



# WORKSHEET PRESSURE ON A SURFACE

## PRESSURE ON A SURFACE

- Pressure is the perpendicular force that is applied on a surface per unit area.
- As we increase the contact area, pressure decreases and as we decrease the contact area, pressure increases.
- The name of the unit newton per square metre is the pascal.
- We can calculate force by multiplying pressure by area.
- The end of a knife is sharp to increase pressure so it can cut through an object, and the knife's handle is thick to decrease pressure and not harm our hands.

### What pressure is

Forces act on the mass of objects and are applied on their surface. The amount of the perpendicular force acting on a certain area is described as **pressure**. When an object applies a force on another object, the pressure it applies depends on their **contact area**.

We can calculate pressure using the mathematical equation:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

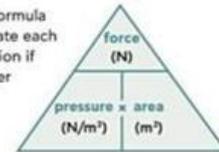
So, pressure is the perpendicular force that is applied on a surface per unit area. As we decrease the contact area, pressure increases, and as we increase the contact area, pressure decreases. As we increase the force, pressure increases and as we decrease the force, pressure decreases.

We measure pressure in **newtons per square metre (N/m<sup>2</sup>)**, since force is measured in newtons (N) and area is measured in square metres (m<sup>2</sup>). N/m<sup>2</sup> is the unit in the SI system for measuring pressure. 1 newton per square metre equals 1 **pascal (Pa)**.

$$1 \text{ Pa} = 1 \frac{\text{N}}{\text{m}^2}$$

N/cm<sup>2</sup> is another unit for measuring pressure.

We can use the formula triangle to calculate each part of the equation if we know the other two quantities.



The pyramid's weight = 0.72 x 10 = 7.2 N.

The contact area is the square face. So pressure = weight / square face

The contact area would be one of the triangular faces, so

Pressure = weight / triangular face

## PRESSURE IN LIQUIDS

### 3.3 Pressure in liquids

Submarines reach great depths at sea. Since pressure increases with depth, submarines have a thick structure and are built with strong materials. Thus, the pressure of the water cannot crush them, while the pressure inside submarines is maintained at normal levels for a human.



The particles of a liquid are in constant motion in all directions. As a result, at a certain point at any depth in the liquid, the pressure coming from all directions is the same from all directions. So, when a very small object such as a small fish is inside a liquid, the same pressure is applied on all its sides.



#### Dive into Science Communicating vessels

The principle of communicating vessels is based on the fact that liquids such as water, contained in vessels connected by a tube, will always seek to reach the same level. This happens regardless of the size or shape of the container.

This can be explained by the fact that for the liquid in the common tube to be balanced it must have the same pressure everywhere. So, the liquid levels in all containers, and therefore the depth, must be the same. Otherwise, the liquid would have to move from points of higher level to lower.

#### Hydraulic systems

When a force is applied to the surface of a liquid enclosed in a container, the pressure is transferred equally throughout the liquid. This principle is known as Pascal's principle, named after Blaise Pascal, a French mathematician, physicist and inventor who lived in the 17th century. So, if the pressure changes at one point in an enclosed liquid, it will also change by the same amount at any other point in it. This principle is very useful as it is true even if the liquid goes around corners in a container. As liquids have no fixed shape, they take the shape of their container. Therefore, when pressure is applied to one end of an enclosed liquid that goes around corners in a container, the pressure will be transferred to the other end. Pascal's principle led to a variety of inventions that have many practical applications such as the invention of hydraulic systems. Hydraulic

systems are made to use this property as a force multiplier. This means that when a small force is applied to a small area, it produces a large force on a larger area. In a simple hydraulic device, a liquid is stored in a container with two ends, one with a larger surface area and one with a smaller surface area. The ends are also called pistons. When a force is exerted on the smaller piston of the liquid, due to transferred pressure, it ends up as a stronger force on the larger piston. An example of a machine that uses the principles of hydraulics is the hydraulic jack. The hydraulic jack is used by mechanics to lift a car. So, if we apply a pressure (pressure<sub>1</sub>) to piston A of the hydraulic system, then the liquid will apply a pressure (pressure<sub>2</sub>) to piston B equal to that which we applied to the piston A.

$$\text{pressure}_1 = \text{pressure}_2$$

#### COMPLETE THE PUZZLE

- The distance the small end of a hydraulic system moves is greater than that of the large end.
- Pressure is transferred throughout a liquid.
- Pressure increases from the top to the bottom of the area.
- The ends of a hydraulic system are also called pistons.
- Hydraulic system use liquids to multiply force.

a. The total weight of the water is  
Weight = \_\_\_\_\_ x 10 = \_\_\_\_\_ N

- b. At half the depth of the barrel there is half the mass of water above, so half the weight

Weight = \_\_\_\_\_ / 2 = \_\_\_\_\_ N and the area there is 0.33m<sup>2</sup>. therefore, the pressure = \_\_\_\_\_ / 0.33 = \_\_\_\_\_ N/m<sup>2</sup>

- c. At the bottom of the barrel, the total weight of the water is exerted at the bottom and the area there is 0.23m<sup>2</sup>. Therefore, the pressure at the bottom is pressure = 1518/0.23 = \_\_\_\_\_ N/m<sup>2</sup>

The pressure the car applies to the large end of the Jack is

Pressure = \_\_\_\_\_ / \_\_\_\_\_ = \_\_\_\_\_ N/m<sup>2</sup>.

## PRESSURE IN GASES

### 3.4 Pressure in gases

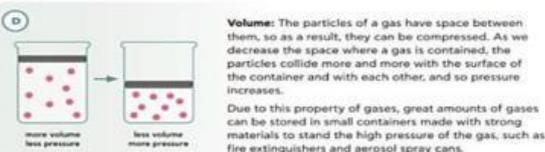
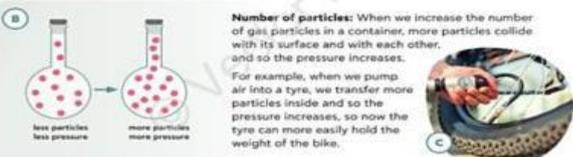
#### Gases and pressure

In gases, particles move around and collide with each other, as they do with other objects. If the gas is in a container, the gas particles collide with the surface of their container. As particles collide, they exert forces on the surface of objects and so they create pressure in the gas.

The particles of a gas move at random in all directions. So, at any certain height, we can feel the pressure from a gas equally from all directions.

Due to the pressure in the gases, a balloon increases in size. By blowing air into a balloon, the pressure increases. Because the balloon is elastic, this causes its surface area to expand.

There are three main factors that affect gas pressure.



- Gas particles have space between them so they can be compressed.
- The particles of a gas collide with each other and with the surface of their container and that creates pressure.
- Earth's atmosphere consists of gases that extend for 1000km above sea level.
- At the sea level, atmospheric pressure is at 100.000N/m<sup>2</sup>, and it decreases as altitude increases.
- The pressure of a gas increases as temperature increases.
- At any certain height, pressure is equal from all directions because the particles of gas move in all directions.