

Chapter 9 Exercise 9A

Q. 1. $0.83 \times 1,000 = 830 \text{ kg/m}^3$

Q. 2. $\frac{375}{1,000} = 0.375$

Q. 3. (i) 1 m^3 has mass $13.6 \times 1,000,000$
 $= 13,600,000$ grammes
 $= 13,600 \text{ kg}$
 \therefore Density $= 13,600 \text{ kg/m}^3$

(ii) $\frac{13,600}{1,000} = 13.6$

Q. 4. Volume $= 0.1 \times 0.06 \times 0.02$
 $= 0.00012 \text{ m}^3$

Density $= \frac{\text{Mass}}{\text{Volume}}$
 $= \frac{1.08}{0.00012} = 9,000 \text{ kg/m}^3$

Relative density $= \frac{9,000}{1,000} = 9$

Q. 5. Volume $= \frac{\text{Mass}}{\text{Density}}$
 $= \frac{70}{980} = \frac{1}{14} \text{ m}^3$

Mass $= \text{Volume} \times \text{Density}$
 $= \frac{1}{14} \times 2,450 = 175 \text{ kg}$

Q. 6.

s	v	sv
1	60	60
0.95	40	38
	100	98

$\bar{s} = \frac{98}{100} = 0.98$

Q. 7.

s	v	sv
7	10	70
9	1	9
	11	79

$\bar{s} = \frac{79}{11} = 7.182$

Q. 8.

s	v	sv
1	100	100
0.9	x	0.9x
	100 + x	100 + 0.9x

$\frac{100 + 0.9x}{100 + x} = 0.9625$

$\Rightarrow 100 + 0.9x = 96.25 + 0.9625x$

$\Rightarrow x = 60 \text{ ml}$

Q. 9. Volume $= 0.4 \times 0.3 \times 0.2 = 0.024 \text{ m}^3$
 Weight $= V\rho g = (0.024)(1,000 \text{ g}) = 24 \text{ g N}$

Q. 10. Volume $= \pi r^2 h = \pi(0.03)^2(0.1)$
 $= 0.00009\pi \text{ m}^3$

Weight $= V\rho g = (0.00009\pi)(800 \text{ g})$
 $= 0.072\pi \text{ g N}$

Q. 11. (i) $V = \frac{1}{3}\pi h(R^2 + Rr + r^2)$
 $= \frac{1}{3}\pi(18)(81 + 54 + 36)$
 $= 1,026\pi \text{ cm}^3 = 0.001026\pi \text{ m}^3$

Weight $= V\rho g = (0.001026\pi)(1,000 \text{ g})$
 $= 1.026\pi \text{ g N}$

(ii) $V = \frac{1}{3}\pi h(R^2 + Rr + r^2)$
 $= \frac{1}{3}\pi(6)(49 + 42 + 36)$
 $= 254\pi \text{ cm}^3 = 0.000254\pi \text{ m}^3$

Weight $= V\rho g = (0.000254\pi)(950 \text{ g})$
 $= 0.2413\pi \text{ g N}$

(iii) Density $= \frac{\text{Mass}}{\text{Volume}}$
 $= \frac{1.026\pi + 0.2413\pi}{0.001026\pi + 0.000254\pi}$
 $= \frac{1.2673}{0.00128} = 990$

Specific gravity $= \frac{990}{1,000} = 0.99$

Exercise 9B

Q. 1. (i) Pressure $= h\rho g = (2)(1,000 \text{ g})$
 $= 2,000 \text{ g N/m}^2$

(ii) Thrust $= \text{Pressure} \times \text{Area}$
 $= 2,000 \text{ g} \times (2)^2 = 8,000 \text{ g N}$

Weight $= V\rho g = (2)^3(1,000 \text{ g})$
 $= 8,000 \text{ g N}$

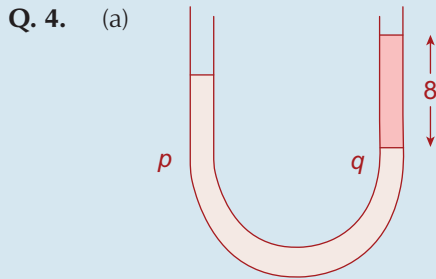
Q. 2. (i) Pressure $= h\rho g = (0.11)(850 \text{ g})$
 $= 93.5 \text{ g N/m}^2$

(ii) Thrust $= \text{Pressure} \times \text{Area}$
 $= (93.5\text{g})\pi(0.05)^2$
 $= 0.23375\pi \text{ g N}$

(iii) Weight $= V\rho g = \pi r^2 h\rho g$
 $= \pi(0.05)^2(0.11)(850 \text{ g})$
 $= 0.23375\pi \text{ g N}$

