AST 301
Homework #5
Due Friday Oct. 10

1. The Sun radiates about $4x10^{26}$ Watts of power from its surface.
a) If the Sun generates the same amount of power by nuclear reactions that it radiates from its surface, how many Joules of energy does it generate each second?
$4x10^{26}$ Joules
b) A typical photon radiated from the surface of the Sun has about $4x10^{-19}$ Joules of energy. About how many photons are needed to make one Joule of energy?
(photons / Joule) = 1 / (Joules / photon) = 1 / $4x10^{-19}$ = $0.25x10^{19}$
c) About how many photons are radiated by the Sun each second?
(photons / second) = (photons / Joule) x (Joules / second) = ($0.25x10^{19}$) x ($4x10^{26}$) = 10^{45}
d) For every four hydrogen atoms converted into one helium atom inside the Sun, two neutrinos are created and about $4x10^{-12}$ Joules of energy is generated. How many helium atoms are made for each Joule of energy generated?
(helium atoms made / Joule generated) = 1 / (Joules generated / He atoms made) = $0.25x10^{12}$
e) About how many helium atoms are made inside of the Sun each second? About how many neutrinos are created each second?
(He atoms made / second) = (He atoms / Joule) x (Joules / second) = $0.25x10^{12}$ x $4x10^{26}$ = 10^{38}
Two neutrinos are made for each He atom made, so $2x10^{38}$ neutrinos are made each second.

2. If you lie outside on a summer day, the power in the sunlight hitting you is about 1000 Watts.
a) Using the numbers given in question 1, about how many sunlight photons are hitting you each second?
(1000 Joules / second) x ($0.25x10^{19}$ photons / Joule) = $0.25x10^{22}$ photons / second
b) How many helium atoms were made each second to generate the power hitting you?
(1000 Joules / second) x ($0.25x10^{12}$ He atoms / Joule) = $0.25x10^{15}$ He atoms /second
c) How many neutrinos from the Sun pass through you each second?
Multiply part b by 2: $0.5x10^{15}$ neutrinos / second
d) Why haven't you noticed all of those neutrinos?
They don't interact through the strong or electromagnetic forces. They only interact with the atoms in your body through the weak force, which is very weak. Maybe one of them will interact with an atom in your body each year and it will just turn one neutron into a proton.