5. (a) Express the atomic units of energy in electron volts

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1 a.u of energy (1 Hartree) $= e^2/a_0$

$$= \frac{(4.8032 \times 10^{-10} \text{ esu})^2}{0.52918 \times 10^{-8} \text{ cm}} = 43.597 \times 10^{-12} \text{ erg}$$

$1 \text{ VC} = 1 \text{ J} \ (10^{+7} \text{ erg})$

$1 \text{ eV} = 1.6022 \times 10^{-19} \text{ C} \times 1 \text{ V} = 1.6022 \times 10^{-19} \text{ J}$

$= 1.6022 \times 10^{-12} \text{ erg}$

$$\therefore 1 \text{ a.u} = \frac{43.597 \times 10^{-12} \text{ erg}}{1.6022 \times 10^{-12} \text{ erg eV}^{-1}} = 27.21 \text{ eV}$$

(b) Calculate the ground state energy of positronium in electron volts, and atomic units.

$$E = -\frac{\mu e^4}{2\hbar^2} \qquad \mu = \tfrac{1}{2} m_e \quad \text{why?}$$

$$= -\frac{m_e e^4}{4\hbar^2} = -\frac{9.1094 \times 10^{-28} \text{ g} \times (4.8032 \times 10^{-10} \text{ esu})^4}{4 \times (1.0546 \times 10^{-27} \text{ erg s})^2}$$

$$= 1089.9 \times 10^{-14} \text{ erg}$$

$$= \frac{1089.9 \times 10^{-14}}{1.6022 \times 10^{-12}} \text{ eV} = 6.802 \text{ eV}$$

$$= 0.25 \text{ a.u}$$

Do these calculations in S I units!