

### **Force (Newtons)**

**Velocity** is measured by distance-over-time (for example, meters-per-second, m/s).

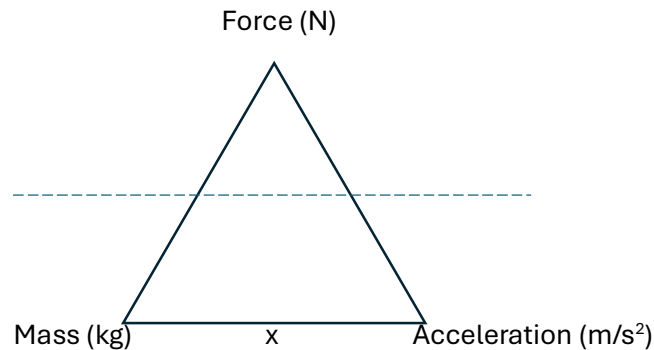
**Acceleration** is the rate of change in velocity. How much is the velocity increasing per second? (m/s-per-second, or  $\text{m/s}^2$ ). If a car was completely stopped, and then after 2 seconds, its velocity is 12 m/s, the average acceleration was  $6 \text{ m/s}^2$ .

On Earth, gravitational acceleration is  $9.81 \text{ m/s}^2$ .

**Force** is mass times acceleration. Mass can be measured in any unit of grams, but for “force” we will use kg as the standard measure of mass. A **Newton** is the standard measure of force in the metric system. **One Newton =  $1 \text{ kg} \times 1 \text{ m/s}^2$**  (the force required to accelerate a 1 kg object  $1 \text{ m/s}^2$ ).

On Earth, the weight of an object with a mass of 1kg will be 9.81 Newtons.

On Earth, the weight of a 0.102 kg object will be 1 Newton. ( $0.102 = 1/9.81$ ), so  $0.102 \times 9.81 = 1$ .



### **Sample Questions:**

**A 2 kg object accelerates at  $3 \text{ m/s}^2$ . What is the force acting on it in Newtons?**

$$2 \text{ kg} \times 3 \text{ m/s}^2 = 6 \text{ kg} \times \text{m/s}^2 = \mathbf{6 \text{ N}}$$

**A car engine exerts a force of 5,000 N on a car with a mass of 1,000 kg. What is the car's acceleration?**

Force / mass = acceleration.

$$5,000 / 1,000 = \mathbf{5 \text{ m/s}^2}$$

**On Earth, an object at rest is exerting a force of 19.62 N. What is the object's mass in grams?**

Force / acceleration = mass; on earth, Acceleration on an object at rest is  $9.81 \text{ m/s}^2$ .

$$19.62 / 9.81 = \mathbf{2 \text{ kg}}$$

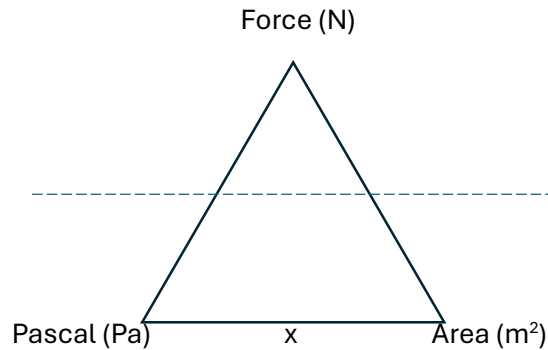
### **Pressure (Pascals)**

Pressure is the amount of force applied to an area.

It is simply  $\text{Pressure} = \text{Force} / \text{Area}$ .

The basic metric unit of pressure is the Pascal (Pa), which is simply:

1 Newton per 1 square meter ( $\text{N}/\text{m}^2$ ).



### **Sample Questions:**

**A force of 200 N is applied to a table through an area of 0.5 m<sup>2</sup>. What is the pressure exerted on the table?**

$$\text{Pa} = 200\text{N} / 0.5\text{m}^2 = \mathbf{400\ Pa}$$

**If a pencil is on the table, with 5 Pa of pressure and an area of 0.2 m<sup>2</sup>, calculate the force (N).**

$$\text{Pa} = \text{N}/\text{m}^2; 5 = \text{N}/0.2 = \mathbf{1\ N}$$

**How much pressure does a person with mass 70kg and a surface area on the bottom of each foot of 0.03m<sup>2</sup> exert when they stand with both feet on the ground on planet Earth.**

First, figure out the persons weight/force in Newtons:  $70\text{kg} \times 9.81\ \text{m}/\text{s}^2 = 686.7\ \text{N}$ .

$$\text{Area of two feet} = 0.03\text{m}^2 \times 2 = 0.06\text{m}^2$$

$$\text{Pressure} = F/A = 686.7 / 0.06 = \mathbf{11,445\ Pa}.$$