Problem 29.15

There are a couple of things to notice here. To begin with, because electrons have no internal structure to vibrate when they absorb energy, the collision must conserved kinetic energy (they *did* say it was an elastic collision). That bit of information suggests:

$$\sum KE_1 + \sum U_1 + \sum W_{ext} = \sum KE_2 + \sum U_2$$

$$\left(\frac{1}{2}\right)m_e v_o^2 + 0 + 0 = \left[\left(\frac{1}{2}\right)m_e v_1^2 + \left(\frac{1}{2}\right)m_e v_2^2\right] + 0$$

To continue, we need the particle speeds. As the particles are said to circle after the collision, we can deduce they are in a B-fld and we can write:

$$q_e v_1 B \sin 90^\circ = m_e a_c$$

$$= m_e \frac{v_1^2}{r_1}$$

$$\Rightarrow \quad v_1 = \frac{eBr_1}{m_e}$$

The sum of the final energies is the same as the initial energy, so we can write:

$$\text{Energy} = \left(\frac{1}{2}\right)m_e v_1^2 + \left(\frac{1}{2}\right)m_e v_2^2$$

$$= \left(\frac{1}{2}\right)m_e\left(\frac{eBr_1}{m_e}\right)^2 + \left(\frac{1}{2}\right)m_e\left(\frac{eBr_2}{m_e}\right)^2$$

$$= \left(\frac{1}{2}\right)\frac{1}{m_e}(eBr_1)^2 + \left(\frac{1}{2}\right)\frac{1}{m_e}(eBr_2)^2$$

$$= \left[\left(\frac{1}{2}\right)\frac{1}{m_e}(eB)^2\right](r_1^2 + r_2^2)$$

$$= \left[\left(\frac{1}{2}\right)\frac{1}{(9.1\text{x}10^{-31}\text{ kg})}\left((1.6\text{x}10^{-19}\text{ C})^2(.044\text{ T})^2\right)\right]\left((.01\text{ m})^2 + (.024\text{ m})^2\right)$$

$$= 1.84\text{x}10^{-14}\text{ joules}$$

Minor Note: You might wonder why the book asked for the answer in kilojoules. In fact, whoever wrote out the solutions for the Solutions book messed up the problem slightly and recorded an answer of 115,000 joules. Their mistake was to multiply by the particle's charge, not the charge squared. In fact, doing the math correctly yields a number that is very small.

So ist das Leben. (Such is life!)