CH102 Answer Key for Chapter 17 (AIR POLLUTION) Review Guide

1. What is the composition of clean air in terms of the most abundant gases in the atmosphere?
   * About 78 % N_2, 21 % O_2 and 1 % other gases like Ar, CO_2 and H_2O vapor (Composition given in volume %)

2. (a) Define air pollutants. (b) Identify 3 major contributors of air pollutants in the US.
   * (a) Air pollutants are substances in the air that, although present in minute amounts (usually much less that 0.5 %), can be detrimental to human health and/or the environment. (b) Electric utilities, vehicles, and industries (other than electric utilities) all contribute to air pollution.

3. (a) What is the relationship between parts-per-million (ppm) and percent? (b) If air contains 0.0007 % by volume of ozone, what is its level in ppm?
   * (a) ppm is 10,000 x %, thus, (b) 0.0007 % equals 7 ppm.

4. Identify three types of fuels used to generate electricity.
   * Coal, oil, natural gas, and nuclear fuel are four types of fuel used for electricity.

5. (a) Aside from C and H, what other elements are in coal? (b) Based on your answer in (a), name two air pollutants produced from the burning of coal.
   * (a) Coal contains a small amount of sulfur and traces of other element such as nitrogen and mercury. (b) Due to these impurities in coal, SO_2, NO_x, and Hg are all released into the air when coal is burned.

6. For each of the following pollutants, give the (a) source(s), (b) biological effect and (c) environmental effect if any. CO, SO_2, NO_x and O_3.
   * **Carbon monoxide, CO**
     Major source: Incomplete combustion of carbon-based fuel like coal and oil (and gasoline).
     Biological effect: CO binds strongly to hemoglobin (in blood), reducing the ability of blood to carry oxygen throughout the body. Exposure to relatively high levels of CO can cause paralysis of the brain and heart due to lack of O_2, which is deadly.
     Environmental effect: Not applicable.
   * **Sulfur dioxide, SO_2**
     Major source: Burning of coal for electricity
     Biological effect: SO_2 is a respiratory tract irritant (remember in Chapter 10 that SO_2 dissolves in (rain)water to produce sulfuric acid? Acids are skin irritant, so when inhaled, SO_2 does the same effect in our respiratory tract); Exposure to relatively high levels of SO_2 could cause breathing problems. Long term exposure could permanently damage the lungs.
     Environmental effect: SO_2 and NO_x causes acid rain
   * **Nitrogen oxides, NO_x**
     Major source: Vehicles or burning of gasoline (NO_x is emitted every time we burn gasoline because due to the high temperature of internal combustion engines, N_2 in the air combines with O_2 to form NO_x)
     Biological effect: Like SO_2, NO_x is also a respiratory tract irritant (this time nitric acid is the acid produced when NO_x combines with water or moisture)
     Environmental effect: SO_2 and NO_x causes acid rain
   * **Gound-level ozone, O_3**
     Major source: Vehicular emissions (like NO_x), especially during heavy traffic on a warm sunny day.

Biological effect: O_3, like SO_2 and NO_x, is a respiratory tract irritant; It also aggravates asthma and other respiratory conditions.
Environmental effect: Ozone produced from vehicular emissions causes smog.

Mercury, Hg

Major source: Burning of coal, improperly disposed Hg thermometers, light switches and light bulbs (all contain Hg)
Biological effect: Hg is a neurotoxin (it attacks the brain and other parts of the nervous system)

7. Be able to name given the chemical formula (and vice versa) of each pollutant in #6.

8. (a) What is a smog and how is it related to ozone? (b) Why is smog a problem?
* (a) Smog is a poisonous mixture of smoke and fog. The smoke component is predominantly made of O_3 formed from further reaction of automobile exhaust. (b) It is a problem because it contains substances that can irritate our respiratory tract and aggravate asthma. It also reduces lung function.

9. (a) Differentiate between *ground-level ozone* and *stratospheric ozone*. (b) What is the effect or function, whichever applies, of each type of ozone?
* (a & b) **Stratospheric ozone** is a natural component of the upper atmosphere present as a thin layer of gas that absorbs harmful ultraviolet (UV) radiation from the sun. Ground-level ozone is an air pollutant produced by human activities. For details on ground-level ozone, read answers to #6 above.

10. Name three conditions that favor the formation of ground-level ozone.
* (1) Heavy traffic on (2)warm sunny days when the (3) air is still are three conditions that favor the formation of O_3 and, consequently, smog.

11. Name two air polluting gases that are present in automobile exhaust.
* Carbon monoxide and nitrogen oxides

12. Name 2 air pollutants that cause *acid rain*.
* Sulfur dioxide and nitrogen oxides

13. Name 3 pollutants that cause irritation of the respiratory tract.
* Sulfur dioxide, nitrogen oxides and (ground-level) ozone

14. Briefly discuss 3 ways by which we can minimize or prevent air pollution.
* One way to prevent air pollutants from being released in the first place is through stricter emission standards for both industry (Ex. power plants) and cars/trucks. Another way by which we can prevent air pollution is by using nonpolluting (alternative) energy sources, like nuclear, wind, geothermal and solar power. These sources of electricity do not release air polluting gases. Other ways include conserving energy at home and at work (or in school), carpooling, biking or walking instead of using our cars, taking public transportation, and becoming educated about energy issues and related problems. These measures reduce our use of fossil fuels, which reduces the amount of air pollution.