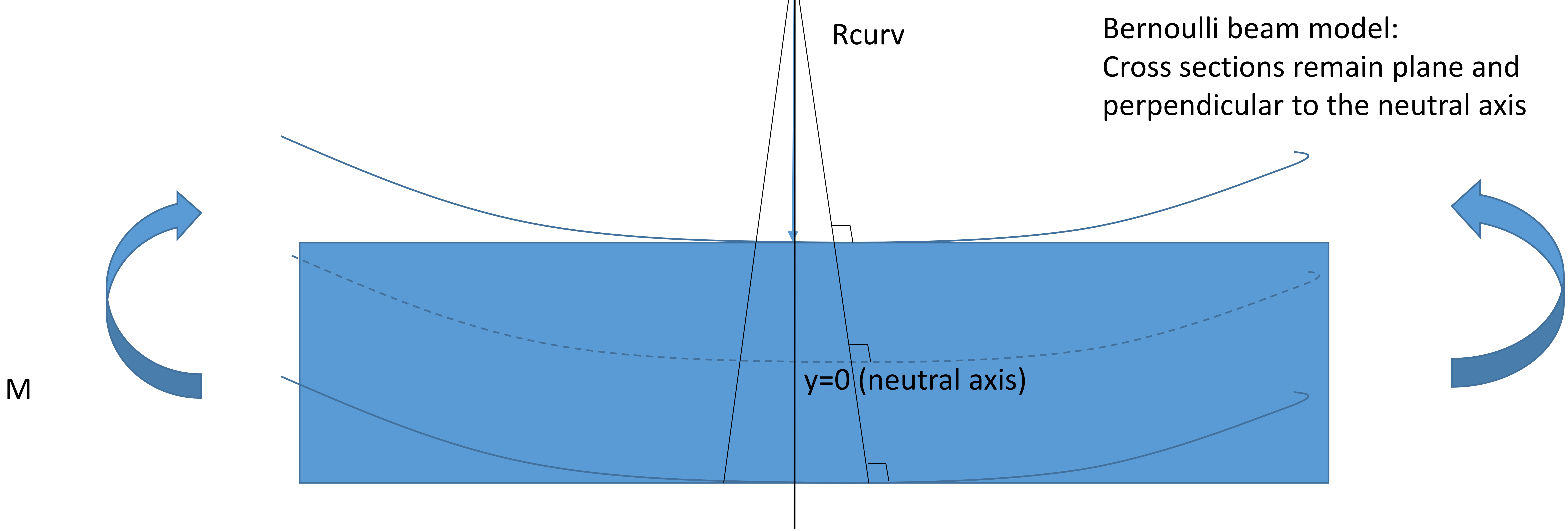


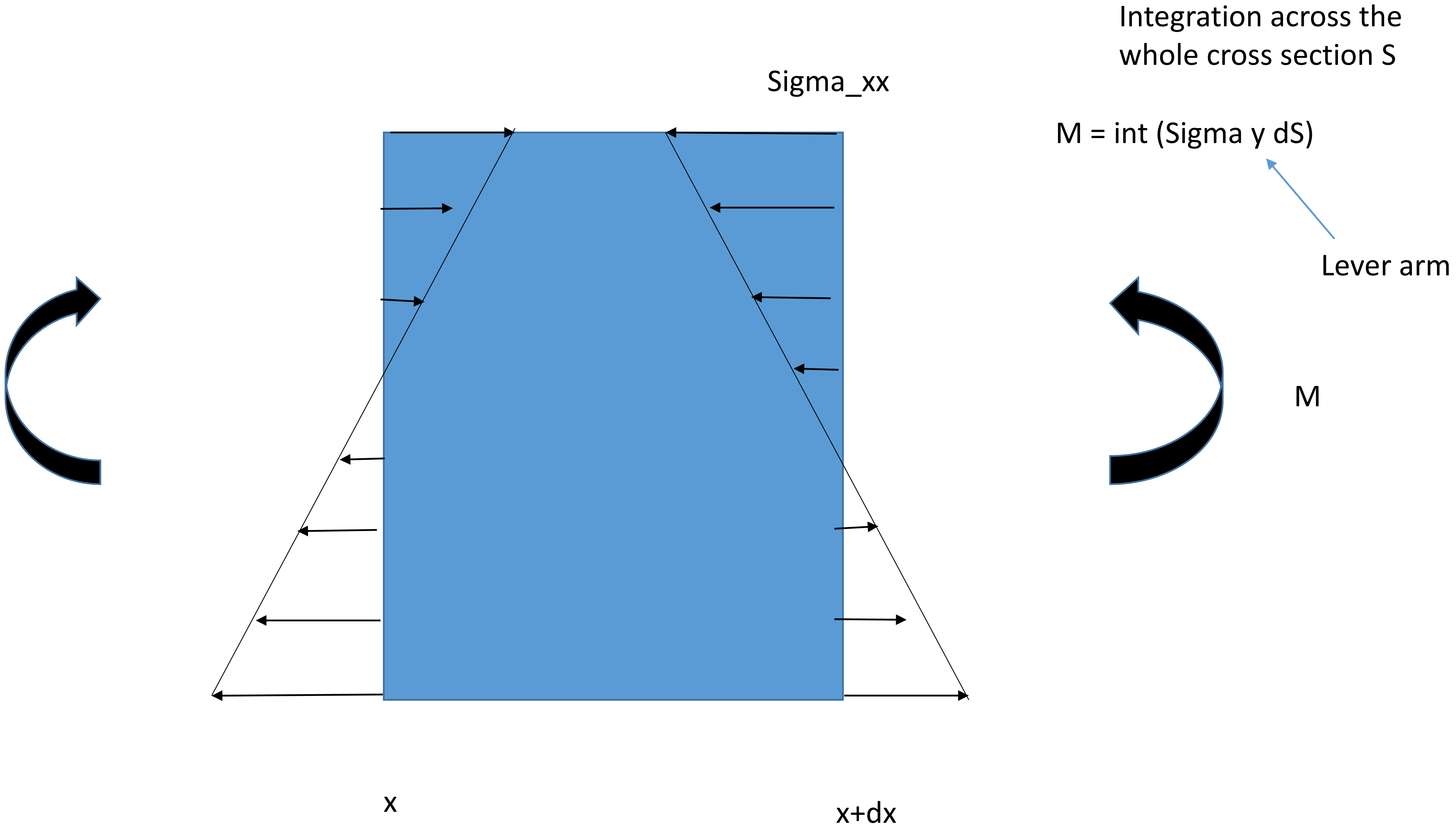
The bending moment => curvature of the beam

Curvature = 1/Rcurv

Elasticity => M = kappa Curvature = kappa / Rcurv

