Capillarity – Excess Pressure

1. Two water drops merge with each other to form a large droplet. In this process

1) Energy is liberated
2) Energy is absorbed
3) Energy is neither liberated nor absorbed
4) Some Mass is converted into Energy.

2. N drops of a liquid, each with surface energy E, join to form a single drop, in this process

1) Some Energy is absorbed
2) Energy absorbed is E $(n-n^{2/3})$
3) Energy released is E $(n-n^{2/3})$
4) Energy released is E $(2^{2/3}-1)$

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

1) $\pi(D^2-d^2)S$
2) $2\pi(D^2-d^2)S$
3) $4\pi(D^2-d^2)S$
4) $8\pi(D^2-d^2)S$

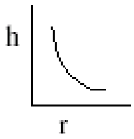
4. The rise of liquid into capillary tube is h_1. If the apparatus is taken in a lift moving up with acceleration, the height is h_2, then

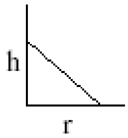
1) $h_1 = h_2$
2) $h_1 < h_2$
3) $h_1 > h_2$
4) $h_2 = 0$

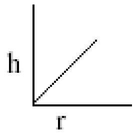
5. Meniscus of mercury in a capillary glass tube is

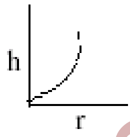
1) Plane
2) Convex Up
3) Concave
4) Cylindrical

6. **Which of the following graphs represent the relation between capillary rise h and bore radius of capillary tube r?**

1) 

2) 

3) 

4) 

7. **The lower end of a capillary tube touches a liquid whose angle of cantct is 90^0. The liquid**

1) Rises into the tube
2) Falls in the tube
3) May rise or fall in the tube
4) Neither rises nor falls

8. **If two soap bubbles of different radii are in communication with each other**

1) Air flows from larger bubble into the smaller one until the two bubbles are of equal size.
2) The sizes of the bubbles remain unchanged.
3) The air flows from the smaller bubble into the larger one and large bubble grows at the expense of the smaller one.
4) Air flows from the larger into the smaller bubble until the radius of the smaller one becomes equal to that of larger one and of the larger one equal to that of the smaller one.

9. **The radii of two soap bubbles are R_1 and R_2. If they coalesce, then the radius of curvature of the common surface will be**

1) $\frac{R_1 + R_2}{2}$
2) R_1R_2
3) R_2-R_1
4) $\frac{R_1R_2}{R_2 - R_1}$

10. By inserting a capillary tube up to a depth *l* in water, the rises to a height h. If the lower end of the capillary tube is closed inside water and the capillary is taken out and closed and opened , to what height the water will remain in the tube when *l* > h

1) Zero 2) l+h 3) 2h 4) h

11. Section - A Section - B

Section - A	Section - B
a) Surface tension decreases	**e) Minimum potential energy**
b) Capillary rise	**f) Domination of adhesive force**
c) Spherical shape of rain drops	**g) Increase in temperature**
d) Tiny droplets of water act as ball bearings	**h) Excess of pressure**

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

12. Four soap bubbles p, q, r & s have volumes 8cm^3, 27cm^3, 64cm^3 and 125cm^3 respectively. Then excess of pressures in them in ascending order will be

1) p, s, q and r 2) p, q, r and s 3) s, r, q and p 4) p, s, r, p

13. 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) 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): When height of a tube is less than liquid rise in the capillary tube, the liquid does not over flow.

R): Product of radius of meniscus and height of liquid in the capillary tube always remain constant.

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. Match the following.

List I	List II
(a) Two soap bubble of radii r_1, and r_2 coalesce in vacuum under isothermal conditions to form a single bubble of radius r	(e) $h = \sqrt{\frac{2S(1-\cos\theta)}{pg}}$
(b) Two soap bubbles of radii r_1 and r_2 are in contact with each other such that the radius of curvature of their interface is r	(f) $h = \frac{2S\cos\theta}{r\rho g}$
(c) The height h of the capillary ascent	(g) $r = \frac{r_1 r_2}{\lvert r_1 - r_2 \rvert}$
(d) The thickness h of a large mercury drop	(h) $r = \sqrt{r_1^2 + r_2^2}$

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

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

16. Match the List - I with List - II.

List - I	List - II
(a) Meniscus of water in a glass capillary tube	**(e) Convex**
(b) Meniscus of water in a glass capillary tube	**(f) Curved**
(c) Meniscus of mercury in glass capillary tube	**(g) Flat**
(d) Meniscus of water in glass capillary tube of insufficient length	**(h) Concave**

