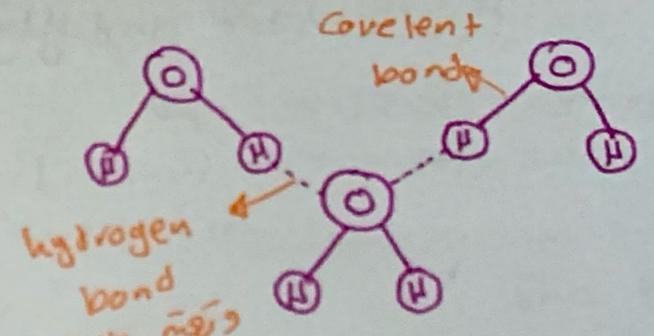


Force per unite = Surface tension
 وحدة قيا = Surface tension
 ما فيا صا كاني استقيم 1cm dynes



Surface Tension of Water

عبارة عن dipole molecule

The surface tension of water is 72 dynes/cm at 25°C. It would take a force of 72 dynes to break a surface film of water 1 cm long. The surface tension of water decreases significantly with temperature as shown in the graph. The surface tension arises from the polar nature of the water molecule.

Hot water is a better cleaning agent because the lower surface tension makes it a better "wetting agent" to get into pores and fissures rather than bridging them with surface tension.

Soaps and detergents further lower the surface tension

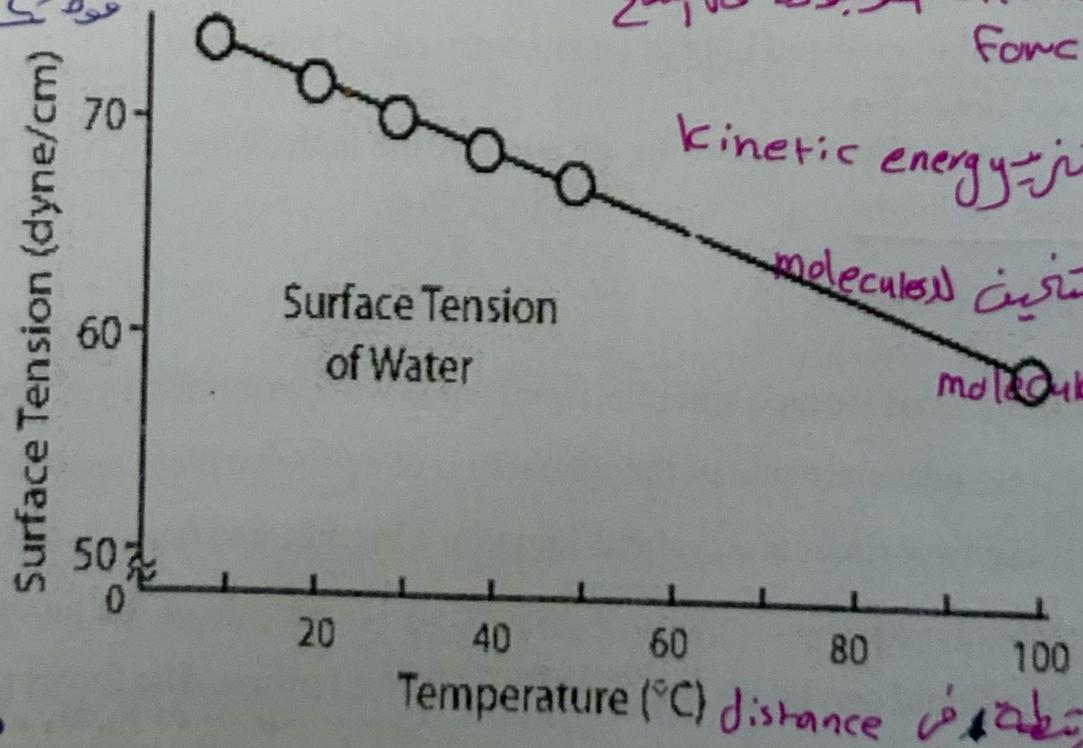
Soaps and detergents interact with hot water and detergents

Surface tension is typically measured in dynes/cm, the force in dynes required to break a film of length 1 cm. equivalently, it can be stated as surface energy in ergs per square centimeter.

