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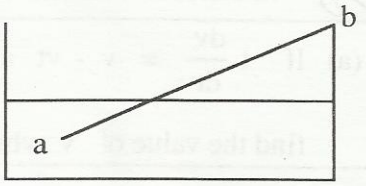
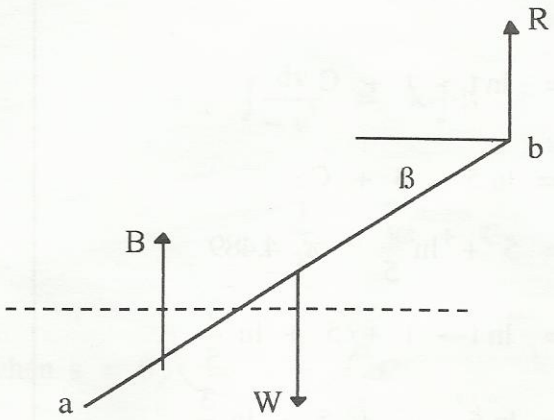
9 (b) A thin uniform rod [ab] of length ℓ and relative density s is in equilibrium in an inclined position with the end a immersed in a container of water and the end b supported on the edge of the container.

Show that the length of the immersed part of the rod is $\ell(1 - \sqrt{1 - s})$.





Let x = length of immersed part

Resolve vertically $R + B = W$ 5

$$B = \frac{W_I s_L}{s} = \frac{xW}{\ell s}$$

Take moments about b

$$B\left(\ell - \frac{x}{2}\right)\cos\beta = W \tfrac{1}{2}\ell\cos\beta \qquad 5{,}5$$

$$\frac{xW}{\ell s}\left(\ell - \frac{x}{2}\right) = W \tfrac{1}{2}\ell$$

$$\Rightarrow \quad x^2 - 2\ell x + \ell^2 s = 0$$

$$\Rightarrow \quad x = \ell(1 - \sqrt{1 - s}) \qquad \text{as } x < \ell \qquad 5$$

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