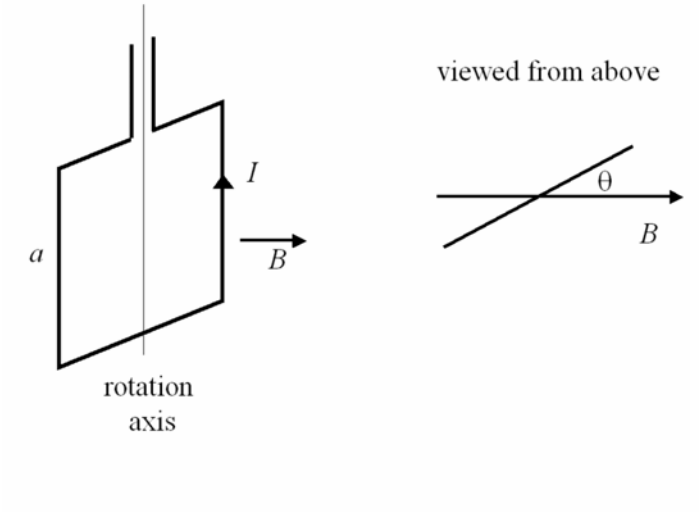
1st year Electricity and Magnetism, Tony Bell

Classwork 5 – 10th March 2005

1) A particle with charge q and mass m is free to move in a uniform magnetic field **B**. **B** is in the *z* direction. Show by substitution into the equations of motion for the particle that its velocity $\mathbf{v}=v_x\mathbf{i}+v_y\mathbf{j}+v_z\mathbf{k}$ is given by $v_x = v_\perp \sin(\omega t + \psi)$, $v_y = v_\perp \cos(\omega t + \psi)$, $v_z = v_\parallel$, for a suitable choice of $v_\perp$, $v_\parallel$, ω, and ψ. If the particle is an electron and the magnetic field is 0.5 Tesla, how many times does the electron gyrate in 1 sec?

2) A current element of vector length $d\mathbf{l}_1=0.002\mathbf{i}$ is at position $\mathbf{r}_1=30\mathbf{i}$ and carries a current of 1Amp. A second current element of vector length $d\mathbf{l}_2=0.004\mathbf{j}$ is at position $\mathbf{r}_2=40\mathbf{j}$ and also carries a current of 1Amp. Lengths are in metres. Calculate the force on each current element. Satisfy yourself that the result does not contradict Newton's law of equal and opposite reactions?

3) A square current-carrying loop of wire with sides of length *a* is free to rotate about a vertical axis. It is placed in a horizontal magnetic field *B* at an angle θ as shown in the diagram.



What is the magnitude of the force on each of the four sides of the loop? What is the magnitude of the magnetic dipole moment of the loop? What is the magnitude of the torque on the loop about the rotation axis? At what angle θ does the loop finally come to rest if its motion is lightly damped?

Electron mass = 9.11×10^{-31} kg
Electron charge = 1.6×10^{-19} Coulomb
$\mu_0 = 4\pi\times10^{-7}$ Hm^{-1}