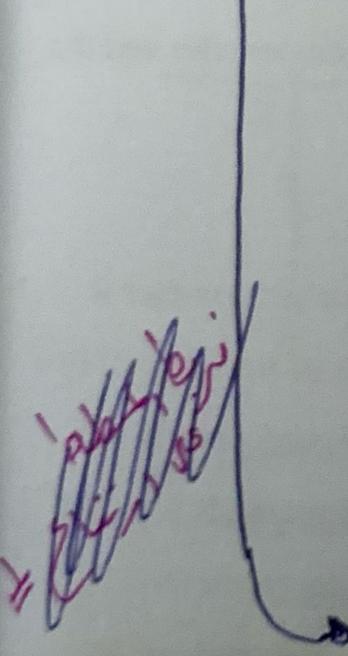
Water at 20°C has a surface tension of 72.8 dynes/cm compared to 22.3 for ethyl alcohol and 465 for mercury.

Surface tension Temperature
 علاقة كسبية مع درجة الحرارة

Surface tension
 Film وهو intact
 قوة تكسر هذا Film



بسبب attractive force ال موجودة على السطح
 kinetic energy تزداد مع الارتفاع في الارتفاع
 وبسبب عندها حركة عالية بالارتفاع لالمolecules
 وتبتعد عن الحركة العالية للمolecules
 distance المسافة بين molecules
 hydrogen bonding مرتبطة في distance



هذا تسمى...
 الية على سطح الماء وتسمى...
 ثابتة لكن لو اضرقت
 الية وفانت كوا
 submersed

فلك ما زاد distance ال bonding ال تزداد attractive force
 ال تزداد وبالتالي surface tension ال تزداد

تسمى intact ك ما تسمى للقوى التي
 To Break This film

! water and glycerol surface tension
 more cohesiveness or
 more attractive force between the molecules
 and liquid

الكبرول قسفة
 مقلنا

Benzene and diethyl ether
 قسفة قسفة قسفة
 القوة بين جزيئاتها
 قليلة

Substance	Surface tension Dyne/cm
water H(OH)	72.7
diethyl ether (CH ₃ -CH ₂) ₂ O	17.0
benzene C ₆ H ₆	40.0
glycerin C ₃ H ₂ (OH) ₃	63
mercury (15°C)	487
(non polar) n-octane	21.8
sodium chloride solution (6M in water)	82.5
discarded sucrose solution (85% in water)	76.4
sodium oleate (soap) solution in water surfactant قسفة	25

high to cohesiveness
 Between the mercury molecule

How is surface tension measured?

الاجزاء الى بقية

As mentioned above, surface tension can be measure using force tensiometers or optical tensiometers (also known as contact angle meter or goniometer). Specific technologies such as volumetric tensiometry and bubble tensiometry can also be used.

كم يحتاج قسفة قسفة
 Breacking Film
 وسيفم كما هو

Examples on methods of measuring surface tension include the Du Nouy tensiometer and the capillary rise methods.

Force Tensiometry

The measurement of surface and interfacial tension as performed by a force tensiometer is based on force measurements of the interaction of a probe with the surface of interface of two fluids. In these experiments a probe is hung on a balance and brought into contact with the liquid interface tested. The forces experienced by the balance as the probe interacts with the surface of the liquid can be used to calculate surface tension. The forces present in this situation depend on the following factors; size and shape of the probe, contact angle of the liquid/solid interaction and surface tension of the liquid. The size and shape of the probe are easily controlled. The contact angle is controlled to be zero (complete wetting). This is

platinum or iridium ← عبارة عن قطعة
 Free movement
 الكفة هاي بيقي
 Du nouy ring

achieved by using probes with high energy surfaces. probes are made of a platinum/iridium alloy which insures complete wetting and easy and reliable cleaning.

