Variable	Value
$a_{gravity}$	9.8 m/s^2
ρ_{water}	1000 kg/m^3
θ_{water}	0°
γ_{water}	0.0728 N/m
γ_{soap}	0.025 N/m
$\rho_{mercury}$	13600 kg/m^3
$\theta_{mercury}$	137°
$\gamma_{mercury}$	0.46 N/m

Class 1:

1. Define Surface Tension
2. Define Surface Tension in terms of molecular interactions.
3. Explain the pheonomenon of surface tension in terms of molecular theory.
4. Define Surface Tension in terms of energy.
5. All matter wants to minimize potential energy. Because surface molecules have more potential energy than molecules in the interior, what two statements can be made?
6. Define Free Surface Energy
7. Define Angle of Contact
8. What requirement must be met for a liquid to 'wet' a surface.
9. What is the direction of the surface tension force?
10. Differentiate surface tension and free surface energy.

Class 2:

For problems 1-6 calculate the coefficient of surface tension for this liquid in this experiment

(:1:) A clean glass tube with a diameter of 3.0mm is placed into a liquid of density, 1280.0kg/m^3. The liquid in the tube rises to a height of 3.81mm and makes an angle of contact of 59.0 degrees.
(2:) A clean glass tube with a diameter of 1.0mm is placed into a liquid of density, 992.0kg/m^3. The liquid in the tube rises to a height of 3.69mm and makes an angle of contact of 10.0 degrees.
(:3:) A clean glass tube with a diameter of 4.0mm is placed into a liquid of density, 664.0kg/m^3. The liquid in the tube rises to a height of 2.44mm and makes an angle of contact of 51.0 degrees.
(:4:) A clean glass tube with a diameter of 6.0mm is placed into a liquid of density, 1272.0kg/m^3. The liquid in the tube falls to a height of -2.45mm and makes an angle of contact of 167.0 degrees.
(:5:) A clean glass tube with a diameter of 9.0mm is placed into a liquid of density, 634.0kg/m^3. The liquid in the tube falls to a height of -1.33mm and makes an angle of contact of 148.0 degrees.
(:6:) A clean glass tube with a diameter of 4.0mm is placed into a liquid of density, 751.0kg/m^3. The liquid in the tube falls to a height of -3.47mm and makes an angle of contact of 110.0 degrees.

(:7:) A clean glass 1m tube with a diameter of 1.2mm is placed into water at 20 degrees Celsius.

- i. How high does the water rise in the tube in millimeters?
- ii. What happens if the tube is lowered so that only 23.0mm of the tube is above the water level?

(:8:) A clean glass 1m tube with a diameter of 5.4mm is placed into water at 20 degrees Celsius.

i. How high does the water rise in the tube in millimeters?

ii. What happens if the tube is lowered so that only 4.0mm of the tube is above the water level?

(:9:) A clean glass 1m tube with a diameter of 4.4mm is placed into water at 20 degrees Celsius.

i. How high does the water rise in the tube in millimeters?

ii. What happens if the tube is lowered so that only 5.0mm of the tube is above the water level?

(:10:) A clean glass 1m tube with a diameter of 8.9mm is placed into water at 20 degrees Celsius.

i. How high does the water rise in the tube in millimeters?

ii. What happens if the tube is lowered so that only 2.0mm of the tube is above the water level?

(:11:) A clean glass 1m tube with a diameter of 5.6mm is placed into water at 20 degrees Celsius.

i. How high does the water rise in the tube in millimeters?

ii. What happens if the tube is lowered so that only 4.0mm of the tube is above the water level?

(:12:) A clean open ended glass U-tube has vertical limbs one of which has a uniform internal diameter of 0.2 mm (Limb A) and the other of 8.3 mm (Limb B). Mercury is poured into the tube; and observed that the height of mercury column in the two limbs is different.

i. What is the raio of height in limb A / height in limb B?

ii. What is the height difference in millimeters between Limb A and Limb B?

(:13:) A clean open ended glass U-tube has vertical limbs one of which has a uniform internal diameter of 1.5 mm (Limb A) and the other of 10.0 mm (Limb B). Mercury is poured into the tube; and observed that the height of mercury column in the two limbs is different.

i. What is the raio of height in limb A / height in limb B?

ii. What is the height difference in millimeters between Limb A and Limb B?

(:14:) A clean open ended glass U-tube has vertical limbs one of which has a uniform internal diameter of 2.9 mm (Limb A) and the other of 8.0 mm (Limb B). Water is poured into the tube; and observed that the height of water column in the two limbs is different.

i. What is the raio of height in limb A / height in limb B?

ii. What is the height difference in millimeters between Limb A and Limb B?

(:15:) A clean open ended glass U-tube has vertical limbs one of which has a uniform internal diameter of 3.9 mm (Limb A) and the other of 5.0 mm (Limb B). Water is poured into the tube; and observed that the height of water column in the two limbs is different.

i. What is the raio of height in limb A / height in limb B?

ii. What is the height difference in millimeters between Limb A and Limb B?

Class 3:

(:1:) Calculate the excess pressure for:

i. A soap bubble of radius 3.7 cm.

ii. An air bubble of the same radius.

(:2:) Calculate the excess pressure for:

i. A soap bubble of radius 7.8 cm.

ii. An air bubble of the same radius.

(:3:) A soap bubble of radius 282.0 cm breaks up into 216.0 identical soap bubbles.

i. What is the radius of the smaller bubbles in centimeters?

ii. How much work has been done to create these soap bubbles?

