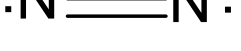
STATION 18

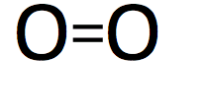
MOLECULAR MODELS OF SOME SMALL MOLECULES AND PENICILLINS

Find the molecular model for each of the chemicals discussed below.

Nitrogen is 78% of the content of our atmosphere. Nitrogen exists as a diatomic molecule (N_2) and is represented by the very stable Lewis structure pictured. Explosives such as TNT contain nitrogen as the reaction of the explosive yields nitrogen and a huge volume of gas and large amounts of energy.

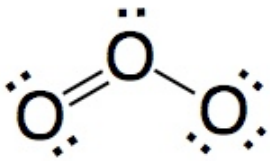


Oxygen is 21% of the content of our atmosphere. Oxygen exists as a diatomic molecule (O_2) and is represented by the structure to the right. There are three formulas of oxygen that can exist - O, O_2 and O_3 (ozone). O and O_3 are very reactive and toxic. It is difficult to imagine a type of life that could exist without O_2. Ozone is produced as a result of combustion processes and is a primary and dangerous constituent of smog.

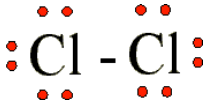


Skeletal structure of O_2.

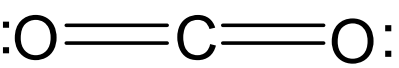
However, O_3 plays a very important role in the upper atmosphere by filtering out substantial amounts of harmful UV radiation. In the 1970's, chemists provided evidence that freons used as spray propellants and in air conditioning units were causing a depletion of the very vital ozone layer. Fortunately, global governmental action has substantially decreased the use of the harmful freons and the ozone layer is slowly recovering from the hazardous decrease (lower ozone results in more skin cancer). Many people incorrectly connect the ozone depletion issue with climate change.



Chlorine is also diatomic (Cl_2) and is highly toxic to life. Its toxicity makes it very useful in water purification.

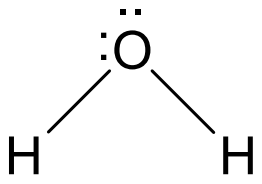


Carbon dioxide (CO_2) is a linear molecule that comprises 0.04% of the content of our atmosphere. CO_2 is fairly unreactive chemically and is used to extinguish fires. As discussed in Stations 19 and 20,

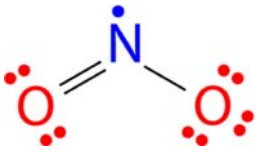


human use of fossil fuels has increased the CO_2 content of the Earth's atmosphere by 44%. This increase is causing an increase in global temperatures with rising sea levels and ice mass loss and is a severe threat to life and our environment.

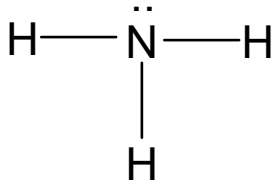
Water (H_2O) is a bent molecule that is probably essential for life anywhere. Because it is bent and has polar bonds, polar molecules like NaCl and sugars will dissolve in water but non-polar molecules like CO_2 have very limited solubility in water and escape from carbonated beverages when the container top is removed.



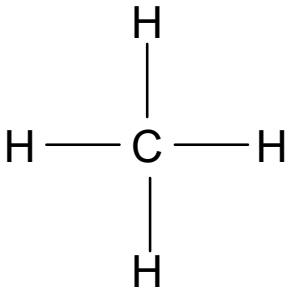
Nitrogen Dioxide (NO_2) is an orange gas that is a very irritating and dangerous component of smog. NO_2 is often formed from oxidation of NO that results from combustion in the automobile's engine. NO_2 is removed from the emissions by a catalytic converter.



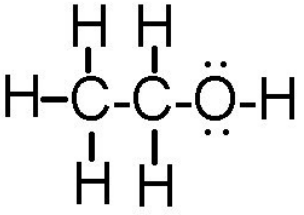
Ammonia (NH_3) is a base (reacts with acid) with an annoying odor. NH_3 is important in the penicillin discussion that follows.



