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Pressure

Pressure is defined as force per unit area.

$$Pressure = \frac{Force}{Area}$$

$$Pressure = \frac{Newton}{(metre)^2}$$

$$1\ Pa = 1N/m^2$$

Which of the following exerts a greater pressure?

A woman of mass 70kg stepping on your foot with a single stiletto heel or an elephant weighing 1 tonne standing on one leg.

Area of a stiletto heel = $0.25cm^2$

Area of elephant foot = $0.25m^2$

$$Pressure_W = \frac{Force}{Area} = \frac{700N}{0.000025m^2} = 28000000Pa$$

$$Pressure_E = \frac{Force}{Area} = \frac{10000N}{0.25m^2} = 40000Pa$$

By calculating the pressure exerted by both the stiletto heel and the elephant's foot, it can be seen that the stiletto heel exerts a larger pressure than the elephant's foot.

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Density $(\boldsymbol{\rho})$

Density is defined as mass per unit volume.

$$Density = \frac{Mass}{Volume}$$

$$Density = \frac{kg}{m^3}$$

$$Density = kg/m^3$$

One of the most common uses of density is in how different materials interact when mixed together. Wood floats in water because it has a lower density, while an anchor sinks because the metal has a higher density. Helium balloons float because the density of the helium is lower than the density of the air.

Relative Density

$$Relative\ Density = \frac{Density\ of\ substance}{Density\ of\ Water}$$

Relative density has no units.

If a substance A has a relative density of 4 then this means that substance A is 4 times denser than water. Hence if substance B has a relative density of 6 then it is 1.5 times denser than substance A.

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Pressure in Fluids

$$Density(\rho) = \frac{Mass}{Volume}$$

$$\therefore Mass = Volume \times Density$$

$$Pressure = \frac{Force}{Area}$$

$$Force = weight\ of\ water = mass\ of\ water \times acceleration\ due\ to\ gravity$$

$$Force = mass \times gravity$$

$$Force = Volume \times Density \times gravity$$

$$Force = Area \times height \times Density \times gravity$$

$$Pressure = \frac{Force}{Area}$$

$$Pressure = \frac{\cancel{Area} \times height \times Density \times gravity}{\cancel{Area}}$$

$$Pressure = Height \times Density \times gravity = h\rho g$$

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Characteristics of Pressures within A Fluid

1. The pressure at one point within a fluid is the same in all directions.

When the direction of the thistle funnel is changed at the same level within the container of water the pressure within the thistle funnel remains constant.

2. The pressure is the same within the fluid at the same horizontal level. The pressure is not dependent upon the shape or width of the tube.

3. Pressure within a fluid increases with depth.

4. Pressure of a fluid changes with density. The denser the fluid the greater is the pressure.

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The Manometer

The manometer is U shaped and is used to measure pressure. When the manometer is unconnected, the level of the fluid on both arms of the U is at the same horizontal level. When the manometer is connected, a pressure is exerted on the fluid causing a difference in height.

The pressure within a fluid at the same horizontal level is the same. The pressure being measures is the pressure at A. The pressure at A is equal to the pressure at B. The pressure at B can be calculated using the formula, $P = h\rho g$.

