

I. OZONE IN OUR ATMOSPHERE

**Q1: What is ozone and where is it in the atmosphere?**

*Ozone is a gas that is naturally present in our atmosphere. Each ozone molecule contains three atoms of oxygen and is denoted chemically as O<sub>3</sub>. Ozone is found primarily in two regions of the atmosphere. About 10% of atmospheric ozone is in the troposphere, the region closest to Earth (from the surface to about 10-16 kilometers (6-10 miles)). The remaining ozone (90%) resides in the stratosphere, primarily between the top of the troposphere and about 50 kilometers (31 miles) altitude. The large amount of ozone in the stratosphere is often referred to as the “ozone layer.”*

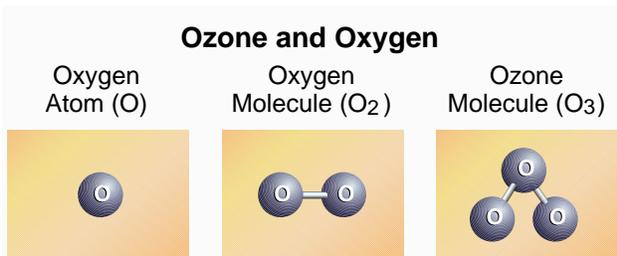
Ozone is a gas that is naturally present in our atmosphere. Because an ozone molecule contains three oxygen atoms (see **Figure Q1-1**), it has a chemical formula of O<sub>3</sub>. Ozone was discovered in laboratory experiments in the mid-1800s. Ozone’s presence in the atmosphere was later discovered using chemical and optical measurement methods. The word ozone is derived from the Greek word *ozein*, meaning “to smell.” Ozone has a pungent odor that allows ozone to be detected even in very low amounts. Ozone will rapidly react with many chemical compounds and is explosive in concentrated amounts. Electrical discharges are generally used to make ozone for industrial processes including air and water purification and bleaching of textiles and food products.

**Ozone location.** Most ozone (about 90%) is found in the stratosphere, a region that begins about 10-16 kilometers (6-10 miles) above Earth’s surface and extends up to about 50 kilometers (31 miles) altitude (see **Figure Q1-2**). The stratosphere begins at higher altitudes (16 kilometers) in the tropics than in the polar regions (10 kilometers). Most ozone resides in the stratosphere in what is commonly known as the “ozone layer.” The remaining ozone, about 10%, is found in the troposphere, which is the lowest region of the atmosphere between Earth’s surface and the stratosphere.

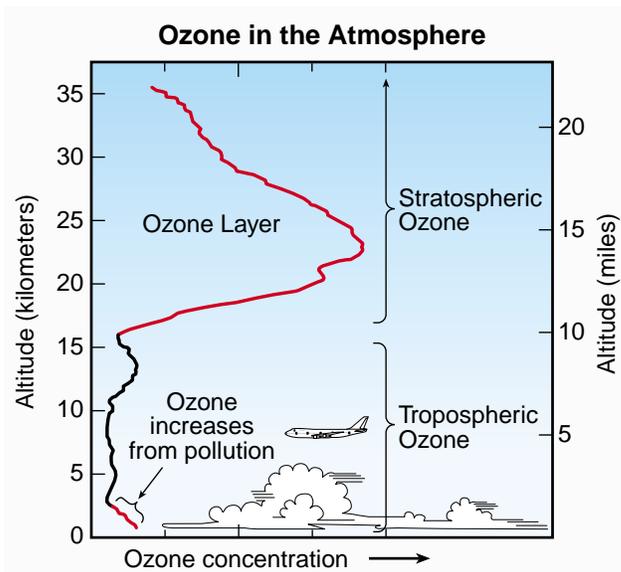
**Ozone abundance.** Ozone molecules have a relatively low abundance in the atmosphere. In the strato-

sphere near the peak of the ozone layer, there are up to 12,000 ozone molecules for every billion air molecules (1 billion = 1000 million). Most air molecules are either oxygen (O<sub>2</sub>) or nitrogen (N<sub>2</sub>) molecules. In the troposphere near Earth’s surface, ozone is even less abundant, with a typical range of 20 to 100 ozone molecules for each billion air molecules. The highest surface values are a result of ozone formed in air polluted by human activities.

As an illustration of the low relative abundance of ozone in our atmosphere, one can consider bringing all the ozone molecules in the troposphere and stratosphere down to Earth’s surface and uniformly distributing these molecules into a gas layer over the globe. The resulting layer of pure ozone would have a thickness of less than one-half centimeter (about one-quarter inch).



**Figure Q1-1. Ozone and oxygen.** A molecule of ozone (O<sub>3</sub>) contains three oxygen (O) atoms bound together. Oxygen molecules (O<sub>2</sub>), which constitute 21% of Earth’s atmosphere, contain two oxygen atoms bound together.



**Figure Q1-2. Atmospheric ozone.** Ozone is present throughout the lower atmosphere. Most ozone resides in the stratospheric “ozone layer” above Earth’s surface. Increases in ozone occur near the surface as a result of pollution from human activities.