Surface Tension-Surface Energy

1. The range of attraction between molecules is of the order of

1) 10^{-6}m 2) 10^{-9}m 3) 10^{-12}m 4) 10^{-15}m

2. The main difference between liquid surface and an elastic membrane is

1) Hook's law is not obeyed by liquid surface

2) Surface tension increases with increase of surface area

3) Both

4) None

3. An iron needle slowly placed on the surface of water floats on it because

1) When inside in water it will displace water more than its weight

2) The density of the material of needle is less than that of water

3) Of surface tension

4) Of its shape

4. 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) Surface tension 4) All of the above

5. When a soap water 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

6. **In a gravity free surface, shape of a large drop of liquid is**

1) Spherical 2) Cylindrical

3) Neither spherical nor cylindrical 4) Nearly Spherical

7. **When salt is added to pure water, surface tension of water**

1) Decreases 2) Increases 3) Does not change 4) Becomes Zero

8. **A disc of paper of radius R has a hole of radius r. It is floating on a liquid of surface tension T. The force of surface tension of the disc is**

1) Tx2πR 2) Tx2π (R-r) 3) Tx2π (R+r) 4) Tx4π (R+r)

9. **A metallic wire of density d floats horizontal in water. The maximum radius of the wire so that the wire may not sink is (surface tension of water = T)**

1) $\sqrt{\frac{2T}{\pi dg}}$ 2) $\sqrt{\frac{2\pi T}{dg}}$ 3) $\sqrt{\frac{2\pi Tg}{d}}$ 4) $\sqrt{2\pi Tgd}$

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

1) Inertia 2) Pressure 3) Surface Tension 4) Viscosity

11. **At boiling point of a liquid, surface tension is**

1) Zero 2) Infinite 3) Very large 4) None

12. **A): A needle placed carefully on the surface of water may float, where as a ball of same material sinks.**

R): Archimedes principle is applicable for only spherical bodies.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.

2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'.

3) ‘A’ is true and ‘R’ is false.

4) ‘A’ is false and ‘R’ is true.

13. A): Kerosene Oil spreads out over water surface.

R): Surface tension is a surface phenomenon.

1) Both ‘A’ and ‘R’ are true and ‘R’ is the correct explanation of ‘A’.

2) Both ‘A’ and ‘R’ are true and ‘R’ is not the correct explanation of ‘A’.

3) ‘A’ is true and ‘R’ is false.

4) ‘A’ is false and ‘R’ is true.

14. A): The impurities always decrease the surface tension of a liquid.

R): The change in surface tension of the liquid depends upon the degree of contamination of the impurity.

1) Both ‘A’ and ‘R’ are true and ‘R’ is the correct explanation of ‘A’.

2) Both ‘A’ and ‘R’ are true and ‘R’ is not the correct explanation of ‘A’.

3) ‘A’ is true and ‘R’ is false.

4) ‘A’ is false and ‘R’ is true.

15. A): At critical temperature, surface tension of a liquid becomes zero.

R): At this temperature, intermolecular forces for liquids and gases become equal. Liquid can expand without any restriction.

1) Both ‘A’ and ‘R’ are true and ‘R’ is the correct explanation of ‘A’.

2) Both ‘A’ and ‘R’ are true and ‘R’ is not the correct explanation of ‘A’.

3) ‘A’ is true and ‘R’ is false.

4) ‘A’ is false and ‘R’ is true.

16. (A): Small drops of mercury are spherical. But large drops of mercury resting on a table tend to become flat on the top.

(R): Gravitational force compete the surface tension.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false but R is true.

17. (a) Surface tension increases with the increase of temperature

(b) Surface tension increases with the addition of soluble impurity

(c) Angle of contact decreases with the addition of a detergent

(d) Angle of contact increases with the increase of temperature

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

18. 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

19. At critical temperature surface tension becomes

1) 0 2) 1 3) Infinite 4) Negative

20. The fundamental 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

21. 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.

