2012 Q9.

(a) $m = \rho V$

$$m_{ss} = m_i + m_c + m_n$$

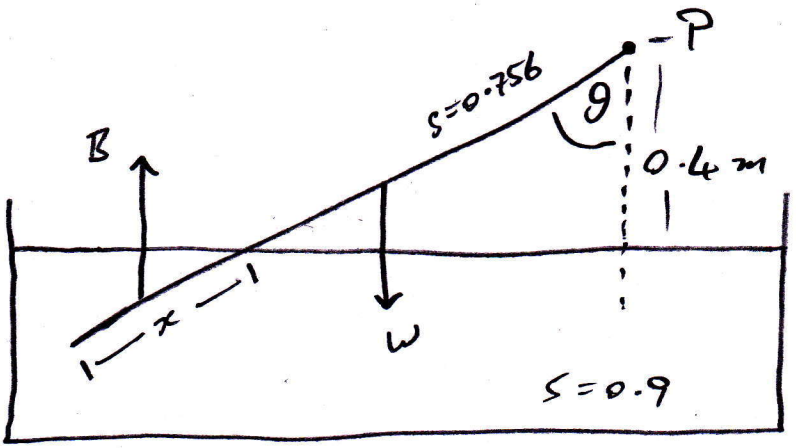
$$\rho V = (7800 \times 0.7V) + (7200 \times 0.2V) + (8900 \times 0.1V)$$

$$\Rightarrow \quad \rho = 5460 + 1440 + 890$$

$$= 7790$$

$$\Rightarrow \quad S = 7.79$$

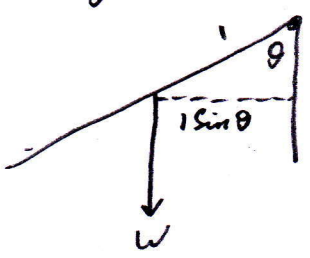
(b) (i)

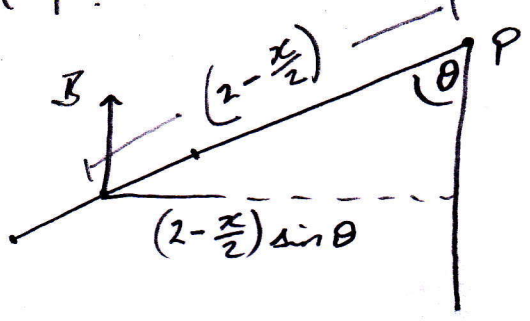


Note:
Weight of immersed part of the rod is $\frac{\text{length immersed}}{\text{total length}} \times W$

Buoyancy in the liquid is $\dfrac{\frac{x}{2} W \times 0.9}{0.756}$

Taking moments about P:





$$\Rightarrow W \times 1 \sin\theta = B \times \left(2 - \frac{x}{2}\right) \sin\theta$$

$$\Rightarrow W = B\left(2 - \frac{x}{2}\right)$$

$$\Rightarrow W = \left(\frac{\frac{x}{2} W \times 0.9}{0.756}\right)\left(2 - \frac{x}{2}\right)$$

$$\Rightarrow 0.756 = \left(\frac{x}{2} \times 0.9\right)\left(2 - \frac{x}{2}\right)$$

$$\Rightarrow 0.756 = 0.9x - \frac{0.9x^2}{4}$$

$$\Rightarrow 3.024 = 3.6x - 0.9x^2$$

$$\Rightarrow 0.9x^2 - 3.6x + 3.024 = 0$$

$$\Rightarrow x^2 - 4x + 3.36 = 0$$

$a = 1$
$b = -4$
$c = 3.36$

$$\Rightarrow x = \frac{4 \pm \sqrt{(-4)^2 - 4(1)(3.36)}}{2(1)}$$

$$= \frac{4 \pm \sqrt{2.56}}{2}$$

$$= 2.8 \text{ m or } 1.2 \text{ m}$$

Rod lengths $= 2$ m $\Rightarrow$ Ans $= 1.2$ m

(ii)

$$\cos\theta = \frac{0.4}{2 - 1.2} = \frac{1}{2}$$

$$\Rightarrow \theta = 60^\circ$$