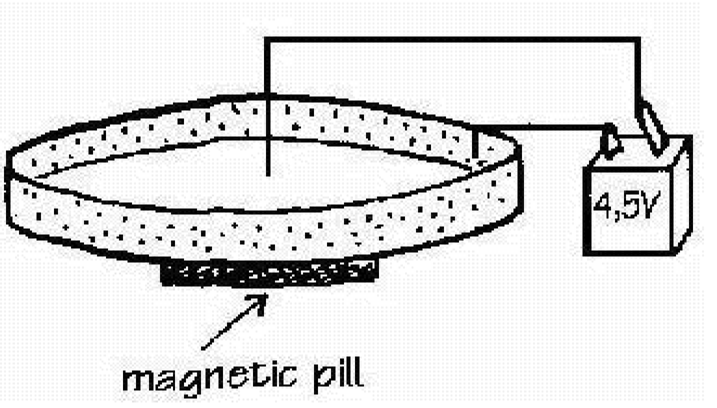
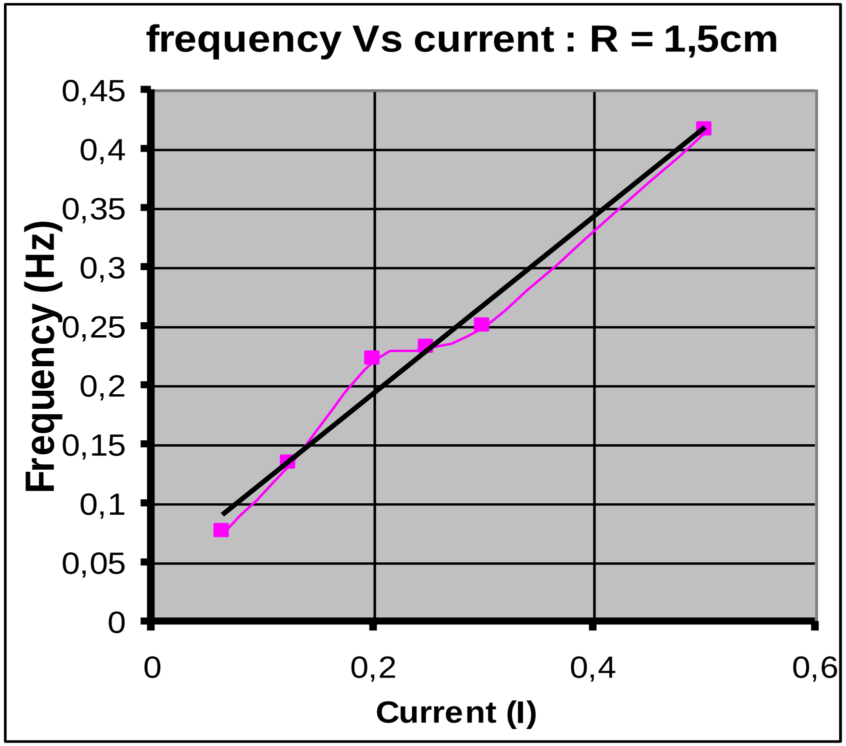


Ionic Motor

Experiences

- 1mol/L natrium chlorid solution
- small magnet or Helmholtz coils
- for different currents and different radius, we measure the solution’s speed
- we made a model
- we compared the model predictions and the measurements

Dependance speed - current



- The speed is proportionnal to the current (moving charges)
- The speed is smaller for a bigger radius

Model

- 3 Forces
  - –electrical : $\mathbf{F}_e = q\,\mathbf{E}$
  - –Magnetic : $\mathbf{F}_m = q\,.\mathbf{V} * \mathbf{B}$
  - –Friction : $\mathbf{F}_f = -f\,.\,\mathbf{V}$
- Equation : $m\,\mathbf{A} = \mathbf{F}_e + \mathbf{F}_m + \mathbf{F}_f$
- System : one charge + from center to border or one charge - from border to center