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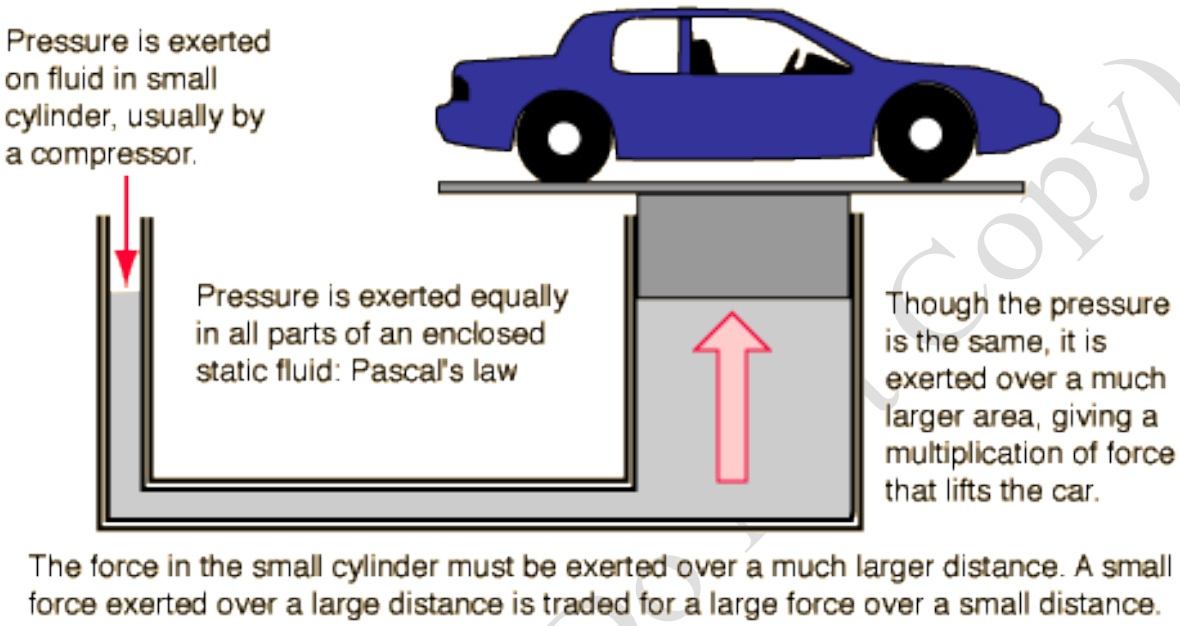
The Hydraulic Jack



In the hydraulic jack there are 2 pistons, a small piston and one very large piston. A force is applied using the small piston since the area of the piston is small then the pressure created is high. This pressure is exerted uniformly throughout the fluid. This pressure is exerted onto the larger piston. Due to the very large area of large piston, the force by the large piston is large. The hydraulic jack is essentially a force multiplied.

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Archimedes Principle

Archimedes principle states that for any body that is wholly or partially immersed in a fluid, the weight of fluid displaced is equal to its up thrust.

Up Thrust

This is the upward force that acts on the body that is exerted by the fluid.

Fluid

A fluid is anything that can flow, ie, gases or liquids.

Experiment to Demonstrate Archimedes Principle

Method:

1. The object is first weighed using an appropriate scale as shown in the diagram.
2. This weight is recorded.
3. The weight is then placed in the prepared eureka can (displacement can).
4. The new weight shown on the scale is recorded.
5. The fluid displaced from the eureka can is also weighed.

Observations:

The drop in weight of the object when placed within the fluid is equal to the weight of the fluid displaced.

Floating and Sinking

1. Objects A and B float whereas object C sinks. This means that the objects A and B are able to displace enough fluid to create an up thrust that is equal to its weight. For an object to float, the up thrust must be equal to the weight of the object.
2. Object B floats better than object A. This occurs because object B needs to displace less fluid to create and up thrust equal to its weight. Object A needs to displace a larger volume of fluid to create an up thrust equal to its weight. This means that object B is less dense than object A. Since both objects float within the fluid, then the densities of both objects are less than water.
3. Object C sinks in the fluid. This means that is it unable to displace enough fluid to create and up thrust equal to its weight. This means that object C is denser than the fluid.

Further Reading:

1. http://www.school-for-champions.com/science/fluid_pressure.htm#.VDr9Oht0zIU
2. http://www.eballoon.org/balloon/how-it-works.html
3. http://science.howstuffworks.com/transport/engines-equipment/submarine1.htm
4. http://www.youtube.com/watch?v=EzbK81BuXYA
5. http://www.youtube.com/watch?v=ChK1en0pxi0
6. http://www.youtube.com/watch?v=ASzMRoQKXaA
7. http://www.youtube.com/watch?v=ROXYr_SzNW4
8. http://www.youtube.com/watch?v=MK_cG85iOO4
9. http://www.youtube.com/watch?v=xV6GbvJ9ywY
10. http://www.youtube.com/watch?v=sTxriJ5BHdo
11. http://www.youtube.com/watch?v=dqYwCOO33Eg