Revision

Date : 19.01.2022

Lecture 06 & 07

What is a Thin **Film** → Supported.
→ unsupported.

What is Surface Tension → Intermolecular interaction.
↓
Induced Dipole - Induced Dipole Van der Waal's forces

(Discussed how this interaction results in the Pressure Correction Term in Van der Waal's E.O.S.

→ Born Repulsion → Lenard Jones potential
6 - 12 Potential.

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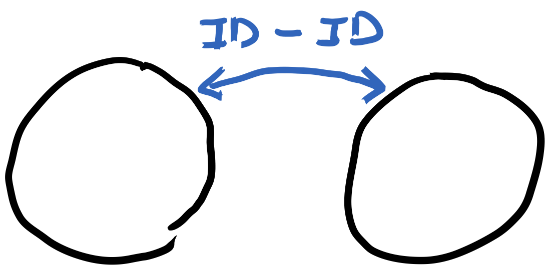
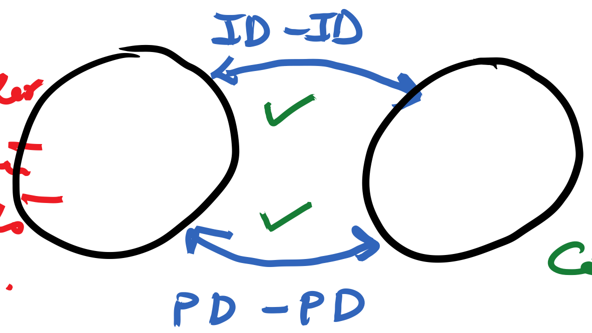
a-Polar Molecule



Intermolecular Interaction in Polar molecule much sharper.

Polar molecule → There will be PD - PD interaction over and above ID - ID interaction.

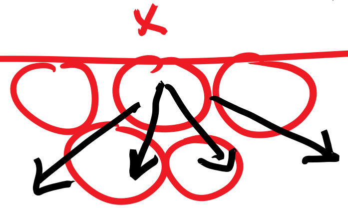


Consequence: →

Surface & Interface

Air / Vacuum

Surface



Cond. Phase

Material

Non Condensed Phase

A Surface Molecule is in a State of Net Inward attraction towards the bulk.

⇒ As if the bulk is pulling the molecule inward

⇒ Molecule is in a State of "Tension" towards the bulk.

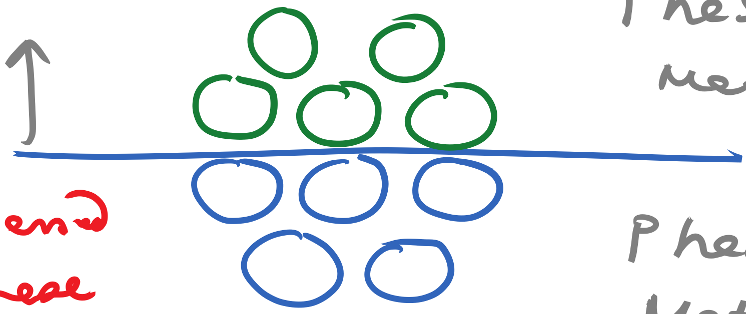
"Surface Tension"

What is an Interface

Interface between 1 and 2.

Condensed Phase

Phase 1 / Material 2.



Condensed phase

Phase 2 / Material 2

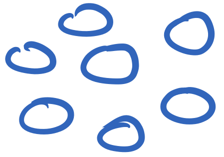
Boundary Between two condensed Phases.

Liquid and Solid Condensed Phases.

Non Condensed Phases → Gas.

* A Surface is a Special case of an Interface, where one of the Phases is a gas or Non-Condensed.