The mathematical interpretation of the force measurements depends on the shape of the probe used. Two types of probes are commonly used, the Du Noüy ring and the Wilhelmy plate. A metal rod can also be used to limit the liquid sample volume.

interaction Between the ring and the liquid
 في التجربة مع اقلي هاي ring تنزل على السائل وبع ديصر حدي
 وبعدين بيقل اسحب الكفة للدخل عن طريق اقرها وبيشوف كم يحتاج

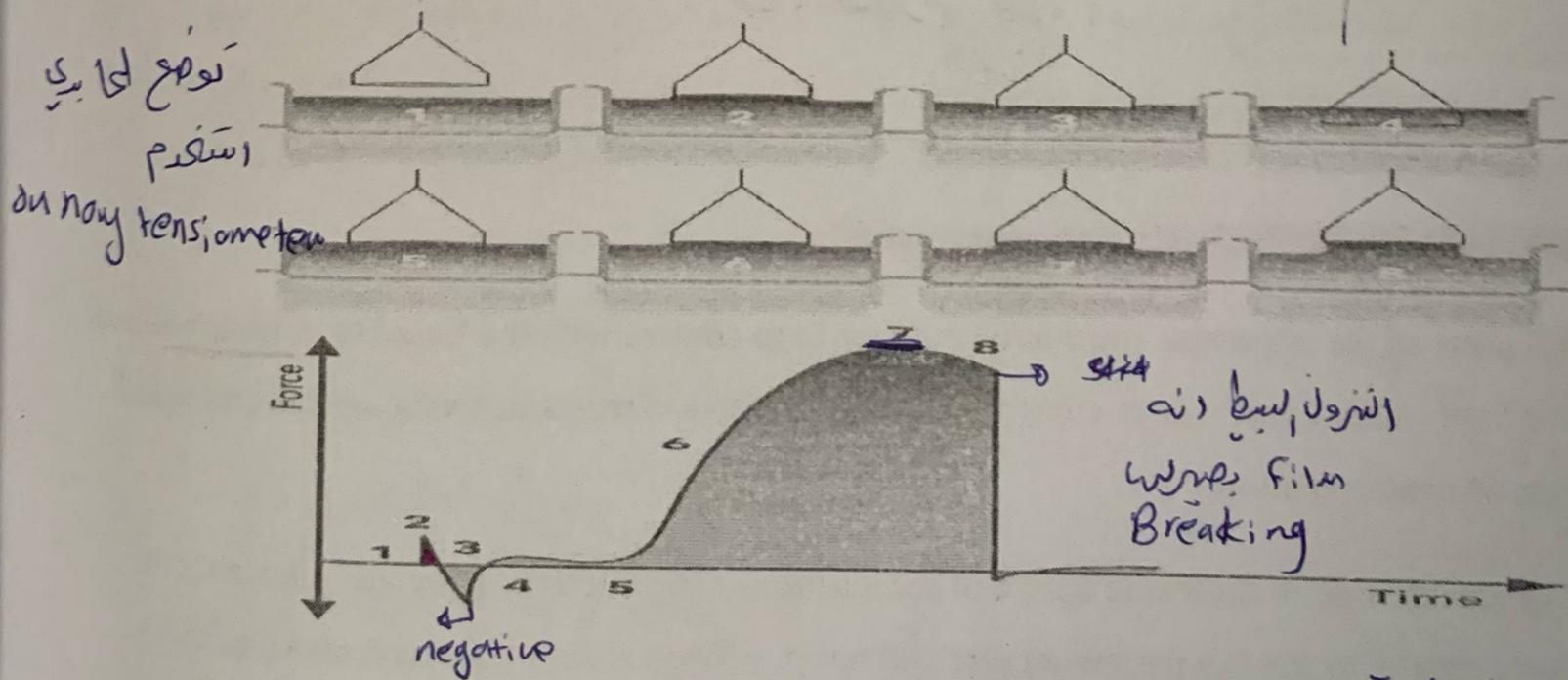
Du Noüy ring

Force to pulled out

The Du Noüy tensiometer will measure the force required to detach a platinum-iridium ring immersed at the surface which is directly proportional to the surface tension.

