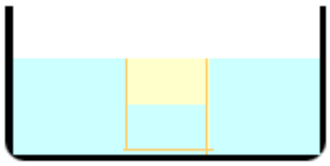
75 (a).

Problem 15.49P (HRW)

A glass beaker, partially filled with water, is placed in a sink. The beaker has a mass of 390 g *and an interior volume of* 500 cm^3. *Sink is slowly filled with water and by experiment it is found that if beaker is less than half full it floats; and if it is more than half full, it remains on the bottom of the sink as the water rises to its rim. We have to find the density of the material of which the beaker is made of.*

Solution:

The statement of the problem is best illustrated through a diagram.



Maximum buoyant force is obtained when water in the sink is up to the brim of the beaker. In that situation maximum volume of water is displaced by the beaker. The maximum volume of water that can be displaced is the sum of the volume of the material of which the

beaker is made of plus the interior capacity of the beaker. This volume is

$$V = \left(\frac{390}{\rho} + 500 \right) \text{ cm}^3,$$

where ρ is the density in g/cm^3 of the material of the beaker and 500 cm^3 is the interior volume of the beaker. Thus, the maximum buoyant force on the beaker is

$$F_{\max} = \left(\frac{390}{\rho} + 500 \right) g.$$

We have taken density of water as 1 g/cm^3. From the data given in the problem, we note that $F_{\max}$ balances weight of $(390 + 250)g$. This gives the equation

$$\left(\frac{390}{\rho} + 500 \right) = 390 + 250 \ .$$

Solving this algebraic equation, we find that the density of the material with which beaker is made of is

$$\rho = 2.79 \text{ g cm}^{-3}.$$