Nuclear reactions and production of radioisotopes Assignment-1

1. Calculate the threshold energy for meson production for the following reactions: (i) $p(\gamma,\pi^+)n$, (ii) $^{12}C(d,\pi^+)^{14}C$. Mass of π+ meson = 273 M_e, where M_e =mass of an electron.
2. Use the Q value equation to show that in an elastic collision, the kinetic energy acquired by the struck particle when it is projected at an angle θ is $E_2=4E_1M_1M_2\cos^2\theta/(M_1+M_2)^2$.
3. Calculate the Coulomb barrier for the reaction $^{12}C + {}^{93}Nb \rightarrow {}^{105}Ag$. Take r_0=1.5 MeV. Calculate the minimum energy of ^{12}C which is required to induce the above reaction. Also calculate the excitation energy and maximum angular momentum (in $\hbar$) of compound nucleus formed when projectile energy is 70 MeV.
4. Calculate the cross section for the reaction $^{59}Co(n,\gamma)^{60}Co$ at neutron energy of 1 eV, assuming the resonance at 8.0 eV with level spin =3, using Briet Wigner formula. Take Γ_n=38 eV, Γ_γ=0.22 eV and $\Gamma=\Gamma_n + \Gamma_\gamma$. Ground state spin of ^{59}Co=7/2.
5. 10 g of natural MoO_3 was irradiated in a reactor for 7 days at a flux of $5x10^{13}$ n/cm^2/s. Calculate the activity of ^{99}Mo, in Curies, at the end of irradiation. Cross section for $^{98}Mo(n,\gamma)^{99}Mo$ = 0.14 barns, Half life of ^{99}Mo=66 hrs, abundance of ^{98}Mo=0.24. Also calculate the specific activity of ^{99}Mo produced.
6. $H_2{}^{18}O$ in a 1 mm thick cuvette is irradiated for 1 hr with 18 MeV proton beam of current 100μA. Calculate the activity of ^{18}F (in Ci) produced at the end of bombardment by the reaction $^{18}O(p,n)^{18}F$. Abundance of ^{18}O=98%, density of $H_2{}^{18}O$ =1.11 g/cm^3, Cross section for the reaction = 50 mbarn, $T_{1/2}$ of ^{18}F = 109 minutes.