Electric field E

- This field is not uniform
- We can show that this field is dependant of the radius :

$$E(r) = \frac{U}{Ln(\frac{R2}{R1})} \times \frac{1}{r}$$

The Magnetic force

- **The solution speed is not the charge speed** :
  - solution speed : 10^{-2} to 10^{-1} m/s
  - electrical force : qE ~1.6 10^{-19}*100 ~ 10^{-17} N
  - Magnetical force : if speed ~10^{-2} m :
  - qvb ~1,6.10^{-19}*10^{-2}*10^{-2} ~ 10^{-25} N
  - the 2 forces are too different and if the charge had the same speed as the solution, the friction force would be zero

Computer simulation

Radius1	Radius2	Tension	charge	MasseA	MasseB	Magnet	Coef_fr	dt
0,01m	0,05m	5V	1,6E-19C	4E-26Kg	4E-26Kg	0,01T	1E-20N.s/m	1e-6s

$$Ax \leftarrow \frac{1}{m}.(q \cdot \frac{U}{r \cdot Ln(\frac{R2}{R1})} \cos(teta) + q \cdot B \cdot Vy - f \cdot Vx)$$

$$Ay \leftarrow \frac{1}{m}.(q \cdot \frac{U}{r \cdot Ln(\frac{R2}{R1})} \sin(teta) - q \cdot B \cdot Vx - f \cdot Vy)$$