Q. 3. Thrust = Pressure \times Area = $(h\rho g)(\pi r^2)$
 $= (0.1)\rho g(\pi(0.2)^2) = 0.00004\pi\rho g$
 Weight = $V\rho g$
 $= \frac{1}{3}\pi h(R^2 + Rr + r^2)\rho g$
 $= \frac{1}{3}\pi(0.1)\{(0.05)^2 + (0.05)(0.02)$
 $+ (0.02)^2\}\rho g$
 $= 0.00013\pi\rho g$

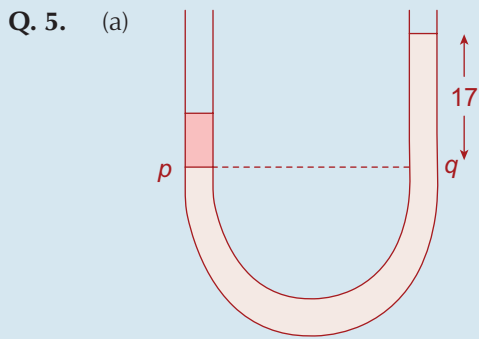
The ratio is, therefore, 4 : 13



Pressure at p = Pressure at q
 $\Rightarrow h(1,000)g = 8(850)g$
 $\Rightarrow h = 6.8 \text{ cm}$

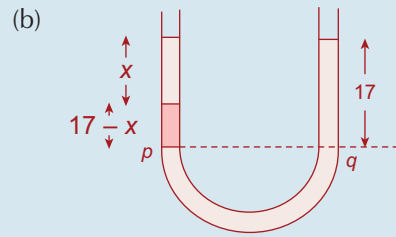
\therefore Difference = $8 - 6.8 = 1.2 \text{ cm}$

(b) Pressure under mercury = Pressure under oil
 $\Rightarrow h(950)g = 8(850)g$
 $\Rightarrow h = 7.16 \text{ cm}$



Pressure at p = Pressure at q
 $\Rightarrow h(13,600)g = 17(1,000)g$
 $\Rightarrow h = 1.25 \text{ cm}$

\therefore Difference = $17 - 1.25 = 15.75 \text{ cm}$



Pressure at p = Pressure at q
 $\Rightarrow x(850)g + (17 - x)(13,600)g = 17(1,000)g$
 $\Rightarrow x = 16.8 \text{ cm}$

Q. 6. Pressure = $h\rho g = (3)(1,000)g = 3,000g \text{ N/m}^2$
 Thrust = Pressure \times Area
 $= (3,000g)(2 \times 2) = 12,000g \text{ N}$
 (i) $2 \times 2 \times h = 1 \times 1 \times 1 \Rightarrow h = \frac{1}{4} \text{ m}$
 (ii) $P = h\rho g = \left(\frac{1}{4}\right)(1,000)(g) \Rightarrow 250g \text{ N/m}^2$
 (iii) $T = P \times A = (250g)(4) = 1,000g \text{ N}$

Q. 7. (i) $\pi R^2 h = \frac{4}{3}\pi r^3$
 $\Rightarrow \pi(16)h = \frac{4}{3}\pi(27)$
 $\Rightarrow h = 2\frac{1}{4} \text{ cm} = 0.0225 \text{ m}$
 (ii) $P = h\rho g = (0.0225)(1,000)g = 22.5g \text{ N/m}^2$
 (iii) Thrust = $P \times A = (22.5g)(\pi(16)) = 360\pi \text{ N}$

Q. 8. (i) $\pi R^2 h = \frac{4}{3}\pi r^3$
 $\pi(36)h = \frac{4}{3}\pi(27)$
 $\Rightarrow h = 1 \text{ cm} = 0.01 \text{ m}$
 (ii) $P = h\rho g = (0.01)(900)g = 9g \text{ N/m}^2$
 (iii) $T = P \times A = (9g)(\pi(0.06)^2) = 0.0324\pi g \text{ N}$

Q. 9. $1 \frac{\text{dyne}}{\text{cm}^2} = \frac{10^{-5} \text{ Newtons}}{10^{-4} \text{ m}^2} = 0.1 \text{ N/m}^2$

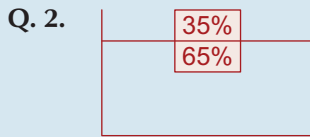
Q. 10. (i) Thrust = Pressure \times Area = $(h\rho g)(\pi r^2)$
 $= (2)(1,250)(9.8)\left(\frac{22}{7}\right)(1.4)^2$
 $= 150,920 \text{ N} = 150.92 \text{ kN}$
 (ii) Volume = $\frac{M}{\rho} = \frac{750}{2,500} = 0.3 \text{ m}^3$
 at x = Increase in depth
 $\Rightarrow \pi r^2 x = 0.3 \Rightarrow x = \frac{0.3}{\pi r^2}$

$$\therefore \text{Increase in pressure} = h\rho g = \frac{0.3}{\pi r^2} (1,250)g$$

$$\begin{aligned} \therefore \text{Increase in thrust} &= P \times A \\ &= \frac{0.3}{\pi r^2} (1,250)g(\pi r^2) \\ &= 3,675 \text{ N} = 3.675 \text{ kN} \end{aligned}$$

