Announcements

To join clicker to class today (Clickers with LCD display joins automatically):

- Turn on the Clicker (the red LED comes on).
- Push "Join" button followed by "20" followed by the "Send" button (switches to flashing green LED if successful).

- Exam Next Lecture Period.
  - Enter through lower doors
  - Leave coats, hats, packs, etc in front
  - Take pencils and calculator to a seat with an exam
  - 7 different multiple choice exam forms with answers and question #'s are scrambled
  - Remember to mark your answers both in the exam book and on the scan sheet
  - Plan to get enough sleep before the exam

- Don't forget to VOTE.
- Lab next week is *Periodic Properties*. Don't forget to do prelab. Handout is on class web site and will be mailed out.

Review

" Nuclear binding energy per nucleon is calculated from the mass defect using $E=mc^2$.

" Elements heavier than $^{56}_{26}Fe$ formed by neutron capture followed by beta decay rather than fusion because the binding energy per nucleon drops after Fe.

" Most isotopes are radioactive.

" Radioactive decay

n:p higher than n:p of stable isotopes=> beta decay

n:p lower than n:p of stable isotopes => positron emission or electron capture

beyond Bi (end of band of stability) mostly see alpha decay.

Cartoons of Radioactive Decay

1. Alpha decay: ${}^{m}_{p}X$ ---> ${}^{4}_{2}\alpha$(expelled) + ${}^{m-4}_{p-2}Y$
2. β decay: n (in nucl) —> p (in nucl) + ${}^{0}_{-1}e$ (expelled)
3. positron emission, p (in nucl) ---> n(in nucl) + ${}^{0}_{1}e$ (expelled)
4. electron capture, p (in nucl) + ${}^{0}_{-1}e$(falls in) --> n (in nucleus)

Review

" Radioactivity detected using a Geiger Counter

radioactive particles (or gamma ray photons) ionize a gas, usually Ar

Ions carry electricity allowing electrical current to flow, which is measured.

Units: counts/s & Ci = 3.7×10^{10} counts/s

Measure with film or Geiger Counter.

" Biological effects—ionizing radiation damages by ionizing atoms and molecules

Ions reactive, so disrupt necessary reactions in cells.

Also breaks DNA destroying the information that controls cellular functions

Biological Effects of Radioactivity

" Same number of Ci of α, β and γ have different amounts of biological effect. Two reasons:

Different amounts of energy deposition per unit body mass. Quantified by the Rad = 1 x 10^{-2} J/kg of tissue.

Same amount of energy deposited does not lead to the same amount of tissue damage. Quantified by REM = Rad x RBE

" RBE = relative biological effectiveness

" RBE = 1 for β and γ

" RBE = 20 for α (large size and charge)

" α still not a problem unless ingested because they do not penetrate well.

Uranium/Radon Decay

Chang Table 21.3

Cyclotron

Chang Fig.
21.4

Uses of Radioisotopes

" Radioactive tracers

Depends on chemical similarity between stable and radioactive isotopes.

Use signal from radioactive decay to locate where substances end up in body or a chemical reaction.

Medical uses

" Imaging

Killing cancer cells

use higher susceptibility to radiation damage.

pick radioisotopes preferentially concentrated by the cancerous organ.

PET scan courtesy of NASA

Exam 1 Review

" light is a wave and a particle

$c=\upsilon\lambda \Rightarrow \upsilon=c/\lambda$ or $\lambda=c/\upsilon$.

$E_{photon}=h\upsilon$. H = 6.626 x 10^{-34} J•s

" remember metric prefixes.

- History of atomic models:
  - e^- embedded in positive sphere (~1900)
  - Rutherford Exp (1910) = dense nucleus (+) and e^- somewhere outside
- Photoelectric effect & emission and absorption line spectra suggested that e- are trapped in quantized energy levels.
- Practiced calculating ΔE of a transition between quantum states. $h\upsilon=|\Delta E|$, $\Delta E= E_f - E_i$ ($\Delta E < 0 \Rightarrow$ emission). Do with arbitrary equations for E_n using proper n for final and initial states.

Exam 1 Review

- Wave particle duality. (deBröglie relation: $\lambda = h/[mv]$)
- Quantum model of the atom.
  - ns, np, nd, nf orbitals (n = 1, 2, 3, ...)
  - know shapes of s and p orbitals.
- Higher numbered shells (n-levels) are higher energy because they are farther from the nucleus on average.
- Pauli exclusion principle & reading the ground state electronic configuration from the periodic table.
  - At most two electrons of opposite spin in each orbital.
  - Extra stability of half-full and full d leads to moving electron from s to d. Cr: $[Ar]3d^5 4s^1$ & Cu:$[Ar]3d^{10} 4s^1$.
  - f-Block filling order varies.

Exam 1 Review

" In a multi-electron atom, electrons in lower shells also shield or screen the electrons which are farther out.

  Farther out electrons see a smaller effective nuclear charge (sometimes called Z_{eff}).

  Within a shell the probability of electrons being near the nucleus goes in the following order s > p > d > f > g.

  Orbitals that penetrate more see a larger Z_{eff} and are lower energy, making s fill before p, which fills before d, etc...

" Periodic trends in ionization energy, radius, ion formation, ionic radius and electron affinity.

Exam 1 Review

- Mass spectrometry. (Charged particles follow different curved paths in a magnetic field depending upon m/z)
- Isotopes and average atomic mass.
- Mole concept

  1 mole = # amu in a gram

  1 mole of any atom weighs in grams its atomic mass
- Writing nuclear reactions. (sum of mass #'s on lhs = sum of mass #'s on rhs, same for sum of charges)
- Fusion in stars converting the H produced after the Big Bang into heavier elements.

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Exam 1 Review

- Biological effects of radioactivity vary with radiation type. α more damaging than others, but less penetrating.
- Making synthetic isotopes (transmutation)
  - Particle accelerators
  - Fusing heavy nuclei
- Uses of radioactivity
  - Tracers
  - Medical imaging
  - Killing cancers