Q- The gravitational force exerted on a solid object is 5.00N. When the object is suspended from a spring scale and submerged in water, the scale reads 3.50N. Find the density of the object.

This problem is based on Archimedes' Principle.

If the mass of the object is m then

Weight of the body in air W = mg = 5.00 N

Weight of the body when submerged in water W' = 3.50 N

Apparent loss in weight of the object = W - W'

Hence the weight of displaced water will also be W_W = W - W' ----- (1)

Now if V be the volume of the object, then the volume of displaced water will also be V and hence

Mass of the displaced water = $V*\rho_W$

Here ρ_W is the density of water

And the weight of the displaced water $W_W = V*\rho_W*g$ ---------- (2)

From equation 1 and 2 we have

$W - W' = V*\rho_W*g$

Gives $V = (W - W')/ \rho_W*g$

Now as we know that the weight of an object of mass m is mg hence the mass of the object

m = W/g

Hence the density of the object = mass/volume

or $$\rho = \frac{m}{V} = \frac{\frac{W}{g}}{\frac{W - W'}{\rho_W * g}}$$

Gives $$\rho = \frac{W}{W - W'}\rho_W$$

This is the formula based on Archimedes' Principle

Substituting the values we have

$$\rho = \frac{W}{W - W'}\rho_W = \frac{5.00}{5.00 - 3.50} * 1 * 10^3 = 3.33 * 10^3 \text{ Kg /m}^3$$