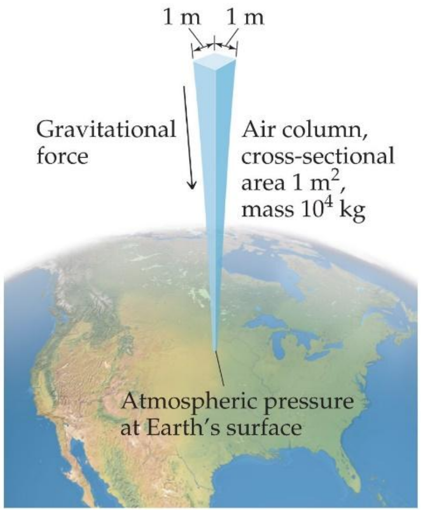
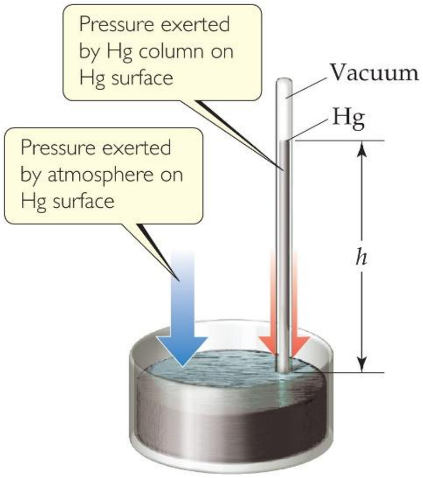
Atmospheric pressure

We all know that the atmosphere of Earth exerts a pressure on all of us. This pressure is the result of a column of air bearing down on us. However, in the seventeenth century, many scientists and philosophers believed that the air had no weight, which we already proved to be untrue in the lab (Remembered the fun you had sucking air out of the POM bottle?). Evangelista Torricelli, a student of Galileo's, proved that air has weight using another experiment. He took a glass tube longer than 760 mm that is closed at one end and filled it completely with mercury. When he inverted the tube into a dish of mercury, some of the mercury flows out, but a column of mercury remained inside the tube. Torricelli argued that the mercury surface in the dish experiences the force of Earth's atmosphere due to gravity, which held up the column of mercury. The force exerted by the atmosphere, which depends on the atmospheric pressure, equals the weight of mercury column in the tube. Therefore, the height of the mercury column can be used as a measure of atmospheric pressure.

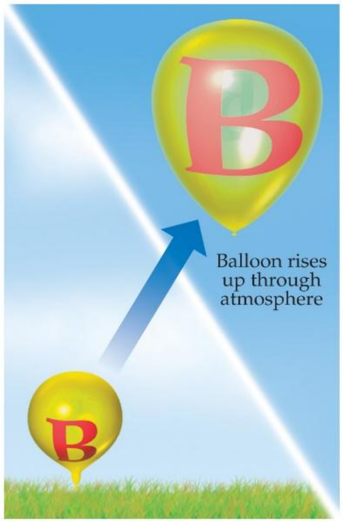




Although Torricelli's explanation met with fierce opposition, it also had supporters. Blaise Pascal, for example, had one of Torricelli's barometers carried to the top of a mountain and compared its reading there with the reading on a duplicate barometer at the base of the mountain. As the barometer was carried up, the height of the mercury column decreased, as expected, because the amount of air pressing down on the mercury in the dish decreased as the instrument was carried higher. These and other experiments eventually prevailed, and the idea that the air has weight became accepted.

The standard atmospheric pressure, which is the air pressure at sea level, is defined based on Torricelli's experiment. It is the pressure that can support a column of mercury 760 mm high.

Examine this figure showing what happens to a balloon as it rises in the atmosphere. Does atmospheric pressure increase or decrease as altitude increases?