(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

17. The energy required splitting a liquid drop having surface tension T and radius R into n identical droplets is

1) $8\pi R^2\left(n^{1/3}-1\right)T$ 2) $4\pi R^2\left(n^{1/3}-1\right)T$ 3) $8\pi R^2\left(n^{2/3}-1\right)T$ 4) $4\pi R^2\left(n^{2/3}-1\right)T$

18. If '*n*' drops of a liquid each with surface energy E join to form a single drop, in this process

1) Some energy is absorbed 2) Energy absorbed is $E\left(n-n^{2/3}\right)$

3) Energy released is $E\left(n-n^{2/3}\right)$ 4) Energy released is $E\left(n^{2/3}-1\right)$

19. A liquid does not wet the solid surface if the angle of contact is

1) 0^0 2) $=45^0$ 3) $= 90^0$ 4) $>90^0$

20. 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

21. 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) $P_0+hdg+\frac{2T}{r}$

22. 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

23. If two soap bubbles of different radii are connected by a tube.

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.

24. When water rises in a capillary tube of radius r to height h, then its potential energy U, If capillary tube of radius 2r is dipped in same water then potential energy of water is U_2. The U_1:U_2 will be

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

25. A 20 cm long capillary tube is dipped in water. The water raises upto 8 cm. If the entire arrangement is put in a freely falling elevator the length of water coloumn in the capillary tube will be

1) 4 cm 2) 20 cm 3) 8 cm 4) 10 cm

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

1) 1.25gm 2) 5gm 3) 10gm 4) 20gm

27. Two similar capillary tubes of sufficient length long are placed in water. One is placed vertically and the other is placed at 60° with the vertical. The length of the liquid raised into tubes is in the ratio

1) 1: 3 2) $\sqrt{3}:\sqrt{2}$ 3) 3: 2 4) 1: 2

28. 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

29. The pressure inside two soap bubbles is 1.01 and 1.02 atmospheres respectively. The ratio of their volumes is (atmospheric pressure=10^5 Pa)

1) 1: 2 2) 2: 3 3) 8: 1 4) 3: 5

30. 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

31. A spherical soap bubble of radius 1 cm is formed inside another of radius 3cm. 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) 4/3 2) 3/4 3) 1/2 4) 2

32. The surface energy of liquid film on a ring of area $0.15m^2$ is (surface tension of liquid is equal to 5 Nm^{-1})

1) 0.75J 2) 1.5J 3) 2.25J 4) 3.0J

33. Two parallel glass plates are dipped perpendicular in a liquid of density p. The separation between the plates is'd' and the surface tension T. The angle of contact of glass is θ. The capillary rise of the liquid between the plates is:

1) $\left(\frac{T\cos\theta}{pd}\right)$ 2) $\left(\frac{2T\cos\theta}{pgd}\right)$ 3) $\left(\frac{2T}{pgd\cos\theta}\right)$ 4) $\left(\frac{T\cos\theta}{pgd}\right)$

34. A U-tube has two vertical limbs of diameters 4mm and 5mm. When water is poured into it, the water level difference between the limbs is (T= 70 dyne cm^{-1}) ($g=10ms^{-2}$)

1) 0.14cm 2) 0.014m 3) 14mm 4) 0.14mm

35. Liquid rises to a height of 2cm in a capillary tube. The angle of contact between the solid and liquid is zero. The tube is depressed more now so that the tip of the capillary tube is only 1 cm above the liquid then the apparent angle of contact between solid and liquid is

1) 0^0 2) 30^0 3) 60^0 4) None

36. A tube of 0.8mm radius is dipped into a liquid with surface tension and density $6x10^{-2}$ N/m and $900kg/m^3$ respectively. If the tube is kept vertical, the height of liquid rises in it will be (g = 10 ms^{-2})

1) 0.017m 2) 0.17m 3) 1.7m 4) 17m

37. A capillary tube is immersed vertically in water such that the height of liquid column in it is 'x'. This arrangement is taken into a mine of depth'd' and the height of the liquid column is found to be 'y'. If 'R' is the radius of the earth, then the depth of mine is

1) $d = R\left(\frac{y-x}{x}\right)$ 2) $d = R\left(\frac{y-x}{y}\right)$ 3) $d = R\left(\frac{x}{y-x}\right)$ 4) $d = R\left(\frac{y}{y-x}\right)$

38. Two soap bubbles combine under isothermal conditions to form a single soap bubble. If in this process, the change in volume is V and change in area is S, then

