SURFACE TENSION

SYNOPSIS

- The attractive forces between the molecules of a substance are called cohesive forces
- The attractive forces between the molecules of different substances are called adhesive forces.
- The maximum distance upto which the cohesive force between two molecules exists is called the molecular range and of the order 10^{-9}m.
- An imaginary sphere drawn around a molecule with a radius of molecular range is called the sphere of influence of that molecule.
- The force per unit length across any imaginary line drawn on the surface of a liquid and acts perpendicular to it is known as surface Tension

$\left(T = \frac{F}{l}\right)$ Unit - N/m or dyne /cm.

- Surface tension is due to cohesion between the molecules of a liquid.
- Surace tension is a molecular phenomenon.
- Surface tension is independent of surface area.
- Factors which influence surface tension of a liquid
  - It depends upon the medium in contact with its surface
  - It decreases with increase of temperature.
  - It decreases when a substance dissolves partially.
  - It increases when a substance dissolves completely.

APPLICATIONS OF SURACE TENSION:

- Rain drops and small droplets of mercury are spherical in shape due to surface tension.
- A new needle can be made to float on the surface of water due to surface tension.
- Mosquitos, spiders etc., can easily walk on the surface of water due to surface tension.
- The property of surface tension is used in the manufacture of lead shots.
- Surface tension of liquid metals is very very high

WORK:

- Work done per unit area in increasing the surface area of a film is known as surface energy. S = W/A. Units - J/m^2 (or) erg/cm^2.
- Work done in forming a liquid drop is, w = Surface Area x Surface tension $= AT = 4\pi r^2 T$.
- Work done in increasing the size of liquid drop from radius r_1 to r_2 is $W = 4\pi T(r_2^2 - r_1^2)$
- Work done in blowing a soap bubble is $w = 8\pi r^2 T$.
- Work done in increasing the size of a soap bubble from radius r_1 to r_2 is, $W = 8\pi T (r_2^2 - r_1^2)$
- Work done in forming a circular liquid film of radius 'r' is, $w = 2\pi r^2 T$.
- Work done in increasing the area of circular soap film from radius r_1 to r_2 is $W = 2\pi T (r_2^2 - r_1^2)$.
- When a liquid drop of radius 'R' splits into 'n' identical droplets, then the total surface area of n droplets will be greater than that of big drop. So energy is absorbed.
- Work done to split a liquid drop of radius 'R' into 'n' no. of identical droplets is $W = 4\pi R^2 T (n^{1/3} - 1)$.
- when n identical droplets are combined to form a big drop, then the energy will be released.
- Work done to form a big drop from 'n' identical droplets each of radius 'r' is $W = 4\pi r^2 T (n - n^{2/3})$.
- A thin disc of radius R has a hole of radius r. The energy required to pull it from the surface of water of surface tension T is($W = T\pi\left(R^2 - r^2\right)$
- If a number of identical smaller drops merge to form a single big drop of radius R, the rise in temperature of the drop is $\frac{3T}{dJS}\left[\frac{1}{r} - \frac{1}{R}\right]$

  Where J is mechanical equivalent of heat, S is specific heat and d is density
- A large number of identical smaller drops each of radius r merge to form a single drop of radius R. The energy released in the process is converted into KE of bigger drop formed. Then speed of the bigger drop formed is $\sqrt{\frac{6T}{d}\left[\frac{1}{r} - \frac{1}{R}\right]}$

ANGLE OF CONTACT:

- Angle of contact of a liquid with respect to a solid is the angle between the tangent drawn to the liquid surface at the point of contact and the surface of the solid, measured inside the liquid.
- The angle of contact depends on solid-liquid pair, temperature and impurities.

- The angle of contact may assume any value between 0^0 to 180^0.
- If the angle of contact is less than 90^0 then the liquid wets the solid and if the angle of contact is greater than 90^0 then the liquid does not wet the solid.
- The angle of contact between water and glass free from grease and oil is nearly equal to zero.
- For mercury and glass pair, angle of contact is 140^0.
- The angle of contact is not changed by the inclination of solid object in the liquid.
- Angle of contact increases with increase in temperature.
- Water proofing agents increase the angle of contact.
- Wetting agents decrease the angle of contact.

CAPILLARITY:

- The rise or fall of a liquid column in a capillary tube dipped in a liquid is known as capillarity.
- Capillarity is due to surface tension and it is due to cohesive and adhesive forces.
- If the angle of contact is greater than 90^0, then
  - The liquid does not spread on the surface.
  - Liquid does not wet the surface.
  - Liquid exhibits convex surface.
  - There will be capillary depression.
  - Cohesive forces will be greater than adhesive forces.
- If the angle of contact is less than 90^0 then
  a. The liquid spreads on the surface.
  b. Liquid wets the surface.
  c. Liquid exhibits concave surface.
  d. There will be capillary rise.
  e. Adhesive forces will be greater than cohesive forces.
- If the angle of contact is equal to 90^0, then
  a. The level of the surface of the liquid will be horizontal
  b. The level does not rise or fall.
  c. Cohesive forces will be equal to adhesive forces.
- If the angle of contact is zero then the tangent drawn to the curvature will coincide with the wall of the immersed tube.
- The weight of the liquid column in the capillary tube is balanced by the force due to surface Tension.

  2π r T $\cos\theta$ = Mg

  $2\pi\ r\ T\cos\theta = \pi r^2 hdg$ [$\because$ M = dV = d π r^{2}h]

- Surface Tension by capillary tube method

  $$T = \frac{r(h + r/3)dg}{2\cos\theta}$$

  If r is very small compared to h, then

  $$T = \frac{hrdg}{2\cos\theta}$$

  where r = radius of the capillary tube
  h = height of liquid column
  d = density of the liquid
  g = acceleration due to gravity
  θ = angle of contact
- When a capillary tube of insufficient length is dipped in the liquid, the liquid will not overflow but stays at the top with adjustable meniscus.
- When diameter of capillary tube increases twice, the height of liquid column falls down to half. ($r_1h_1 = r_2h_2$).
- Since $h \propto \frac{1}{r}$, the graph between h and r is a rectangular hyperbola.
- When capillary tube is dipped vertically in a liquid then the rise in the liquid is h. If the tube is tilted by making the inclination 'θ' with vertical then the slant height of the liquid is l = h/cos θ.

EFFECT OF TEMPERATURE ON SURFACE TENSION

- Over small ranges of temperature, the surface tension of a liquid decreases linearly with the rise of temperature according to the relation $S_t = S_0 (1 - \alpha\Delta t)$
  where a = temperature coefficient of surface tension
  s_t = surface tension at t^0C
  s_0 = surface tension at 0^0C
  Δt = Change in temperature.
  α = temperature coefficient of surface tension
- In the case of molten copper and molten cadmium,surface tension increases with increase of temperature.
- The surface tension of any liquid at its critical temperature is zero.

EXCESS PRESSURE INSIDE A LIQUID DROP & SOAP BUBBLE

- Excess pressure inside a liquid drop of radius r is given by P = 2T/r.
- Excess pressure in a soap bubble of radius r is given by P = 4T/r.

- When two soap bubbles of radii a and b in vaccum coalesce under isothermal condition, then radius of the resultant bubble is,

$R = \sqrt{a^2 + b^2}$

- When a soap bubble of radius r_1 and another of radius r_2 are brought together, then the radius of curvature 'R' on the common interface is

$R = \frac{r_1 r_2}{r_2 - r_1} (If\ r_2 > r_1)$

FORCE AGAINST SURFACETENSION:

- Force required to pull a wire of length 'l' from the surface of water of surface tension T is F=2lT
- Force required to pull a circular ring of radius r from the surface of water of surface tension T is F= $4\pi\ rT$
- Force required to pull a rectangular plate of length 'l' and breadth 'b' from the surface of water of suface tension T is

$F = 2(l + b)T$

- Force required to pull a rectangular plate of lentgh 'l' and thickness 't' from the surface of water of surface tension T is

$F = 2(l + t)T$

- Force required to pull a circular disc of radius R from the surface of water of surface tension T is

$F = 2\pi RT$

- Force required to pull a circular disc of radius R with hole of radius r from the surface of water of surface tension T is

$F = 2\pi (R + r)T$

- Between two glass plates a water drop is squeezed to form a thin film of thickness (d) and surface area (A). The force required to seperate the two plates is, F = 2TA/d.
- If the radii of the two limbs of a U-tube are r_1 and r_2, the difference between the levels of a liquid poured in it is

$h = \frac{2T}{dg}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$ here $r_1 > r_2$

Where d is density and T surface tension of the liquid.

