XI. Nuclear Chemistry

General observation: nuclear reactions (radioactive decay, etc.) are not affected by the chemical form (oxidation state, bonds) of the element.

A. Nuclear Reactions and Radioactivity.

Balancing nuclear reactions (atomic & mass number), the 5 types of radioactive decay and 3 types of radiation ($\alpha$ decay and radiation, $\beta$ decay and radiation, $\gamma$ radiation, positron emission, electron capture), fission (chain reaction, critical mass) and fusion and nuclear transmutation.

B. Radioactive Decay Rates.

First order kinetics, calculations using $\log(N/N_0) = -kt/2.303$; $k_{1/2} = 0.693$ ($t_{1/2}$ = half-life) ; $(N/N_0) = (1/2)^{t_{1/2}}$.

C. Nuclear Stability.

General observations on the roll of neutrons in the nucleus, and the trend toward maintaining a particular neutron-to-proton ratio.

D. Energy Changes during Nuclear Reactions.

Calculation of the mass defect and the binding energy per nucleon or per mole. Graph of B.E. per nucleon vs atomic number - why fusion is exothermic for the lighter nuclei and fission is exothermic for heavier nuclei.

E. Biological Effects of Radiation.

Ionizing radiation ($\alpha$, $\beta$, $\gamma$ and x-rays) knock electrons from atoms, causing random reactions.