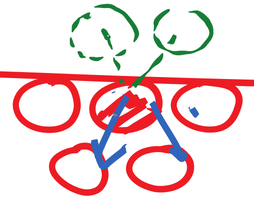
Surface

Bulk 

Net Int Force = 0

INTERFACE

A molecule at the interface is subject to both Cohesive & adhesive Interaction

A 

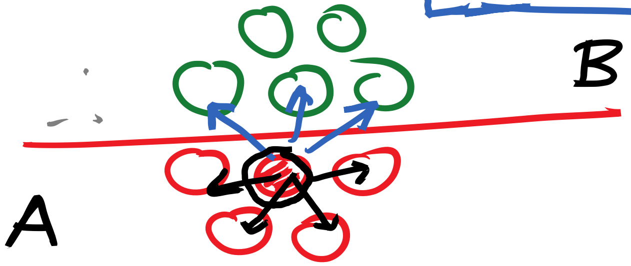
In a state of Inward tension.

(ID-ID, may be PD-PD)

γ_A → Surface Tension of A (Always Positive)

Every Surface molecule has NON ZERO Net Interaction.

$\gamma_A \rightarrow \sum$ (Net Interaction) (All Surface Molecules)

A  B

Net force ?

γ_{AB} → Interfacial Tension between A and B.

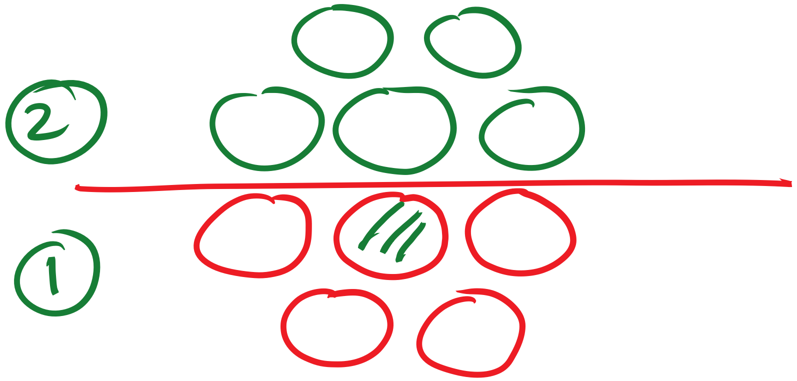
γ_{AB} → Is the energy reqd. for creating an interface.

may be positive or Negative

Surface Molecules are UNDER COORDINATED.

19.01.2022

Lecture 6 & 7



For a molecule at the Interface

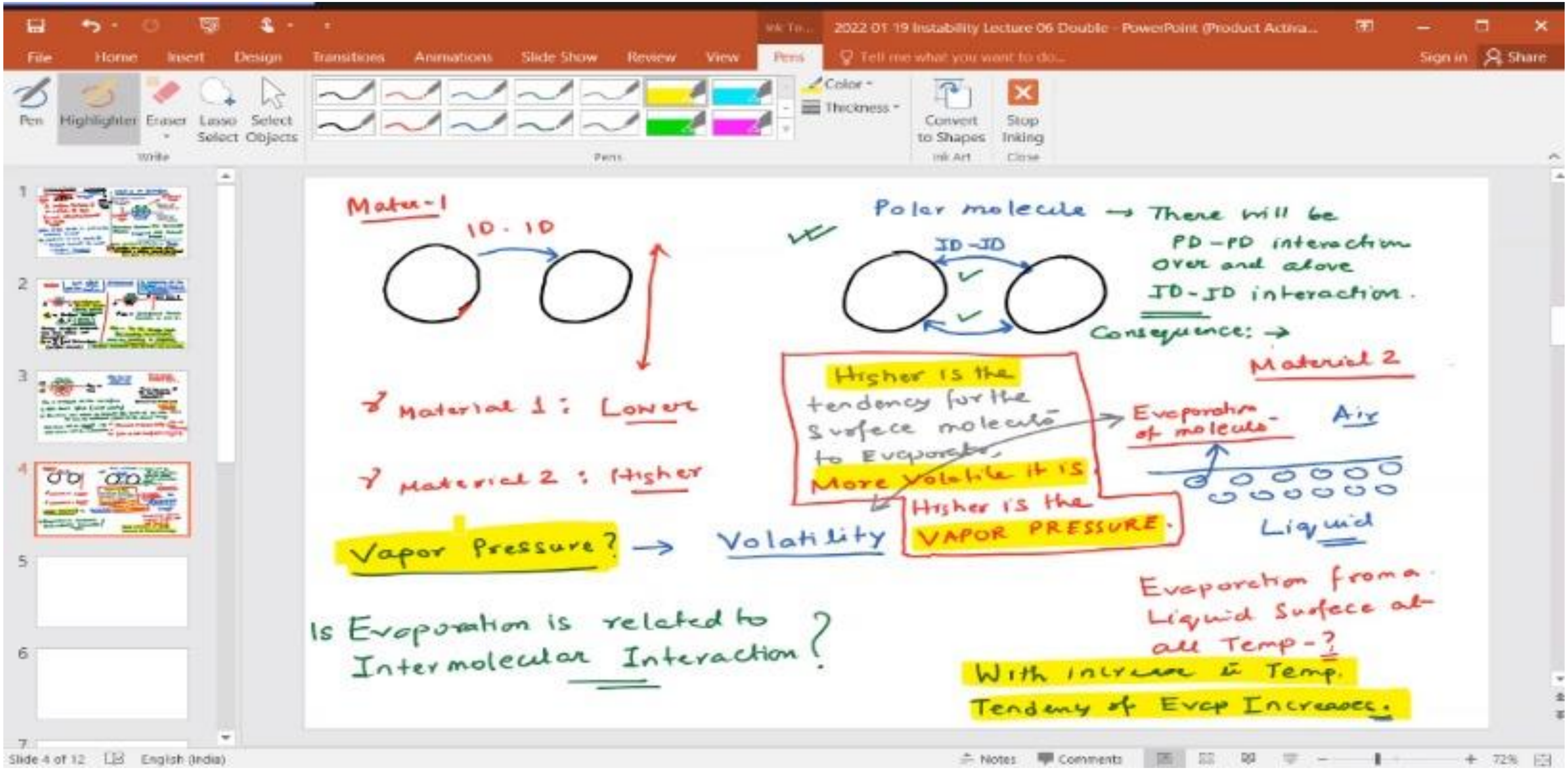
1) Net force $\neq 0$ (Most Likely)