- When a cylindrical glass tube is closed at one end and it is made heavy such that it floats in the vertical position. If the depth of the heavy end is h below liquid surface, then $h = \frac{2\pi rT + mg}{\pi r^2 dg}$
- Drops of liquid of density d_1 are floating half immersed in a liquid of density d_2. If T is the surface tension of the liquid, then the radius of the drop is

$r = \sqrt{\frac{3T}{(2d_1 - d_2)g}}$

- A capillary tube is vertically dipped in a liquid. The height of the liquid in the tube is 'h' and the total set up is kept in a lift.
If the lift is moving up with an acceleration 'a' then the height of the liquid in the tube is given by

$h' = h\left[\frac{g}{g + a}\right]$

If the lift is moving down with an acceleration 'a' then the height of the liquid in the tube is given by

$h' = h\left[\frac{g}{g - a}\right]$

CONCEPTUAL QUESTIONS

01. Two needles are floating on the surface of water. A hot needle when touches water surface between the needles, then they move
1. Closer 2. Away
3. Out of the liquid 4. Into the liquid

02. When there are no external forces, shape of the liquid is determined by
1. Density of liquid 2. Temperature only
3. Surface tension 4. Viscosity

03. When a soap bubble is given a positive charge it expands. If it is given a negative charge, then it
1. Expands 2. Contracts
3. Remains Same
4. Does not hold negative charge.

04. The rise of liquid into capillary tube is h_1. If the apparatus is taken in a lift moving up with acceleration, the height is h_2, then
1. $h_1 = h_2$ 2. $h_1 > h_2$
3. $h_2 > h_1$ 4. $h_2 = 0$

05. In a gravity free space, shape of a large drop of liquid is
1. Spherical 2. Cylindrical
3. Neither Spherical nor cylindrical
4. Nearly spherical

06. A bubble of radius r_1 is inside the other of radius r_2 ($r_2 > r_1$). The radius of a bubble which has same pressure difference as the pressure difference of inside the smaller and outside the larger bubble is

1. $\frac{r_1 r_2}{r_2 + r_1}$ 2. $\frac{r_1 - r_2}{r_1 r_2}$ 3. $\frac{r_1 r_2}{r_2 - r_1}$ 4. $\frac{2(r_1 r_2)}{r_1 - r_2}$

07. An air bubble of radius r is formed at a depth h below the surface of water. The pressure inside the bubble is : [T = surface tension, P_0 = atmospheric pressure, d = density of water)

1. $P_0 + \frac{2T}{r}$ 2. $\frac{4T}{r} + \frac{h}{r}$

3. $P_0 + hdg + \frac{4T}{r}$ 4. $P_0 + hdg + \frac{2T}{r}$

08. Neglecting gravity, the potential energy of a molecule of a liquid on the surface of the liquid when compared to the potential energy of a molecule inside the liquid is
1. Greater 2. Less 3. equal
4. depending on the liquid, sometimes less and sometimes more

09. The nature of r-h graph ('r' is radius of capillary tube and 'h' is capillary rise) is
1. Straight Line 2. Parabola
3. Ellipse 4.Rectangular hyperbola

10. The factor on which the rise of liquid in a capillary tube does not depend is
1. Density of Liquid 2. Atmospheric pressure
3. Radius of Capillary 4. Angle of Contact

11. It is difficult to fill a capillary tube with mercury than with water since
1. Angle of contact between glass & mercury is more than 90^0 and the angle of contact between glass and water is less than 90^0.
2. Angle of contact is between glass and mercury is less than 90^0 and the angle of contact between glass and water is more than 90^0.
3. Angle of contact is same for both water and mercury.
4. Mercury is denser than water.

12. The surface tension of a liquid at its boiling point is
1. Maximum 2. Zero
3. Same as at room temperature
4. Minimum but more than zero

13. The addition of soap changes the surface tension of water to T_1 and that of sugar solution changes to T_2. Then
1. $T_1 = T_2$ 2. $T_1 > T_2$ 3. $T_1 < T_2$ 4. T_2 / T_1

14. Surface tension of liquid metals when compared to common liquids is
1. Very high 2. Very low
3. Same order 4. Depends on temperature

15. A water proofing agent changes the angle of contact from
1. Acute to $\pi/2$ 2. $\pi/2$ to obtuse
3. Acute to obtuse value
4. Obtuse to acute value

16. A drop of water of surface area A and radius R at a temperature T breaks into two drops of area A_1 and A_2, radii r_1 and r_2 and having temperatures T_1 and T_2. Then the correct statement is
1. $A = A_1 + A_2$ 2. $T = T_1 + T_2$
3. $R = r_1 + r_2$ 4. $A < (A_1 + A_2)$

17. Surface tension of water is T_1. When oil spreads on water surface tension becomes T_2, then

1. $T_1 > T_2$ 2. $T_1 = T_2$ 3. $T_1 < T_2$ 4. $T_2 = \frac{T_1}{2}$

18. If 'L' is the capillary rise or dip and 'A' the cross sectional area of the tube, other conditions being the same, then

1. L A = Constant 2. $L\sqrt{A}$ = Constant
3. L /A = Constant 4. $L/\sqrt{A}$ = Constant

19. A disc of paper of radius r is floating on the surface of water of surface tension T. Then force of surface tension on the disc is

1. T . π r 2. T . 2 π r 3. T . 4 π r4. $\frac{T}{2\pi r}$

20. A disc of paper of radius R has a hole of radius r. It is floating on the surface of a liquid of surface tension 'T'. Then force of surface tension on the disc is
1. T.2 π R 2. T.2 π (R-r)
3. T.2 π (R+r) 4. T.4 π (R+r)

21. A disc of paper of radius R has a hole of radius r. It is floating on the surface of a liquid of surface tension 'T'. The energy needed to pull it out carefully is
1. T.2 π (R+r) 2. T. π (R^2-r^2)
3. T. π (R^2+r^2) 4. T. π r^2

KEY

01) 2	02) 3	03) 1	04) 2
05) 1	06) 1	07) 4	08) 1
09) 4	10) 2	11) 1	12) 2
13) 3	14) 1	15) 3	16) 4
17) 3	18) 2	19) 2	20)3
21) 2			

NUMERICAL QUESTIONS
LEVEL-1

WORK:

01. The work done in forming a soap bubble of radius 10 cm from soap water of surface tension 35 dyne cm^{-1} is ..... Joule
1.8800 2.8.8 x 10^{-3} 3.88 4.14000

02. The work done in incresing the raduis of a soap bubble from 4 cm to 5 cm is ..... Joule(given surface tension of soap water to be 25 x 10^{-3} N/m)
1. 0.5657 x 10^{-3} 2. 5.657 x 10^{-3}
3. 56.5 x 10^{-3} 4. 565 x 10^{-3}

CAPILLARY TUBE

03. Surface tension of water is 70 x 10^{-3} Nm^{-1} and g = 10 ms^{-2}. When a capillary tube of radius 0.5 mm is dipped in water, the length of the liquid column due to rise of liquid in the capillary is cm
1.0.28 2. 0.028 3. 2.8 4.2.8 x 10^{-3}

04. When two capillary tubes A and B are immersed in water, the heights of water columns are found to be in the ratio 2 : 3. The ratio of the radii of tubes A and B is
1. 2 : 3 2. 4 : 9 3. 9 : 4 4. 3 : 2

