

13. An electric field with circular field lines is induced as the magnetic field is turned on. Suppose the magnetic field increases linearly from zero to B in time t . According to Eq. 31-27, the magnitude of the electric field at the orbit is given by

$$E = \left(\frac{r}{2}\right) \frac{dB}{dt} = \left(\frac{r}{2}\right) \frac{B}{t} ,$$

where r is the radius of the orbit. The induced electric field is tangent to the orbit and changes the speed of the electron, the change in speed being given by

$$\Delta v = at = \frac{eE}{m_e} t = \left(\frac{e}{m_e}\right) \left(\frac{r}{2}\right) \left(\frac{B}{t}\right) t = \frac{erB}{2m_e} .$$

The average current associated with the circulating electron is $i = ev/2\pi r$ and the dipole moment is

$$\mu = Ai = (\pi r^2) \left(\frac{ev}{2\pi r}\right) = \frac{1}{2} evr .$$

The change in the dipole moment is

$$\Delta\mu = \frac{1}{2} er \Delta v = \frac{1}{2} er \left(\frac{erB}{2m_e}\right) = \frac{e^2 r^2 B}{4m_e} .$$