TOPIC 2

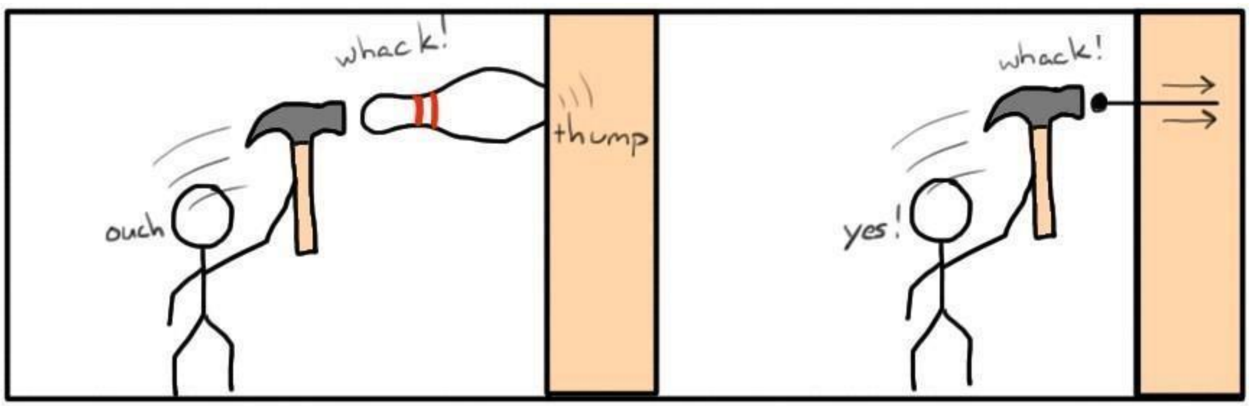
BASIC Air Properties

What is pressure?

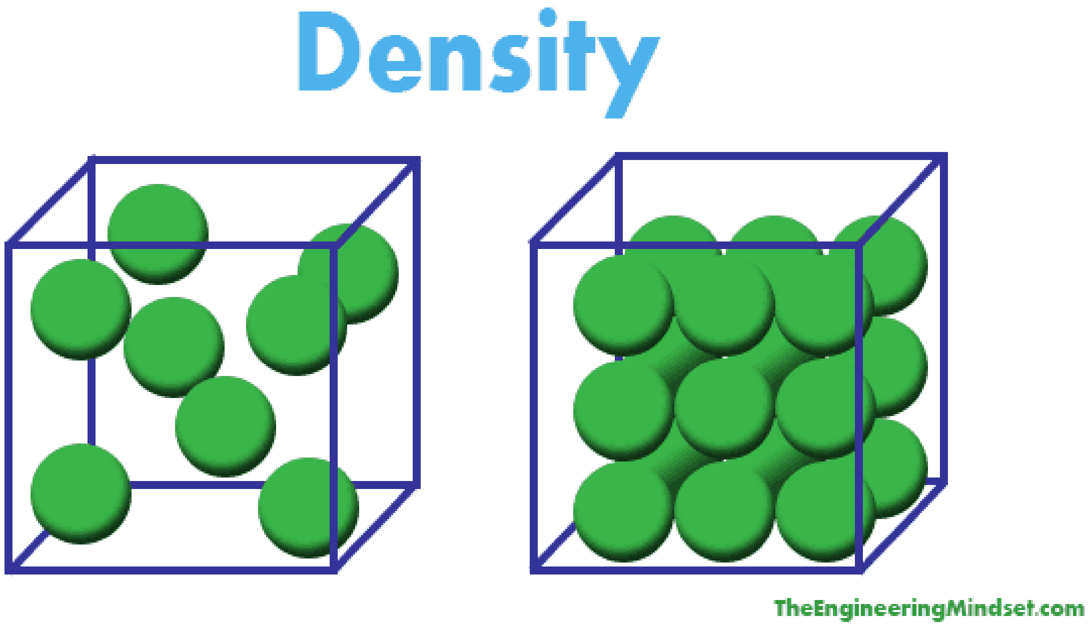
Pressure is kind of like force, but not quite.

What does pressure mean?

If you tried to hammer a bowling pin into the wall, nothing would probably happen except for people deciding to no longer lend you their bowling pins. However, if you hammer with the same force on a nail, the nail would be a lot more likely to penetrate the wall. This shows that sometimes just knowing the magnitude of the force isn't enough: you also have to know how that force is distributed on the surface of impact. For the nail, all the force between the wall and the nail was concentrated into the very small area on the sharp tip of the nail. However, for the bowling pin the area touching the wall was much larger, and therefore the force was much less concentrated.