Exercise 9C

Q. 1. Buoyancy = 12 - 8 = 4
 $B = \frac{W}{S} \Rightarrow 4 = \frac{12}{S} \Rightarrow S = 3$



$$\begin{aligned} W &= V\rho g \\ B &= \left(\frac{65}{100}V\right)(1,000)g = 650Vg \\ \text{But } B &= W \Rightarrow \rho = 650 \Rightarrow S = 0.65 \end{aligned}$$

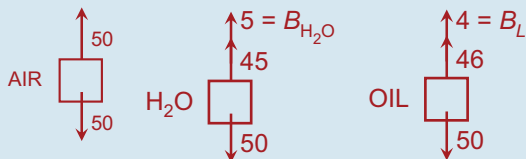
Q. 3. 0.9, as in the last question

Q. 4. $B = 18 - 15 = 3$
 $B = \frac{W}{S} \Rightarrow 3 = \frac{18}{S} \Rightarrow S = 6$
 $B_L = 18 - 16 = 2$
 $B_L = S_L B_W$
 $\Rightarrow 2 = S_L(3) \Rightarrow S_L = \frac{2}{3}$

Q. 5. (i) $B = \frac{W}{S} = \frac{30}{6} = 5$
 \therefore Apparent weight = 30 - 5 = 25 N
 (ii) $B_L = S_L B_W = (0.9)(5) = 4.5$
 \therefore Apparent weight = 30 - 4.5 = 25.5 N

Q. 6. $B_L = S_L B_W = S_L \left(\frac{W}{S}\right) = 13.6 \left(\frac{200}{17}\right) = 160$
 \therefore Apparent weight = 200 - 160 = 40 N

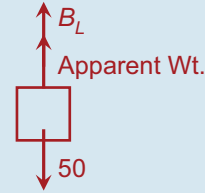
Q. 7. Note: B_{H_2O} = Buoyancy in water
 B_L = Buoyancy in liquid
 W_I = Immersed weight
 S = Specific gravity of object
 S_L = Specific gravity of liquid



(i) $B_{H_2O} = \frac{W_I}{S} \Rightarrow 5 = \frac{50}{S} \Rightarrow S = 10$

(ii) $B_L = S_L \frac{W_I}{S} \Rightarrow 4 = S_L \frac{(50)}{S} \Rightarrow S_L = 0.8$

(iii) In liquid, $S_L = 0.75$



$$\begin{aligned} \text{Apparent Wt.} &= 50 - B_L \\ &\Rightarrow \text{Apparent Wt.} = 50 - S_L \frac{W_I}{S} \\ &\Rightarrow \text{Apparent Wt.} = 50 - 0.75 \frac{(50)}{S} \\ &= 46.25 \text{ N} \end{aligned}$$

Q. 8. Buoyancy in water, $B_W = 80 - 60 = 20$
 Buoyancy in oil, $B_L = 80 - 64 = 16$
 $B_L = S_L B_W \Rightarrow 16 = S_L(20) \Rightarrow S_L = 0.8$

Q. 9. (i) $V = \frac{4}{3}\pi r^3$
 $= \frac{4}{3}\pi(0.3)^3$
 $= 0.036\pi \text{ m}^3$ OR $\frac{9\pi}{250} \text{ m}^3$

(ii) $W = \rho Vg$
 $= 2,500 \left(\frac{9\pi}{250}\right)g$
 $= 90\pi g \text{ N}$

(iii) App. Wt. = Weight - Buoyancy,
 $B = \frac{W_I}{S}$
 $= 90\pi g - \frac{90\pi g}{2.5}$
 $= 54\pi g \text{ N}$

Q. 10. $V = \frac{\pi r^2 h}{3}$
 $r = 0.3, h = 0.7$
 (i) $\Rightarrow V = \frac{22}{7} \frac{(0.3)^2}{3} (0.7)$
 $\Rightarrow V = \frac{33}{500} \text{ m}^3$ OR $V = 0.066 \text{ m}^3$
 (ii) $W = \rho Vg$
 $= 8,000 \left(\frac{33}{500}\right) 9.8$
 $= 5,174.4 \text{ N}$

$$(iii) B_{H_2O} = \frac{W_l}{S} = \frac{5174.4}{8} = 646.6$$

$$\begin{aligned} \text{App. Wt.} &= \text{Weight} - \text{Bouyancy} \\ &= 5174.4 - 646.6 \\ &= 4527.6 \text{ N} \end{aligned}$$