This method utilizes the interaction of a platinum ring with the surface being tested. The ring is submerged below the interface and subsequently raised upwards. As the ring moves upwards it raises a meniscus of the liquid. Eventually this meniscus tears from the ring and returns to its original position. Prior to this event, the volume, and thus the force exerted, of the meniscus passes through a maximum value and begins to diminish prior to the actually tearing event.

The process is shown in the diagram below:



1. The ring is above the surface and the force is zeroed.
2. The ring hits the surface and there is a slight positive force due to the adhesive force between ring and surface.
3. The ring must be pushed through the surface (due to the surface tension) which causes a small negative force.

يتوقف لانه الكفة معلقة
 ② تيلس تنزل الكفة داخل سائل وبيقل الجهد تيلس قرادة بسيطة
 والقوة مع تنزل السبب ما بين ring and liquid

③ الكفة بتزيد اكثر والقوة هون بتقل
 negative السبب انه اذا بعلو زواكي مني
 surface tension

Breaking the film

(4) بس تفتون الكفة حوا السائل بصيرنا

(5) بسبعه كمان للاكل ببيلس الجهاز قيراه القوة بتزيد

4. The ring breaks through the surface and a small positive force is measured due to the

positive force supporting wires of the ring.

5. When lifted through the surface the measured force starts to increase.

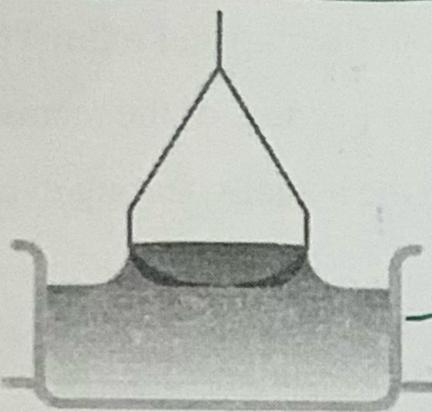
6. The force keeps increasing until the maximum force is reached

7. After the maximum there is a small decrease of in the force until the lamella breaks.

The calculation of surface or interfacial tension by this technique is based on the measurement of this maximum force. [The depth of immersion of the ring and the level to which it is raised

when it experiences the maximum pull are irrelevant to this technique.] The original calculations based on the ring technique were based on theories which apply to rings of infinite diameter and do not consider an additional volume of liquid which is raised due to the

proximity of one side of the ring to the other. This additional liquid lifted is diagrammed below as the darker turquoise portion:



الكفة بتكون عبارة عن سلا تاعم وتبصر انه الكفة مالها اي تاثير كل زيادة الحجم مع السائل فالقياس بتبصر انه ياثر كل حجم الالمنيوم

في حال كانه الخمية مقلية بعدا ستقدم rod او عيانه

Basic rule for Du Noüy ring measurements:

All parts of the apparatus must to be coming in to contact with the liquid to be measured have to be kept meticulously clean since the interfacial tension reacts in a very sensitive way to all kinds of contamination.

The enrichment of molecule active in the surface or the interface generally takes place very slowly, that is to say the parameter age and temp. influence the measurements significantly, during any measuring series its therefore essential to maintain constant test condition like temp.