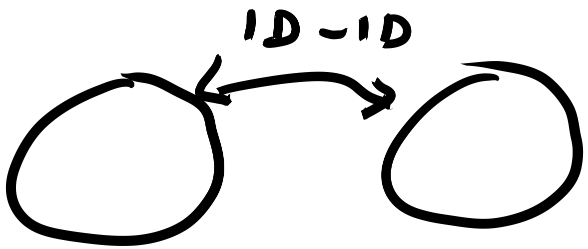
2) Direction can either be towards the bulk of its own phase
Or can be outward (Bulk of the Second phase)

Net force will be inward $\longrightarrow$ ✓ |Strength of Cohesive Int| > |Str. of Adh. Interaction|

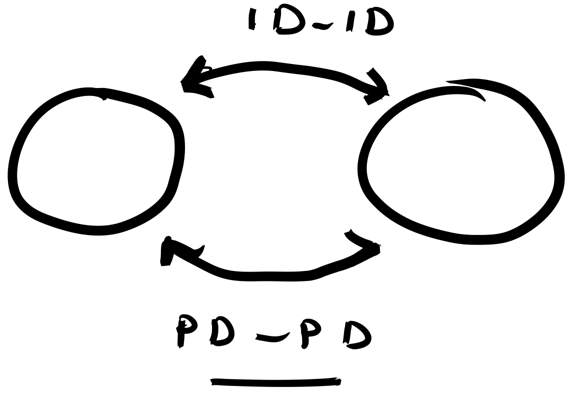
~~Net~~ Net force will be outward $\rightarrow$ ✓
↳ |Str. of Adh. Int| > |Cohesive Int|

Part of the Text that we lost





Material 1



Material 2

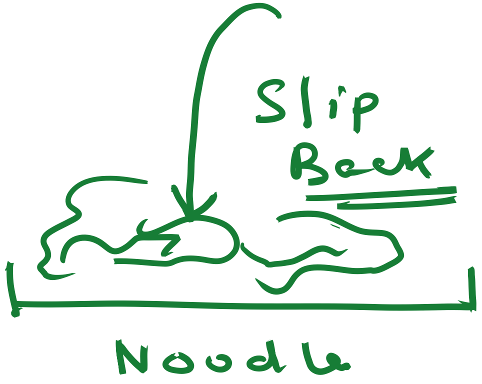
(1) $\gamma_1 < \gamma_2$

(2) $P_1^* > P_2^*$ (Vapor Pressure)

