EXERCISE – II

MULTIPLE CHOICE QUESTIONS

1. Initial surface Area

$= 2 [1 \times b] = 2 [10 \times 0.5] = 10\ cm^2$

final surface area

$= 2 [10 \times (0.5 + 0.1)] = 12\ cm^2$

Increase in surface Area = 12 – 10

$= 2 \times 10^{-4}\ m^2$

W.D. = Surface Tension × Increase in Surface Area

$W.D. = 72 \times 10^{-3} \times 2 \times 10^{-4}$

$= 1.44 \times 10^{-5}$ Joule

$W.D. = 1.44 \times 10^{-5}$ Joule

2. $(Force)_{surface\ Tesion}$

= Surface Tension × circumference

$= 6 \times 10^{-2} \times$ circumference.

$(force)_{S.T.} = (Force)_{weight\ of\ liquid}$

$6 \times 10^{-2} \times C = 75 \times 10^{-4}$

$$C = \frac{75 \times 10^{-4}}{6 \times 10^{-2}}$$

Surface Tension $= 1.25 \times 10^{-2}$ m

3. $(Force)_{S.T.}$ = S.T. × Total length

$F = \sigma \times (2\pi r + 2\pi R) = 2\pi\sigma (r + R)$

$$\sigma = \frac{F}{2\pi(r + R)}$$

$F = 3.97\ gwt = 3.97 \times 10^{-3} \times 9.8\ N$

$r = 4.25 \times 10^{-2}\ m,\ R = 4.35 \times 10^{-2}\ m$

putting values

$\sigma = 7.2 \times 10^{-2}\ Nm^{-1}$

4. Initial pressure of air in the cylinder

$P_0 = 10^5\ Nm^{-2}$

$$P_m \text{ inside bubble} = P_1 = P_0 + \frac{4\sigma}{r}$$

$$P_{final} \text{ inside bubble} = P_2 = P + \frac{4\sigma}{r/2}$$

$$V_{initial} = v_1 = \frac{4}{3}\pi r^3$$

$$V_{final} = v_2 = \frac{4}{3}\pi\left(\frac{r}{2}\right)^3 = \frac{1}{8}v_1$$

By Boyle's law

$P_1V_1 = P_2V_2$

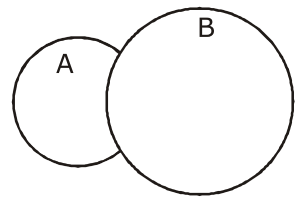
$$\left(P_0 + \frac{4\sigma}{r}\right)v_1 = \left(P + \frac{8\sigma}{r}\right)\frac{v_1}{8}$$

$$P = 8P_0 + \frac{24\sigma}{r} = 8 \times 10^5 + \frac{24 \times 0.08}{2.4 \times 10^{-4}}$$

$P = 8.08 \times 10^5\ Nm^{-2}$

5. Excess pressure in bubble A

$$P_1 = \frac{4\sigma}{r_1}$$



Excess pressure in bubble B

$$P_2 = \frac{4\sigma}{r_2}$$

Excess pressure in double bubble

$$P = \frac{4\sigma}{r}$$

$P_1 - P_2 = P$

$$\frac{4\sigma}{r_1} - \frac{4\sigma}{r_2} = \frac{4\sigma}{r}$$

$$\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2}$$

$$r = \frac{r_1 r_2}{r_2 - r_1}$$

r = .004 m

6. For bubble of radius a (σ is surface tension)

$$P_a - P = \frac{4\sigma}{a} \text{ or } P_a = P + \frac{4\sigma}{a}$$

$$P_b = \left(P + \frac{4\sigma}{b}\right)$$

$$P_c = \left(P + \frac{4\sigma}{c}\right)$$

As two bubbles combine

$P_aV_a + P_bV_b = P_cV_c$

$$\left(P + \frac{4\sigma}{a}\right) \times \frac{4}{3}\pi a^3 + \left(P + \frac{4\sigma}{b}\right) \times \frac{4}{3}\pi b^3 = \left(P + \frac{4\sigma}{c}\right) \times \frac{4}{3}\pi c^3$$

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

7. Total excess pressure = weight of liquid column of h

$$\frac{4T\cos 0^o}{r} = h\rho g$$

$$h = \frac{4T}{r\sigma g}$$

$$h = \frac{4\times 73.5\times 10^{-3}}{2\times 10^{-3}\times 10^{3}\times 9.8}$$

$h = 1.5 \times 10^{-2}$ m

h = 1.5 cm

8. Let P_1 in the broader tube & P_2 that in the narrower tube

Pressure just below the meniscus in the

broader tube = $P_1 - \frac{2T}{r_1}$

narrower tube = $P_2 - \frac{2T}{r_2}$

difference of these pressure is

$$\left(P_1 - \frac{2T}{r_1}\right) - \left(P_2 - \frac{2T}{r_2}\right) = h\,\rho\,g$$

$$P_1 - P_2 = h\,\rho\,g - 2T\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$P_1 - P_2 = 0.2 \times 10^3 \times 9.8 - 2 \times 72 \times 10^{-3} \left[\frac{1}{7.2\times 10^{-4}} - \frac{1}{1.44\times 10^{-3}}\right]$$

$P_1 - P_2 = 1860\ \text{Nm}^{-2}$

9. initial pressure in the capillary $P_1 = P$

Initial volume of air in

capillary = v_1 = LA

Final pressure in capillary

$$= P_2 = P + \frac{2T}{r}$$

Final volume of air in capillary

$V_2 = (L - 1)\,A$

$P_1V_1 = P_2V_2$

$$P \times LA = \left(P + \frac{2T}{r}\right)(L - 1)\,A$$

$$\ell = \frac{L}{1 + \frac{Pr}{2T}}$$

Putting values

ℓ = 1 cm

10. $F_{net} = F_B + 6\,\eta\,r\,v - mg$

$$a = \frac{F_B}{m} + \frac{6\eta rv}{m} - g$$

11. Pressure due to S.T. = $\frac{2T}{r}$

Pressure difference due S. T. = ρgh

$$\Rightarrow \quad 2T\left[\frac{2}{10^{-3}} - \frac{2}{10^{-2}}\right] = 3600\times 7\times 10^{-2}$$

$$h = \frac{2\times 18\times 7}{100}\ \text{cm.}$$

h = 2.52 cm

2. $v_T = \frac{2}{9}\frac{r^2(p-\sigma)}{\eta}g$

$v_T^2 - 0 = 2\,g \times h$

$$h = \frac{vT^2}{2g} = \frac{4}{81}\frac{r^4(\rho-\sigma)^2 g}{2\eta^2}$$

h = 20.4 m

13. Let its initial volume be v_0

$$V_p = \frac{2}{3}V_0$$

PV = const.

$$(9\ m)V_0 = (9 + h)\ m\ \frac{2}{3}v_0$$

$$9 = (9 + h)\ \frac{2}{3}$$

h = 4.5 m