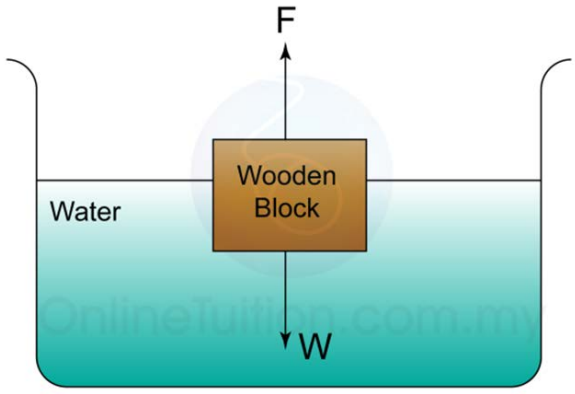
Archimedes' Principle

Archimedes Principle states that when a body is wholly or partially immersed in a fluid it experiences an upthrust equal to the weight of the fluid displaced.

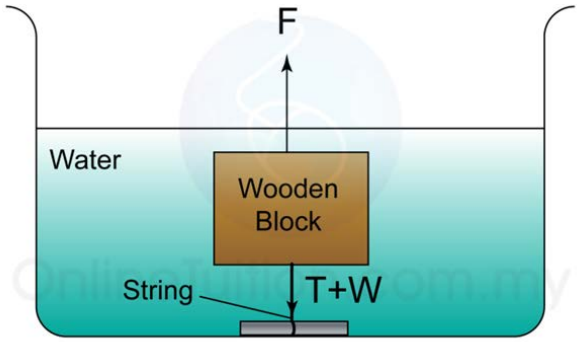
Upthrust, $F = \rho_2 V_2 g$

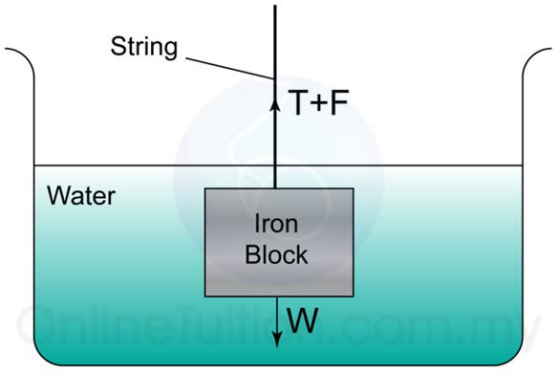
Weight of the object, $W = \rho_1 V_1 g$

ρ_1 = *density of wooden block*
V_1 = *volume of the wooden block*
ρ_2 = *density of water*
V_2 = *volume of the displaced water*
g = *gravitational field strength*



The principle of floatation states that when an object floats in a liquid the buoyant force/upthrust that acts on the object is equal to the weight of the object.





Density of water > Density of wood

F = T + W

$\rho Vg = T + mg$

Density of Iron > Density of water

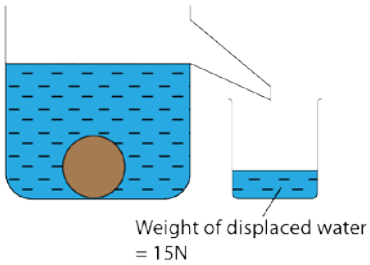
T + F = W

$\rho Vg + T = mg$

Example 1

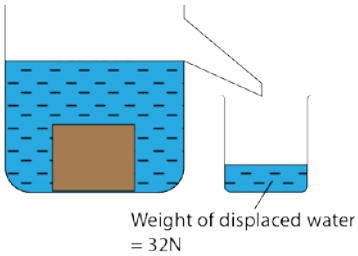
Determine the upthrust acted on the objects immerse in the water below.

a.



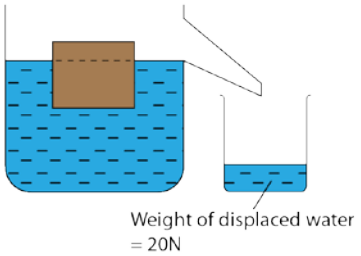
Upthrust =

b.



Upthrust =

c.