Power = M dRotation = M L dCurvature = kappa Curvature L dCurvature

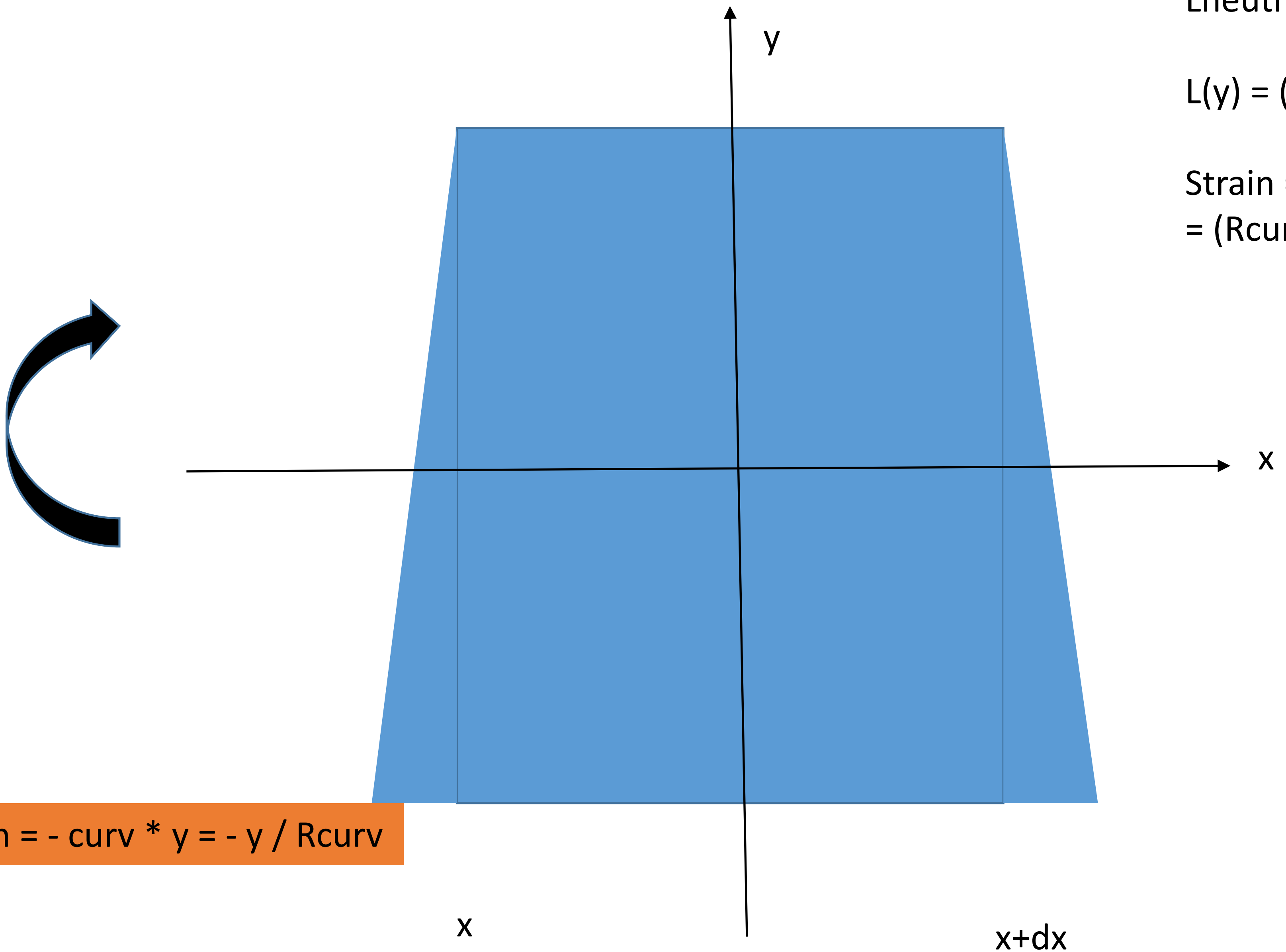
Energy = integral over time (Power) = ½ kappa L curvature^2