05. A capillary tube of radius 0.25 mm is dipped vertically in a liquid of density 800 kg m^{-3} and of surface tension 3x 10^{-2} Nm^{-2}. The angle of contact of liquid-glass is given by Cos q = 0.3. If g = 10ms^{-2} the rise of liquid in the capillary tube is ..... Cm
1. 9 2. 0.9 3. 9 x 10^{-3} 4. 0.09

06. Water rises to a height of 6 cm in a capillary tube of radius 'r'. If the radius of the capillary tube is 3r, the height to which water will rise is .....cm.
1. 18 2. 9 3. 2 4. 3

07. When a capillary tube is immersed in ethyl alcohol whose surface tension is 20 dyne cm^{-1}, the liquid rises to a height of 10 cm. Density of the liquid is 0.8 $gmcm^{-3}$. If g = 10 ms^{-2}, the radius of the capillary tube is ..... mm. (Angle of contact of ethyl alchol w.r.t. glass is 60^0).
1. 0.0025 2. 0.025 3. 0.25 4. 2.5

08. The capillary rise of water in a tube of diameter 0.70 mm is 4 cm. If g = 10 ms^{-2}, the surface tension of water is ..... Nm^{-1}.
1. 70 x 10^{-3} 2.70 3. 0.35 x 10^{-2} 4.7.0 x 10^{-3}

09. When a clean lengthy capillary tube is dipped vertically in a beaker containing water, the water rises to a height of 8 cm. What will happen if another capillary tube of length 4 cm and same radius is dipped vertically in the same beaker containing water. Angle of contact of water is 0^0.
1. Water will flow out like a fountain.
2. Water will rise to a height of 4 cm only and the angle of contact will be zero.
3. Water will rise to a height of 4 cm only and the angle of contact will be 60^0.
4. Water will not rise at all

10. Two capillary tubes 'A' and 'B' are dipped in water. The cross section of 'B' is four times that of 'A'. The capillary rise in 'B' is ..... times that of 'A'.
1.2 2. 0.5 3.4 4.0.25

11. Capillary tubes of diameters 1, 1.5, 2 mm are dipped vertically in the same liquid. The capillary ascents of the liquid in the tube are in the ratio
1. 2 : 3 : 4 2.6 : 4 : 3 3.3 : 4 : 6 4. 4 : 3 : 2

EXCESS PRESSURE INSIDE A LIQUID DROP AND SOAP BUBBLE

12. The surface tension of soap solution is 0.05 $N.m^{-1}$. If the diameter of the soap bubble is 4 cm. The excess pressure inside the soap bubble over that of outside is ..... pascal
1.10 2.1.0 3.0.1 4.0.25

13. Two liquid drops have their diameters as 1 mm and 2 mm. The ratio of excess pressures in them is
1.1 : 2 2.2 : 1 3.4 : 1 4.1 : 4

14. The excess pressure inside a small air bubble of radius 0.05 mm in water of surface tension 70 dyne cm^{-1} is pascal
1.28 2. 2.8 x 10^2 3.2800 4.280

15. If the diameter of a soap bubble is 20 mm and if the surface tension of soap water is 0.04 $N.m^{-1}$, the excess pressure inside the bubble is .. Nm^{-2}
1.0.16 2.1.6 3.0.016 4.16

16. The surface tension of a soap solution is 25 x 10^{-3} N/m. The excess pressure inside a soap bubble of diameter 1 cm is
1. 5 pa 2. 10 pa 3. 20 pa 4. 40 pa

RADIUS OF THE RESULTANT BUBBLE

17. If a soap bubble of radius 3 cm coalesce with another soap bubble of radius 4 cm under isothermal conditions, the radius of the resultant bubble formed is ..... cm
1.7 2.1 3.5 4.12

18. A soap bubble of radius 6 cm and another bubble of 8 cm coalesce under isothermal conditions in vacuum. The radius of the new bubble is
1. 3 cm 2.4 cm 3.10 cm 4.7 cm

KEY

01) 2	02) 1	03) 3	04) 4
05) 2	06) 3	07) 2	08) 1
09) 3	10) 2	11) 2	12) 1
13) 2	14) 3	15) 4	16) 3
17) 3	18) 3		

LEVEL-2

WORK:

01. A soap bubble of radius 2 cm explodes. If the surface tension of soap water is 40 dyne cm^{-1}, the energy released is ..... Joule
1. 1280π x 10^{-7} 2. 1280
3. 12800 4. 128

02. Surface tension of mercury is $35\times10^{-3}\ Nm^{-1}$. The energy spent in spraying a drop of mercury of radius 1 cm into 1 million drops of equal size is ..... micro joule
1. 4356 2. 4.356 3. 43.56 4. 0.4356

03. The work done in blowing a soap bubble slowly from a radius of 5 cm to a radius of 10 cm is ..... Joule (given the surface tension of water is 3.5 x 10^{-2} N m^{-1})
1. 6.6. x 10^{-3} 2. 2.2 x 10^{-3}
3. 4.4 x 10^{-3} 4. 8.8 x 10^{-3}

04. The energy required to break a mercury drop of 1 cm radius into 1000 small drops of equal size is ..... Joule (given the surface tension of mercury is 0.4 $N.m^{-1}$)
1. 144π x 10^{-2} 2. 1.44π
3. 14.4π x 10^{-4} 4. 144π

05. The amount of energy dissipated when 8 water drops of 0.6 mm radius coalesce to form one big drop is ..... Joule (given surface tension of water is 7.2 x 10^{-2} Nm^{-1})
1. 1.3 x 10^{-7} 2. 13 x 10^{-6}
3. 13 x 10^{-7} 4. 0.13 x 10^{-8}

CAPILLARY TUBE

06. A capillary tube of diameter 0.4 mm is dipped in a beaker containing mercury of density 13.6 x 10^3 kg m^{-3} and surface tension 0.49 N m^{-1}. The angle of contact of mercury w.r.t. glass is 130^0. [Cos 130^0 = -0.64280. The depression of the meniscus in the capillary tube is ..... cm (g = 9.8 ms^{-2}).
1. 0.24 2. 2.24 3. 2.4 4. 0.024

07. When a capillary tube of radius 0.2 mm is dipped vertically in a beaker containing water of surface tension 7.0 x 10^{-2} Nm^{-1}. The height to which water rises is ..... cm (g = 10m s^{-2}; density of water = 1000 kg m^3, angle of contact of water glass is 0^0.)
1. 0.7 2. 7 3. 7.7 4. 3.5

08. What should be the radius of a capillary tube if water has to rise to a height of 6 cm in it, if surface tension of water is 7.2 x 10^{-2} Nm^{-1}
1. 0.24 mm 2. 2.4 mm 3. 2 cm 4. 1.2 cm

09. When a capillary tube is dipped vertically in water, water rises upto a height of 10 cm. When the same capillary tube is dipped in mercury it falls through a height of 3.5 cm. The specific gravity of mercury is 13.6 and angle of contact of water w.r.t. glass is 0^0. Angle of contact of mercury w.r.t. glass is 135^0. Then the ratio of surface tensions of water and mercury is
1. 6.8 : 1 2. 1 : 6.8 3. 1 : 5 4. 1 : 1

10. The surfacetension of a liquid is 0.245 Nm^{-1}. Its angle of contact is 60^0. Its density is 1000 kg/m^3. When a capillary tube of diameter 1 mm is dipped vertically in it, the capillary rise is ..... cm($g=10ms^{-2}$)
1. 49 2. 4.9 3. 98 4. 9.8

11. A liquid rises to a height of 0.5 cm in a capillary tube. If another capillary tube of four times area of cross section is used, then the height of the liquid column will be ..... cm
1. 2.5 2. 0.25 3. 5 4. 0.5

12. How high does methyl alcohol rise in a glass tube of diameter 0.06 cm? The surface tension of methyl alcohol is 0.023 $N.m^{-1}$. Its density is 0.8 gm cm^{-3}. Angle of contact is zero.
1. 0.2 cm 2. 0.02 cm 3. 2 cm 4. 4 cm

13. A capillary tube is dipped in water vertically. Water rises to a height of 10mm. The tube is now tilted and makes an angle 60^0 with vertical. Now water rises to a height of
1. 10 mm 2. 5 mm 3. 20 mm 4. 40 mm

