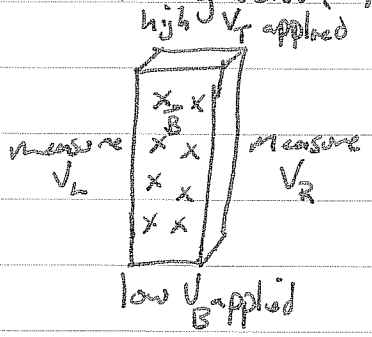
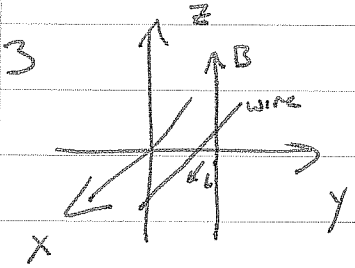
1 The particle must be moving and its velocity must not be parallel to $\vec{B}$.

2 The Hall effect experiment will do this.
Take a block of metal, apply a potential difference and a magnetic field



if electrons are moving they move from low applied V to high applied V (up)
$\vec{v} \times \vec{B}$ is to left so $q\vec{v} \times \vec{B}$ is right
∴ negative charges pile up on right side of bar + are left on the left.
this means that there will be a potential difference left to right $V_L > V_R$

3



a) $\left|\left|\frac{\vec{F}}{L}\right|\right| = iB = 8\text{mA}\ 3\text{T} = 24\frac{\text{mN}}{\text{m}}$

b) the force will be $i d\vec{s} \times \vec{B} \Rightarrow -\hat{j}$ direction

4 Ampere's law states

$$\oint_{\text{closed loop}} \vec{B} \cdot d\vec{s} = \mu_0 i + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$

so a changing Electric flux and a current will both cause a $\vec{B}$-field to exist.

5 a) an solenoid creates a uniform magnetic field inside the coils.

b) $\|\vec{B}\| = \mu_0 i \frac{N}{L} = 20\,mT$

$4\pi \times 10^{-7}\, i \frac{N}{L} = 2 \times 10^{-2} \frac{Amp}{meter}$

$i \frac{N}{L} = \frac{1}{2\pi} \times 10^5 \frac{Amp}{meter}$

so if $i = \frac{1}{2\pi}$ Amp and the solenoid had $10^5 \frac{turns}{meter}$ that would work.

6 currently we have gauss' law for magnetic fields

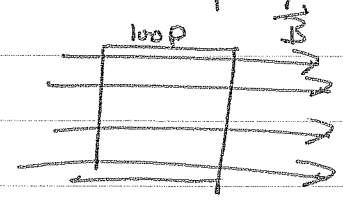
$$\oint_{\text{closed surface}} \vec{B} \cdot d\vec{A} = 0$$

if we found magnetic monopoles the right hand side would no longer be zero.

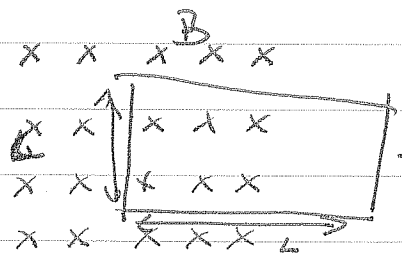
7 The situation is governed by

$$EMF = \oint_{\text{closed loop}} \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$$

if $EMF = 0$ then Φ_B must be constant. This would happen if Φ_B = zero constant with, ie if $\vec{B} \cdot d\vec{A} = 0$ so if the loop of wire doesn't have $\vec{B}$ piercing it.



b) orient the loop so that



then $\frac{d\Phi_B}{dt} = \frac{d\,\|\vec{B}\|\,\|\vec{A}\|}{dt} = \|\vec{B}\|\frac{dA}{dt} = BLv$

$|\mathcal{E}_{MF}| = BLv$

c if flux of B into page through loop is decreasing the current will flow to preserve that flux. B ~~will~~ indeed will be into page so current will flow clockwise.

8 $B = \mu_0 i n$ ← magnetic field inside inductor

$B\pi a^2$: flux through 1 loop

$nl\,B\pi a^2$ = flux through whole solenoid

$$\mathcal{E}_{MF} = \oint_{\text{closed loop}} \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt} = -nl\pi a^2 \mu_0 n \frac{di}{dt}$$

$$= -\pi a^2 n^2 l \mu_0 \frac{di}{dt}$$

$$= -\pi (0.02\,m)^2 \left(\frac{2\times10^3\ \text{loop}}{\text{m}}\right)^2 0.1\,m\ \ 4\pi\times10^{-7}\ \ 150\times10^{-3}\ \frac{A}{s}$$

$$= 64\pi^2\times10^{-7}\ V$$