

School of Tomorrow
Addis Ababa
Grade 9 Physics Lessons

Air pressure and atmospheric pressure

Week one

Lesson 1

1. Pressure: -

Pressure is force exerted per unit area.

Anything that exerts pressure is capable of producing change and doing work.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$
$$P = \frac{F}{A}$$

Pressure (P) is a scalar quantity.

In the SI system, the unit of pressure is the **Pascal (Pa)**, which is 1 N/m^2 . Because the Pascal is a small unit, the kilopascal (kPa), equal to 1000 Pa, is more commonly used. The force, F , on a surface is assumed to be perpendicular to the surface area, A .

If a large force is exerted on a small area the pressure is so great.

For example, after an exciting but exhausting lecture, a physics teacher

stretches out for a nap on a bed of nails, as in the figure, suffering no injury and only moderate discomfort. How is this possible?



Explanation If you try to support your entire weight on a single nail, the pressure on your body is your weight divided by the very small area of the end of the nail. The resulting pressure is large enough to penetrate the skin. If you distribute your weight over several hundred nails, however, as demonstrated by the teacher, the pressure is considerably

reduced

because the area that supports your weight is the total area of all nails in contact with your body. (Why is lying on a bed of nails more comfortable than sitting on the same bed? Extend the logic to show that it would be more uncomfortable yet to stand on a bed of nails without shoes.)

2. What causes air pressure?

The thick cloud of air that surrounds Earth has mass and weight. the simplest way to think about air pressure is to treat it as the pressure due to the weight of the air above pushing down on an area. when the air particles are near a surface some will bounce into it and so exert a force on the surface. It is this force that gives rise to a pressure.

3. Atmospheric Pressure

Air pressure and atmospheric pressure

The atmosphere is the layer of air that surrounds the earth. This column of air has a weight, which presses down on you and it is this that gives rise to atmospheric pressure. There is a kind of equilibrium between the pressure in our bodies and the surrounding atmosphere. If you went some where, where the pressure is extremely larger than the atmospheric pressure our bodies would be crushed. For example the body of a deep-sea submerging must be very strong to withstand the crushing effect of pressure due to water at a depth.

How big is atmospheric pressure?

Experimental results show that the atmospheric pressure at the ground level (sea level) has a value of

$$1 \text{ atm} = 101,000 \text{ Pa.}$$

- The heating effect from the sun causes small changes in pressure due to the uneven heating of the earth's surface. This leads to high or low pressure weather systems.
- The height above sea level, or altitude, also has a significant effect on atmospheric pressure. As altitude increases atmospheric pressure decreases.

Some Typical Pressures	
Location	Pressure (Pa)
The center of the Sun	3×10^{16}
The center of Earth	4×10^{11}
The deepest ocean trench	1.1×10^8
Standard atmosphere	1.01325×10^5
Blood pressure	1.6×10^4
Air pressure on top of Mt. Everest	3×10^4
The best vacuum	1×10^{-13}

On every square centimeter of Earth's surface at sea level, the atmospheric gas exerts a force of approximately 10 N, about the weight of a 1-kg object. The pressure of Earth's atmosphere on your body is so well balanced by your body's outward forces that you seldom notice it. You probably become aware of this pressure

only when your ears pop as the result of pressure changes, as when you ride an elevator in a tall building or fly in an airplane. Atmospheric pressure is about 10 N per 1 cm^2 (10^{-4} m^2), which is about

$1.0 \times 10^5 \text{ N/m}^2$, or 100 kPa. Other planets in our solar system also have atmospheres. The pressure exerted by these atmospheres, however, varies widely. For example, the pressure at the surface of Venus is about 92 times the pressure at the surface of Earth, while the pressure at the surface of Mars is less than 1 percent of Earth's.

Class work

Answer the following questions

1. What is atmosphere?
2. What is atmospheric pressure?
3. What is the difference between air pressure and atmospheric pressure?

Air pressure and atmospheric pressure

4. Explain the meaning of the terms atmospheric pressure, absolute pressure, and gauge pressure.
5. The gas pressure inside an inflated rubber balloon is always greater than the air pressure outside. Explain.
6. In which direction does the air pressure push on your body?
7. Why are cloudy nights generally warmer than the clear ones?