Nucleosynthesis Temperature for ⁴He burning

According to theoretical models the stellar core temperature for fusion of ⁴He occurs at about $2x10^8$ °K. The ashes from ⁴He burning are ¹²C, ¹⁶O and ²²Ne. Once the sun has converted most of its hydrogen into ⁴He the core temperature has changed from $15x10^6$ °K to the higher temperature for ⁴He burning.

a) Using a very simplified model of constant density for the sun we discussed an approximation to determine the temperature at the core of a body of the sun's mass and radius. Here we used the gravitational force acting on the proton as it falls into the center to compute the work done on the proton. Reproduce this calculation. Let the proton start at the radius of the sun with negligible kinetic energy.

b) Assume the sun loses negligible mass to produce a core of ⁴He. Using the same approximation as in part a), what would be the new radius of the sun to achieve a core temperature of $2x10^8$ °K?