22. The surface tension of a liquid _____ with rise of temperature.

1) Increases
2) Decreases
3) Remains same
4) First decreased and then increases

23. 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

24. A uniform wire of 20 cm long is bent into a circle. It is placed gently on the surface of water of surface tension 0.07 Nm^{-1}. The extra force than its weight required to pull it out of the water is

1) 0.014 N
2) 0.028 N
3) zero
4) 0.0035 N

25. A thin wire ring of 3 cm radius float 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 its weight. 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}

26. Under isothermal conditions two soap bubbles of radii a and b coalesce to form a single bubble of radius c. If external pressure is P_O, the surface tension is equal to

1) $\frac{P_o(a^3+b^3-c^3)}{4(a^2+b^2+c^2)}$ 2) $\frac{4(a^3+b^3-c^3)}{(a^2+b^2-c^2)}$ 3) $\frac{P_0(c^3-a^3-b^3)}{4(a^2+b^2-c^2)}$ 4) $\frac{P(a^3+b^3-c^3)}{(a^2-b^2-c^2)}$

27. A drop of radius 1mm is sprayed into 1000 droplets of same size. If surface tension of the liquid is 40 dyne (cm^{-1}), the amount of work done in the process is

1) 4.53erg 2) 4.53J 3) 4.53×10^{-6}J 4) 9.06×10^{-6}J

28. A liquid drop of diameter 'D' is split into 27 droplets. If T is surface tension of the liquid the change in energy is

1) $2\pi D$ 2) $2\pi D^2$ 3) $2\pi D^2 T$ 4) Zero

29. If the work done in blowing a soap bubble of volume 'v' is w, then the work done in blowing a soap bubble of volume '2v' is

1) 4 W 2) 8 W 3) $2^{1/3}$ W 4) $4^{1/3}$ W

30. 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

31. A soap bubble of radius $\frac{1}{\sqrt{\pi}}$ cm is expanded to double its radius. If the surface tension is 30dynes/cm, the work done is

1) 700 ergs. 2) 720 ergs 3) 800 ergs 4) 360 ergs

32. A mercury drop of radius 1 cm is sprayed into 10^6 drops of equal size. The energy expended in joules is (surface tension of mercury i s 460 x $10^{-3}Nm^{-1}$)

1) 0.057 2) 5.7 3) 5.710^{-4} 4) 5.710^{-6}

33. A wire of length 'l' meters, 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 millimeters) up to which it can continue to float is (surface tension of water is T = $70x10^{-3}$ Nm^{-1})

1) 1.5 2) 1.1 3) 0.75 4) 0.55

34. A ring is cut from a platinum tube having 10 cm internal and 11 cm external diameter. It is supported horizontally from a pan of balance, so that it comes in contact with water in a glass vessel. What is the surface tension of water if an extra, 4.752gram weight is required to pull it away from water? (g = 10 m/s^2) :

1) 7.2 x 10^{-2} N/m 2) 72 N/m 3) 14.4 x 10^{-2} N/m 4) 144 N/m

35. A film of water is formed between two straight parallel wires each 10 cm long and at separation 5 mm. To increase the distance between them to 6 mm, the work done is 144 x 10^{-7}J. The surface tension of water is

1) 7 x 10^{-3} Nm^{-1} 2) 7.2 x10^{-3} Nm^{-1} 3) $0.72Nm^{-1}$ 4) 0.072 Nm^{-1}

36. A drop of water of volume $0.05cm^3$ is pressed between two glass plates, as a consequence of which it spreads and occupies an area of $40cm^2$. If the surface tension of water is 70 dyne/cm, then the normal force required to separate out the two glass plates will be in Newton

1) 90 2) 45 3) 22.5 4) 450

37. If a number of small droplets of water each of radius r coalesce to form a single drop of radius R, then the rise of temperature is : (J = mechanical equivalent of heat, d = density of water, T= surface tension of water)

