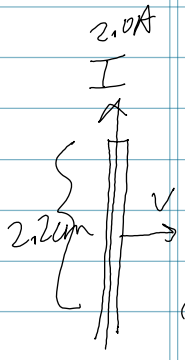
Magnetism from Notes 1 & 2

1) A wire that is placed on a flat surface and the coefficient of friction between the two is 0.42. The wire is 2.2 cm long, has a mass of 3.0g, and has a current of 2.0 A moving through it to the north. What is the magnitude and direction of a magnetic field that would cause the wire to move at a constant speed to the east?



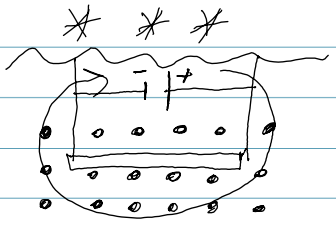
$m = 3g = .003kg$ $\uparrow F_N$
$w = 0.03N$ $\downarrow w$

① $\Sigma F_y = 0 = F_N + w$
$F_N = w$
$F_N = 0.03N$

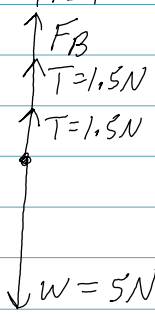
② $F_B = F_K$
$BIl = \mu F_N$
$B(2)(0.022) = .42(.03)$

$B = 0.286\,T$ out of the page

2) A 0.5 kg conductor is suspended by 2 wires. What current must exist in the 0.8m conductor if the tension in each wire is 1.5N? The magnetic field is 4.2 T. What is the direction of current in the conductor?



$m = .5kg$
$w = 5N$
$l = .8m$
$T_1 = T_2 = 1.5N$
$B = 4.2T$



$\Sigma F_y = 0 = F_B + T_1 + T_2 + w$
$0 = F_B + 1.5 + 1.5 - 5$
$F_B = 2N$

$F_B = BIl$

$2 = (4.2)(I)(.8)$

$I = 0.595A$ left

3) A proton moves in a circular path ⊥ to a uniform magnetic field with a magnitude of 4.0 mT. If the speed of the proton is 6.8×10^7 m/s, (a) what is the radius of the circular path and (b) the time it takes to complete one revolution?

$B = 4 \times 10^{-3}$ T
$q = 1.6 \times 10^{-19}$ C
$m = 1.67 \times 10^{-27}$ kg
$r = ?$
$t = ?$
$v = 6.8 \times 10^7$ m/s

(a) $a_c = \frac{v^2}{r}$ & $F = ma$

$F_c = \frac{mv^2}{r}$

$F_B = qvB$

$qvB = \frac{mv^2}{r}$

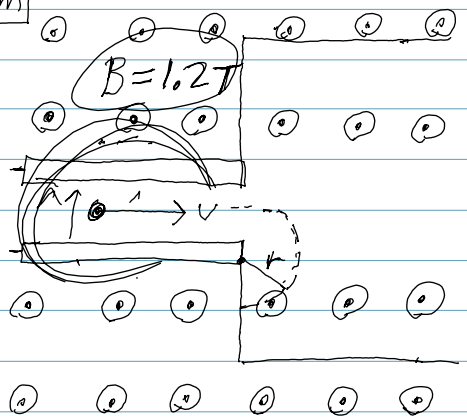
$(1.6 \times 10^{-19})(4 \times 10^{-3}) = \frac{(1.67 \times 10^{-27})(6.8 \times 10^7)}{r}$

$r = \frac{1.1356 \times 10^{-19}}{6.4 \times 10^{-22}} = \boxed{177\text{ m}}$

(b) $v = \frac{2\pi r}{T}$

$6.8 \times 10^7 = \frac{2\pi(177)}{T}$

$\boxed{T = 1.64 \times 10^{-5}\text{ s}}$



4) What is the strength & dir. of the ~~electric~~ field between the two plates if an ~~electron~~ proton travels straight between the charged plates at a constant velocity. When it passes through the plates it takes the path shown that has a radius of 0.5m. What is the charge on the plates if they are 0.3mm apart & have a capacitance of 1 μF?

① $r = \frac{mv}{qB}$ $.5 = \frac{(1.67 \times 10^{-27})\,v}{(1.6 \times 10^{-19})(1.2)}$

$v = 5.75 \times 10^7$ m/s

② $F_B = qvB$ $E = \frac{F_E}{q}$ $F_E = F_B$

$qvB = Eq$

$(5.75 \times 10^7)(1.2) = E = \boxed{6.9 \times 10^7\text{ N/C}}$ top of page

① $E = \frac{V}{d}$ $6.9 \times 10^7 = \frac{V}{.0003}$

$V = 20{,}700$ V

② $C = \frac{Q}{V}$ $1 \times 10^{-6} = \frac{Q}{20{,}700}$

$\boxed{Q = 0.0207\text{ C}}$