Answer on Question 78046, Physics, Atomic and Nuclear Physics

Question:

A juniper-wood plank measuring $0.46\ ft$ by $1\ ft$ by $14\ ft$ is totally submerged in water.

(a) What is its weight?

(b) What is the buoyant force acting on it?

(c) What is the size and the direction of the net force on it?

Solution:

(a) By the definition, the weight density is the weight per unit volume:

$$D = \frac{W}{V},$$

here, $D = 35\ lb/ft^3$ is the weight density of the juniper-wood plank [1], W is the weight of the juniper-wood plank and V is the volume of the juniper-wood plank.

Then, from this formula we can find the weight of the juniper-wood plank:

$$W = VD = 0.46\ ft \cdot 1\ ft \cdot 14\ ft \cdot 35\ \frac{lb}{ft^3} = 225.4\ lbs.$$

(b) By the definition, the buoyant force is equal to the weight of the water displaced by the juniper-wood plank:

$$F_B = \rho_{water} V_{plank} g = D_{water} V_{plank},$$

here, F_B is the buoyant force, $D_{water} = 62.4\ lb/ft^4$ is the weight density of the water [2] and V_{plank} is the volume of the juniper-wood plank.

Then, we can calculate the buoyant force:

$$F_B = D_{water} V_{plank} = 0.46\ ft \cdot 1\ ft \cdot 14\ ft \cdot 62.4\ \frac{lb}{ft^3} = 402\ lbs.$$

(c) There are two forces acting on the juniper-wood plank when it totally submerged into the water: the weight of the juniper-wood plank directed downward and the buoyant force directed upward. Let's assume the upwards as a positive direction. Then, we can find the size of the net force:

$$F_{net} = F_B - W = 402\ lbs - 225.4\ lbs = 176.6\ lbs.$$

The sign plus indicates that the net force directed upward.

Answer:

(a) $W = 225.4\ lbs.$

(b) $F_B = 402\ lbs.$

(c) $F_{net} = 176.6\ lbs$, upward.

References:

1. https://www.engineeringtoolbox.com/wood-density-d_40.html
2. https://www.engineeringtoolbox.com/water-density-specific-weight-d_595.html