HW 9-4 Soln)

If an atom of nuclear charge Z is ionized so that only one electron remains, that electron will behave the same as it would in a hydrogen atom but with Z times the attractive force acting on it. The energy levels would then be

$$E_{n\,Z^{+(Z-1)}} = -Z^2 \frac{13.6\text{ eV}}{n^2} \quad .$$

For such a helium atom, the energy of the Paschen alpha line photon is then

$$E_{photon} = E_{4\,He-I} - E_{3\,He-II} = -2^2\frac{13.6\text{ eV}}{4^2} - -2^2\frac{13.6\text{ eV}}{3^2} = \frac{7}{36}13.6\text{ eV} = 2.64\text{ eV} \quad .$$

Convert this to a wavelength:

$$\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}(3\times10^{8})}{2.64(1.6\times10^{-19})} = 4.78\times10^{-7}\text{m} = 471\text{ nm}$$

There is indeed such a line at 469 nm.