1) $\frac{3Td}{J}\left(\frac{1}{R}-\frac{1}{r}\right)$ 2) $\frac{3J}{TD}\left(\frac{1}{r}-\frac{1}{R}\right)$ 3) $\frac{3T}{dJ}\left(\frac{1}{r}-\frac{1}{R}\right)$ 4) none

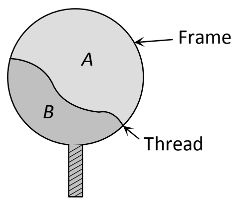
38. Several spherical drops of a liquid of density'd' and radius 'r' coalesce to form a single drop of radius 'R'. If all the energy released is converted into K.E. Then the velocity acquired by the drop is

1) $\sqrt{\frac{6T}{d}\left(\frac{1}{r}-\frac{1}{R}\right)}$ 2) $\sqrt{\frac{3T}{d}\left(\frac{1}{r}-\frac{1}{R}\right)}$ 3) $\sqrt{\frac{T}{6d}\left(\frac{1}{r}-\frac{1}{R}\right)}$ 4) $\sqrt{\frac{T}{3d}\left(\frac{1}{r}-\frac{1}{R}\right)}$

39. Drops of liquid of density d are floating half immersed in a liquid of density ρ. If the surface tension of liquid is T then the radius of the drop will be (d = density of liquid drop)

1) $\sqrt{\frac{3T}{g(2d-\rho)}}$ 2) $\sqrt{\frac{6T}{g(2d-\rho)}}$ 3) $\sqrt{\frac{2T}{g(2d-\rho)}}$ 4) $\sqrt{\frac{3T}{g(4d-3\rho)}}$

40. A thread is tied slightly loose to a wire frame as in figure and the frame is dipped into a soap solution and taken out. The frame is completely covered with the film. When the portion *A* punctured with a pin, the thread.



1) Becomes concave toward *A*
2) Becomes convex towards *A*
3) Remains in the initial position
4) Either (a) or (b) depending on the size of *A w.r.t. B*

Key

1) 2	**2) 1**	**3) 3**	**4) 2**	**5) 1**	**6) 1**	**7) 2**	**8) 3**	**9) 1**	**10) 3**
11) 1	**12) 3**	**13) 2**	**14) 4**	**15) 1**	**16) 1**	**17) 4**	**18) 1**	**19) 1**	**20) 1**
21) 2	**22) 2**	**23) 4**	**24) 2**	**25) 1**	**26) 3**	**27) 3**	**28) 3**	**29) 4**	**30) 3**
31) 2	**32) 1**	**33) 1**	**34) 1**	**35) 4**	**36) 2**	**37) 3**	**38) 1**	**39) 1**	**40) 1**

Hints

23. $F = 2[\ell + b]T \;= 2[9.8 + 0.2]60 \;= 1200$ Dyne.

24. $\ell = 2\pi r = 20\,cm = 20 \times 10^{-2}\,m$

In the case of Ring

$F = T \times 2 \times 2\pi r$

$F = 0.07 \times 2 \times 20 \times 10^{-2} \;= 0.028N$

25. $T = \frac{F}{4\pi r} = \frac{30.14 \times 10^{-3}}{4 \times 3.14 \times 3 \times 10^{-2}}$

T = 80 x 10^{-3} m

26. $\left[P_0 + \frac{4T}{c}\right]\frac{4}{3}\pi c^3 = \left(P_0 + \frac{4T}{a}\right)\frac{4}{3}\pi a^3 + \left[P_0 + \frac{4T}{b}\right]\frac{4}{3}\pi b^3$

On simplifying we get

$T = \frac{P_0(c^3 - a^3 - b^3)}{4(a^2 + b^2 - c^2)}$

27. $w = 4\pi R^2 T\left(n^{1/3} - 1\right)$

$w = 4\times3.14\times\left(10^{-3}\right)^2\left[1000^{1/3} - 1\right]\times40\times10^{-3}$

