Homework Ch12-13 Name _____

1. Calculate the Q-values of the following reactions

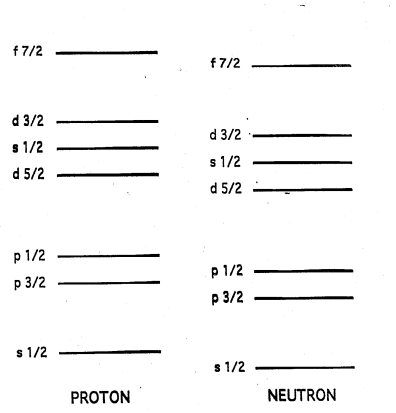
Reaction	**Q-value (MeV)**
. $p + {}^3H \rightarrow n + {}^3He$ (used to make neutrons)	
$2H + 2H \rightarrow n + {}^3He$ (used in fusion reactors)	
$2H + 3H \rightarrow n + {}^4He$ (used in 'dirty' fusion reactors)	
$n + {}^6Li \rightarrow 3H + {}^4He$ (used in weapons to produce tritium during detonation)	
$4He + 4He \rightarrow {}^8Be$ (occurs during He burning in stars)	
$4He + 4He + 4He \rightarrow {}^{12}C$ (the triple alpha process in stars)	

2. Calculate the total angular momentum and parity of the *entrance* channel in the following reactions. All reactants given below have positive parity. The parity associated with the orbital part of the wavefunction is $(-1)^l$.

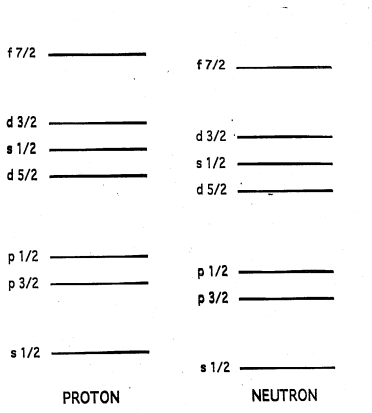
Reaction	s_1	s_2	l	j_{tot}	parity
. p + 3H → n + 3He	½	½	0		
. p + 3H → n + 3He	½	½	1		
4He + 4He → 8Be	0	0	0		
4He + 12C → 16O	0	0	0		
4He + 12C → 16O	0	0	1		
4He + 16O → 20Ne	0	0	0		
4He + 16O → 20Ne	0	0	1		
4He + 16O → 20Ne	0	0	2		

3. 13-6 In order to measure the cross section of the $\alpha + {}^{12}C \rightarrow p + {}^{15}N$ reaction, a proton detector subtending a solid angle of 3E-3 steradians is used at the scattering angle θ. A 0.2 microAmp beam of alpha particles is incident on the 12C target of mass/area 'nx'=100 microgram/cm^2. If the differential cross section is 0.2 millibarns/steradian, calculate the count rate of protons in the detector. (Hint: must change the product 'nx' to have units of #/cm^2).

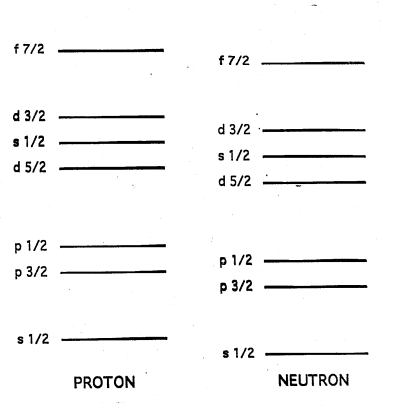
4. Diagram the nuclear shell model filling scheme for the ground states of the following nuclei.