Q. 11. Let W = the weight of the body.
Let B = Bouyancy in water.

$$\therefore W_1 = W - B$$

$$B_L = S_L B_W \Rightarrow \text{Bouyancy in liquid 1} = (0.8)B$$

$$\therefore W_2 = W - 0.8B$$

$$\text{Similarly, } W_3 = W - 0.75B$$

$$\begin{aligned} 5W_2 - 4W_3 &= 5(W - 0.8B) - 4(W - 0.75B) \\ &= W - B = W_1 \quad \text{QED} \end{aligned}$$

Exercise 9D

Q. 1. $\frac{3}{4}$ of volume under water $\Rightarrow S = \frac{3}{4}$

$$\begin{aligned} \therefore \rho &= \frac{3}{4} \times 1,000 \\ &= 750 \end{aligned}$$

$$\begin{aligned} W &= V\rho g \\ &= (0.1)(750)g \\ &= 75g \end{aligned}$$

$$B = \frac{W}{S} = \frac{75g}{\frac{3}{4}} = 100g$$

$$B = W + T$$

$$\Rightarrow 100g = 75g + T$$

$$\Rightarrow T = 25g$$

Q. 2. Its specific gravity is 0.8, as in question 1

Let V = its volume, xV = volume under the liquid

$$\begin{aligned} W &= V\rho g \\ &= V(800)g \\ &= 800Vg \end{aligned}$$

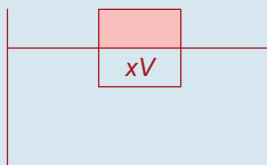
$$\begin{aligned} B &= xV(1,200)g \\ &= 1,200xVg \end{aligned}$$

Since it is in equilibrium, $W = B$

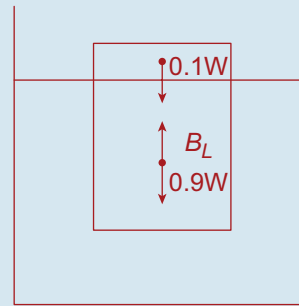
$$\Rightarrow 800Vg = 1,200xVg$$

$$\Rightarrow x = \frac{2}{3}$$

$\therefore \frac{1}{3}$ of its mass, or $33\frac{1}{3}\%$, is above the surface.



Q. 3. (i)



$B_L = S_L B_W = S_L \left(\frac{W}{S} \right)$ where W = weight of the **immersed** part.

$$\therefore B_L = (1.1) \left(\frac{0.9W}{S} \right) = \frac{0.99W}{S}$$

Since it is in equilibrium

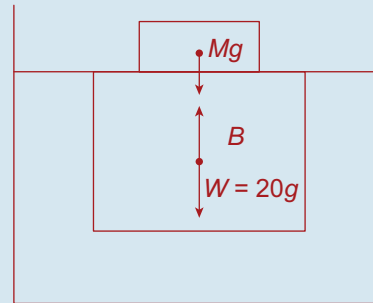
$$0.1W + 0.9W = B_L$$

$$\Rightarrow W = \frac{0.99W}{S}$$

$$\Rightarrow S = 0.99$$

(ii) 0.99 of its mass will be below, as in question 2.

Q. 4. Its specific gravity is $\frac{3}{4}$, as in question 1.



Let M = the mass of the glass

$$B_L = S_L B_W$$

$$= S_L \left(\frac{W}{S} \right)$$

$$= (0.8) \left(\frac{20g}{0.75} \right)$$

$$= 21\frac{1}{3}g$$

$$B = Mg + 20g$$

$$\Rightarrow 21\frac{1}{3}g = Mg + 20g$$

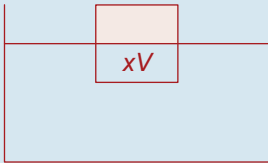
$$\Rightarrow M = 1\frac{1}{3}kg$$

Q. 5. $B = 360 - 330 = 30$

$$B = \frac{W}{S} \Rightarrow 30 = \frac{360}{S}$$

$$\Rightarrow S = 12. \text{ It is lead}$$

Q. 6.



Let V = its volume,
 xV = volume under the sea.