The Du Noüy ring is highly sensitive prope which gets useless when deformed (Don't ever touch the ring it self with your fingers it can easily get deformed by even low forces) to handle the ring take the opening between your fingers so that the ring can fall in to the palm of your hand, clean the ring you must rinse it under warm flowing water and D.W

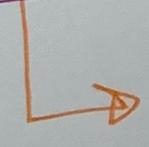
القراءه لافادة منه اذا تغير شكله

Basic rule for Du Nouy ring measurements

هدول مش موجودين
بباعتنا بول بس لا كوة
شخصهم بالفنيدو ال
مش

- ① The size and shape of the probe are easily controlled
- ② The contact angle is controlled to be zero (Complete wetting) (الانتم تكون عندي)
This is achieved by using probes with high energy surfaces
- ③ probes are made of platinum / iridium alloy which insures etc
Complete wetting and easy and reliable cleaning
- ④ The mathematical interpretation of the force measurements depends on the size ~~and~~ of the probe used

⑤ Two types of probes are commonly used, The Du Nouy ring  and the Wilhelmy plate 

⑥ A metal rod can also be used to limit the liquid sample volume  يستعملها بس تكون كمية liquid قليلة

⑦ Clean the ring you must rinse it under warm flowing water and D.W.

سائل موجود في Beaker واستعملت Capillary tubes

وذلك هو liquid راجع يصير عندي ~~is~~ ^{up}

السبب: interaction Between

The liquid and walls in the capillary

Capillary rise method

[استخدام خاصية سحيرية]

When a capillary tube is placed in a liquid contained in a beaker, the liquid rises up the tube a certain distance because the liquid molecules and capillary wall is greater than cohesion between liquid molecules.

The liquid continues to rise in the tube due to the surface tension, until the upward movement is balanced by downward force of gravity due to the weight of the liquid.
 الارتفاع (h) من راجع يكون مستمر
 لانه راجع عاكس قوة الجاذبية الارضية
 الى سبب الوزن الذاتي

The best known method for determining surface tension, and one which is capable of considerable accuracy depends on the measurement of the rise of the liquid surface in a capillary tube if the height h to which the liquid ascends is ascertained and the radius r of the tube is known the surface tension can be calculated by means of equation.

نقطة في عندي ماء وفيه انحناء
 Cohesive force
 Adhesive force
 Capillary
 Between the water and glass surface

Capillary rise method is based on the fact that if the forces of adhesion between the liquid molecules and the glass surface exceed the cohesive forces among the liquid molecules, the liquid will spread over the capillary wall and its surface tension will result in an upward drag force resulting in the liquid level rising through the capillary until this upward force is balanced by the downward gravitational force. That's why water rises and forms a concave surface in glass capillaries. It is clear that the greater the surface tension, the greater is the capillary rise. Surface tension can be calculated from capillary rise by the following equation:

$$\gamma = \frac{1}{2} r \rho g h$$

Where γ is the surface tension,

$\uparrow h$ is \uparrow surface tension

r is the capillary radius,

p is the density of the liquid, $\rho = \frac{w}{V}$

g is the acceleration due to gravity
 تسارع الجاذبية الارضية
 9.8 او 10

and h is the capillary rise (make sure to use the right units).
 من جيبه من سطح السائل الى
 احد نقطه بيوصلها (بقراءة)
 Capillary
 من سطح السائل الى
 من البعير

If the surface tension of any material, like water in our case, is known, and its capillary rise is determined at the same conditions as our solution of interest, then:

$$\frac{\gamma_{\text{solution}}}{\gamma_{\text{water}}} = \frac{\rho_{\text{solution}} h_{\text{solution}}}{\rho_{\text{water}} h_{\text{water}}}$$

$$\frac{\gamma_{\text{solution}}}{\gamma_{\text{water}}} = \frac{\rho_{\text{solution}}}{\rho_{\text{water}}} * \frac{h_{\text{solution}}}{h_{\text{water}}}$$

