CHAPTER 13 HOMEWORK

#4- (a) $hf = 2\,\mu\,B = 2\,g_n\,\mu_B\,B = 2\,(1.9135)(5.05\times10^{-27}\,J/T)(1T) = 1.93\times10^{-26}\,J$
$f_n = 1.93\times10^{-26}\,J / h = 1.93\times10^{-26}\,J / 6.63\times10^{-34}\,J\text{-}s =$ 29.1 Mhz

(b) $hf = 2\,\mu\,B = 2\,g_p\,\mu_B\,B = 2\,(2.7928)(5.05\times10^{-27}\,J/T)(1T) = 1.93\times10^{-26}\,J$
$f_p = 2.82\times10^{-26}\,J / h = 2.82\times10^{-26}\,J / 6.63\times10^{-34}\,J\text{-}s =$ 42.5 MHz

(c) $f = 2\,\mu\,B / h = 2\,(2.7928)(5.05\times10^{-27}\,J/T)(50\times10^{-6}\,T)/ h =$ 2.13 kHz

#5- $KE_\alpha = 0.5MeV$ z1 = 2 Z2=79

(a) $KE_\alpha = k\,q1\,q2 / R = k\,z1\,Z2\,e^2$
$R = k\,q1\,q2 / KE = (9\times109\,Nm^2/C)\,(2)(79)\,e^2 / (500\times10^3\,e\,V)$
$R = (9\times10^9\,Nm^2/C)\,(2)(79)\,(1.6\times10^{-19}C) / (500\times10^3\,V) = 4.55\times10^{-13}\,m$
R ≤ 455 fm *The nuclear radius must at least this small!*

(b) $v = \sqrt{2KE/m} = 6.0\times10^{6}\,m/s$

#15- $BE_X = Z\,Mp + N\,Mn - M(X)$

(a) $^{20}Ne_{10}$
BE = [10(1.007825u)+10(1.008665u)-(19.992436u)]931.494MeV/u
BE = 160.650MeV BE/A = 8.04 MeV/nucleon

(b) $^{40}Ca_{20}$
BE = [20(1.007825u)+20(1.008665u)-(39.962591)]931.494MeV/u
BE = 342.053 MeV BE/A = 8.55 MeV/nucleon

(c) $^{93}Nb_{41}$
BE = [41(1.007825u)+52(1.008665u)-(92.906377)]931.494MeV/u
BE = 805.768 MeV BE/A = 8.66 MeV/nucleon

(d) $^{197}Au_{79}$
BE = [79(1.007825u)+118(1.008665u)-(196.996543)]931.494MeV/u
BE = 1559.416 MeV BE/A = 7.92 MeV/nucleon

#23- (a) From $R = Ro\,e^{-\lambda t}$
$\lambda = 1/t\,\ln\{Ro/R\} = 1/4h\,\ln(10/8) = 5.58\times10^{-2}\,hr^{-1} = 1.55\times10^{-5}\,s^{-1}$
$T1/2 = 0.693/\lambda =$ 12.4 h

(b) $Ro = 10\,mCi = 10\times10^{-3}\,3.7\times10^{10}\,decays/s = 3.7\times10^{8}\,1/s$
$No = Ro/\lambda = 3.7\times10^{8}\,s^{-1} / 1.55\times10^{-5}\,s^{-1} =$ 2.39 x 10^{13} atoms

(c) $R = Ro\,e^{-\lambda t} = (10mCi)\,\exp\{-(5.58\times10^{-2}\,hr^{-1})(30hr)\} =$ 1.87 mCi

#38 - R = 10 Ci at t=30 mo. = 2.5 y Co^{60}

$\lambda = 0.692/5.2\ y = 0.133\ y^{-1} = 4.22 \times 10^{-9}\ s^{-1}$

Using $R = Ro\ e^{-\lambda t}$ $Ro = No\ \lambda$

(a) $10\ Ci = No\ \lambda\ e^{-2.5y\ \lambda}$

$No = (10Ci / \lambda)\ e^{2.5y\ \lambda}$

$= [(3.7 \times 10^{11}\ decays/s)/ 4.22 \times 10^{-9}\ s^{-1}] \exp\{(2.5y)(0.133\ y^{-1})\}$

