



# 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,  $W = \rho_1 V_1 g$

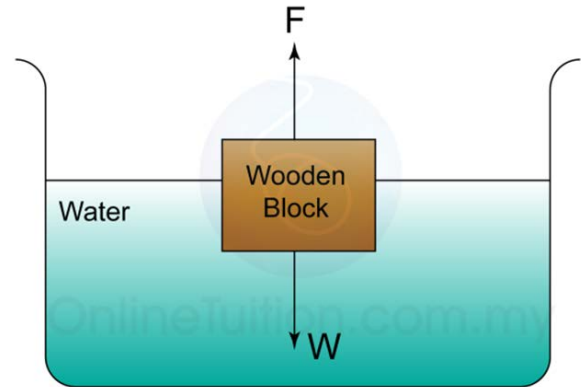
$\rho_1$  = density of wooden block

$V_1$  = volume of the wooden block

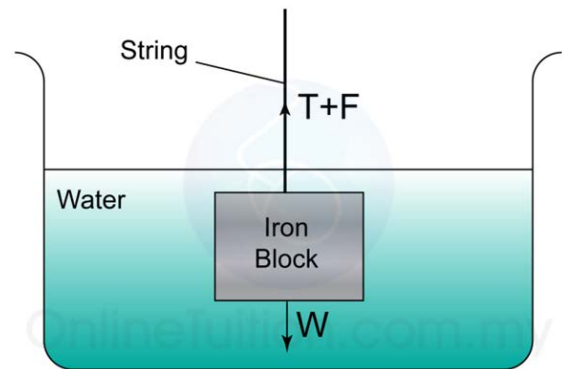
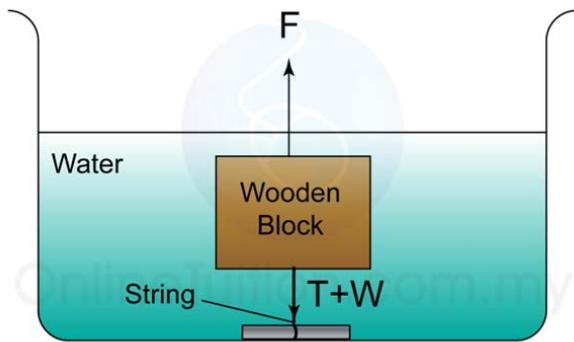
$\rho_2$  = density of water

$V_2$  = 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

$$F = T + W$$
$$\rho V g = T + mg$$

Density of Iron > Density of water

$$T + F = W$$
$$\rho V g + T = mg$$

## Example 1

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

<p>a</p> <p>Weight of displaced water = 15N</p> <p>Upthrust =</p>	<p>b</p> <p>Weight of displaced water = 32N</p> <p>Upthrust =</p>	<p>c</p> <p>Weight of displaced water = 20N</p> <p>Upthrust =</p>
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[a. 15N; b. 32N; c. 20N]

[[Step by step solution](#)]

## Example 2

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# Archimedes' Principle

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

[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  $150\text{kg}$ . Find

- the upthrust acting on the boat.
- The mass of the water displaced by the boat.
- The maximum mass that the boat can load safely if the volume of the boat at the safety level is  $3.0\text{ m}^3$ .

[a.  $1500\text{N}$ ; b.  $150\text{kg}$ ; c.  $2850\text{kg}$ ]

[\[Step by step solution\]](#)

### Buoyant Force and Weight of Object

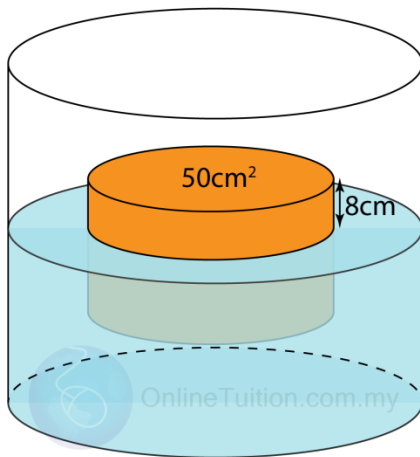
Table below compare the formulae used to calculate the weight of an object immersed in water to the upthrust.

Weight of object	Upthrust/Buoyant Force
$W = \rho Vg$	$F = \rho Vg$
<p><math>W</math> = weight of object  <math>g</math> = gravitational field strength (<math>10\text{N/kg}</math>)  <math>\rho</math> = <b>density of the object</b>  <math>V</math> = <b>volume of the object</b></p>	<p><math>F</math> = Upthrust (Weight of displaced water)  <math>g</math> = gravitational field strength (<math>10\text{N/kg}</math>)  <math>\rho</math> = <b>density of the displaced fluid</b>  <math>V</math> = <b>volume of the displaced fluid</b>            (volume of displaced fluid = volume of the object that immerse in the fluid.)</p>



# Archimedes' Principle

## Example 4



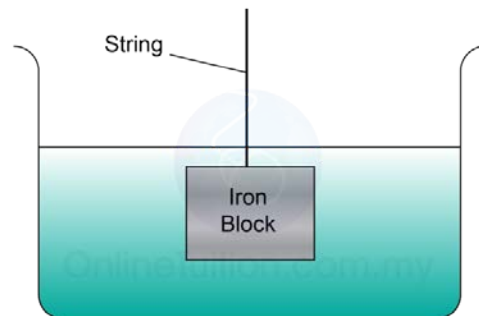
In figure above, if the height of the cylinder is 20cm, the density of the cylinder is  $1200\text{kg/m}^3$  and the density of the liquid is  $1000\text{kg/m}^3$ , find:

- a. The weight of the cylinder
- b. The buoyant force acted on the cylinder

[8N]

[\[Step by step solution\]](#)

## Example 6



A metal block that has volume of  $0.2\text{ m}^3$  is hanging in a water tank as shown in the figure above. What is the tension of the string?  
[ Density of the metal =  $8 \times 10^3\text{ kg m}^{-3}$ , density of water =  $1 \times 10^3\text{ kg m}^{-3}$ ]

[a. 12N; b. 6N]

[\[Step by step solution\]](#)

## Example 5

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

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

[14,000N]

[\[Step by step solution\]](#)



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## Example 7

A wooden sphere of density  $0.9 \text{ g/cm}^3$  and mass  $180 \text{ g}$ , 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.

## Example 8

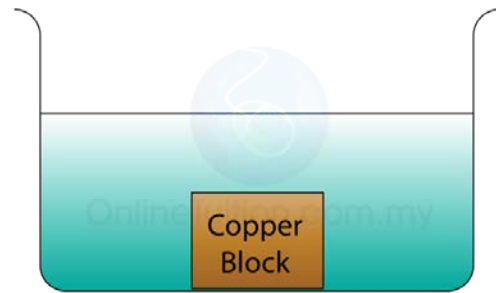


Figure to the left shows a copper block rest on the bottom of a vessel filled with water. Given that the volume of the block is  $1000 \text{ cm}^3$ . Find the normal reaction acted on the block.

[Density of water =  $1000 \text{ kg/m}^3$ ; Density of copper =  $3100 \text{ kg/m}^3$ ]

[0.4N]

[\[Step by step solution\]](#)

[21N]

[\[Step by step solution\]](#)