Integration across the whole cross section S
Sigma_xx
M = int (Sigma y dS)
Lever arm
M
x
x+dx

Lneutral axis = Rcurv theta

L(y) = (Rcurv-y) theta

Strain = (L(y)-L(0))/L(0))
= (Rcurv-y-Rcurv)/ Rcurv = - y/Rcurv



Strain = - curv * y = - y / Rcurv

Elasticity

Hooke’s law: Sigma = Y epsilon = Y curv y

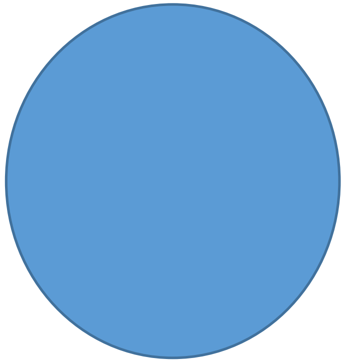
Y is the elastic(Young’s) modulus

$M = \int (\sigma\, y\, dS)$

$M = Y\, curv \int (y^2\, dS)$

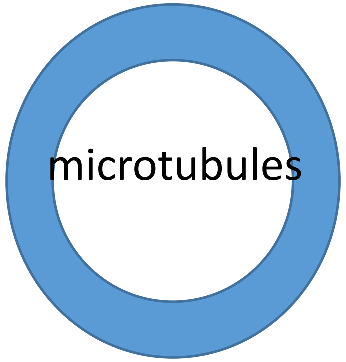
I/S = ratio between momnt of inertia and cross section area

Moment of inertia of the beam: I



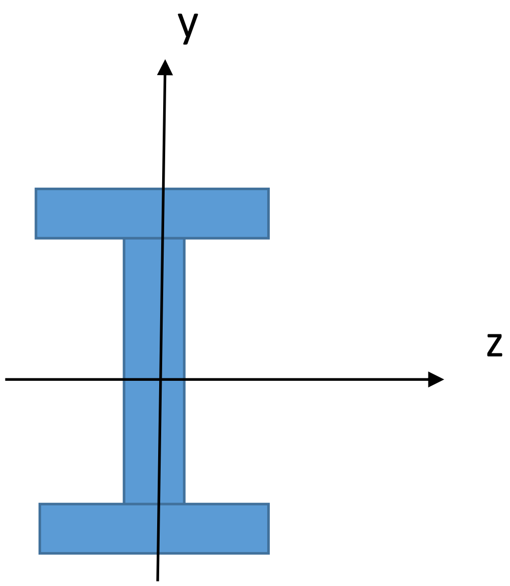
$I = \pi R^4/4$
$S = \pi R^2$

$I/S = R^2/4$



$I = \pi(R_o^4 - R_i^4)/4$
$S = \pi(R_o^2 - R_i^2)$

$I/S = (R_o^2 + R_i^2)/4$
$= R^2/2$



Beam in civil eng

Thermodynamics

Probability of having the filament with energy E

$P(E) = A \exp(-E/kT) = A \exp(-YI\, L/(2kT\, R^2)$

$YI\, L/(2kT\, R^2)$

$YI/(kT)$ = dimension is m => persistence length

$L/(2R^2)$ = dimension is 1/m

persistence length of DNA?