B = weight of liquid displaced
 $= (xV)(1,030)g$

W = weight of the object
 $= V(900)g$

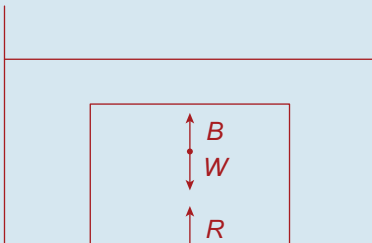
Since $B = W$,

$$xV(1,030)g = V(900)g$$

$$\Rightarrow x = 0.87$$

Answer: 87%

Q. 7. $V = (0.8)(0.6)(0.4) = 0.192 \text{ m}^3$



$$W = V\rho g$$

$$= (0.192)(2,500)g = 480g$$

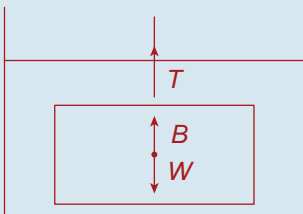
$$B = (0.192)(1,000)g = 192g$$

$$B + R = W$$

$$\Rightarrow 192g + R = 480g$$

$$\Rightarrow R = 288g = 2,822.4 \text{ N}$$

Q. 8.



$$(i) \quad V = \frac{M}{\rho}$$

$$= \frac{12.5}{2,500}$$

$$= 0.005 \text{ m}^3$$

$$(ii) \quad M = V\rho$$

$$= 0.005(800)$$

$$= 4 \text{ kg}$$

$$(iii) \quad W = 12.5g, \quad B = 4g$$

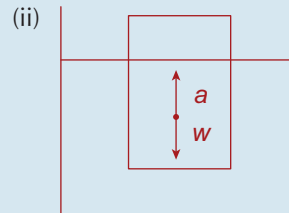
$$W = T + B$$

$$\Rightarrow T = 12.5 - 4 = 8.5g$$

$$= 83.3 \text{ N}$$

Q. 9. (i) $V = (0.1)(0.2)(0.08)$

$$= 0.0016 \text{ m}^3$$



$$M = V\rho$$

$$\Rightarrow 1 = 0.0016\rho$$

$$\Rightarrow \rho = 625$$

$$\therefore S = \frac{625}{1,000} = \frac{5}{8}$$

$\frac{5}{8}$ th of its length is submerged

$$\therefore \text{Depth} = \frac{5}{8} \times 20 = 12.5 \text{ cm}$$

Q. 10. $B = 40 - 35 = 5$

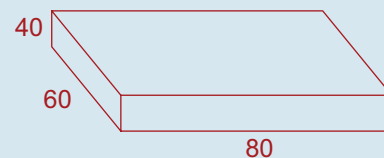
$$B = \frac{W}{S} \Rightarrow 5 = \frac{40}{S} \Rightarrow S = 8$$

Q. 11. Total area = $(80 \times 60) + 2(80 \times 40)$

$$+ 2(60 \times 40)$$

$$= 16,000 \text{ cm}^2$$

$$= 1.6 \text{ m}^2$$



$$\text{Volume} = 1.6 \times 0.0015$$

$$= 0.0024 \text{ m}^3$$

$$\text{Weight} = V\rho g$$

$$= (0.0024)(8,000)g = 19.2g$$

Let X = the depth of the tank in the lake.

B = weight of liquid displaced

$$= (0.6 \times 0.8 \times X)(1,000)g = 480Xg$$

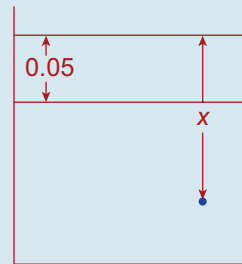
$$B = W$$

$$\Rightarrow 480Xg = 19.2g$$

$$\Rightarrow X = 0.04 \text{ m}$$

$$= 4 \text{ cm}$$

Q. 12. Pressure at 5 cm = $h\rho g$
 $= (0.05)(900)g$
 $= 45g$
 Pressure at 9.5 cm = $(0.05)(900)g + (0.045)(1,000)g$
 $= 90g$
 \therefore Pressure at 9.5 cm = Twice pressure at 5 cm
 Pressure at 3 cm = $(0.03)(900)g$
 $= 27g$
 5 times pressure at 3 cm = 135g
 Let x = the depth (in metres)
 Pressure = $(0.05)(900)g + (x - 0.05)(1,000)g = 135g$
 $\Rightarrow 45g + 1,000g - 50g = 135g$
 $\Rightarrow x = 0.14$ m
 $= 14$ cm



Q. 13. Let A = Atmospheric pressure
 Pressure at 14 m = $2 \times$ Pressure at 2 m
 $A + 14(1,000)g = 2(A + 2(1,000)g)$
 $\Rightarrow A = 10,000g$
 $= 98,000$ N/m²