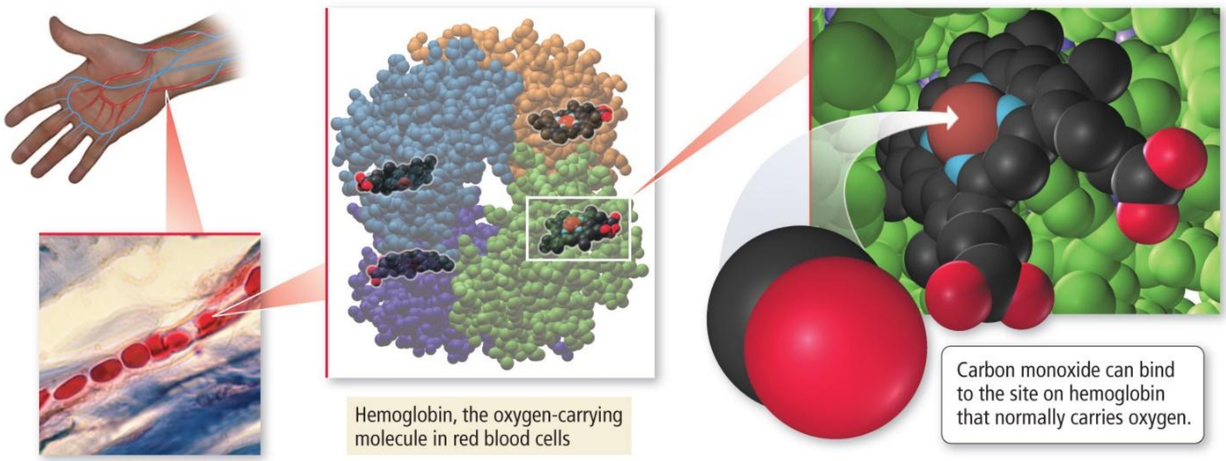


Carbon Monoxide (CO) *Vs* Carbon Dioxide (CO_2)

Carbon monoxide (CO) and carbon dioxide (CO_2) are often mistaken for one another. Both gases are odorless and colorless and target the cardiovascular system. Both gases can enter the body through inhalation, skin and/or eye. Similar symptoms that both gases have in common are headaches, dizziness, seizures, and hallucination.

Most people have a hard time determining the difference and do not realize that vehicle exhaust emits both CO and CO_2. In an indoor environment, this build-up of gas can be hazardous to the health and safety of the individual exposed to it.

CO has been referred to as the “Silent Killer” (The Dangers of Carbon Monoxide). Once CO is inhaled, oxygen levels are displaced in the blood causing vital organs to starve. Therefore, causing people to suffocate and lose consciousness.



CO_2, on the other hand, is referred to as “hypercarbia or hypercapnia” (Carbon Dioxide Poisoning). Since our blood expels CO_2, inhaling more CO_2 would cause the inability for the body to expel the gas.

Since it is extremely difficult to detect CO and CO_2 gases based on the symptoms alone, installing a gas detector is suggested. There are a large range of detectors available on the market; therefore, choosing the right one that suites your need is ideal. Choose a gas detector from a manufacturer that is reputable and has their products tested following certain standards.

Differences between CO and CO_2

Carbon Monoxide	Carbon Dioxide
Doesn't occur naturally in the atmosphere	Occurs naturally in the atmosphere
Result of oxygen starved combustion in improperly ventilated fuel-burned equipment	Natural by-product of human and animal respiration, fermentation, chemical reactions, and combustion of fossil fuels/woods
Generated by any gasoline engine WITHOUT a catalytic converter	Generated by any gasoline engine WITH a catalytic converter
Common type of fatal poisoning	Poisoning is rare
Flammable gas	Non-flammable gas
Symptoms: confusion, nausea, lassitude, syncope, cyanosis, chest pain, abdominal pain	Symptoms: dyspnea, sweating, increased heart rate, frostbite, convulsion, panic, memory problems
Target organ: lungs, blood, central nervous system	Target organ: respiratory system
Based on the Occupational Safety & Health Administration (OSHA) standards, the permissible exposure limit (PEL) is 50 parts per million (ppm).	Based on the OSHA standards, the PEL is 5,000 ppm
Based on the National Institute for Occupational Safety and Health (NIOSH) standards, the recommended exposure limit (REL) is 35 ppm.	Based on the NIOSH standards, the REL is 5,000 ppm

UV radiation, UV Index, sunscreen and sunblock

Every second, light is emitted by the Sun and after some time, reaches our planet. The sunlight that reaches Earth's surface contains different types of light. Some of this light we can see; some we cannot. Part of the sunlight we cannot see contains ultraviolet (UV) light. The UV light in the sunlight can be further divided into UV-A, UV-B and UV-C according to their wavelengths as indicated in the table below.