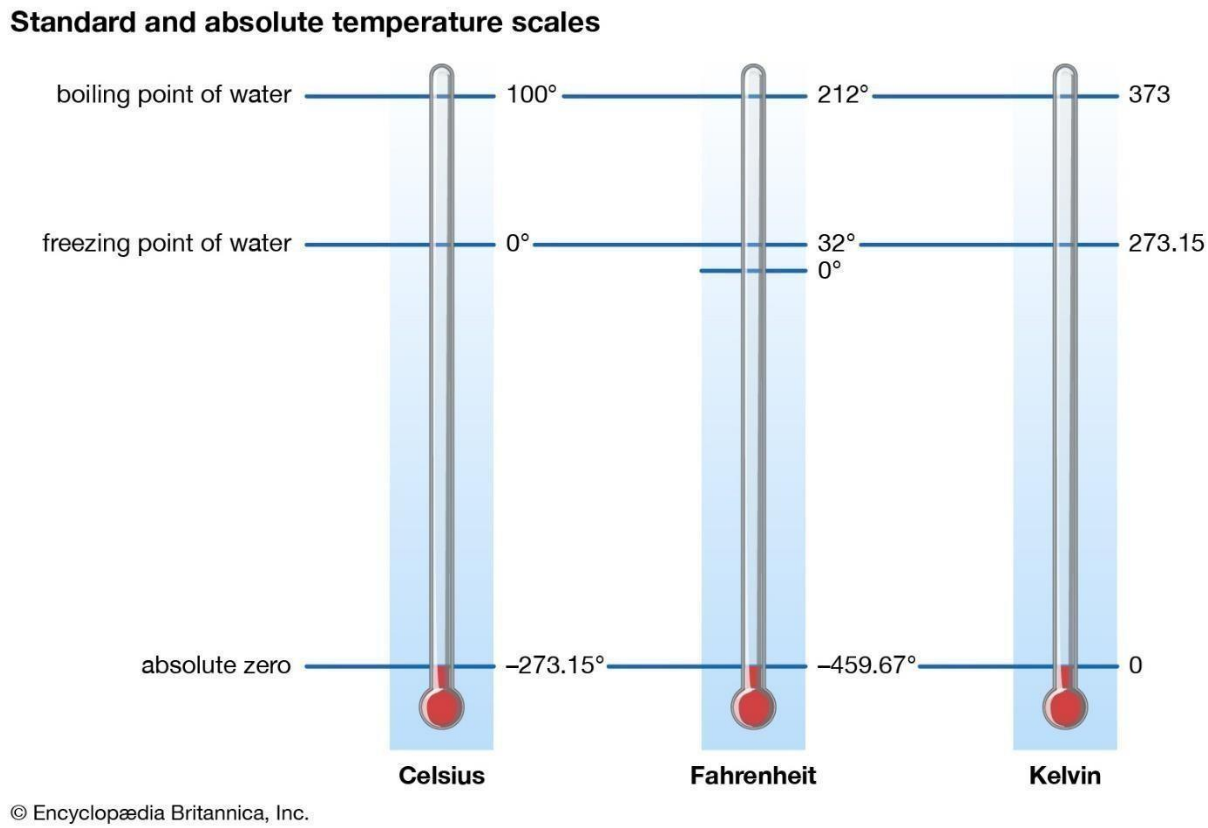
Density



Density, mass of a unit volume of a material substance. The formula for density is = *M*/*V*, where *d* is density, *M* is mass, and *V* is volume. Density is commonly expressed in units of grams per cubic centimeter. For example, the density of water is 1 gram per cubic centimeter, and Earth's density is 5.51 grams per cubic centimeter.

Density can also be expressed as kilograms per cubic meter (in MKS or SI units). For example, the density of air is 1.2 kilograms per cubic meter. The densities of common solids, liquids, and gases are listed in textbooks and handbooks. Density offers a convenient means of obtaining the mass of a body from its volume or vice versa; the mass is equal to the volume multiplied by the density ($M = Vd$), while the volume is equal to the mass divided by the density ($V = M/d$). The weight of a body, which is usually of more practical interest than its mass, can be obtained by multiplying the mass by the acceleration of gravity. Tables that list the weight per unit volume of substances are also available; this quantity has various titles, such as weight density, specific weight, or unit weight. *See also* specific gravity. The expression *particle density* refers to the number of particles per unit volume, not to the density of a single particle, and it is usually expressed as *n*.

Temperature



Temperature, measure of hotness or coldness expressed in terms of any of several arbitrary scales and indicating the direction in which heat energy will spontaneously flow—i.e., from a hotter body (one at a higher temperature) to a colder body (one at a lower temperature). Temperature is not the equivalent of the energy of a thermodynamic system; e.g., a burning match is at a much higher temperature than an iceberg, but the total heat energy contained in an iceberg is much greater than the energy contained in a match. Temperature, similar to pressure or density, is called an intensive property—one that is independent of the quantity of matter being considered—as distinguished from extensive properties, such as mass or volume.

What Is Velocity in Physics?