Q. 14. (i) Bouyancy = weight of liquid displaced
 $= \left(\frac{2}{3}\pi(1)^3\right)(1,000)g$
 $= \frac{2,000}{3}\pi g$ N

(ii) Pressure = $h\rho g$
 $= (2)(1,000)g$
 $= 2,000g$

Thrust = $P \times A$
 $= (2,000g)(\pi(1)^2)$
 $= 2,000\pi g$ N

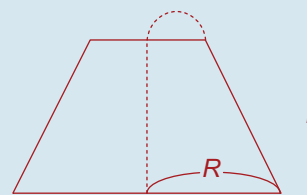
(iii) $B = Fu - Fd$
 $\Rightarrow \frac{2,000}{3}\pi g = 2,000\pi g - Fd$
 $\Rightarrow Fd = \frac{4,000}{3}\pi g$ N

Q. 15. (i) Bouyancy = weight of displaced liquid
 $= \left(\frac{1}{3}\pi(2)^2(6)\right)(900)g$
 $= 7,200\pi g$ N

(ii) Pressure = $h\rho g$
 $= (7)(900)g = 6,300g$ N
 Thrust = $P \times A$
 $= (6,300g)(\pi(2)^2)$
 $= 25,200\pi g$ N

(iii) $B = Fu - Fd$
 $\Rightarrow 7,200\pi g = 25,200\pi g - Fd$
 $\Rightarrow Fd = 18,000\pi g$ N

Q. 16.



Since $\pi r^2 = \frac{1}{4}(\pi R^2)$, $R = 2r$

Volume = $\frac{1}{3}\pi h\{(2r)^2 + (2r)r + r^2\}$
 $= \frac{7}{3}\pi h r^2$

Weight = $V\rho g = \frac{7}{3}\pi h r^2 \rho g$

Pressure at base = $h\rho g$

$$\therefore \text{Thrust} = P \times A = (h\rho g)(\pi(2r)^2) \\ = 4\pi hr^2\rho g$$

Ratio, Thrust : Weight

$$= 4\pi hr^2\rho g : \frac{7}{3}\pi hr^2\rho g \\ = 12 : 7$$

Q. 17. (i) $P = h\rho g = \left(\frac{1}{2}\right)(1,000)g = 500g \text{ N/m}^2$

(ii) $T = P \times A$

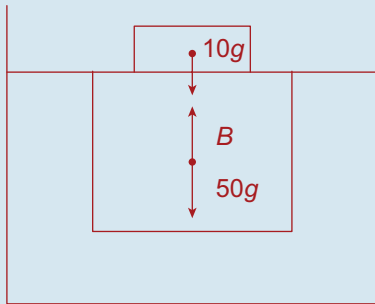
$$= (500g)\left(\pi\left(\frac{1}{8}\right)^2\right) \\ = \frac{125}{16}\pi g \text{ N}$$

(iii) $W = V\rho g$

$$= \frac{1}{3}\pi\left(\frac{1}{2}\right)\left\{\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)\left(\frac{1}{8}\right) + \left(\frac{1}{8}\right)^2\right\}(1,000)g \\ = \frac{875}{16}\pi g \\ \therefore \frac{\text{Weight}}{T} = \frac{7}{1}$$

Q. 18. Relative density of the wood = $\frac{3}{4} = 0.75$

$$\therefore \text{Volume} = \frac{M}{\rho} = \frac{50}{750} = \frac{1}{15} \text{ m}^3$$



$$B = 50g + 10g = 60g = \text{Weight of liquid}$$

$$\Rightarrow 60g = \left(\frac{1}{15}\right)\rho g$$

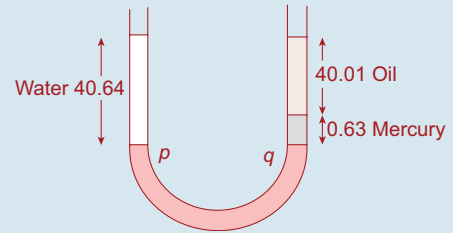
$$\Rightarrow \rho = 60 \times 15 = 900$$

$$\Rightarrow s = 0.9$$

Q. 19. (i) $M = \rho V$

$$= 13,600\left(\frac{1}{2}\right) = 6,800 \text{ kg} \\ = 6.8 \text{ tonnes}$$

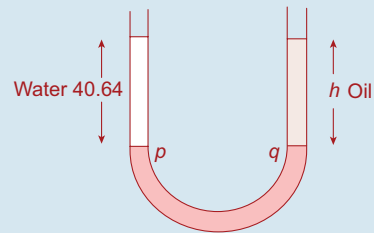
(ii)



