**PHYS 315 EXAM I** **11/17/05**

*Place your answers in the spaces provided. You must show your work for full credit. 10 pts each.*

**#1-** Find the resonant MRI frequency $f$ of a proton in a magnetic field of B = 4.0 T. *( $g_p = 2.793$ )*

$f$ = _____ Hz

$\Delta E = 2\ g\ \mu_N\ B = 2\ (2.793\ )\ (5.05 \times 10^{-27}\ J/T) =\ 7.04\ 10^{-7}$ eV

$f = \Delta E/h =$ 7.04 e-7 eV/ *4.136e-15 eV-s* = ***1.7 e8 Hz***

**#2-** A beam of energy 200MeV protons with intensity $Io = 10^6$/s is incident on a thin slab of $^{27}Al_{13}$ ($\rho$=2.7 g/cm$^3$) of thickness z = 1cm. The interaction cross section for protons in Al is $\sigma$ = 15b.

What fraction of the initial beam passes through the foil? $I/Io$= _____ 1/s

n = (2.7)(6.02e23)/27 = 6.02e22/cm3
n σ z = (6.02e22/cm3 )(15e-24)(1cm) = 0.9
I/Io = exp{- n σ z } = exp{ -0.9} = 0.41

What power from the beam is released in to the slab? $P$ = _____ W

Iabs = Io-0.41Io = 0.59 Io
P = (200 MeV ) (0.59 Io) = 1.19e14 eV = 1.9e-5 W

**#3-** Consider the alpha decay $^{210}Po_{84} \rightarrow {}^{206}Pb_{82} + {}^{4}He_{2}$ . Find the approximate kinetic energy KE of the alpha particle and lead nucleus if the $Q$ of the reaction is 5.4 MeV.

$KE_{\alpha}$ = _____ MeV

KE = $Q$ [ M(Pb)/ M(Pb) + M(He) ] = 5.4 (206/210) = 5.3 MeV

**#4-** Consider the reaction $^{4}He_{2} + {}^{27}Al_{13} \dashrightarrow {}^{30}P_{15} + {}^{1}n_{0}$ in which alpha particles bombard an aluminium foil. Find the $Q$ value of this reaction and the reaction threshold.

$M(^{1}n_{0})$=1.008665u
$M(^{4}He)$=4.002603u,
$M(^{27}Al)$=26.981538u,
$M(^{30}P)$=29.978310u,

$Q$ = _____ MeV

KEth = _____MeV

$Q$ = M(He)+M(Al) – M(P) – M(n) = 4.002603u+26.981538u-29.978310u-1.008665u
$Q$ = -0.002842u x 931.5MeV/u
$Q$ = -2.647 MeV

KEth = |$Q$| [ 1 + M(He)/M(Al)] = |$Q$| (1 + 4/27) = 2.647 ( 1.148) = 3.04 MeV

**#5-** A certain African artifact is found to have a $^{14}C$ activity of 0.05 Bq per gram of carbon. If the half-life of $^{14}C$ is 5730 years and the activity of atmospheric carbon is 0.25 Bq per gram, find the age of the artifact.

Age = _____ y

$\lambda = 0.693/T1/2 = 0.000121$ $\tau = 1/\lambda = 8268$ y

$0.05/0.25 = \exp[-\lambda t]$

$t = -(1/\lambda) \ln[\ 0.05/0.25)\ ] = 1.6\ \tau =$ 13230 y

**#6-** (a) What is the half-thickness of an absorber? Answer in your own words.

The thickness at which half the gamma intensity is absorbed from the beam.

(b) Why is lead not a good absorber for gammas of about 1 MeV?

The Compton and Photoelectric cross sections drop to their minimum value at about 1.055 MeV = 2 me. The Pair production cross section begins to rise.