14. The liquid column in a capillary on the surface of the moon as compared to that on the earth is
1. 1/6 times 2. 6 times
3. 4 times 4. 1/4 times

EXCESS PRESSURE IN A LIQUID DROP AND SOAP BUBBLE

15. The radius of a soap bubble is 4 cm. The radiusof the drop formed by soap solution is 2 cm. The ratio of excess pressures in the two is
1. 1 : 2 2. 2 : 1 3. 1 : 1 4. 1 : 4

16. A small air bubble of 0.1 mm diameter is formed just below the surface of water. If surface tension of water is 0.072 Nm^{-1}, the pressure inside the air bubble in kilo pascal is (Atmospheric pressure = 1.01 x 10^5 pa)
1. 28.9 2. 0.289 3. 0.0289 4. 103.88

RADIUS OF CURVATURE OF INTERFACE

17. Two air bubbles of radii 2 mm and 4 mm, formed in the same liquid come together to form a big bubble. If the surface tension of the liquid is 0.70 Nm^{-1}, the radius of curvature of common interface to both bubbles will be
1. 6 mm with concave surface towards smaller bubble.
2. 2 mm with concave surface towards bigger bubble.
3. 4 mm with concave surface towards smaller bubble.
4. 4 mm with concave surface towards bigger bubble.

FORCE AGAINST SURFACE TENSION

18. A thin film of water of thickness 80 mm is sandwiched between the glass plates and forms a circular patch of radius 12 cm. The normal force required to separate the plates is (surface tension of water is 0.072 N/m)
1.8.14 N 2.81.4 N 3.40.7 N 4.0.814 N

19. Calculate the force required to separate the glass plates of area 10^{-2} m^2 with a film of water 0.05 mm thickness between them (surface tension of water = 70 x 10^{-3} N/m)
1. 28 N 2. 112 N 3. 5.6 N 4. 11.2 N

20. A vessel has a small hole at its bottom. If water can be poured into it upto a height of 7 cm without leakage (g=10 ms^{-2}), the radius of the hole is (surface tension of water is 0.07 Nm^{-1}).
1.2 mm 2.0.2 mm 3.0.1 mm 4.0.4 mm

21. A square wire frame of side 'L' is dipped in a liquid. On taking out, a membrane is formed. If the surface tension of liquid is T, the force acting on the frame due to the membrane will be
1.2 TL 2.4 TL 3.8 TL 4.16 TL

22. If the force required to pull out a glass plate of length 9.8 cm and thickness 2 mm from a liquid is 0.6 gmwt. The surface tension of water is ..Nm^{-1}
1.2.94 x 10^{-3} 2.29.4 x 10^3
3.29.4 x 10^{-2} 4.29.4 x 10^{-3}

23. The length of a rubber cord floating on water is 5 cm. The force needed to pull the cord out of water is ..... N (surface tension of water is 7.2 x 10^{-4} Nm^{-1}) .
1.7.2 x 10^{-3} 2.7.2 x 10^{-4}
3.7.2 x 10^{-5} 4.7.2 x 10^{-2}

KEY

01) 1	02) 1	03) 1	04) 3
05) 3	06) 3	07) 2	08) 1
09) 2	10) 2	11) 2	12) 3
13) 1	14) 2	15) 3	16) 4
17) 3	18) 2	19) 1	20) 2
21) 3	22) 4	23) 3	

HINTS

4) $w = 4\pi R^2 T\left[n^{\frac{1}{3}} - 1\right]$

5) $w = 4\pi r^2 T\left[n - n^{\frac{2}{3}}\right]$

6) $h = \frac{2\cos\theta T}{rdg}$

7) $h = \frac{2T}{rdg}$

8) $r = \frac{2T}{hdg}$

9) $T \propto \frac{hd}{\cos\theta}$

11) $\frac{h_1}{h_2} = \sqrt{\frac{A_2}{A_1}} = \frac{r_2}{r_1}$

13) $h^1 = \frac{h}{\cos\theta}$

14) $g^1 = \frac{g}{6}$

15) $\frac{P_1}{P_2} = \frac{4T/r_1}{2T/r_2} = \frac{4r_2}{2r_1}$

16) Total pressure inside air bubble= excess pressure inside soap bubble+ Atmospheric pressure

$P = \frac{2T}{r} + P_0$

18) $F = \frac{2T}{d}A = \frac{2T}{d}\pi r^2$

20) $r = \frac{2T}{d\,\lg}$

21) For each wire force is 2 Tl so that for four wires of frame 8Tl

22) $T = \frac{F}{2(l+t)}$

23) $T = \frac{F}{2l}$

LEVEL - 3

WORK

01. A film of water is formed between two straight parallel wires each of 10 cm long and at seperation of 0.5cm. The work to be done to increase the distance between the wires by 1 mm is ..... micro joule (given surface tension of water is 72×10^{-3} Nm^{-1})
1.144 2.14.4 3.1.44×10^{-6} 4.1.44

02. Let W be the work done when a bubble of volume V is formed from a given solution. Work is required to be done to form a bubble of volume 2V is
1.W 2.2W 3.$2^{1/3}$ W 4. $4^{1/3}$ W

CAPILLARY TUBE

03. A long capillary tube of radius 1 mm, open at both ends is filled with water and placed vertically. What will be the height of water column left in the capillary ? (Surface tension of water is 73.5×10^{-3} $N.m^{-1}$)
1.03cm 2. 3cm 3. 6cm 4. 0.03 cm

04. When an experiment is done to find the surface tension of a liquid on earth by capillary rise method, the height of the liquid column is 4 cm. When the same experiment is done on another planet whose mass is 4 times and radius is twice that of the earth, then the height of liquid column is ...cm
1.4 2.2 3.1 4.8

05. A 20cm long capillary tube is dipped in water. The water rises upto 8 cm. If the entire arrangement is put in a freely falling elevator, the length of the water column in the capillary tube will be
1.Zero 2.8 cm 3. 4 cm 4.20 cm

06. In a surface tension experiment, with a capillary tube water rised upto 0.1m. If the same experiment is repeated in an artificial satellite, which is revolving around the earth and at an altitude of 3R from the surface of the earth, water will rise in the capillary tube up to a height of
1.0.1 m 2.0.2 m
3. 0.4 m 4. Full length of the tube

EXCESS PRESSURE INSIDE A LIQUID DROP AND SOAP BUBBLE

07. The excess pressure due to surface tension inside a spherical drop is 6 units. If eight such drops coalesce, the excess pressure inside the new drop is
1.3 units 2.6 units
3.12 units 4.48 units

FORCE AGAINST SURFACE TENSION

08. When a capillary tube of radius 0.2 mm is dipped vertically in water of surface tension 0.072 Nm^{-1} and of angle of contact is 0^0, the weight of water supported by surface tension in the capillary tube is ... N
1. 90.5×10^{-6} 2. 90.5×10^{6}
3. 90.5×10^{-5} 4. 90.5×10^{5}

09. When a 'U' shaped slider of negligible mass is dipped in a soap solution and lifted, a thin film of soap is formed in the frame. It supports a weight of 2.0×10^{-2} N. If the length of the slider is 40 cm, the surface tension of the film of soap is
1. 25 Nm^{-1} 2. 2.5 Nm^{-1}
3. 2.5×10^{-2} Nm^{-1} 4. 2.5×10^{-3} Nm^{-1}

10. A vessel whose bottom has round holes with diameter 0.1 mm is filled with water. The maximum height upto which water can be filled without leakage is ..... cm (given surface tension = 7.5×10^{-2} Nm^{-1} and $g = 10ms^{-2}$)
1. 100 cm 2.75 cm 3.50 cm 4.30 cm

11. A glass plate of length 20 cm and breadth 2 cm and thickness 4.0 mm weighs 18 gm wt. in air. It is held vertically with longside horizontally and the lower half under water. If the surface tension of water is 7×10^{-2} Nm^{-1} and $g = 10ms^{-2}$, the apparent weight of the plate is ..... N.
1.0.1 2.0.01 3.0.0018 4. 0.12056

