Pb# 24.

a) $\alpha = \frac{ke^2}{\hbar c}$ $\qquad \frac{1}{\alpha} = \frac{\hbar c}{ke^2} = 137.$

b) $\frac{\lambda_c}{r_0} = \frac{2\pi}{\alpha} = 2\pi \times 137$

c) $\frac{a_0}{\lambda_c} = \frac{137}{2\pi}$

d) $\frac{1}{R a_0} = 4\pi \times 137.$

Pb# 25. H.W.

$$\langle u \rangle = \int_0^\infty u\, P_{1s}(r)\, dr \qquad P_{1s} = \frac{4}{a_0^3} r^2 e^{-\frac{2r}{a_0}}$$

$$= \int_0^\infty -\frac{ke^2}{r} P_{1s}(r)\, dr = -\frac{4ke^2}{a_0^3} \int_0^\infty r\, e^{-\frac{2r}{a_0}} dr$$

let $z = \frac{2r}{a_0}$ $\qquad r = \frac{a_0}{2} z \qquad dr = \frac{a_0}{2} dz$

$$\langle u \rangle = -\frac{4ke^2}{a_0^3} \left(\frac{a_0}{2}\right)^2 \int_0^\infty z\, e^{-z} dz = -\frac{4ke^2}{4a_0} = -\frac{ke^2}{a_0}$$

$\int_0^\infty z\, e^{-z} dz = 1! = 1$

$$\langle u \rangle = -2(13.6) = -27.2 \text{ eV}$$

$$\langle u \rangle + \langle K \rangle = \langle E \rangle \Rightarrow \langle K \rangle = \langle E \rangle - \langle u \rangle$$

$$= -13.6 + 27.2 = 13.6 \text{ eV}$$

Pb# 26.

$$\langle r \rangle = \int_0^\infty r\, P_{2s}\, dr \qquad P_{2s} = r^2 |R_{2s}|^2$$

average value of r

$$\langle r \rangle = \int_0^\infty r\, P_{2p}\, dr \qquad P_{2p} = r^2 |R_{2p}|^2$$

average value of r