Upthrust =

[a. 15N; b. 32N; c. 20N]

[Step by step solution]

Example 2

Archimedes' Principle

An iron block which has volume $0.3m^3$ is immersed in water. Find the upthrust exerted on the block by the water. [Density of water = 1000 kg/m^3]

[3000N]
[Step by step solution]

Example 3

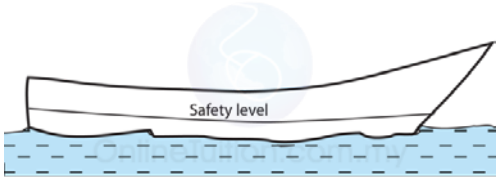


Figure above shows an empty boat floating at rest on water. Given that the mass of the boat is 150kg. Find

a. the upthrust acting on the boat.
b. The mass of the water displaced by the boat.
c. The maximum mass that the boat can load safely if the volume of the boat at the safety level is 3.0 m^3.

[a. 1500N; b. 150kg; c. 2850kg]
[Step by step solution]

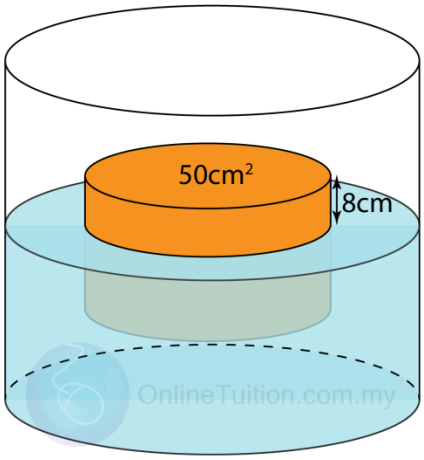
Buoyant Force and Weight of Object

Table below compare the formulae used to calculate the weight of an object immersed in water to the upthrust.

Weight of object	Upthrust/Buoyant Force
$W = \rho V g$	$F = \rho V g$
W = weight of object g = gravitational field strength (10N/kg) ρ **= density of the object** V **= volume of the object**	F = Upthrust (Weight of displaced water) g = gravitational field strength (10N/kg) ρ **= density of the displaced fluid** V **= volume of the displaced fluid** (volume of displaced fluid = volume of the object that immerse in the fluid.)

Archimedes' Principle

Example 4



In figure above, if the height of the cylinder is 20cm, the density of the cylinder is 1200kg/m^3 and the density of the liquid is 1000 kg/m^3, find:

a. The weight of the cylinder

b. The buoyant force acted on the cyclinder

[a. 12N; b. 6N]

[Step by step solution]

Example 5

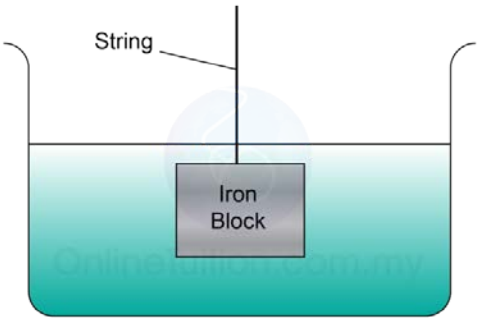
The density and mass of a metal block are 5.0×10^3 kg m^{-3} and 4.0kg respectively. Find the upthrust that act on the metal block when it is fully immerse in water.

[Density of water = 1000 kgm^{-3}]

[8N]

[Step by step solution]

Example 6



A metal block that has volume of 0.2 m^3 is hanging in a water tank as shown in the figure above. What is the tension of the string?

[Density of the metal = 8×10^3 kg m^{-3}, density of water = 1×10^3 kg m^{-3}]

[14,000N]

[Step by step solution]

Archimedes' Principle

Example 7

A wooden sphere of density 0·9 g/cm^3 and mass 180 g, is anchored by a string to a lead weight at the bottom of a vessel containing water. If the wooden sphere is completely immersed in water, find the tension in the string.

[0.4N]
[Step by step solution]

Example 8

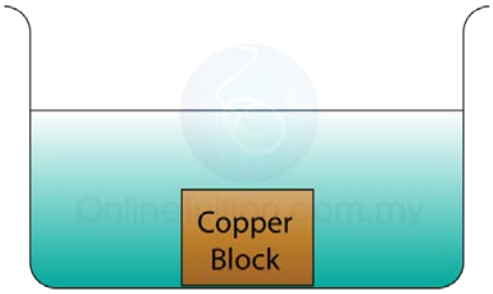


Figure to the left shows a copper block rest on the bottom of a vessel filled with water. Given that the volume of the block is 1000cm3. Find the normal reaction acted on the block.
[Density of water = 1000 kg/m$_3$; Density of copper = 3100 kg/m^3]

[21N]
[Step by step solution]