12. A needle of length 5 cm is floating on water of surface tension 0.07 Jm^{-2} and is not wetted by water. Then the weight of the needle will be
1.1.7×10^{3} N 2.2.7×10^{-3} N
3.5.2×10^{-2} N 4.4.4×10^{-2} N

13. A small hole is made at the bottom of a hollow sphere. The water enters into it when it is taken to a depth of 40 cm under water. If the surface tension of water is 0.07 Nm^{-1}, diameter of the hole is
1.1/7 mm 2.1/14 mm 3.2/15 mm 4.3/14 mm

14. The length of one edge of a glass plate of thickness 0.2 cm is 9.8 cm. If this edge of the glass plate touches the surface of a liquid of surface tension 60 dyne/cm, then it is pulled down with a force of (Assume that angle of contact to be zero).
1.1100 dyne 2.2400 dyne
3.1000 dyne 4.1200 dyne

15. The material of a wire has specific gravity 8. If it is not wetted by water. what is the maximum diameter of the wire that will float on the surface of water? (T = 70 dyne / cm)
1.0.75 cm 2.1.5 mm
3.0.75 cm 4.1.5 cm

KEY

01) 2	02) 4	03) 2	04) 1
05) 4	06) 4	07) 1	08) 1
09) 3	10) 4	11) 4	12) 2
13) 3	14) 4	15) 2	

HINTS

1. $w = 2T\Delta A$

2. $r \propto v^{\frac{1}{3}}$

   $w \propto v^{\frac{2}{3}}$

3. $\pi r^2 hdg = 2 \times 2\pi\ rT\cos\theta$

4. $\frac{g_1}{g_2} = \frac{m_1}{m_2} \times \frac{r_2^2}{r_1^2}$

7. $R = n^{\frac{1}{3}} r$ R= radius of the big drop
   r= radius of the small drop

   $r = R / n^{1/3}$

   $P = \frac{2T}{r}$

8. $F = 2\pi\ r\ T\cos\theta$

9. $T = \frac{F}{2l}$

10. $h = \frac{2T}{drg}$

11. Apparant weight of the plate in water = weight of the plate in air - (Surface tension+ Upthrust)

12. F= 2LT

13. $d = \frac{4T}{P\lg}$

14. $F = 2(l+t)T$

15. $2lT = \frac{d_g}{d_r} \times \pi\ r^2 \lg$

NEW MODEL QUESTIONS:

TRUE OR FALSE TYPE QUESTIONS:

1. Consider the following two statements A and B and identify the correct answer.
   A) Work done in blowing a soap bubble of radius r and surface tension T is $8\pi r^2 T$.
   B) An impurity which is highly soluble in liquid increases the surface tension of the liquid.
   1, A & B are true 2) A is false but B is true
   3. A is true but B is false.4) A & B are false

2. Consider the following two statements A and B, and identify the correct choice in the given answers.
   A. The excess of pressure inside a small drop is more than that of a big drop .
   B. As the aeroplane moves fast on the runway the pressure is more on the upper surface of its wings and less on the bottom surface of the wings.
   1. both A and B are true 2. A is true but B is false
   3. A is false but B is true 4. both A and B are false

3. Consider the following two statements A and B and identify the correct answer.
   A) The work done in blowing a bubble of volume V is W, then the work done in blowing a soap bubble of volume 2V will be $2^{2/3}$ W.
   B) The excess pressure inside a soap bubble of diameter D and surface tension S is $\frac{8S}{D}$
   1) A&B are false 2) A is false but B is true
   3) A is true but B is false 4) A & B are true.

4. A drop of water breaks into two droplets of equal size. In this process which of the following statements is correct ?
   a) the sum of temperature of the two droplets together is equal to the original temperature of the drop.
   b) the sum of masses of the two droplets is equal to the original mass of the drop.
   c) the sum of the radii of the two droplets is equal to the radius of the original drop.
   d) the sum of the surface areas of the two droplets is equal to the surface area of the original drop.
   1. a is correct 2) b is correct
   3) c is correct 4) d is correct

KEY

1)1 2) 2 3) 4 4) 2

MATCHING TYPE QUESTIONS

1. Match the following:

List -I	List - II
a) Surface tension	e) Minimum potential energy
b) Capillary rise	f) Domination of adhesive force
c) Spherical shape of rain dropos	g) Increase in temperature
d) Tiny droplets of water act as ball bearings.	h) Excess of pressure

The correct match is
1) a -- e ; b -- f ; c -- g ; d -- h
2) a-- h ; b-- g ; c -- f ; d -- e
3) a - f; b -- e ; c -- g; d -- h

4) a --g ; b --f ; c --e ; d -- h

2. Match List - I with List II

Angle of contact

a) 0^0 e) liquid will rise

b) 90^0 f) water silver

c) $= 90^0$ g) liquid will not wet

d) $> 90^0$ h) pure water and glass

The correct match is

1) a-- h; b -- g; c-- f; d-- e

2) a -- e; b-- f; c-- g;d-- h

3) a-- e; b-- g; c-- f; d-- h

4) a--h; b-- f; c-- g; d-- e

3. Match List I with List - II

List - I List-II

a) Meniscus of water in a glass e) convex Capillary tube

b) Meniscus of water in silver f) curved capillary tube

c) Meniscus of mercury is glass g) flat capillary tube

d) Meniscus of water in glass h) concave capillary tube of insufficient length

The correct match is

1) a -- h; b-- g; c-- e; d-- f 2) a -- e; b-- f;c-- g; d -- h

3) a -- f; b-- e; c--g; d-- h 4) a-- h; b-- g; c-- f; d-- e

4. Study the following:

List - I List -II

a) Excess pressure e) Independent of temperature

b) Surface energy f) Varies directly with $(radius)^2$

c) Capillary rise g) Varies directly proportional to temperature

d) Angle of contact h) Varies inversely with $(Area)^{12}$

i) Varies inversely with $(Volume)^{1/3}$

The correct match is

1) a-- i; b-- h; c -- e; d -- f

2) a-- h; b-- i; c -- g; d -- e

3 a -- h; b-- f; c -- i; d -- e

4) a-- i; b-- f; c -- h; d -- g

5. Match List -I with List-II

List-I

a) Radius of the common surface when two soap bubbles of radii R_1 and R_2 coalesce

b) Radius of the large drop when two liquid drops of radii R_1 and R_2 combine at constant temperature

c) Excess of pressure in cylindrical drop

d) Excess of pressure in the air bubble in water

List -II

e) $\sqrt{R_1^2 + R_2^2}$

f) $\frac{R_1 R_2}{R_2 - R_1}$

g) $\frac{2T}{r}$

h) $\frac{T}{r}$

The correct match is

1) a -- e; b-- f; c-- g; d-- h 2) a--f; b-- e; c-- h; d-- g

3) a-- f; b-- e; c-- g; d-- h 4) a--e; b-- f; c-- h; d-- g

ANSWERS:

1) 4 2) 1 3) 1 4) 4 5) 2

ORDER ARRANGING TYPE QUESTIONS:

1. Four capillary tubes a, b, c and d having diameters 2 mm, 1mm , 0.8mm, and 0.6mm are dipped in four beakers containing water with 'a', tube vertically 'b' tube 30^0, 'c' tube 45^0 and 'd' tube 60^0 inclination with the vertical. Arrange the lengths of water column in the tubes in descending order.

   1. d, c, b, a 2) d, a, b, c 3) a, c, d, b 4) a,b,c,d

2. Identify the ascending order of the works done in the following cases.

   a) Work done in increasing the radius of soap bubble from 2 cm to 4 cm ($T = 0.04\ Nm^{-1}$).

   b) Work done in increasing the radius of a soap bubble from 2 cm to 4 cm ($T = 0.04\ Nm^{-1}$).

   c) Work done in breaking a liquid drop of radius 1 cm into 10^6 droplets of same size ($T = 0.08\ Nm^{-1}$).