Velocity is defined as a vector measurement of the rate and direction of motion. Put simply, velocity is the speed at which something moves in one direction. The speed of a car traveling north on a major freeway and the speed a rocket launching into space can both be measured using velocity.
As you might have guessed, the scalar (absolute value) magnitude of the velocity vector is the speed of motion.
In calculus terms, velocity is the first derivative of position with respect to time.
You can calculate velocity by using a simple formula that includes rate, distance, and time.

Velocity Formula

The most common way to calculate the constant velocity of an object moving in a straight line is with this formula: $r = d / t$ r is the rate or speed (sometimes denoted as v for velocity) d is the distance moved t is the time it takes to complete the movement

Units of Velocity

The SI (international) units for velocity are m/s (meters per second), but velocity may also be expressed in any units of distance per time. Other units include miles per hour (mph), kilometers per hour (kph), and kilometers per second (km/s).

Speed, Velocity, and Acceleration

Speed, velocity, and acceleration are all related to each other, though they represent different measurements.
Be careful not to confuse these values with each other.

- **Speed**, according to its technical definition, is a scalar quantity that indicates the rate of motion distance per time. Its units are length and time. Put another way, speed is a measure of distance traveled over a certain amount of time. Speed is often described simply as the distance traveled per unit of time. It is how fast an object is moving.
- **Velocity** is a vector quantity that indicates displacement, time, and direction. Unlike speed, velocity measures *displacement,* a vector quantity indicating the difference between an object's final and initial positions. Speed measures distance, a scalar quantity that measures the total length of an object's path.
- **Acceleration** is defined as a vector quantity that indicates the rate of change of velocity. It has dimensions of length and time over time. Acceleration is often referred to as "speeding up", but it really measures changes in velocity. Acceleration can be experienced every day in a vehicle. You step on the accelerator and the car speeds up, increasing its velocity.

Units

SI units

- Pressure
  - Pascal (Pa)
    - $\frac{N}{m^2}$
- Density
    - $\frac{kg}{m^3}$
- Temperature
    - Celsius (°C)
    - Kelvin (°K)
- Velocity
    - $\frac{m}{s}$ or $\frac{km}{s}$

English Units

- Pressure
    - $\frac{lb}{in^2}$ or $\frac{lb}{ft^2}$
- Density
    - $\frac{slugs}{ft^3}$
- Temperature
    - Fahrenheit (°F)
    - Rankine (°R)
- Velocity
    - $\frac{ft}{s}$ or fps

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3

NOTE: Volumes greater than 1000 l shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

SUMMARY OF BASIC AIR PROPERTIES

1. Pressure P is the force applied perpendicular to the surface of an object per unit area over which that force is distributed. Various units are used to express pressure. Some of these derive from a unit of force divided by a unit of area; the SI unit of pressure, the pascal (Pa), for example, is one newton per square meter (N/m2); similarly, the pound-force per square inch (psi) is the traditional unit of pressure in the imperial and U.S. customary systems.

2. Pressure may also be expressed in terms of standard atmospheric pressure; the atmosphere (atm) is equal to this pressure, and the torr is defined as 1⁄760 of this. Manometric units such as the centimeter of water, millimeter of mercury, and inch of mercury are used to express pressures in terms of the height of column of a particular fluid in a manometer.

3. The density (more precisely, the volumetric mass density; also known as specific mass), of a substance is its mass per unit volume. The symbol most often used for density is ρ although the Latin letter D can also be used. Mathematically, density is defined as mass divided by volume $\rho = \frac{m}{V}$ where ρ is the density, m is the mass, and V is the volume.

4. Temperature is a physical quantity that expresses hot and cold. It is the manifestation of thermal energy, present in all matter, which is the source of the occurrence of heat, a flow of energy, when a body is in contact with another that is colder.

5. Temperature is measured with a thermometer. Thermometers are calibrated in various temperature scales that historically have used various reference points and thermometric substances for definition. The most common scales are the Celsius scale (formerly called centigrade, denoted °C), the Fahrenheit scale (denoted °F), and the Kelvin scale (denoted K), the last of which is predominantly used for scientific purposes by conventions of the International System of Units (SI).

6. The velocity of an object is the rate of change of its position with respect to a frame of reference, and is a function of time. Velocity is equivalent to a specification of an object's speed and direction of motion. Velocity is a fundamental concept in kinematics, the branch of classical mechanics that describes the motion of bodies.

7. Velocity is a physical vector quantity; both magnitude and direction are needed to define it. The scalar absolute value (magnitude) of velocity is called speed, being a coherent derived unit whose quantity is measured in the SI (metric system) as meters per second (m/s) or as the SI base unit of (ms^−1). For example, "5 meters per second" is a scalar, whereas "5 meters per second east" is a vector. If there is a change in speed, direction or both, then the object has a changing velocity and is said to be undergoing an acceleration.