YI/(kT) => persistence length

$k = 1.38064852 \times 10^{-23}$

$T = 300$

$kT = 4 \times 10^{-21}$

$1/kT = 0.25 \times 10^{+21}$

$Y = 1GPa = 10^{+9}$ Pa

$I = \pi R^4/4 = 10^{-36}$ $\quad YI = 10^{-27}$ R=1nm $\pi/4 \sim 1$

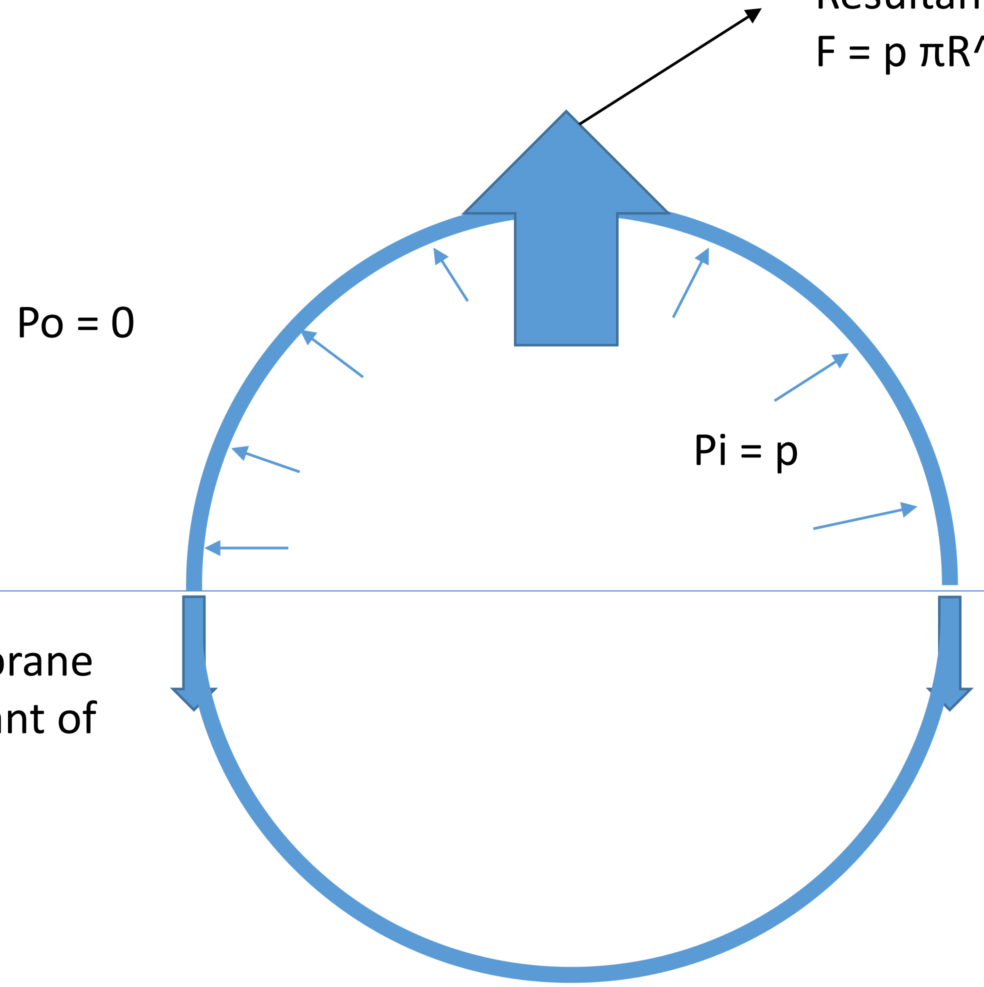
$YI = 0.2 \times 10^{-27}$ R=0.67nm $\pi/4 \sim 1$

persistence length = 50 nm

persistence length = 0.25×10^{-6} = 250 nm

Resultant of all pressure forces

$F = p\,\pi R^2$



Tension in the membrane balancing the resultant of pressure forces

$T\,2\pi R$

T is the tension

Equilibrium:

$T\,2\pi R = p\,\pi R^2$

$T = pR/2$

Law of Lapace

$T = (p_i - p_c)R_c/2$ Law of Laplace inside the micropipette

$2T/R_c = p_i - p_c$

$T = (p_o - p_c)R_p/2$

$2T/R_p = p_o - p_c$ Law of Laplace outside the micropipette

$$2T\,(1/R_c - 1/R_p) = p_i - p_o$$