   1) b, a & c 2) c, a & b3) a, b & c 4) c, b & a

3. Arrange the increasing order of forces required to pull the body from thesurface of liquid in addition to their weights.

   a) A circular ring of radius R with its plane on the liquid surface.

   b) A circular ring of radius R with its plane in the liquid surface.

   c) A wire loop of square shape having the diagonal equal to 2R with its plane on the liquid surface.

   1. a, b, c 2) c, b, a 3) b, a, c 4) a, c, b

ANSWERS

1) 1 2) 1 3) 2

ASSERTION AND REASON TYPE QUESTIONS:

Directions

These questions consist of two statements as Assertion and reason. While answering these questions you are required to choose any of the following four responses.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B.If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertrion is false, but the reason is true.

1. A: At critical temperature, surface tension of a liquid becomes zero.
   R: At this temperature intermolecular forces for liquid and gases become equal. Liquid can expand without any restriction.
   1) A 2) B 3) C 4)D
2. A : When height of a tube is less than calculated height of liquid in the tube, the liquid does not overflow.
   R: The meniscus of liquid at the top of the tube becomes flat.
   1) A 2) B 3) C 4) D
3. A : Hot soap solution is preferred for washing dirty clothes.
   R: Surface tension of soap solution decreases on heating.
   1) A 2) B 3)C 4) D
4. A: The impurities always decreasethe surface tension of a liquid.
   R: The change in surface tension of the liquid depends upon the degree of contamination of the impurity.
   1)A 2)B 3)C 4)D
5. A: Detergent should have small angles of contact.
   R: If angle of contact is small therefore detergents rinse the clothes dust in less time
   1) A 2) B 3) C 4) D
6. A: The angle of contact of pure water with glass is acute.
   R: The adhesive force between molecules of water and glass is greater than cohesive force between water molecules.
   1) A 2) B 3) C 4) D
7. A : Tiny drops of liquid resist deforming forces better than bigger drops.
   R: Excess pressure inside a drop is directly proportional to the surface tension
   1) A 2) B 3) C 4) D
8. A: A large soap bubble expands while a small bubble shrinks, when they are connected to each other by a capillary tube.
   R: The excess pressure (due to surface tension) inside a spherical bubble increases, as its volume decreases.
   a) A 2) B 3) C 4) D

ANSWERS

1)1 2) 1 3) 1 4) 1 5) 3 6) 1 7) 2 8) 1

MULTI CORRECT TYPE QUESTIONS:

1. Identify the correct statements from the following.
   a. Every liquid surface acquires a minimum surface area due to surface tension.
   b. Small liquid drops are spherical.
   c. Oil is sprayed on stagnated water pools to destroy the mosquito breed by increasing the surface tension of liquid.
   d. Hooke's law can be applied as the liquid surface behaves as an stretched elastic membrane.
   1) a & b are true 2) c & d are true
   3) a, b & c are true 4) all are true.
2. Identify the correct statements from the following.
   a) Some work mut be expended in bringing molecules on to the surface of a liquid.
   b) Surface tension is due to cohesive forces.
   c) Adhensive forces cause friction and cohesive forces cause surface tension.
   d) Adhesive forces and cohesive forces do not exist simulataneously when a liquid is taken in a tube.
   1)only a&b are true 2) a,b & c are true
   3) allare true 4) b, c & d are true
3. When impurities are added to a liquid its surface tension.
   a) always increases. b) always decreases.
   c) if impurities are sparingly soluble surface tension decreases.
   d) if impurities are highly soluble surface tension increases.
   1) a, c are correct 2) c, d are correct
   3)b, d are correct 4) a, d are correct
4. The rise of liquid in a capillary tube depends on
   a) the material of tube and nature of liquid
   b) the lengthof tube c) the outer radius
   d) the inner radius of the tube
   1. only a & b are correct 2) a & c are correct
   3) only a & d are correct 4) a, b & d are correct.
5. Angle of contact between a liquid and a solid is a property of
   a) the material of liquid b) the material of solid.
   c) the mass of the solid d) the shape of the solid.
   1. a & b are correct 2) a & c are correct
   3) a &d are correct 4) a, b & d are correct
6. If for a liquid in a vessel, force of cohesive is twice of adhesion.
   a) the miniscus will be convex upwards.
   b) the angle of contact will be obtuse,
   c. the liquid will descend in the capillary tube.
   d. the liquid will wet the solid.
   1) only a & b are correct 2) only a & c are correct
   3) a & d are correct 4) a, b & c are correct

7. When a capillary tube is immersed into a liquid, the liquid neither rises nor falls in the capillary.
   a. The angle of contact must be 90^0.
   b. The angle of contact may be 90^0.
   c. The surface tension of liquid must be zero.
   d. The surface tension of liquid may be zero.
   1. b & d are correct 2) a & b are correct
   3. b & c are correct 4) a & c are correct.
8. When an air bubble moves up from the bottom of a lake
   a) its acceleration decreases and becomes zero.
   b) its acceleration increases and becomes constant.
   c) its velocity increases and becomes constant.
   d) its velocity decreases and becomes zero.
   1) a & b are correct 2) a & c are correct
   3) b & c are correct 4) b & d are correct.
9. When a drop splits up into number of drops
   a) area increases b) volume increases
   c) energy is absorbed d) energy is liberated
   1) a & b are correct 2) a & c are correct
   3) a & d are correct 4) b & d are correct

ANSWERS:

1)1 2) 2 3) 2 4) 4 5) 1 6) 4 7) 1 8) 2 9) 2

PREVIOUS EAMCET QUESTIONS

EAMCET 2004(M)

1. The radii of the two columns in a 'U' tube are 'r_1' & 'r_2', when a liquid of density (angle of contact is 0^o } is filled in it, the level difference of the liquid in the two arms in 'h'. The surface tension of the liquid is {g = acceleration due to gravity }

   1) $\frac{\rho ghr_1r_2}{2(r_2-r_1)}$ 2) $\frac{\rho gh(r_2-r_1)}{2r_2r_1}$

   3) $\frac{2(r_1-r_2)}{\rho ghr_2r_1}$ 4) $\frac{2(r_1-r_2)}{\rho gh}$

EAMCET 2004 (E)

2. One end of a uniform glass capillary tube of radius r = 0.025cm is immersed vertically in water to a depth h = 1 cm. The excess pressure in N/m^2 required to blow an air bubble out of the tube
   Surface tension of water = 7×10^{-2} Nm $^{-1}$
   Density of water = 10^3 Kg m $^{-3}$
   Acceleration due to gravity = 10 ms $^{-2}$
   1) 0.0048×10^5 2) 0.0066×10^5
   3) 1.0018×10 4) 1.0033×10^5

EAMCET 2003 (E)

3. Water raises to a height of 10cm in a capillary tube and mercury falls to a depth of 3.5cm in the same capillary tube. If the density of mercury is 13.6 gm/c.c and its angle of contact is 135^0 and densityof water is 1 gm/c.c and its angle of contact is 0^0, then the ratio of surface tensions of two liquids is (cos $135^0 = 0.7$)
   1) 1:14 2) 5:34 3) 1:5 4) 5:27

EAMCET 2003 (M)

4. The rate of steady volume flow of water through a capillary tube of length 'l' and radius 'r' under a pressure difference of P is V. This tube is connected with another tube of same length but half the radius in series. Then the rate of steady volume flow through them is (pressure across the combination is P)
   1) V/16 2) V/17 3) 16V/17 4) 17V/16

EAMCET-2002 (E)

5. A glass capillary tube of inner diameter 0.28 mm is lowered vertically into water in a vessel. The pressure to be applied on the water in the capillary tube so that water level in the tube is same as the vessel in N/m^2 is(surface tension of water = 0.07 N/m atmospheric pressure= $10^5\ N/m^2$)
   1. 10^3 2. 99×10^3 3. 100×10^3 4. 101×10^3

EAMCET-2002 (M)

6. The work done in increasing the size of a rectangular soap film with dimensions 8cmx3.75cm to 10 cm x 6 cm is 2 x 10^{-4} J. The surface tension of the film in N/m is
   1. 165×10^{-2} 2. 3.3×10^{-2}]
   3. 6.6×10^{-2} 4. 8.25×10^{-2}

EAMCET-2001 (E)

7. A mercury drop of radius 1 cm is sprayed into 10^6 drops of equal size. The energy expended in joule is (surface tension of mercury is $460\ x\ 10^{-3}\ N/m$)
   1. 0.057 2. 5.7 3. 5.7×10^{-4} 4. 5.7×10^{-6}

EAMCET-2001 (M)

8. Consider the following two statements A and B and identify the correct choice in the following:
   A: The excess pressure inside a small liquid drop is more than that of a big drop.
   B:As the aeroplane moves fast on the runway the pressure is more on the upper surface of its wings and less on the bottom surface of the wings.
   1. Both A and B are true
   2. A is true but B is flase
   3. A is flase but B is true
   4. Both A and B are flase

EAMCET-2000 (E)

9 8000 identical water drops combine together to form a big drop. Then the ratio of the final surface energy to the initial surface energy of all the drops together is.