1) PV+TS = 0 2) 4PV+3TS=0 3) 3PV+4TS=0 4) 3PV+TS=0

39. One end of a uniform glass capillary tube of radius r=0.025 cm is immersed vertically in water to a depth h = 1cm. The excess pressure in N/m^2 required to blow an air bubble out of the tube:

Surface tension of water = 710^{-2}N/m

Density of water = $10^3kg/m^3$

Acceleration due to gravity = $10ms^{-2}$

1) 0.0048×10^5 2) 0.0066×10^5 3) 1.0018×10^5 4) 1.0033×10^5

40. A liquid of density'd' and surface Tension 'T' ascends into a capillary tube. Then the potential energy of the liquid is

1) $\frac{2\pi T}{dg}$ 2) $\frac{\pi T^2}{dg}$ 3) $\frac{2\pi T^2}{dg}$ 4) $\frac{\pi T^2}{2dg}$

Key

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

Hints

24. $U \propto h^2 r^2$

$\frac{U_1}{U_2} = \frac{h_1^2}{h_2^2} \frac{r_1^2}{r_2^2}$

$U_1 : U_2 = 1 : 1$

25. In a freely falling lift capillary height = full length of the capillary tube.

26. $\frac{m_1}{m_2} = \frac{r_1}{r_2} \Rightarrow \frac{5}{m_2} = \frac{r}{2r} \Rightarrow m_2 = 10gm$

27. $\ell_1 : \ell_2 = \cos\alpha : 1 = \frac{1}{2} : 1 = 1 : 2$

28. Angle of contact is independent of inclination

29. $P_1 = 1.01 \text{ atm} = 1.01\times10^5\,\text{Pa}$

$\Delta P_1 = (1.01-1)\times10^5 = 1\times10^3\,\text{Pa}$

$P_2 = 1.02\text{atm} = 1.02\times10^5\,\text{Pa}$

$\Delta P_2 = (1.02-1)\times10^5 = 2\times10^5\,\text{Pa}$

$\Delta P\,\alpha\,\frac{1}{r}$

$r_1 : r_2 = \Delta P_2 : \Delta P_1 = 2:1$

$v_1 : v_2 = r_1^3 : r_1^3 = 8:1$

30. $F = \frac{2TA}{d}$

31. $R = \frac{r_1 r_2}{r_1 + r_2} = \frac{1\times3}{1+3} = \frac{3}{4}\text{cm}$

32. E= T A = 5 x 0.3 = 1.5 J

33. $T = \frac{h\,d\,\rho\,g}{2\cos\theta} \Rightarrow h = \frac{2\,T\cos\theta}{\rho\,g\,d}$

34. $h = h_1 - h_2$

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

$h = \frac{2\times70}{1\times1000}\left[\frac{2}{0.4} - \frac{2}{0.5}\right] = 0.14 \text{ cm}$

35. $h_1 = \frac{h_2}{\cos\theta} \Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = 60^0$

36. $h = \frac{2T}{rdg} = \frac{2\times6\times10^{-2}}{0.8\times10^{-3}\times900\times10}$ = 0.017m

37. $T = \frac{hrdg}{2}$

$h_1 g_1 = h_2 g_2$

$xg = y\,g\left[1 + \frac{d}{R}\right]$ $\frac{x}{y} = 1 - \frac{d}{R}$

$d = R\left(\frac{y - x}{y}\right)$

38. $PV = P_1 V_1 + P_2 V_2$

$\left(P + \frac{4T}{r}\right)\left(\frac{4}{3}\pi r^3\right) = \left(P + \frac{4T}{r_1}\right)\left(\frac{4}{3}\pi r_1^3\right) + \left(P + \frac{4T}{r_2}\right)\left(\frac{4}{3}\pi r_2^{\,3}\right)$

$\Rightarrow 3PV + 4TS = 0$

39. $h = \frac{2T}{rdg} = \frac{2 \times 7 \times 10^{-2}}{25 \times 10^{-5} \times 10^3 \times 10} = 5.6\,cm$

Excess pressure = $(h + h')dg$

= $(5.6 + 1) \times 10^{-2} \times 10^3 \times 10 = 0.0066 \times 10^5\ Pa$

40. $P.E = \frac{mgh}{2}$

$P.E = \frac{\pi r^2 h^2 dg}{2} = \frac{\pi dg}{2}\left[\frac{4T^2}{d^2 g^2}\right]$

$P.E = \frac{2\pi T^2}{dg}$