Pressure at p = Pressure at q

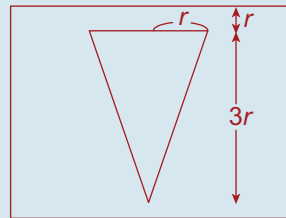
$$\therefore (40.64)(1,000)g = (40.01)\rho g \\ + (0.63)(13,600)g \\ \Rightarrow \rho = 801.6 \text{ kg/m}^3$$

(iii)



$$(0.64)(1,000)g = h(801.6)g \\ \Rightarrow h = 50.7 \text{ cm} \\ = 507 \text{ mm}$$

Q. 20.



(i) Pressure = $h\rho g = r\rho g$

$$\text{Thrust} = P \times A = r\rho g(\pi r^2) = \pi r^3\rho g \text{ N}$$

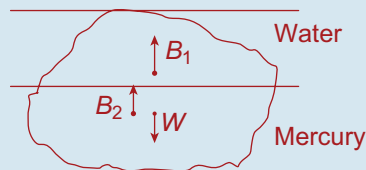
(ii) $B = V\rho g = \left(\frac{1}{3}\pi r^2(3r)\right)\rho g = \pi r^3\rho g$

$$B = F_u - F_d$$

$$\pi r^3\rho g = F_u - \pi r^3\rho g$$

$$F_u = 2\pi r^3\rho g \text{ N}$$

Q. 21.



$$W = V\rho g = (v_1 + v_2)(7,800)g \\ = 7,800(v_1 + v_2)g$$

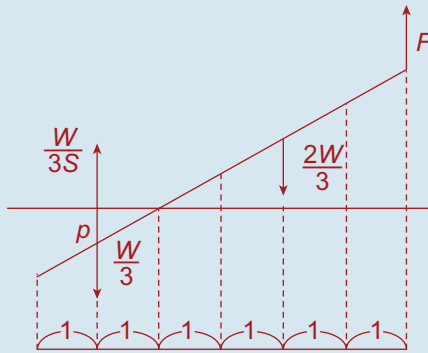
$$B_1 = v_1(1,000)g = 1,000v_1g$$

$$B_2 = v_2(13,600)g = 13,600v_2g$$

Since the body is in equilibrium
 $B_1 + B_2 = W$
 $\Rightarrow 1,000v_1g + 13,600v_2g = 7,800(v_1 + v_2)g$
 $\Rightarrow 5,800v_2 = 6,800v_1$
 $\Rightarrow \frac{v_1}{v_2} = \frac{58}{68} = \frac{29}{34}$

Exercise 9E

Q. 1. (i)

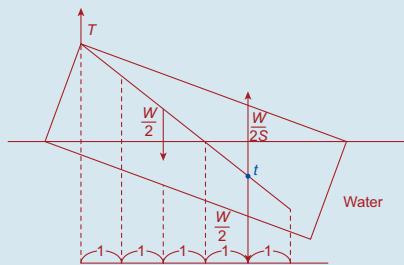


① $F + \frac{W}{3s} = W$

② Taking moments about p :
 $\frac{2W}{3}(3) = F(5) \Rightarrow F = \frac{2}{5}W$

(ii) ① $\Rightarrow \frac{2}{5}W + \frac{W}{3s} = W$
 $\Rightarrow \frac{W}{3s} = \frac{3}{5}W$
 $\Rightarrow s = \frac{5}{9}$

Q. 2. (i)

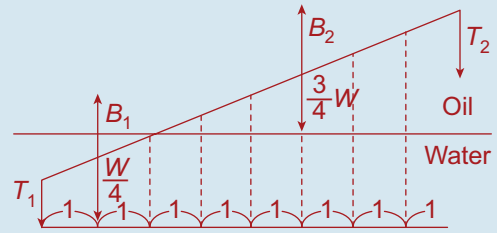


(ii) ① $T + \frac{W}{2S} = W$

② (Taking moments about t)
 $\frac{W}{2}(2) = T(4) \Rightarrow T = \frac{1}{4}W \left(\therefore B = \frac{3}{4}W \right)$

(iii) ① $\Rightarrow \frac{1}{4}W + \frac{W}{2S} = W$
 $\Rightarrow \frac{W}{2S} = \frac{3}{4}W$
 $\Rightarrow s = \frac{2}{3}$

Q. 3.



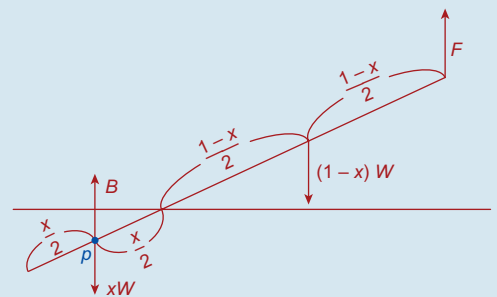
$B_W = \frac{W}{S} \Rightarrow B_1 = \frac{W/4}{3/4} = \frac{W}{3}$