(3) $BP_1 < BP_2$ (Normal Boiling Point)

Str. of Intermolecular Interaction > Surface Tension
Vapor Pressure
Normal Boiling Point

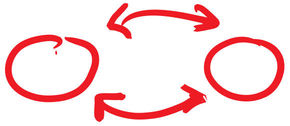
Type of Intermolecular Interactions: -



1. ID - ID

2. PD - PD (over and above ID - ID)

3. Steric Interaction ("Structure") → Long chain molecules.

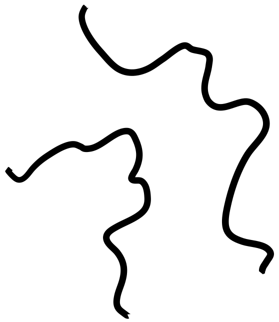


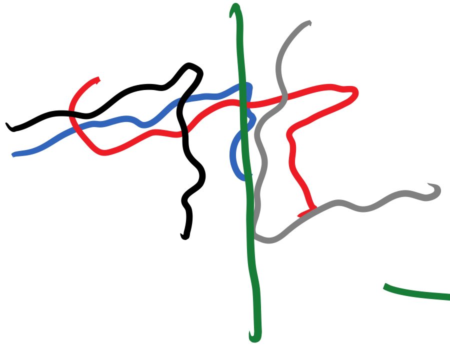
Entanglement

Enhanced Viscosity

Polymer melts (No Polarity) often has high viscosity.

→ Additional Interaction due to structure of the molecules.





Long chain molecules
→ Jumbled up !!
} Entanglement

Polymers → Long chain Molecules

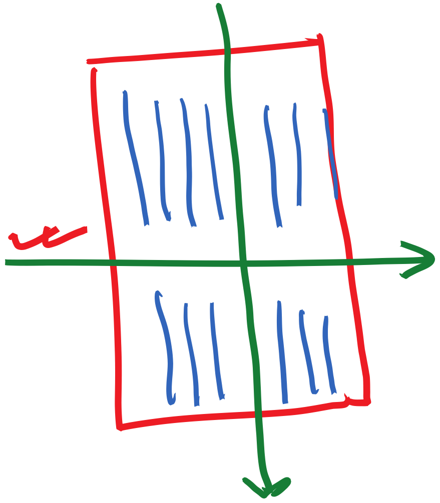
→ Pierce some of the longer chains
→ Additional Energy → Additional Comp of Surface Energy

Tearing a News paper /

Paper is made of

Cellulose → Cellulosic Fibres

Because of the Long Chain Nature of the Fibres.



Teer plain is orthogonal to the direction of fibres

Very Difficult to Cut.

You have to chop/cut every single fibre

✓ Easy to Cut! (Teer Plain is aligned to the fibres)

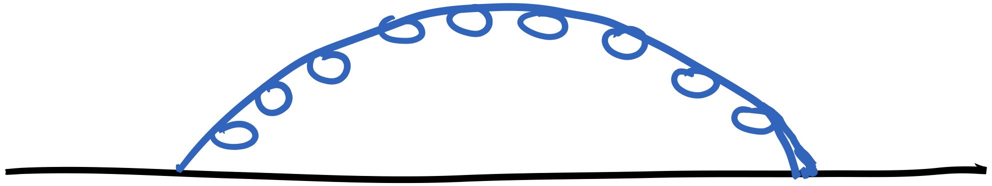
Young's Equation (A drop of Liquid on a Solid Surface)

Liquid Drop (γ_L) → Hemispherical Shape (Part of a Sphere)

Why hemispherical Shape?