Table 2.4 Types of UV Radiation

Type	Wavelength	Relative Energy	Comments
UV–A	320–400 nm	Lowest energy	Least damaging and reaches the Earth's surface in greatest amount
UV–B	280–320 nm	Higher energy than UV–A but less energetic than UV–C	More damaging than UV–A but less damaging than UV–C. Most UV–B is absorbed by O_3 in the stratosphere.
UV–C	200–280 nm	Highest energy	Most damaging but not a problem because it is completely absorbed by O_2 and O_3 in the stratosphere

When the UV light falls on your skin and is absorbed, it may cause damage to the skin cells and DNA in the cells. In most cases, your body repairs the damage or the cell dies. However, excessive exposure to UV light over extended periods of time can cause DNA molecules to mutate and lead to skin cancer. Your risk of developing skin cancer depends on many factors such as where you live, how well you protect yourself from the Sun, whether or not you do indoor tanning. Your genetic makeup is another important factor.

Wearing protective sunscreen is one way to reduce the risk of skin cancer. Sunscreen contains compounds that absorb UV-B to some extent together with others that absorb UV-A. The American Academy of Dermatology recommends a sunscreen with a skin protection factor (SPF) of 15 to 30. But wearing sunscreen does not mean that you are completely protected from UV rays.

Wearing protective sunblock is another way to reduce the risk of skin cancer due to UV exposure. These products block the light from reaching your skin. Sunblock creams reflect the light; some absorb UV as well. A familiar example is the white opaque cream used by lifeguards ("lifeguard nose") at a pool or beach. This sunblock contains small white particles of ZnO (zinc oxide) and or TiO_2 (titanium dioxide) and has a track record of safety.

The US centers for Disease Control and Prevention (CDC) warns that the use of tanning booths, tanning beds, and sun lamps in dangerous, particularly for younger people. The reason is straightforward: these booths use both UV-A and UV-B, the same dangerous UV light that are emitted by the Sun.

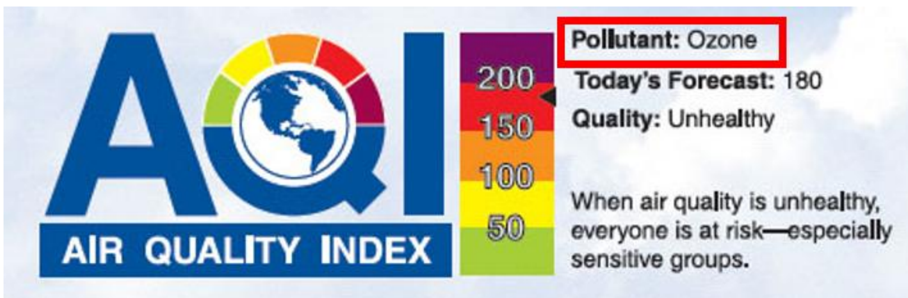
The UV index forecast, issued by the US National Weather Service, provides a convenient way to assess the harshness of the Sun's rays. Ranging from 0 to 15, the UV index values are based on how long it takes skin damage to occur. The higher the number, the less time it takes skin damage to occur. They are color-coded for ease of interpretation.

Table 2.5 The UV Index Scale

Exposure Category	Index	Tips to Avoid Harmful Exposure to UV
LOW	< 2	If you burn easily, cover up and use sunscreen.
MODERATE	3–5	Stay in shade when the rays of the Sun are the strongest.
HIGH	6–7	Reduce exposure between 10 AM and 4 PM. Cover up, wear a hat and sunglasses, and use sunscreen.
VERY HIGH	8–10	White sand and bright surfaces reflect UV, increasing your exposure. Minimize exposure between 10 AM and 4 PM.
EXTREME	11+	Take full precaution against sunburn. Unprotected skin can burn in minutes. Avoid the Sun between 10 AM and 4 PM.

