PRESSURE

Pressure in Solids

Pressure is defined as the force acting normally per unit surface area (in a perpendicular direction). i.e. it depends on the force applied and the direction to which the force is applied.

Formula:

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

Units: Pa (Pascals)

OR

N/m^2

Example Question

Calculate the pressure under a gir1's foot in pascals if her mass is 33.6 kg and the area under her shoe is 165 cm^2.

Pressure in Fluids

Pressure in liquids

Pressure in liquids increases with depth, this is caused by the weight of the liquid above (i.e. the weight of the liquid is proportional to the depth of the liquid).

Experiments have Shown that:

i. The pressure in a liquid is proportional to the depth of the liquid (pressure increases with depth) and the density of the liquid

ii. The pressure is the same at all points at the same depth in the same liquid.

iii. The pressure acts equally in all directions in a liquid.

iv. The pressure of a liquid only depends on the height

v. The pressure do not depend of the shape of the container

vi. The pressure in a liquid is independent of the area.

We can calculate the pressure in a liquid by using:

Pressure in liquids = hpg

Where: h = height (m)
p = density (kg/m^3)
g = gravity (N/kg)

Pressure in Gases

U-tube manometer

This instrument is used to measure pressure. Since the air pressure acts down on the liquid surfaces on both sides, then the liquid levels are equal. However when the pressure is greater on one side, the liquid level changes until the pressure of the extra liquid balances the pressure difference.

Pressure at A = Pressure at B

Pressure at B = PA (atmospheric pressure) + Liquid/excess pressure

Mercury Barometer

We can use the mercury barometer to measure atmospheric pressure. It uses the same principle as the U-tube manometer. There is a vacuum above C and the atmospheric pressure is equal to the pressure formula:

PA =hpg

The atmospheric pressure is so large that if we use water in the tube instead of mercury we would need a tube that is 10m high. Using mercury which is 14 times denser than water allows us to measure atmospheric pressure for height 14 times shorter. (PA = 100 000 Pa)

Atmospheric/Air Pressure

This is also known as air pressure. This is caused by the weight of air above us in the earth's atmosphere. It varies above the surface of the earth and with the height of sea level. Atmospheric pressure is measured in millibars.

1 bar = 1000 millibars

1 bar = 100 000 Pa (Normal PA)

Hydraulic Jack

The hydraulic jack is able to use liquid pressure to transfer energy from one place to another because of the following properties:

(i) Liquids cannot be compressed.
(ii) Liquid pressure acts equally in all directions.
(iii) Changes in liquid pressure are transmitted instantaneously to all parts of the liquid.

Advantages of using The Hydraulic Jacks are:

(i) We are able to magnify a small force by using a piston with a larger area.

(ii) We are able to apply a force at any point in any direction.

(iii) We can apply forces to several points simultaneously.

We can use the following formula for the hydraulic jack:

Pressure at 1 = Pressure at 2

Archimedes Principle and Upthrust

Heavy steel ships float even though steel is denser than water, and heavy objects appear lighter and easier to lift than when they are out of water because of an upward force which comes from the water itself. This upward force is called upthrust. Therefore the resultant force is the weight of the object minus the upthrust.

Resultant force = weight of object - upthrust

$R = W - U$

We can use Archimedes principle to describe this effect. This principle states that when a body is wholly or partially submerged in a fluid it experiences an upward force which is equal but opposite to the weight of the fluid displaced by the object.

Floating and Sinking

The law of floatation states that a floating object displaces its own weight of the fluid in which it floats.

Weight of object = Upward forces (upthrust)

W = U

Buoyancy

Case 1;	Case 2:	Case 3:
Floating Boat Weight = Upthrust W = U	A Sinking Rock Weight > Upthrust W > U	A Rising Submarine Upthrust > Weight U > W

Read:
PFC Page 83-84

- Can crushing experiment
- Magdeburg hemisphere
- Sucking
- Rubber suckers
- Syringe