$B_L = S_L B_W = S_L \left(\frac{W}{S} \right) \Rightarrow B_2 = (0.9) \left(\frac{3W}{4} \right) = \frac{9W}{10}$

① $\frac{W}{3} + \frac{9W}{10} = T_1 + \frac{W}{4} + \frac{3}{4}W + T_2$
 $\Rightarrow T_1 + T_2 = \frac{7W}{30}$

② (Taking moments about the lower end)
 $\frac{W}{3}(1) + \frac{9W}{10}(5) = \frac{W}{4}(1) + \frac{3}{4}W(5) + T_2(8)$
 $\Rightarrow T_2 = \frac{5W}{48}$
 $\Rightarrow T_1 = \frac{7W}{30} - \frac{5W}{48}$
 $= \frac{31W}{240}$

Q. 4.



Let W = the weight of the rod.

Let x = the length of the submerged part.

$B_W = \frac{W}{S} \Rightarrow B = \frac{xW}{0.36} = \frac{25xW}{9}$

① $\frac{25xW}{9} + F = W$

② (Taking moments about p).
 $(1-x)W \left(\frac{x}{2} + \frac{1-x}{2} \right) = F \left(\frac{x}{2} + 1-x \right)$
 $\Rightarrow (1-x)W \left(\frac{1}{2} \right) = F \left(1 - \frac{x}{2} \right)$
 $\Rightarrow F = \frac{(1-x)W}{2-x}$

Putting this result into equation ① gives:

$$\frac{25xW}{9} + \frac{(1-x)W}{(2-x)} = W$$

... Multiply by $\frac{9(2-x)}{W}$

$$\Rightarrow 25x(2-x) + 9(1-x) = 9(2-x)$$

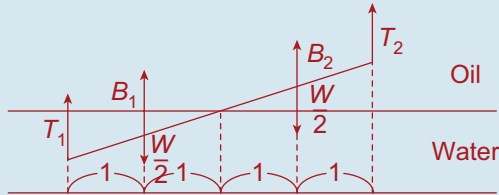
$$\Rightarrow 25x^2 - 50x + 9 = 0$$

$$\Rightarrow (5x-1)(5x-9) = 0$$

$$\Rightarrow x = \frac{1}{5} \text{ m } (x = \frac{9}{5} \text{ m is too long)}$$

Answer: 20 cm is submerged.

Q. 5.



$$B_W = \frac{W}{S} \Rightarrow B_1 = \frac{\frac{1}{2}W}{6} = \frac{W}{12}$$

$$B_L = S_L B_W = S_L \left(\frac{V}{S} \right) = 0.8 \left(\frac{\frac{1}{2}W}{6} \right) = \frac{W}{15}$$

$$T_1 + \frac{W}{12} + \frac{W}{15} + T_2 = W$$

$$\Rightarrow T_1 + T_2 = \frac{51}{60} W$$

(Taking moments about the lower end).

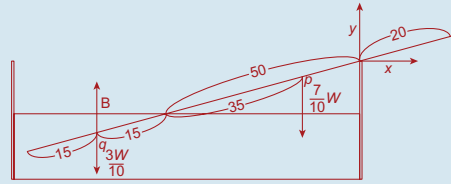
$$\textcircled{1} + \frac{W}{15}(3) + T_2(4) = \frac{W}{2}(1) + \frac{W}{2}(3)$$

$$\Rightarrow T_2 = \frac{103}{240} W$$

$$\Rightarrow T_1 = \frac{51}{60} W - \frac{103}{240} W$$

$$= \frac{101}{240} W$$

Q. 6. (i)



Let x and y be the horizontal and vertical components of the reaction at p , $x = 0$ since no other forces act along the vertical. Therefore, the reaction at p is vertical. We shall henceforth call it R .

$$\text{(ii) } B_W = \frac{W}{S}$$

$$\Rightarrow B = \frac{\frac{3}{10}W}{S} = \frac{3W}{10S}$$

$$\textcircled{1} \frac{3W}{10S} + R = W$$

$$\textcircled{2} \text{ (Taking moments about } q)$$

$$\frac{7}{10}W(50) = R(65)$$

$$\Rightarrow R = \frac{7}{13}W$$

Putting this into equation ① gives:

$$\frac{3W}{10S} + \frac{7}{13}W = W$$

$$\Rightarrow \frac{3W}{10S} = \frac{6W}{13}$$

$$\Rightarrow S = \frac{39}{60}$$

$$= \frac{13}{20}$$