$= 1.22 \times 10^{20}$ atoms

$m = (No/N_A)\ 60\ g/mole = 1.22 \times 10^{-2}\ g =$ 12.2 mg

(b) $R(t=2.5y) = 10\ Ci = 3.7 \times 10^{11}$ decays/s *Activity at t=2.5 y*

Power $= dE/dt = E\ dN/dt = E\ R$

$= \{0.31+1.17+1.33\}$ MeV/decay) $\times\ 3.7 \times 10^{11}$ decays/s

$= 1.04 \times 10^{12}$ MeV/s $= 0.166$ J/s $=$ 166 mW

#41- $Q = M(^{238}U) - M(^{234}Th) - M(^{4}He) \times 931.5$ MeV/u

$Q = 238.048\ 608u - 234.043\ 583u - 4.002\ 603u) \times 931.5$ MeV/u $=$ 2.26 MeV OR

$Q = 238.050785u - 234.043593u - 4.002\ 603u) \times 931.5$ MeV/u $=$ 4.27 MeV

#45- $Q = M(X^{Initial}) - M(X^{Final}) \times 931.5$ MeV/u

(a) $Q = \{ M(^{40}Ca_{20}) - M(^{40}Ca_{19}) - M(^{0}e_{1})\} \times 931.5$ MeV/u

$Q = \{39.96259\ u - 0.000548\ u - 39.964\ u\} \times 931.5$ MeV/u

$Q =$ -1.82 MeV *will not occur unless energy supplied*

(b) $Q = \{ M(^{98}Ru_{44}) - M(^{4}He_{2}) - M(^{94}Mo_{42}) \} \times 931.5$ MeV/u

$Q = \{97.9055\ u - 4.0026\ u - 93.9077u\} \times 931.5$ MeV/u

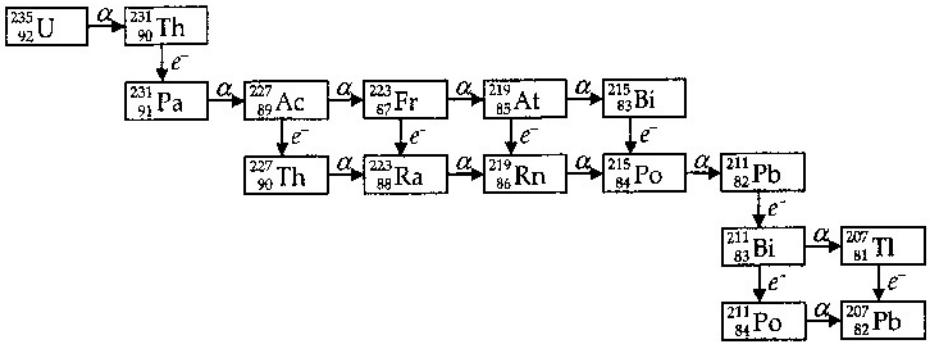
$Q =$ -1.68 MeV *will not occur unless energy supplied*

(c) $Q = \{ M(^{144}Nd_{60}) - M(^{4}He_{2}) - M(^{140}Ce_{58}) \} \times 931.5$ MeV/u

$Q = \{143.9099\ u - 4.0026\ u - 1399054\ u\} \times 931.5$ MeV/u

$Q =$ -1.86 MeV *can occur spontaneously*

#50-



#59- R = (0.12+-0.01) Bq per gram of Carbon $T_{1/2}$=5730 y

$\lambda = 0.693/ T_{1/2} = 1.21 \times 10^{-4}\ y^{-1}$ and $No = (1/12)\ N_A = 5.02 \times 10^{22}$ atoms
$Ro = No\ \lambda = 0.25$ Bq *Original Activity C14 in the atmosphere*
R = 0.12 Bq *Current Activity*
Using $R = Ro\ e^{-\lambda t}$
$t\ (R=.12Bq) = -\ln(R/Ro)/\lambda = -\ln(0.12/0.25)/(1.21 \times 10^{-4}\ y^{-1}) =$ 6066 y
$t\ (R=.11Bq) = -\ln(R/Ro)/\lambda = -\ln(0.11/0.25)/(1.21 \times 10^{-4}\ y^{-1}) =$ 6785 y
$t\ (R=.13Bq) = -\ln(R/Ro)/\lambda = -\ln(0.13/0.25)/(1.21 \times 10^{-4}\ y^{-1}) =$ 5404 y
t ~ (6066+-690) y