Surface and Interface

surface	boundary between 2 phases, one of them is in the gaseous state
interface	boundary between 2 immiscible phases has context menu

Types

gas-liquid	surface tension	
gas-solid	adsorption	e.g., antiflatulents
liquid-liquid	interfacial tension	e.g., emulsions
solid--liquid	wetting	e.g., tablets

Surface tension definition and units

Definition	Force per unit length that must be applied to counterbalance the net inward pull.
	the work done to increase the surface area of a mass of liquid by 1 cm2. (Units: erg/cm2)
Units	dyne/cm
	Nm-1
	mNm-1
	erg/cm2

surface tension (γ)

Cohesive	intermolecular forces between like molecules
Adhesive	intermolecular forces between unlike molecules
inward force	Molecules of the liquid at the surface exhibit an inward force toward the bulk, therefore contract the surface & pull it towards the inside.

Net force

Surface molecule	somewhat down because of the inward force
Bulk molecule	zero (cancel each others)

Examples on ST

1. Water film on hand Water
2. Water dipping from a tap
3. Water beading on a leaf
4. Soap bubbles
5. Paper clip on water surface
6. Coin on water surface

ST of water

Unit	73 dyne/cm at 25C
Why are water droplets spherical?	High stability, low energy, low SA
	A sphere has the smallest possible surface area to volume ratio
Surface free energy	Surface > Bulk
	The surface layer of a liquid possesses additional energy as compared to the bulk liquid. This energy increases when the surface of the same mass of liquid increases.

Cleansing effect between hot and cold water

There is an inverse relation between surface tension & temperature

1. high temp.
2. more kinetic energy
3. weakens cohesion
4. lower ST, which is defined as specific temp.

Cleansing effect between hot and cold water (cont)

Hot water is better cleaning agent than cold water, because it has lower ST, so can get better into pores and fissures, while cold wate can form only bridges between them

IT (Interfacial Tension)

Definition	the force per unit length existing at the interface between two immiscible liquid phases
	the work required to separate the 2 sections of liquids.
Unit	dyne/cm
	erg/cm2
The interfacial tension reflects the interaction between the 2 phases:	1. high IT
	2. low molecular interactions
	3. low adhesive
	4. high cohesive
	5. immiscible liquids
completely miscible	high interactuins
immiscible	low interactions

Measurements of ST and IT

1. Capillary rise method
2. Du Nouy ring method
3. Wilhelmy plate method
4. Pendent drop method
5. Spinning drop method
6. Bubble pressure method

1. Capillary rise method

Capillary placed in a liquid contained in a beaker, the liquid generally rises up the tube a certain distance

liquid rises due to the ST, at some point it will stop due to its weght. so the upwaed movement will be balanced by the downward force of gravity

ST determined by measuring the rise in the capillary

ST= 0.5 rhpg

r = radius, h = hight, p = density, g = gravity

2. DuNouy ring method

slowly lifting a platinum-irridium ring from the surface of a liquid.

The force required to detach the ring from the liquid surface is recorded in dynes on a calibrated dial.

This force is equivalent to the maximum pull exerted on the ring by the surface)

3. Wilhelmy plate method

a thin plate usually made from glass or platinum-oriented perpendicular to the interface and attached to a scale or balance via a thin metal wire

The force on the plate due to wetting is measured and used to calculate the surface tension.

4. Pendant drop method (Drop weight)

A liquid drop hanging on the bottom of a capillary tube starts to fall when the weight of the drop is in an equilibrium state with the surface tension.

The drop is falling when the weight (mg) is equal to the circumference (2πr) multiplied by the surface tension (σ).

$mg = 2 \pi r \sigma$

4. Pendant drop method (Drop weight) (cont)

we can use a reference liquid of known surface tension (mostly using water as a reference) to compare with the liquid which we are interested in

Methods used to measure IT between 2 liquids

Solid-liquid interface (Contact angle θ)

If a drop of liquid is placed on a flat, smooth, horizontal solid surface, it forms a drop.

contact angle (θ): drop will exhibit a definite angle against the solid. It's contact angle (θ): the angle the tangent to the liquid surface makes with the solid surface over which it spreads.

θ is determined by the interactions across the three interfaces; solid/liquid/gas.

θ depends on the nature of both the solid surface and the liquid drop.

θ (range of 0 = 180)

θ for pure water-pure silver is 90°

Contact angle differs depending on surface type "even same types of drops"

θ reflects wetting of the surface

On contact of a liquid droplet with a surface, the behavior of the liquid drop will depend on the balance between the cohesive forces of the liquid and the adhesive forces with the solid surface.

If the attractive forces between the liquid & solid exceed the cohesive forces in the liquid drop > low contact angle (α < 90°) > good wetting

e.g., water drop on glass surface

High θ = bad wetting