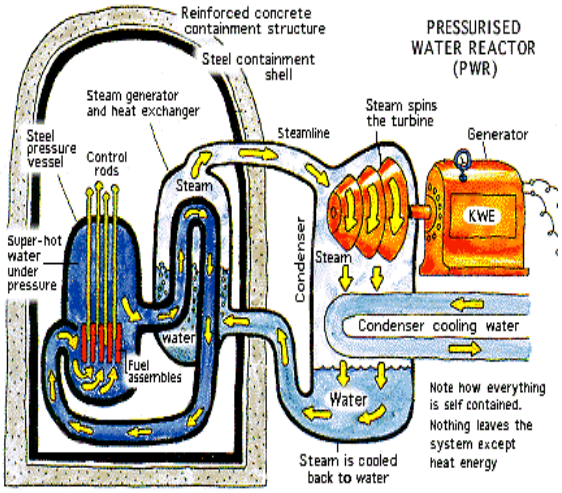
Nuclear Reactors continued

- Shielding: Protection
  - Reaction occurs in _____
  - Internal shield: _____lining protects walls of reactor from radiation damage
  - External shield: high density _____ for radiation containment

30

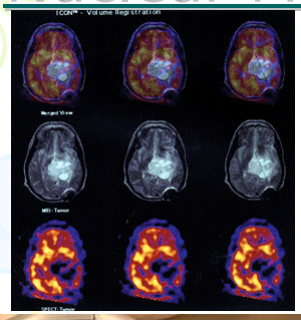
Nuclear Reactors continued





31

Nuclear Medicine



32

Nuclear Medicine continued

- Radioactive isotopes are used to help diagnose medical problems
  - Used as _____ for imaging
  - Material used must have a _____half life to prevent additional damage to the system
    - _____for digestive tract
    - _____ for thyroid

33

- X-rays, mri's, cat scans etc., also use

Nuclear Medicine continued

- Radiation Therapy
  - Kills _____ cells
  - Inserted into effected region (but may also kill _____)
    - May be _____ etc.
  - _____ cancer
  - _____ cancer

34