Ozone, the Earth's Sunscreen

One morning, you overheard your local weatherman saying that today's air quality is unhealthy for sensitive groups. The main pollutant in the air, according to him, is ozone. After hearing this, you said to yourself, I though ozone is good for us. Doesn't it protect us from the harmful UV radiation from the Sun? Aren't we trying to slow down the depletion of Antarctic ozone layer near the South Pole? You vaguely remember reading about an article on eliminating the use of refrigerant such as Freon (a chlorofluorocarbon, or CFC) for this purpose. Why bother if it is a pollutant? A search on your iPhone for ozone as a pollutant turned up the picture below which did list ozone as a pollutant.



Now you are really confused. Is ozone good or bad for us? Try to resolve the seemingly contradictory information.

To understand ozone, think *location*. "Good up high; bad nearby". Down here in the troposphere, where we live, ozone is a pollutant. If you have even been near a sparking electric motor or in a severe lightning storm, most likely you have smelled ozone. Its odor is unmistakable but difficult to describe. Some compare it to that of chlorine gas; others think the odor reminds them of newly mown grass. Even at very low concentrations, it reduces lung function in healthy people who are exercising outdoors. Ozone also damages crops and the leaves of trees. Contrary to common belief, ozone does not come out of a tailpipe and is not produced when coal is burned. Instead, it forms from other pollutants in the atmosphere in the presence of sunlight. Once the Sun goes down, the generation of ozone ceases.

But up in the stratosphere, the story of ozone is altogether different. All of the ozone up high is formed naturally. Also unlike ground-level ozone, stratospheric ozone plays a vital role in protecting us from damaging solar radiation. One might say it acts like the Earth's sunscreen.

In the 1970s, chemists discovered that certain chemicals could make their way into the upper atmosphere and partially destroy the protective ozone found there. Ever since, scientists, policy makers and concerned citizens worldwide have participated in efforts to control and reverse ozone destruction. The most severe depletion has been over Antarctica, and the yearly images of the ozone hole have become some of the most widely recognized scientific graphics.

A major cause of stratospheric ozone depletion was chlorofluorocarbons (CFCs). As the name implies, CFCs are compounds composed of the elements chlorine, fluorine and carbon. CFCs are better known by their trade name Freon which were widely used as refrigerant gas in refrigerators. Freon replaced ammonia and sulfur dioxide, two toxic and corrosive refrigerant gases before Freon became available. In many aspects, Freon is an ideal substitute because it is nontoxic, odorless, colorless, and does not burn. In fact, it is so stable that it does not react with much of anything! It has also revolutionized air conditioning, making it readily accessible for homes, office buildings, shops, schools, and automobiles. Beginning in the 1960s and 1970s, CFCs even helped to spur the growth of cities in hot and humid parts of the world.

However, the very property that makes CFCs ideal for so many applications – their chemical inertness – ended up doing harm to our atmosphere. It has been estimated that an average CFC molecule can persist in the atmosphere for 120 years before it meets some fate that decomposes it. In contrast, it only takes about five years for atmospheric wind currents to bring CFC molecules up to the stratosphere, where some of the CFC molecules ended up. In the stratosphere, high-energy UV-C rays break the bonds in CFC molecules, releasing chlorine atoms from CFC. It is the chlorine atoms released from CFCs that are destroying ozone. The figure below shows two sets of data from the Antarctic, one for ozone concentration and the other for chlorine oxide (ClO), a product from the reaction between chlorine and ozone molecules. As stratospheric concentration of stratospheric chlorine increases, the stratospheric ozone decreases; the two curves mirror each other almost perfectly. The major effect is a decrease in ozone. The evidence is so compelling that this figure is sometimes referred to as the "smoking gun" for stratospheric ozone depletion.