Surface Tension

SET Self Evaluation Test - 10

1. A soap film of surface tension $3 \times 10^{-2}\ Nm^{-1}$ formed in rectangular frame, can support a straw. The length of the film is 10 *cm*. Mass of the straw the film can support is

(a) 0.06 *gm* (b) 0.6 *gm*

(c) 6 *gm* (d) 60 *gm*

2. Energy required to form a soap bubble of diameter 20 *cm* will be (Surface tension for soap solution is 30 *dynes*/*cm*)

(a) 12000 π *ergs* (b) 1200 π *ergs*

(c) 2400 π *ergs* (d) 24000 π *ergs*

3. If the work done in blowing a bubble of volume V is W, then the work done in blowing the bubble of volume $2V$ from the same soap solution will be

(a) $W/2$ (b) $\sqrt{2}\ W$

(c) $\sqrt[3]{2}\ W$ (d) $\sqrt[3]{4}\ W$

4. Surface tension of soap solution is $2 \times 10^{-2}\ N/m$. The work done in producing a soap bubble of radius 2 *cm* is

(a) $64\pi \times 10^{-6}\ J$ (b) $32\pi \times 10^{-6}\ J$

(c) $16\pi \times 10^{-6}\ J$ (d) $8\pi \times 10^{-6}\ J$

5. Excess pressure inside a soap bubble is three times that of the other bubble, then the ratio of their volumes will be

(a) 1 : 3 (b) 1 : 9

(c) 1 : 27 (d) 1 : 81

6. When a capillary tube is dipped in water it rises upto 8 *cm* in the tube. What happens when the tube is pushed down such that its end is only 5 *cm* above the outside water level

(a) The radius of the meniscus increases and therefore water does not overflow

(b) The radius of the meniscus decreases and therefore water does not overflow

(c) The water forms a droplet on top of the tube but does not overflow

(d) The water start overflowing

7. A bubble of 8 mm diameter is formed in the air. The surface tension of soap solution is 30 *dynes*/*cm*. The excess pressure inside the bubble is

(a) 150 *dynes*/*cm*^{2} (b) 300 *dynes*/*cm*^{2}

(c) 3×10^{-3} *dynes*/*cm*^{2} (d) 12 *dynes*/*cm*^{2}

8. The height upto which water will rise in a capillary tube will be

(a) Maximum when water temperature is 4°*C*

(b) Maximum when water temperature is 0°*C*

(c) Minimum when water temperature is 4°*C*

(d) Same at all temperatures

9. Water rises to a height of 10 *cm* in capillary tube and mercury falls to a depth of 3.112 *cm* in the same capillary tube. If the density of mercury is 13.6 and the angle of contact for mercury is 135°, the ratio of surface tension of water and mercury is **[MP PET/PMT 1988]**

(a) 1 : 0.15 (b) 1 : 3

(c) 1 : 6 **[MP PET 1989]** (d) 1.5 : 1

10. The angle of contact between glass and water is 0° and it rises in a capillary upto 6 *cm* when its surface tension is 70 *dynes*/*cm*. Another liquid of surface tension 140 *dynes*/*cm*, angle of contact 60° and relative density 2 will rise in the same capillary by

(a) 12 *cm* (b) 24 *cm*

(c) 3 *cm* (d) 6 *cm*

11. A drop of water breaks into two droplets of equal size. In this process, which of the following statement is correct **[NCERT 1976]**

(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 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

12. A soap bubble of radius R is blown. After heating the solution a second bubble of radius $2R$ is blown. The work required to blow the second bubble in comparison to that required for the first bubble is

(a) Double

(b) Slightly less than double **[MP PET 1990]**

(c) Slightly less than four times

(d) Slightly more than four times

13. A false statement is

(a) Angle of contact $\theta < 90°$, if cohesive force < adhesive force

(b) Angle of contact $\theta > 90°$, , if cohesive force > adhesive force

(c) Angle of contact $\theta = 90°$, if cohesive force = adhesive force

(d) If the radius of capillary is reduced to half, the rise of liquid column becomes four times

14. The diameter of rain-drop is 0.02 *cm*. If surface tension of water be 72×10^{-3} *newton* per *metre*, then the pressure difference of external and internal surfaces of the drop will be