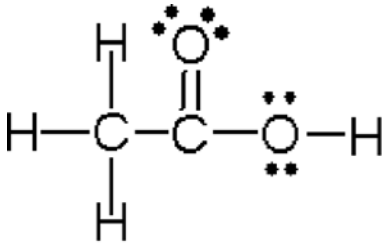
Methane (CH_4) is the major component of natural gas but is also a potent Greenhouse gas. As a result of pipeline leaks, fracking carelessness and other sources, the atmospheric CH_4 concentration is increasing and contributing to global warming.



Ethanol (a.k.a. ethyl alcohol or alcohol - CH_3CH_3OH) is a member of the class of compounds called alcohols. Alcohols have an OH group attached to a carbon bonded to three additional atoms (usually C or H). Ethanol is the alcohol in alcoholic beverages.

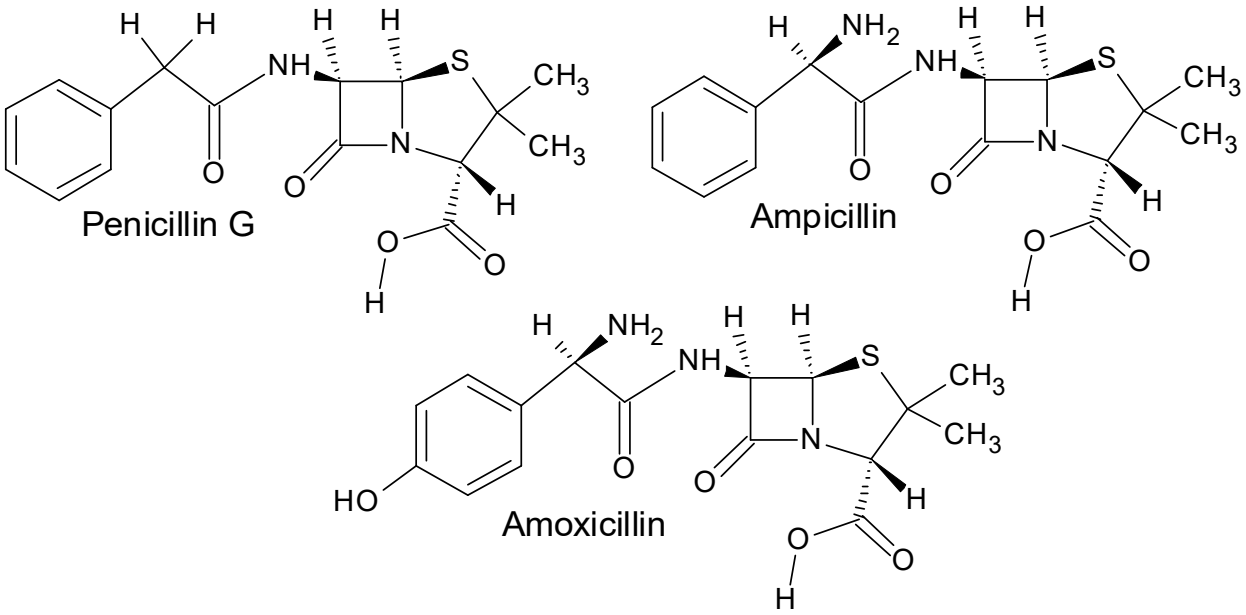


Acetic acid (CH_3COOH) is the active component of vinegar (about 5%) and is formed from air oxidation of ethanol. Opened bottles of alcoholic beverages acquire a vinegar taste if left standing.



PENICILLINS

In 1928, Alexander Fleming serendipitously discovered penicillin G. As penicillin G is unstable in stomach acid, it cannot be taken orally and has to be delivered with an injection. Some brilliant and what appears to be simple chemistry (actually very difficult and time consuming) was performed to convert penicillin into ampicillin. Ampicillin is stable in the stomach acid and can be administered orally. Ampicillin has been slightly modified to make one of the most common antibiotics still in use today called amoxicillin. Examine the molecular models and the structures below and determine the differences between penicillin G, ampicillin and amoxicillin.



1. Describe the differences between each of the penicillins.

2. The ammonia molecule (NH_3) is a base and reacts with hydrochloric acid to give a stable ammonium chloride salt. Does this give you any information about why the change from penicillin G to ampicillin and amoxicillin made them stable in the stomach?