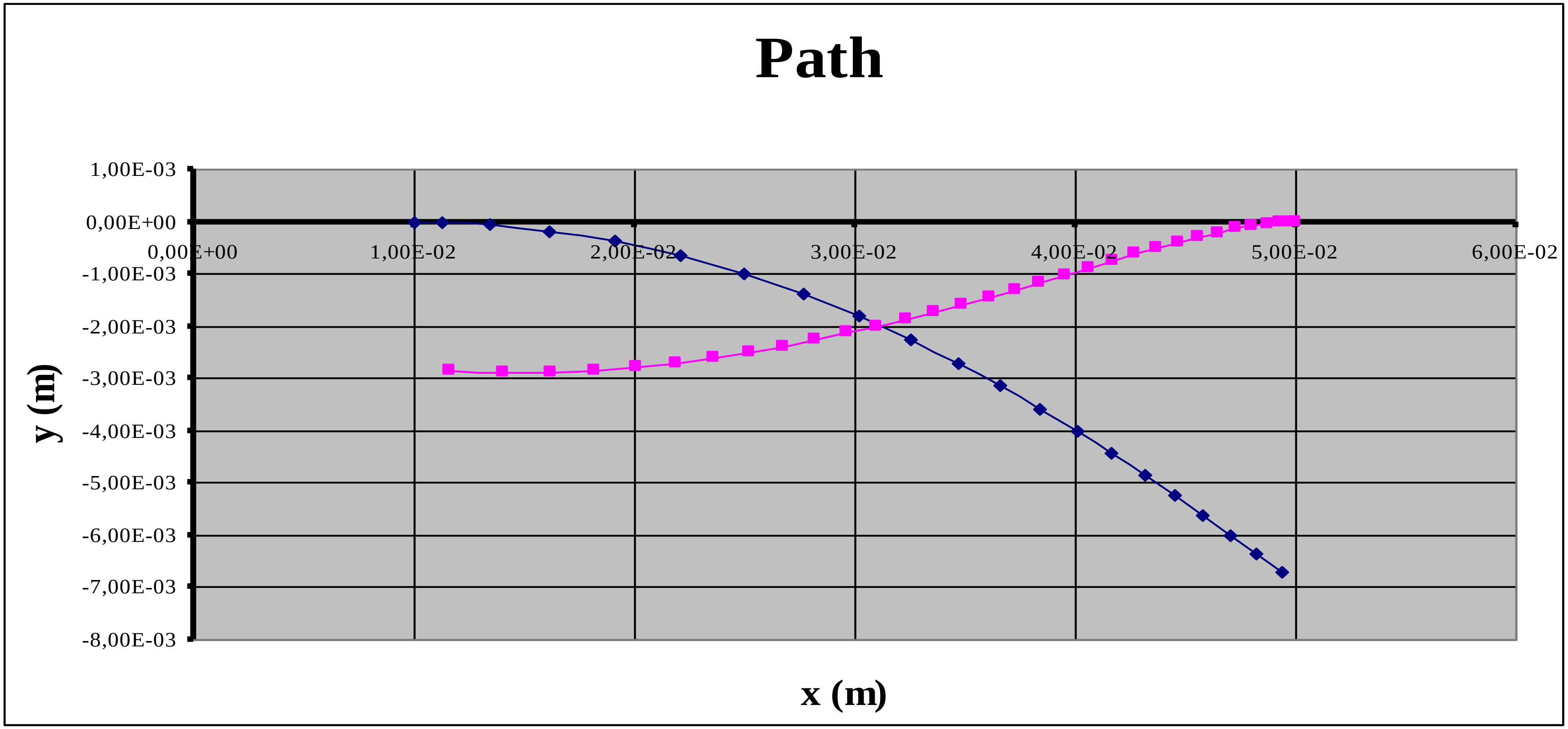
$$Vx \leftarrow Vx + Ax \cdot dt$$

$$Vy \leftarrow Vy + Ay \cdot dt$$

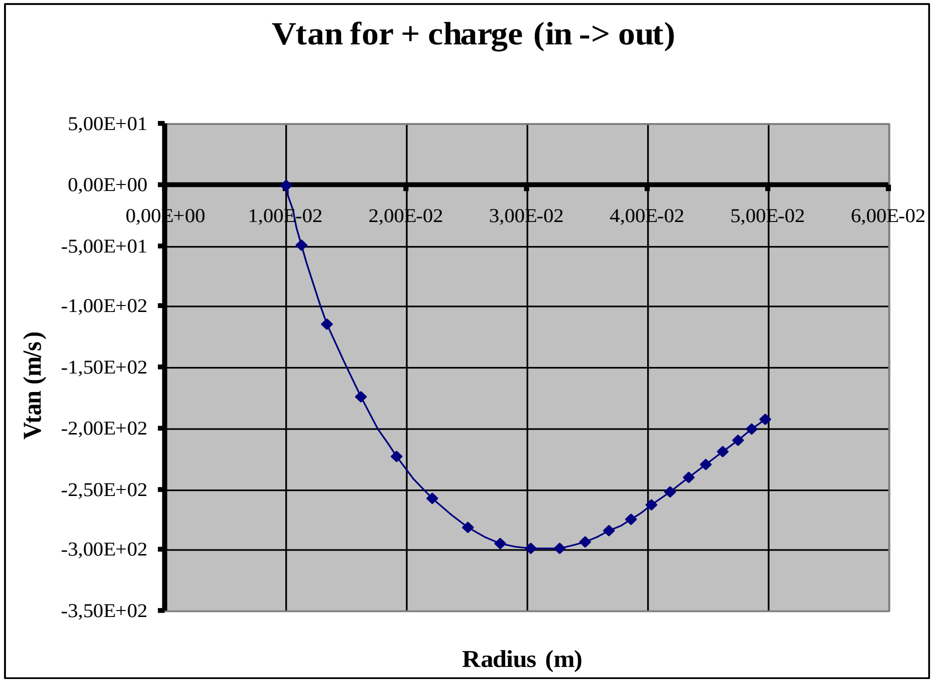
$$x \leftarrow x + Vx \cdot dt$$

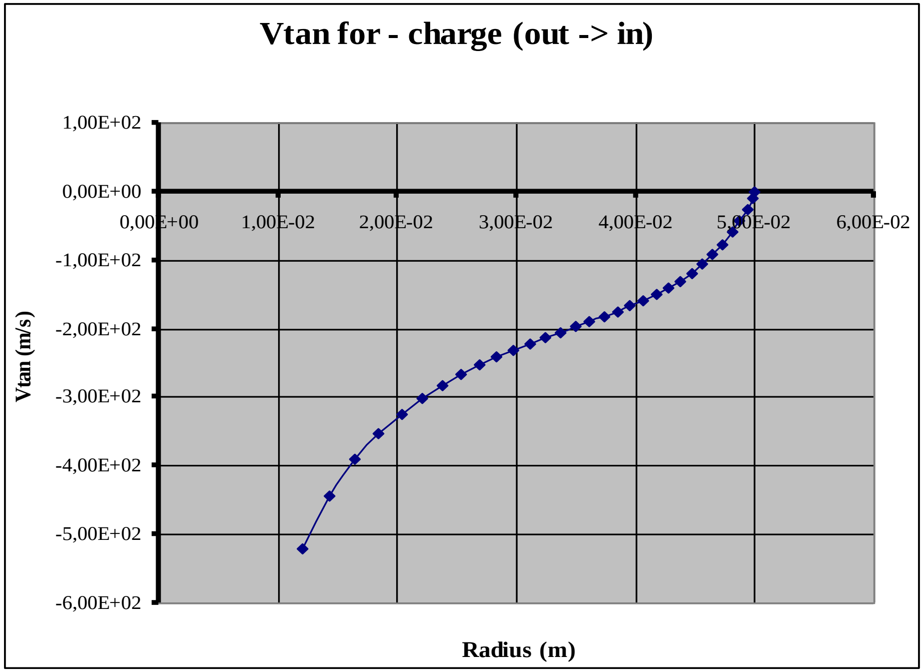
$$y \leftarrow y + Vy \cdot dt$$

Path of charges + and -



Lateral Velocities



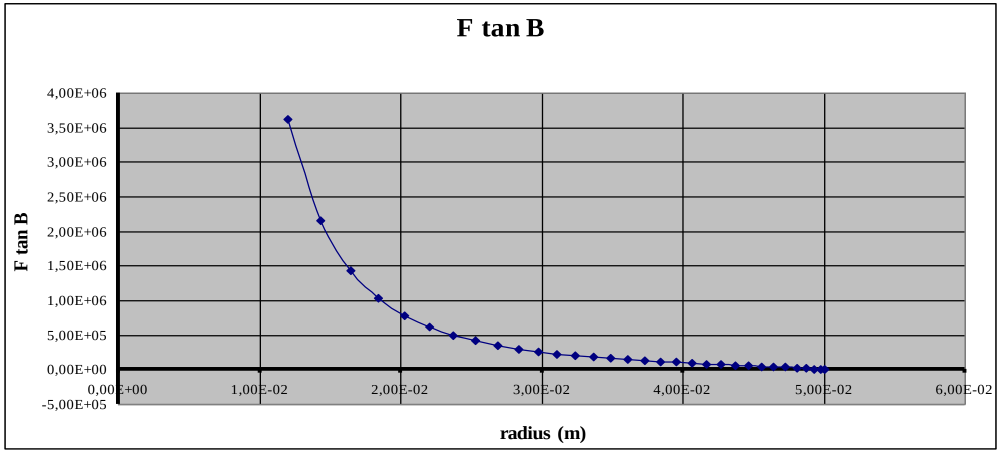