(a) 1.44×10^{4} *dyne* $- cm^{-2}$

(b) 1.44×10^{4} *newton* $- m^{-2}$

(c) 1.44×10^{3} *dyne* $- cm^{-2}$

(d) 1.44×10^{5} *newton* $- m^{-2}$

15. Water rises to a height of 16.3 *cm* in a capillary of height 18 *cm* above the water level. If the tube is cut at a height of 12 *cm*

(a) Water will come as a fountain from the capillary tube

(b) Water will stay at a height of 12 *cm* in the capillary tube

(c) The height of the water in the capillary will be 10.3 *cm*

(d) Water will flow down the sides of the capillary tube

Answers and Solutions

(SET - 10)

1. (b) The weight of straw will be balanced by the force of surface tension $\therefore\ mg = 2Tl \Rightarrow m = \frac{2Tl}{g}$

$= \frac{2 \times 3 \times 10^{-2} \times 10 \times 10^{-2}}{9.8} kg = 0.6\,gm$

2. (d) $E = 8\pi r^2 T = 8\pi(10)^2 \times 30 = 24000\ \pi\ erg$

3. (d) Work done to form a soap bubble

$W = 8\pi R^2 T$ (As $V \propto R^3\ \therefore\ R \propto V^{1/3}$)

$\therefore\ W \propto V^{2/3}$

$\frac{W_2}{W_1} = \left(\frac{V_2}{V_1}\right)^{2/3} = (2)^{2/3} \Rightarrow W_2 = (4)^{1/3} W$

4. (a) $W = 8\pi R^2 T = 8 \times \pi \times (2 \times 10^{-2})^2 \times 2 \times 10^{-2} = 64\pi \times 10^{-6}\ J$

5. (c) $\Delta P \propto \frac{1}{r} \Rightarrow \frac{\Delta P_1}{\Delta P_2} = \frac{r_2}{r_1} \Rightarrow \frac{r_2}{r_1} = \frac{3}{1}$

$\therefore\ \frac{V_1}{V_2} = \left(\frac{r_1}{r_2}\right)^3 = \left(\frac{1}{3}\right)^3 = \frac{1}{27}$

6. (a) $h = \frac{2T}{Rdg} \Rightarrow hR = \frac{2T}{dg} = \text{constant}$

When h decreases, R increases.

7. (b) $\Delta P = \frac{4T}{r} = \frac{4 \times 30}{0.4} = 300\ dyne/cm^2$.

8. (c) $h = \frac{2T\cos\theta}{rdg}$. For water, density is maximum at 4^oC, so the height is minimum at 4^oC.

9. (c) $h = \frac{2T\cos\theta}{rdg} \therefore T = \frac{hrdg}{2\cos\theta}$

$\Rightarrow \frac{T_1}{T_2} = \frac{h_1}{h_2} \times \frac{r_1}{r_2} \times \frac{d_1}{d_2} \times \frac{\cos\theta_2}{\cos\theta_1} = \frac{1}{6}$

10. (c) $h = \frac{2T\cos\theta}{rdg} \therefore \frac{h_2}{h_1} = \frac{T_2}{T_1} \times \frac{\cos\theta_2}{\cos\theta_1} \times \frac{d_1}{d_2} \times \frac{r_1}{r_2}$

$\frac{h_2}{h_1} = \frac{140}{70} \times \frac{\cos 60°}{\cos 0°} \times \frac{1}{2} \times 1 = \frac{1}{2} \Rightarrow h_2 = \frac{h_1}{2} = 3\,cm.$

11. (b)

12. (c) Work done to form a bubble of radius R

$W_1 = 8\pi R^2 T_1$

Work done to form a bubble of radius $2R$

$W_2 = 8\pi(2R)^2 T_2 = 32\pi R^2 T_2\ \therefore \frac{W_1}{W_2} = \frac{T_1}{4T_2}$

If surface tension of soap solution is same then

$W_2 = 4W_1$

But in the problem temperature of solution is increased so its surface tension decreases.

$\therefore\ W_2 < 4W_1$

13. (d) If radius of capillary is reduced to half, the rise of liquid column will be two times. as $h \propto 1/r$

14. (a) $\Delta P = \frac{2T}{r} = \frac{2 \times 72 \times 10^{-3}}{0.01 \times 10^{-2}} = 1440\ N/m^2$

$= 1.44 \times 10^4\ dyne/cm^2$

15. (b) Because if the length available is less than required, then water will rise upto available height and adjust its radius of curvature.

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