$w = 4\times3.14\times40\times9\times10^{-9}\,J$

$= 4521.6\times10^{-9}\,J \;= 4.53\times10^{-6}\,J$

28. $W = 4\pi\left(\frac{D}{2}\right)^2\left[27^{1/3} - 1\right]T \qquad W = 4\pi\frac{D^2}{4}\left[3-1\right]T$

$W = 2\pi D^2 T$

29. $R = \left(\frac{3V}{4\pi}\right)^{1/3}$

$R \alpha V^{1/3} \Rightarrow R^2 \alpha V^{2/3}$

$W = 8\pi R^2 T$

$\frac{W_1}{W_2} = \frac{R_1^2}{R_2^2} = \frac{V^{2/3}}{(2v)^{2/3}}$

$\frac{W}{W_2} = \frac{1}{4^{1/3}} \Rightarrow \omega_2 = 4^{1/3}\,\omega$

30. $R_{big} = n^{1/3} R_{small}$

$R_{big} = (8000)^{1/3}\,R_s = 20R_s$

$\frac{E_{big}}{E_{small}} = \frac{\left(R_{big}\right)^2}{8000\,R_s^2} = \frac{400\,R_s^2}{8000\,R_s^2} = 1/20$

31. $W = T.8\pi\left[R_2^2 - R_1^2\right]$

$W = 30\times 8\pi\left[\frac{4}{\pi} - \frac{1}{\pi}\right]$

$W = 30\times 8\times 3 = 720\,\text{ergs}$

32. $W = 4\pi R^2 T\left[n^{1/3} - 1\right]$ = 0.057 J

33. $\text{sp.gr} = \frac{d_b}{d_w} \Rightarrow d_b = 8\times 10^3\,\text{kg/m}^3$

$mg = 2\ell T \;\Rightarrow \ell.\pi r^2 d_b\;\; g = 2\ell T$

$r^2 = \frac{2T}{\pi d_b g} = \frac{2\times 140\times 10^{-3}}{3.14\times 8\times 10^3\times 9.8}$

$r = 0.75\text{ mm} \Rightarrow 2r = 1.5\text{ mm}$

34. $T\,2\pi\left(R_1 + R_2\right) = mg$

$T = \frac{4.75\times 10^{-3}\times 10}{2\times 3.14\left(5\times 5.5\right)\times 10^{-2}} = 7.2\times 10^{-2}\,\text{N/m}$

35. $T = \frac{W}{2\Delta A} = \frac{144\times 10^{-7}}{2\times 10\times 10^{-2}\left(6-5\right)\times 10^{-3}} = 0.072\;\text{Nm}^{-1}$

36. $F = \frac{2AT}{d} = \frac{2A^2T}{V}$

$F = \frac{2\times 40\times 40\times 70}{0.05} = 44.8\times 10^5$ = 45N

37. $R = n^{1/3} r \quad E = T.\Delta A = ms\Delta T.\,J$

$T\left[n.4\pi r^2 - 4\pi R^2\right] = Vd\;SJ\;\Delta T$

$$\Delta T = \frac{T}{dJ}\left[\frac{n.4\pi r^2}{\frac{n\,4\pi r^3}{3}} - \frac{4\pi R^2}{\frac{4\pi R^3}{3}}\right]$$

$$\Delta T = \frac{3T}{dJ}\left[\frac{1}{r} - \frac{1}{R}\right]$$

38. $$\frac{1}{2}mv^2 = 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right]$$

$$\frac{1}{2}m \times \frac{4}{3}\pi R^3 dv^2 = 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right]$$

$$V = \sqrt{\frac{6T}{d}\left(\frac{1}{r} - \frac{1}{R}\right)}$$

39. F = mg

$$2\pi rT + \frac{1}{2} \times \frac{4}{3}\pi r^3 \rho g = \frac{4}{3}\pi r^3 dg$$

$$r = \sqrt{\frac{3T}{g(2d - \rho)}}$$

40. Because film tries to cover minimum surface area.