(Because of Surface Tension)

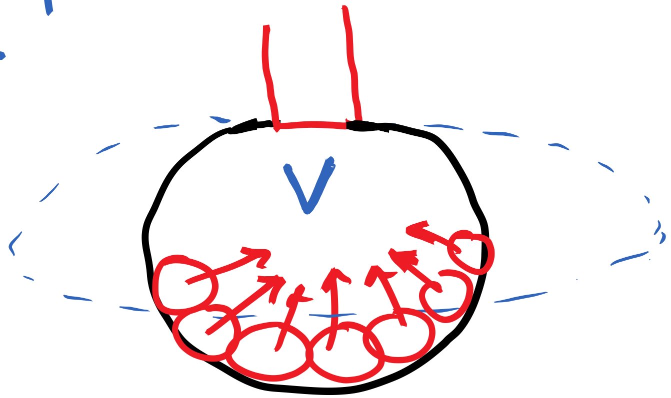
[For a given volume, a Sphere has the minimum Surface Area]



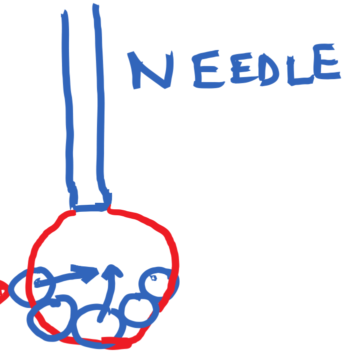
Solid Surface (γ_S)

Surface molecules can re-organise and take hemi spherical shape.

No change in Shape of a Solid occurs due to Surface Tension. → Due to Rigidity.

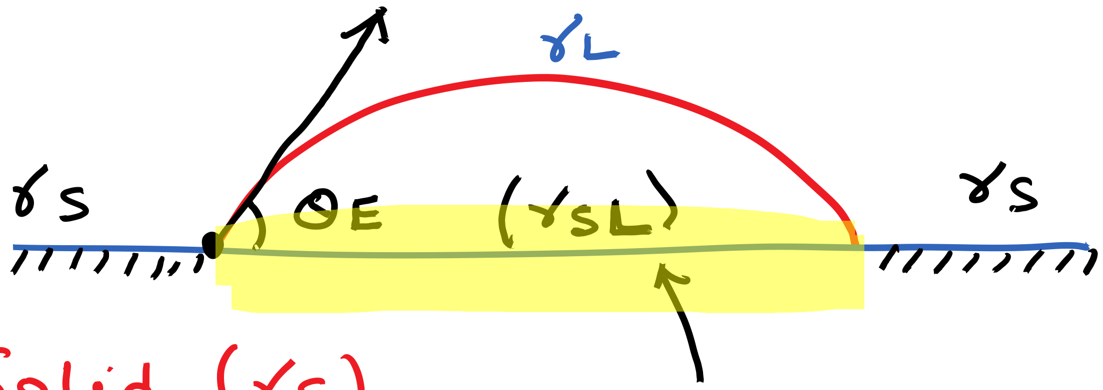


Looks Like a Sphere →



Young's Configuration

Liquid (γ_L)



Solid (γ_S)

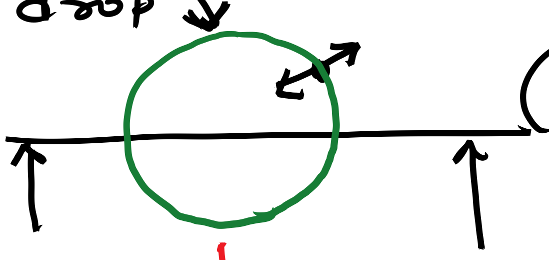
Interface

$\theta_E \rightarrow$ Equilibrium Contact Angle.

$\theta_E \rightarrow$ Depends on the combination of the Liquid & Solid.

Top View

Boundary of the drop

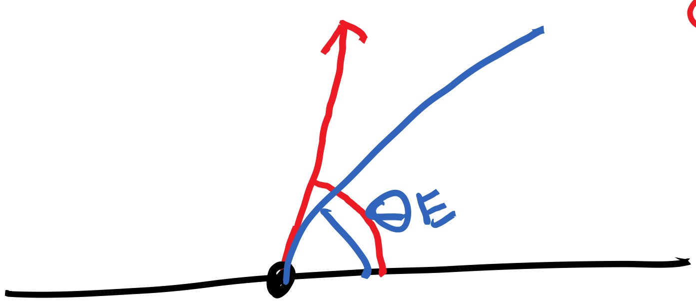


(Section)