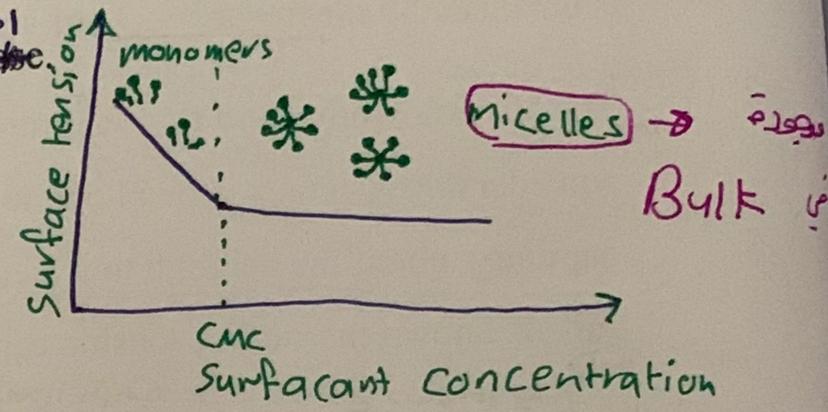
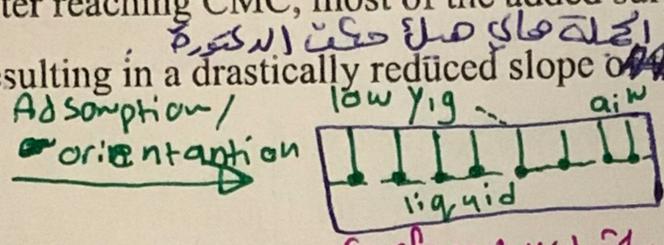
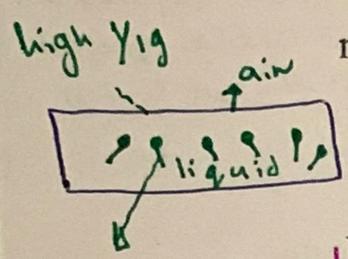
72 at 25°C

سرفاکنٹ لایقہ سطحی
 liquid ویدیا تھوف
 سٹو یا تری

Surface tension • Wetting agent - surfactants :

Upon adding surfactant, the surface tension will decrease as the surfactant molecules accumulate at the surface because the attractive forces between the hydrophobic groups are less than that between water molecules, so that the surface tension of water will be decreased as more surfactant molecules are added to the surface until the CMC is reached. [The decrease in surface tension will be linear in relation to the logarithm of surfactant concentration. But, after reaching CMC, most of the added surfactant molecules will go to the micelles in the bulk resulting in a drastically reduced slope of the graph.]

العلاقة بين
 surface tension
 and concentration



Procedure Part 1: Du Nouy tensiometer demonstration

Part 2: Capillary rise method

- Materials and equipment:

Capillary tubes, beakers, graduated ruler, rubber band, v. pipette, pipette filler, volumetric flasks 50 ml.

Procedure:

1. Prepare the following concentrations of sodium lauryl sulfate solutions: 0.005M, 0.006M, 0.008M, 0.010M, 0.015M, 0.020M
2. Clean the ruler very well with distilled and dry it very well.
3. Attach a perfectly clean capillary to the ruler using a rubber band.
4. Place the capillary attached to the ruler in a 50 ml beaker containing 25 ml of the liquid.
5. Measure the difference in height between the liquid surface in the beaker and the capillary and record it.
6. Repeat for the other solutions.
7. Estimate the density of each solution by measuring the weight of a small beaker before and after pipetting 10 ml of the solution into it.

Aims and objectives of this experiment

- 1- we will study how is surface tension measured
- 2- we will determine the surface tension of different solution using capillary rise method.

Wetting agent
 فونہ یون
 Wetting agent
 ترائیزہ مٹی
 Bulk on liquid
 surface tensions
 یون عالی
 surfactant
 بالاضافہ مٹی
 اسطرح S.T کالی

$M_1 V_1 = M_2 V_2$

* قبل النقطه الی التریضہ یسین بصرہ CMC
 ویدہ ہاں النقطہ Micelles بنیداً تھون

15

Done By Shatha Zyadat



Artery Academy