1.1 : 10 2.1 : 15 3.1 : 20 4.1 : 25

EAMCET-2000 (M)

10. The surface energy of a liquid film on a ring of area 1.5 m^2 is (surface tension of liquid=5Nm^{-1}

1.0.75 Joule 2.7.5 Joule

3.2.25 Joule 4.3.0 Joule

EAMCET-1999 (M)

11 When a cylindrical tube is dipped vertically into a liquid the angle of contact is 140^0. when the tube is dipped with an inclination of 40^0 the angle of contact is

1.100^0 2.140^0 3.180^0 4.60^0

EAMCET-1999 (M)

12. When a capillary tube is lowered into water, the mass of the water raised above the outside level is 5 gm. If the radius of the tube is doubled the mass of water that raises in the tube above the outside level is

1.1.25 gm 2.5 gm 3.10 gm 4.20 gm

EAMCET-1998 (E)

13. Neglecting gravity, the potential energy of a molecule of a liquid on the surface of a liquid when compared to the potential energy of a molecule inside a liquid is

1. greater 2. less 3. equal

4. depending upon the liquid some times more, some times less

EAMCET-1998 (M)

14. Two soap bubbles are blown. In first soap bubble excess pressure is 4 times of the second soap bubble. The ratio of the radii of the first and second soap bubble is

1.1:4 2.1:2 3. 2 :1 4.4:1

EAMCET-1996 (M)

15. A capillary tube when immersed vertically in a liquid rises to 3 cm. If the tube is held immesed in the liquid at an angle of 60^0 with the vertical, the length of the liquid column along the tube will be

1. 2 cm 2. 4.5 cm 3. 6 cm 4. 7.5 cm

EAMCET-1995 (M)

16. The liquid meniscus in a capillary tube will be convex, if the angle of contact is

1. greater than 90^0 2. less than 90^0

3. equal to 90^0 4. equal to zero

EAMCET-1994 (E)

17. A drop of liquid pressed between two glass plates spreads to a circle of diameter 10 cm. Thickness of the liquid film is 0.5 mm and surface tension is 70 x 10^{-3} Nm^{-1}. The force required to pull them apart is

1. 4.4 N 2.1.1 N 3. 2.2 N 4.3.6 N

EAMCET-1993 (E)

18. A spherical soap bubble of radius 1 cm is formed inside another of radius 3 cm. The radius of single soap bubble which maintains the same pressure difference as inside the smaller and outside the larger soap bubble is ----------cm.

1.1 2. 0.75 3.0.5 4.0.25

EAMCET-1992 (M)

19. A spherical soap bubble has a radius 'r'. The surface of tension of the soap solution is 'T'. The energy needed to double the diameter of the bubble at the same temperature is

1. 24 πr^2T 2.4 πr^2T 3.2 πr^2T 4.12 πr^2T

EAMCET-1992 (E)

20. Three small identical mercury drops in a thermally isolated system merge into a single drop. The temperature of the drop will be ___ than the original temperature of small drops

1. less 2. greater

3. equal to 4. may be less or greater

EAMCET-1991 (M)

21. The work done to get n smaller identical drops to form a big spherical drop of water is proportional to

1. $\frac{1}{n^{2/3}-1}$ 2. $\frac{1}{n^{1/3}-1}$ 3. $n^{1/3}-1$ 4. $n^{4/3}-1$

EAMCET-1991

22. If surface tension of water is 7.3 x 10^{-2} N/m. The excess pressure inside a spherical drop of radius 1 mm is _____ N/m^2

1. 146 2. 1.46 3. 14.6 4. 292

EAMCET-1990

23. The surface tension of soap water is 0.04 $N.m^{-1}$. The excess pressure inside a 10 mm diameter soap bubble in N/m^2 will be

1. 4 2.8 3.16 4.32

EAMCET-1990

24. The rise of a liquid due to surface tension in a narrow capillary tube of diamter d is 'h'. When the diameter is reduced to d/2, the height will be

1.h 2.2h 3. $\frac{h}{2}$ 4.4h

EAMCET-1989

25. At critical temperature surface tension becomes
1.0 2.1 3. Infinite 4. Negative

EAMCET-1989

26. The fundemantal quantity which has the same power in the dimensional formula of surface tension and coefficient of viscosity is
1. Mass 2. Length 3. Time 4. None

EAMCET-1988

27. Droplets of a liquid are generally more spherical in shape than large drops of the same liquid because
1. Force of surface tension is equal and opposite to the force of gravity
2. Force of surface tension predominates the force of gravity
3. Force of gravity predominates the surface tension
4. Force of surface tension and force of gravity act in the same direction and are equal.

EAMCET-1987

28. The excess pressure inside a soap bubble is
1.Inversely proportional to the surface tension
2.Inversely proportional to its radius
3.Directly proportional to square of its radius
4.Directly proportional to its radius

EAMCET-1987

29. The surface tension of a liquid _____ with rise of temperature.
1. Increases 2.Decreases
3. Remains same
4. First decreased and then increases

EAMCET-2005 (M)

30. The pressures inside two soap bubbles are 1.01 and 1.02 atm respectively. The ratio of their respective volumes is
1. 16 2. 18 3. 4 4. 2

EAMCET-2005 (E)

31. A thin wire ring of 3 cm radius flat on the surface of a liquid. The pull required to raise the ring before the film breaks is 30.14 x 10^{-3}N more than it is after. The surface tension of the liquid (in Nm^{-1}) is
1. 80×10^{-3} 2. 87×10^{-3}
3. 90×10^{-3} 4. 98×10^{-3}

EAMCET-2006 (M)

32. A wire of length L metres, made of a material of specific gravity 8 is floating horizontally on the surface of water. If it is not wet by water, the maximum diameter of the wire (in mm) upto which it can continue to float is (surface tension of water is T = $70\times10^{-3}\,Nm^{-1}$)
1. 1.5 2. 1.1 3. 0.75 4. 0.55

EAMCET-2006 (E)

33. Two soap bubbles combine to form a single bubble. In this process, the change in volume and surface area are respectively 'V' and 'A'. If P is the atmospheric pressure, and T is the surface tension of the soap solution, the following relation is true
1. 4 PV + 3 TA = 0 2. 3 PV – 4 TA = 0
3. 4 PV – 3 TA = 0 4. 3 PV + 4 TA = 0

KEY

1) 1	2) 2	3) 2	4) 2
5) 4	06) 2	07) 1	08)2
9) 3	10) 2	11) 2	12) 3
13) 1	14) 1	15) 3	16) 1
17) 3	18) 2	19) 1	20) 2
21) 3	22) 1	23) 4	24) 2
25) 1	26) 1	27) 2	28) 2
29) 2	30) 2	31) 1	32) 1
33) 4			

QUESTIONS FROM OTHER COMPETITIVE EXAMS

AIIMS-2002

01. If the surface tension of water is 0.06 Nm^{-1} then the capillary rise in a tube of diameter 1 mm is $(\theta = 0^o)$
1. 3.86 cm 2.3.12 cm 3. 2.44 cm 4.1.22 cm