(:4:) A soap bubble of radius 672.0 cm breaks up into 343.0 identical soap bubbles.

i. What is the radius of the smaller bubbles in centimeters?
ii. How much work has been done to create these soap bubbles?
(:5:) A soap bubble of radius 252.0 cm breaks up into 343.0 identical soap bubbles.
i. What is the radius of the smaller bubbles in centimeters?
ii. How much work has been done to create these soap bubbles?
(:6:) A bubble of radius of 5.22 cm and is broken into many identical 0.58 cm bubbles.
i. How many smaller bubbles are formed?
(:7:) A bubble of radius of 5.74 cm and is broken into many identical 0.41 cm bubbles.
i. How many smaller bubbles are formed?
(:8:) Soap Bubble A has a radius of 4.9 cm and Soap Bubble B has a radius of 9.9 cm.
i. Compare the excess pressure inside.
ii. Compare the ratio of work required to create these bubbles.
iii. If these bubbles coalesce in a vacuum, what is the radius of the new bubble?
iv. If these bubbles coalesce in air, what is the radius of the shared interface?
(:9:) Soap Bubble A has a radius of 4.7 cm and Soap Bubble B has a radius of 9.6 cm.
i. Compare the excess pressure inside.
ii. Compare the ratio of work required to create these bubbles.
iii. If these bubbles coalesce in a vacuum, what is the radius of the new bubble?
iv. If these bubbles coalesce in air, what is the radius of the shared interface?
(:10:) Soap Bubble A has a radius of 3.0 cm and Soap Bubble B has a radius of 5.1 cm.
i. Compare the excess pressure inside.
ii. Compare the ratio of work required to create these bubbles.
iii. If these bubbles coalesce in a vacuum, what is the radius of the new bubble?
iv. If these bubbles coalesce in air, what is the radius of the shared interface?
(:11:) Soap Bubble A has a radius of 0.5 cm and Soap Bubble B has a radius of 6.0 cm.
i. Compare the excess pressure inside.
ii. Compare the ratio of work required to create these bubbles.
iii. If these bubbles coalesce in a vacuum, what is the radius of the new bubble?
iv. If these bubbles coalesce in air, what is the radius of the shared interface?

Class 1:

1. Surface Tension is The force per unit length in the plane of a liquid surface acting in the surface and perpendicular to one side of an imaginary line drawn in the surface.
2. Surface Tension is the sum of all inter-molecular forces on the surface of a material.
3. Interior molecules in a liquid experience forces from all directions. Molecules on the surface only experience inter-molecular forces from below, resulting in an increase in potential energy. These surface molecules form a network such that they exist as a thin membrane, a scenario referred to as surface tension.
4. Surface Tension can be described as the work done per unit area in increasing the surface area of a liquid at constant temperature.
5. Because liquid surface molecules have more potential energy, liquids assume a spherical shape in the absence of other forces to minimize surface area (thus the number of surface molecules). The spacing between surface molecules is greater than the spacing between interior molecules as well to minimize the number of high-energy molecules.
6. Free Surface Energy is the work done per unit area in increasing the surface area of a liquid at constant temperature.
7. The angle between the solid surface and the tangent plane to the liquid surface at a point where it touches the solid.
8. A liquid 'wets' a surface if it creates a angle of contact less than 90 degrees (concave meniscus).
9. The surface tension force is parallel to the surface.
10. Surface tension is the elastic tendency of a fluid surface which makes it acquire the least surface area possible while surface energy is the energy required to form a new liquid surface.

Class 2:

(:1:)
  i. 0.0695957866925855

(:2:)
  i. 0.009106524570475054

(:3:)
  i. 0.025229705291311015

(:4:)
  i. 0.0470160995864517

(:5:)
  i. 0.02192446523288986

(:6:)
  i. 0.07466959621639141

(:7:)
  i. 24.761904761904763
  ii. 21.744340038012606

(:8:)
  i. 5.502645502645502
  ii. 43.370938859935784

(:9:)
  i. 6.753246753246753
  ii. 42.23581078897021

(:10:)
  i. 3.33868378812199
  ii. 53.198936479292314

(:11:)
  i. 5.306122448979592
  ii. 41.075348874402046

(:12:)
  i. 41.499999999999986
  ii. 49.26712658978704

(:13:)
  i. 6.666666666666666
  ii. 5.721474536476503

(:14:)
  i. 2.758620689655172
  ii. 6.532019704433496

(:15:)
  i. 1.2820512820512822
  ii. 1.676190476190477

Class 3:

(:1:)
  i. 2.7027027027027026
  ii. 3.935135135135135

(:2:)
  i. 1.2820512820512822
  ii. 1.8666666666666667

(:3:)
  i. 47.0
  ii. 24.98320141840747

(:4:)
  i. 96.0
  ii. 170.24315722544316

(:5:)
  i. 36.0
  ii. 23.940443984827944

(:6:)
  i. 729

(:7:)
  i. 2744

(:8:)
  i. 2.020408163265306
  ii. 4.082049146189087
  iii. 11.046266337545914
  iv. 9.702000000000002

(:9:)
  i. 2.0425531914893615
  ii. 4.1720235400633765
  iii. 10.688779163215974
  iv. 9.208163265306123

(:10:)
  i. 1.7
  ii. 2.8899999999999997
  iii. 5.9169248769948055
  iv. 7.285714285714288

(:11:)
  i. 12.0
  ii. 144.0
  iii. 6.020797289396148
  iv. 0.5454545454545455