Announcements

To join clicker to class today (Clickers with LCD display join 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).

- Get your clickers registered. About 85% of you have so far.
- Get signed up for the e-mail discussion list. About 80% of you have so far.

- First quiz in discussion Wednesday, covers material through Friday's lecture.

Review

- Doppler effect • Red Shift => expansion
- Expansion of universe/Big Bang
  - energy->quarks->n -> p + e -> nucleons -> atoms -> stars/galaxies
- radioactive decay
- Isotopes (average atomic mass)
  - Example H + D: 1.007825(0.99985) +2.014108(0.00015) = 1.0080 amu = $m_H f_H$ + $m_D f_D$ = m_{avg}

Temperature Scales

Chang Fig. 1.8

- $^{o}C = (^{o}F - 32) * 5/9$
- $K = {}^{o}C + 273.15$

Chapter 2: Nuclear Chemistry

A. Fusion

B. Nuclear binding energy/Mass defect/binding energy per nucleon

C. Neutron & electron capture

D. Radioactive decay (β, positron emission, α)-Belt of stability.

E. Nuclear fission (chain reaction, critical mass)

F. Artificial isotopes/elements (accelerators)

G. Measurement of radioactivity

H. Biological effects of radioactivity (medical uses and radon)

I. Radiochemical dating

J. Review of composition of Universe.

Fusion of Hydrogen

- This is a multistep process

Step 1: $2\ {}^{1}_{1}H \rightarrow {}^{2}_{1}H + {}^{0}_{1}e$ (positron)

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

Step 3: $2\ {}^{3}_{2}He \rightarrow {}^{4}_{2}He + 2\ {}^{1}_{1}H$

- Note need 2 of steps 1 and 2 to generate enough He for the last step.
- positrons eventually collide with ${}^{0}_{-1}e$ (electrons) destroying each other to produce energy in the form of gamma (Υ) rays.

Fusion of Heavier Elements in Larger Stars

- $^{2}_{1}d + {}^{4}_{2}\alpha \rightarrow {}^{6}_{3}Li$ (stable isotope)
- $2\ {}^{4}_{2}\alpha \rightarrow {}^{8}_{4}Be$ (but rapidly decays...)
- Still may see $^{8}_{4}Be + {}^{4}_{2}\alpha \rightarrow {}^{12}_{6}C$ (stable)
- More collisions ---> heavier nuclei.
- Dense Centers of large stars (~10^9 K) kinetic energy can overcome electrostatic repulsion to fuse nuclei up to $^{56}_{26}Fe$.
- Cannot go any farther with fusion.

Binding Energy per Nucleon

- Deuterium ($^2_1$d) = n + p
  - total mass = M_d = 3.34370 x 10^{-24}g
  - M_n = 1.67493 x 10^{-24} g
  - M_p = 1.67262 x 10^{-24} g
- Mass lost = $M_n + M_p - M_d$ = 0.00385 x 10^{-24} g
- Total binding energy = E= mc^2 =

0.00385 x 10^{-24} g(1 kg/1000 g)(2.998 x 10^8 $ms^{-1})^2$ = 3.46 x 10^{-13} J.

- Have 2 nucleons, so per nucleon we have : 3.46 x 10^{-13} J/2 =1.73 x 10^{-13} J/nucleon

Chang Fig. 21.2