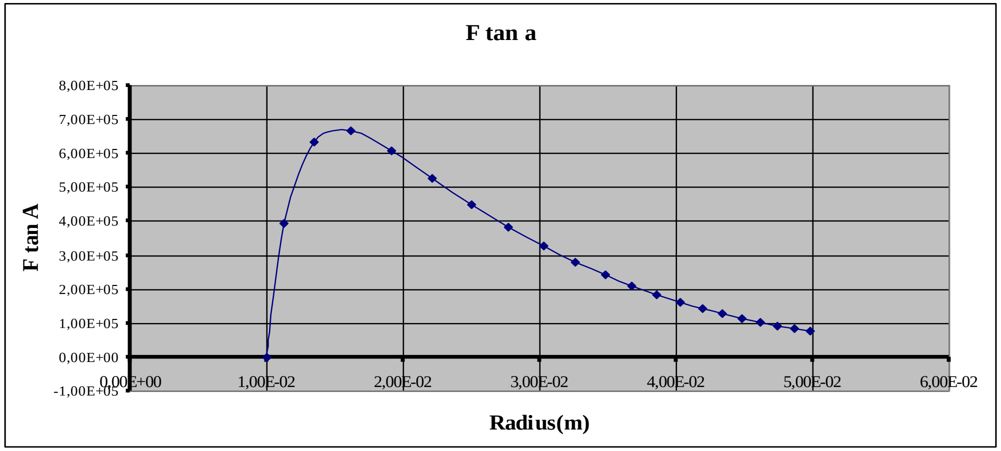
Friction force

- The friction force is proportional to the velocity
- it is also proportional to the charge density, that means inverse proportional to r^2

$$F = k \cdot \frac{V}{r^2}$$

Force causing the solution ’s movement (1/2)





Force causing the solution 's movement (2/2)