AIIMS-1999

02. A dry clean needle of diameter 'd' and density ρ when carefully placed on the surface of water remains floating. If T is the surface tension of water, then maximum value for the diameter 'd' of the needle for enabling it to float will be

1. $d=\sqrt{\frac{8\rho\pi}{T\ g}}$ 2. $d=\sqrt{\frac{4\rho\pi}{T\ g}}$

3. $d=\sqrt{\frac{8T}{\rho\pi g}}$ 4. data incomplete

JIPMER 1997 CPMT : 1999, 1986

03. Liquid drops acquire spherical shape due to
1. gravity 2. surface tension
3. viscosity 4. intermolecular attraction

MNR 1999;CPMT 1999

04. A greased iron needle may float on water because of
1. its shape 2. Archemedes' uplift force
3. surface tension effect 4. the statement is wrong

ROHILKHAND PET 1999

05. The height upto which water will rise in a capillary tube will be:
1) maximum when water temperature is 4^0C
2) minimum when water temperature is 4^0C
3) minimum when water temperature is 0^0C
4) same at all temperatures

AMUPMT 1999

06. A metal disc of radius 'r' floats on the surface of water.The water layer goes down and makes an angle θ with the vertical edge of the disc. If it displaces a weight of W of water and the surface tension of waer is T, then weight of disc is

1) 2π rT cos θ 2) 2π rT

3) $2\pi rT\cos\theta$ +W 4) $2\pi rT\cos\theta$ -W

AMUPMT 1999

07. A 10cm long wire is placed horizontally on the surface of water and is gently pulled up with a force of 2 x 10^{-2} N to keep the wire in equilibrium. The surface tension of water in N/m is

1) 0.002 2) 0.001 3) 0.1 4) 0.2

MPPMT 1997, BCECE 1999

08. The pressure of air inside a soap bubble of diameter 0.7 cm is 8mm of water above atmospheric pressure.The surface tension of soap solution is

1) 9.8 $\times10^{-1}$ N/m 2) $6.8\times10^{-2}N/m$

3) 7.2 $\times$ 10^{-2} N/m 4) 1.37 $\times$ 10^{-1} N/m

MPPET 1999

09. The work done in increasing the size of a soap film from 10cm x 6cm to 10 cm x 11cm is 3×10^{-4} Joule. The surface tension of the film is

1) $1.5\times10^{-2}N/m$ 2) $3.0\times10^{-2}N/m$

3) $6.0\times10^{-2}N/m$ 4) $11.0\times10^{-2}N/m$

AIIMS 1998

10. The amount of a liquid cohesive force per unit length is called

1) deperession 2) adhesion

3) apparent weight 4) surface tension

AFMC 1998

11. If the surface tension of water is $0.06Nm^{-1}$ then the capillary rise in the tube of diameter 1 mm is (assume $\theta=0^0$)

1) 1.22 cm 2)2.44 cm 3) 3.12 cm 4) 3.86 cm

MNR 1998

12. Two capillary tubes A and B of radii 0.2 cm and 0.4 cm are dipped in the same liquid. The ratio of heights through which liquid rises in the tubes A and B is

1) 1: 2 2) 2:1 3) 1:4 4) 4:1

AFMC 1998

13. A big drop of radius R is formed by 1000 small droplets of water,then the radius of small drop is

1) $\frac{R}{2}$ 2) $\frac{R}{5}$ 3) $\frac{R}{6}$ 4) $\frac{R}{10}$

MPPMT 1998

14. At which of the following temperatures the value of suface tension is minimum.

1) 4^0C 2) 25^0C 3) 50^0C 4) 75^0C

MP PET 1997

15. Mercury does not wet glass, wood or iron because

1) cohesive force is less than adhesive force
2) cohesive force is greater than adhesive froce
3) angle of contact is less than 90^0
4) cohesive force is equal to adhesive force

RAJ PMT 1997

16. A capillary tube of radius'r' is immersed in water and water rises in it to a height H. Mass of water in the capillary tube is m. If the Capillary of radius 2r is taken and dipped in water, the mass of water that will rise in the capillary tube will be

1) m 2)2m 3)m/2 4) 4m

AIIMS 1997

17. What is the pressure inside a water drop of radius 1mm in an atomosphere of pressure 101293 Nm^{-2} (surfce tension of water $72\times10^{-3}Nm^{-1}$)

1)101293 Nm^{-2} 2) 101437 Nm^{-2}

3) 101581 Nm^{-2} 4) none of the above

JIPMER 1997

18. Two pieces of glass plate one upon the other with a little water between them cannot be separated easily because of

1) inertia 2) pressure
3) viscosity 4) surface tension

MPPET 1997

19. One thousand small water drops of equal size combine to form a big drop. The ratio of the final surface energy to the total initial surface energy is

1) 10:1 2) 1:10 3) 1000:1 4) 1:1000

MPPET 1996

20. The amount of work done in blowing a soap bubble such that its diameter increases from d to D is (surface tension of solution= T)

1) $4\pi(D^2-d^2)T$ 2) $8\pi(D^2-d^2)T$

3) $\pi(D^2-d^2)T$ 4) $2\pi(D^2-d^2)T$

CPMT 1997

21. Excess pressure of one soap bubble is four times more than that of other. Then the ratio of volume of first bubble to second one is

1) 1:64 2) 64:1 3) 4:1 4) 1:2

MPPET 1996

22. A capillary tube, made of glass is dipped into mercury. Then

1) mercury rises in the capillary tube
2) mercury descends in capillary tube
3) mercury rises and flows out of capillary tube
4) mercury neither rises nor descends in the capillary tube.

AMU 1996

23. The surface tension of water is T. The weight (W) of water supported by surface tension in capillary tubue of radius Ris

1) $T.4\pi R^2$ 2) $T.2\pi R$ 3) T.R 4) $T/2\pi R$

CPMT 1995

24. The quantity on which the rise of liquid in a capillary tube does not depend is

1) Density of liquid 2) radius of capillary tube
3) angle of contact 4) atmospheric pressure

MP PMT 1995

25. Work done in blowing a soap bubble of radius 10cm is (surface tension of soap solution is $\frac{3}{100} N/m$)

1) $75.36\times10^{-4} J$ 2) $37.68\times10^{-4} J$

3) $150.72\times10^{-4} J$ 4) 75.36J

CMEET 1995

26. If σ is surface tension, the work done in breaking a big drop of radius 'R' into 'n' drops of equal raidus is

BHU 1995

1) $Rn^{2/3}\sigma$ 2) $\left(n^{2/3}-1\right)\sigma R^2$

3) $4\pi R^2\left(n^{1/3}-1\right)\sigma$ 4) $\pi R^2\left(n^{1/3}-1\right)\sigma$

27. A soap bubble of radius 'r' is formed in air. The excess pressure inside the bubble is

1) $\frac{4T}{r}$ 2) $\frac{2T}{r}$ 3) $P_0+\frac{2T}{r}$ 4) $P_0-\frac{4T}{r}$

28. A vessel, whose bottom has round holes with diameter of 1mm is filled with water Assuming that surface tension acts only at holes, then the maximum height to which the water can be filled in vessel without leakage is **(J & K CET 2002)**
(Given surface tension of water is $75 \text{ X } 10^{-3}$ N/m and g = 10m / s^2

1)3 cm 2) 0.3 cm 3)3 mm 4)3 m

29. If two soap bubbles of different radii are connected by a tube. **(AIEEE 2004)**

1) air flows from the bigger bubbles to the smaller bubble till the sizes become equal.
2) air flows from bigger bubble to the smaller bubble till the sizes are interchanged
3) air flows from the smaller bubble to the bigger.
4) there is no flow of air.

KEY

01) 3	02)3	03)2	04) 3
05) 2	06) 3	07) 3	08)2
09)2	10) 4	11)2	12)2
13)4	14)4	15)2	16)2
17)2	18)4	19)2	20)4
21)1	22)2	23)2	24)4
25)1	26)3	27)1	28) 3
29) 3			

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