# PHYSICS

# BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

# SURFACE TENSION

Example

1. Calculate the amount of energy evolved when eight drplets of mercury (surface

tension $0.55 Nm^{-1}$) of radius 1 mm each combine into one.

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## Exercises

**1.** Calculate the work done in spraying a spherical drop of mercury of 1 mm radius into a million droplets of equal size. The surface tension of mercury $= 550 \times 10^{-3} Nm^{-1}$

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## Others

**1.** Find the work done in blowing a soap bubble of surface tension $0.03Nm^{-1}$ from so that its diameter changes from 2 cm to 4 cm.

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**2.** A small hollow sphere which has a small hole in it is immersed in water to a depth of

40 cm, before any water is penetrated into it. If the surface tensionof water si $0.073Nm^{-1}$, find the radius of the hole.

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**3.** A spherical soap bubble of radius 2 cm attached to the outside of a spherical bubble of radius 4 cm. Find the radius of curvature of the common surface.

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**4.** Two spherical bubbles of radii 3 cm and 4cm coalesce to form another spherical bubble. Calculate the surface tension of the bubble. The radius of the bubble formed=4.498 cm and the atmopheric pressure $=10^5$ Pa

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**5.** Two vertical, parallel glass plates are partially submerged in water. The distance between the plates is d=100$\mu m$, their length is l=10 cm. Assuming that the water between the plates does not reach the upper edge of the plates and that the wetting is complete, find the force of attraction, indicating how the force arises. Surface tension of water =73m N/m.

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**6.** Two drops of water of radius $2 \times 10^{-7}$ m coalesce. What is the resultant rise in temperature? (S.T. of water

$= 74 \times 10^{-3} Nm^{-1}$, sp. Heat capacity of water =4200 J/kg/K).

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7. To what height can mercury be filled in a vessel without any leakage if there is a pin hole of diameter 0.1 mm at the bottom of the vessel? ( Density of mercury $= 13.6 \times 10^3 kgm^{-3}$, surface tension of mercury $= 550 \times 10^{-3} Nm^{-1}$, Neglect angle of contact.

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**8.** A tube of $1mm$ bore is dipped into a vessel containing a liquid of density $0.8g/cm^3$, surface tension $30 \text{dyne}/\text{cm}$ and angle of contact zero. Calcualte the length which the liquid will occupy in the tube when the tube is held $(a)$ vertical $(b)$ inclined to the vertical at an angle of $30^\circ$.

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**9.** What should be the pressure inside a small air bubble of $0.1mm$ radius situated just below the water surface. Surface tension of water $= 7.2 \times 10^{-2} N/m$ and atmosphere pressure $= 1.013 \times 10^5 N/m^2$.

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**10.** Two soap bubbles are joined together so that they have a common surface. If their radii are 3 cm and 4 cm respectively, find the radius of the common surface.

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**11.** By how much will the surface of a liquid be depressed in a glass tube of radius 0.2 mm if the angle of contact of the liquid is $135^\circ$ and the surface tension is $0.547 Nm^{1}$? Density of the liquid is $13.5 \times 10^3 kgm^{-3}$.

[ Hint: Neglecting the liquid in the meniscus we have for equilibrium

$$\pi r_2 h\rho g = 2\pi r T\cos\theta, h = \frac{2T\cos\theta}{\rho g r}]$$

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**12.** A glass tube of radius 0.5 mm is dipped in water. Calculate the rise of water in the tube.( Neglect mass of water in the mensiscus and take the angle of contact to be zero. Surface tension of water $= 70 \times 10^{-3} Nm^{-1}$)

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**13.** Two spherical soap bubble coalesce. If $V$ is the consequent change in volume of the contained air and $S$ the change in total surface area, show that

$$3PV + 4ST = 0$$

where $T$ is the surface tension of soap bubble and $P$ is

Atmospheric pressure

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**14.** If a number of little droplets of water, each of radius $r$, coalesce to form a single drop of radius $R$, show that the rise in temperature will be given by $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ where $T$ is the surface tension of water and $J$ is the mechanical equivalent of heat.

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**15.** A glass plate of length 10 cm, breadth 4 cm, and the thickness 0.4cm , weighs 20g in air. It is held vertically with long side horizontal and half the plate immersed in water. What will be its apparent weight? Surface tension of water = $70 dyne / cm$.

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**16.** Calculate the radius or the largest drop of water that might evaporate at $0^\circ C$ without heat being supplied to it. The surface energy of watee at $0^\circ C$ is $117 \times 10^{-3} Jm^{-2}$ and the latent heat capacity of water is $606 \times 10^3$

clorie par kg at $0^{\circ} C$ One calorie equal 4.2 joules.

[Hint: Equate change in surface energy to the heat required for evaporation of the mass that will disapper.]

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**17.** A sphere of radius 6 cm weighs 2 kg in air. It is held with its lower half immersed in water. What will be its appent weight? ( Surface tension of water

$= 72.5 \times 10^{-3} Nm^{-1}$ and $g = 9.81 ms^{-2}$)

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**18.** The end of a capillary tube of radius r is immersed in water of surface tension T and density $\rho$. How much heat will be evolved when water rises in the tube?

[Hint: Heat evolved = work done by surface tension - gravitational energy stored in the standing column.]

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19. Water rise to a height h in a long capillary tubes. The length of the tube inside the water is l. The tube is taken out gently. What length of water will remain in the tube?

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20. Find the work done in blowing a soap bubble of radius R if pressure outside in $p_0$

and the surface tension of the soap solution is T.

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**21.** Find the force of attraction between parallel glass plates separated by a distance d=1/10 mm, after a water drop of mass m=80 mg is introduced between them. The wetting is assumed to be complete. Surface tension of water =73mN/m.

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