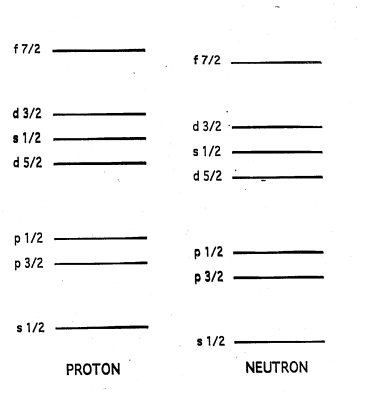
3He



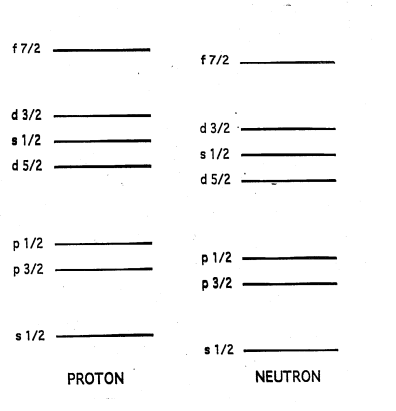
12C



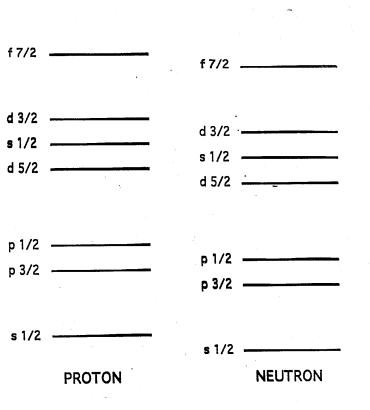
23Na



39K



27Al



48Ca

Z	A	Atomic Mass (u)	$t_{1/2}$ or Abundance	Decay Mode
Neutron (n)				
0	1	1.008665	10.4 m	β^-
Hydrogen (H)				
1	1	1.007825	99.985%	
1	2	2.014102	0.015%	
1	3	3.016049	12.33 y	β^-
Helium (He)				
2	3	3.016029	0.000137%	
2	4	4.002603	99.999863%	
2	5	5.012220	0.60 MeV	α, n
2	6	6.018888	806.7 ms	β^-
2	7	7.028030	160 keV	n
2	8	8.033922	119.0 ms	$\beta^-, \beta^- n$
Lithium (Li)				
3	5	5.012540	1.5 MeV	α, p
3	6	6.015122	7.5%	
3	7	7.016004	92.5%	
3	8	8.022487	838 ms	$\beta^-, \beta^- 2\alpha$
3	9	9.026789	178.3 ms	$\beta^-, \beta^- n$
3	10	10.035481	1.2 MeV	n
3	11	11.043796	8.5 ms	$\beta^-, \beta^- n\alpha$
Beryllium (Be)				
4	6	6.019726	92 keV	$2p$
4	7	7.016929	53.29 d	ϵ
4	8	8.005305	6.8 eV	2α
4	9	9.012182	100%	
4	10	10.013534	1.51×10^6 y	β^-
4	11	11.021658	13.81 s	$\beta^-, \beta^- \alpha$
4	12	12.026921	23.6 ms	$\beta^-, \beta^- n$
Boron (B)				
5	8	8.024607	770 ms	$\epsilon\alpha, \epsilon, \epsilon 2\alpha$
5	9	9.013329	0.54 keV	$2\alpha, p$
5	10	10.012937	19.9%	
5	11	11.009305	80.1%	
5	12	12.014352	20.20 ms	$\beta^-, \beta^- 3\alpha$
5	13	13.017780	17.36 ms	β^-
5	14	14.025404	13.8 ms	β^-
5	15	15.031097	10.5 ms	β^-
Carbon (C)				
6	9	9.031040	126.5 ms	$\epsilon, \epsilon p, \epsilon 2\alpha$
6	10	10.016853	19.255 s	ϵ

Z	A	Atomic Mass (u)	$t_{1/2}$ or Abundance	Decay Mode
Carbon (C)				
6	11	11.011434	20.39 m	ϵ
6	12	12.000000	98.89%	
6	13	13.003355	1.11%	
6	14	14.003242	5730 y	β^-
6	15	15.010599	2.449 s	β^-
6	16	16.014701	0.747 s	β^-
6	17	17.022584	193 ms	$\beta^-, \beta^- n$
6	18	18.026760	88 ms	β^-
Nitrogen (N)				
7	12	12.018613	11.000 ms	$\epsilon, \epsilon 3\alpha$
7	13	13.005739	9.965 m	ϵ
7	14	14.003074	99.63%	
7	15	15.000109	0.37%	
7	16	16.006101	7.13 s	β^-
7	17	17.008450	4.173 s	$\beta^-, \beta^- n$
7	18	18.014082	624 ms	$\beta^-, \beta^- \alpha, \beta^- n$
7	19	19.017027	304 ms	$\beta^-, \beta^- n$
7	20	20.023370	100 ms	$\beta^-, \beta^- n$
7	21	21.027090	95 ms	$\beta^- n, \beta^-$
7	22	22.034440	24 ms	$\beta^- n, \beta^-$
Oxygen (O)				
8	13	13.024810	8.58 ms	ϵ
8	14	14.008595	70.606 s	ϵ
8	15	15.003065	122.24 s	ϵ
8	16	15.994915	99.76%	
8	17	16.999132	0.038%	
8	18	17.999160	0.20%	
8	19	19.003579	26.91 s	β^-
8	20	20.004076	13.51 s	β^-
8	21	21.008655	3.42 s	β^-
8	22	22.009970	2.25 s	β^-
Fluorine (F)				
9	16	16.011466	40 keV	p
9	17	17.002095	64.49 s	ϵ
9	18	18.000938	109.77 m	ϵ
9	19	18.998403	100%	
9	20	19.999981	11.00 s	β^-
9	21	20.999949	4.158 s	β^-
9	22	22.002999	4.23 s	β^-
9	23	23.003570	2.23 s	β^-
9	24	24.008100	340 ms	β^-