THE LAST HOMEWORK SET 27: FUSION POWER

Due Friday, May 3, 2024

PROBLEMS FROM TZDII

17.54. Use kinematics to figure out the time for the protons to pass and apply the statement in the problem that the mean life (τ) for β decay is a minute … thus the probability per second of β decay is $r = 1/\tau$. TZDII get the probability = $rt_{passage} = 4.6 \times 10^{-23}$

PROBLEMS FROM AOD

1) On p. 598, TZDII writes the fusion of hydrogen to helium as

$$4\,^1H \rightarrow {}^4He + 2e^+ + 2\nu + 24.7MeV$$

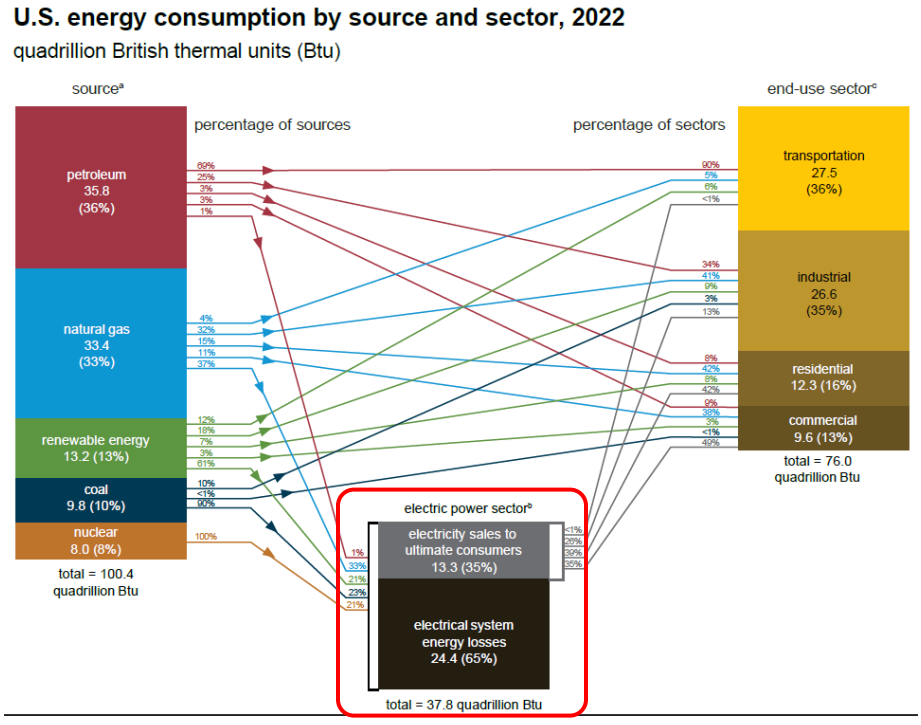
Then explains that the annhiliation of the two positrons results in another 2 MeV of energy so that the total reaction is

$$4\,^1H \rightarrow {}^4He + 2\nu + 26.7MeV$$

a) The Sun's luminosity is 3.827×10^{26} W. How many kilograms of helium does the Sun fuse into helium each second to produce this luminosity? State your answer in Nimitz Class aircraft carrier masses of 98.6 Gg.

b) Two neutrinos are released in each fusion reaction in the Sun. Use this to calculate the flux of solar neutrinos at the distance of Earth in ν/cm^2 and compare this to the 6×10^{10} ν/cm^2 I gave you in class.

2) According th the US Energy Information Administration, the US consumed 37.8×10^{15} BTU of electic power in 2022. If we could build a nuclear fusion reactor that could supply that electricity at 100% efficiency, how many kilograms of hydrogen would have to be fused into helium to provide this power? Comment on how this compares to your answer to problem 1. Are you impressed by the local star?



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