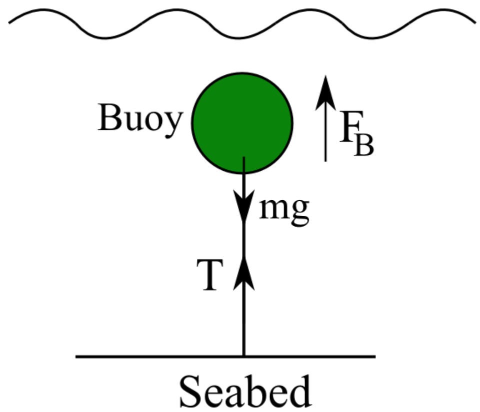
Answer on Question 58946, Physics, Mechanics, Relativity

Question:

A spherical buoy of diameter $0.5\ m$ and mass $35\ kg$ is attached to the seabed by a mooring rope and floats fully submerged as shown to the right. Calculate the tension in the mooring rope. The density of sea water is $1020\ kgm^{-3}$.

Solution:



Let's consider the free-body diagram in the picture above. From the FBD we can see that the buoyant force tends to pull the buoy upward while the force of gravity (or weight of the buoy) tends to pull the buoy downward. So, we can write the tension in the mooring rope as follows:

$$T = F_B - mg,$$

here, F_B is the buoyant force, mg is the force of gravity (or weight of the buoy).

By the definition, the buoyant force is equal to the weight of the sea water displace:

$$F_B = \rho_{sea\ water} V_{sea\ water} g,$$

here, $\rho_{sea\ water}$ is the density of the sea water, $V_{sea\ water} = V_{buoy}$ is the volume of the sea water displaced that is equal to the volume of the buoy, g is the acceleration due to gravity.

We can find the volume of the spherical buoy from the formula:

$$V_{buoy} = \frac{4}{3}\pi R_{buoy}^3,$$

here, R_{buoy} is the radius of the bouy.

Finally, we can calculate the tension in the mooring rope:

$$T = F_B - mg = \rho_{sea\ water}\frac{4}{3}\pi R_{buoy}^3 g - mg = \left(\rho_{sea\ water}\frac{4}{3}\pi R_{buoy}^3 - m\right)g.$$

Let's substitute the numbers:

$$T = \left(1020\frac{kg}{m^3}\cdot\frac{4}{3}\pi\cdot(0.25\ m)^3 - 35\ kg\right)\cdot 9.8\ \frac{m}{s^2} = 311.24\ N.$$

Answer:

$T = 311.24\ N.$