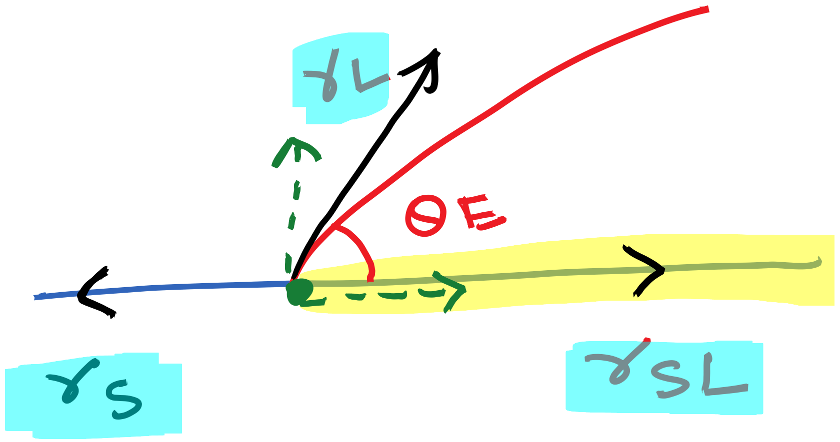
$\rightarrow$ Contact Line

Force Balance (Surface & Interfacial Tension)

At any point over the Contact Line



$\theta_E \rightarrow$ Angle Between the Solid and the Tangent to the Liquid Meniscus at the Point of Contact.



Force Belance in the Horizontal Direction:

Equilibrium Contact Angle.

Contact Angle Does not change →
As contact Line is stationary →.
The outward force = Inward force | at the Contact Line

$$\boxed{\gamma_S = \gamma_{SL} + \gamma_L \cos\theta_E}$$

Young's Eqn:

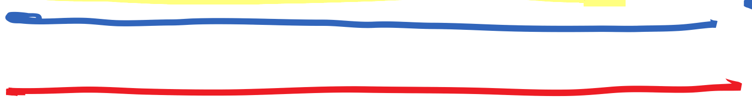
$$\Rightarrow \cos\theta_E = \frac{\gamma_S - \gamma_{SL}}{\gamma_L}$$

[Physically measurable Entities →]

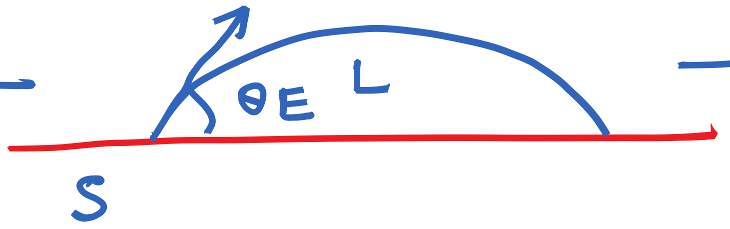
What are the Limiting values of θ_E

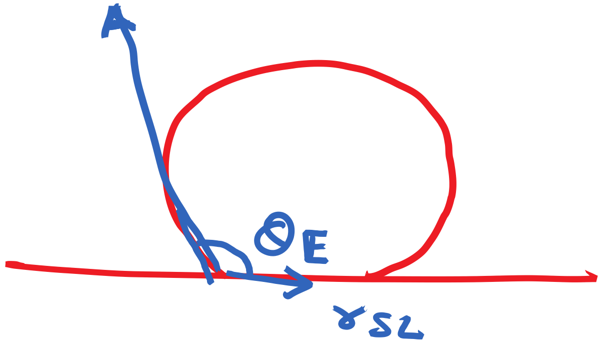
FILM

(Complete Wetting)



(Partial Wetting)





Higher Limit

$\theta_E \rightarrow 180^\circ$

Lower Limit $\rightarrow 0$

Not Possible

$\theta_E = 0$ would mean Liquid Surface and the solid Surface are parallel.

Liquid is Spreading Completely on the Surface

WETTING

$\leftarrow$ Liquid Spreads partially on the Solid Surface $\rightarrow$

$\rightarrow$ Extent of Spreading Reduces as θ_E increases