104 Period 16: Chemical Energy – Consequences of Its Use

1. Watch the demonstration involving particulate matter from candles and other sources. a) Which source(s) caused the most particulate matter? b) What do you think the "soot" or particulate matter is made of?

   a. Burning rubber and oil both create a lot of soot.

   b. Carbon.

2. a) How can we use lasers to detect particulate pollution? b) What is an electrostatic precipitator and how does it work?

   a & b. Both questions are answered explicitly in the textbook, Chapter 16, pages 193-194.

3. a) What is meant by "incomplete combustion?" b) What kind of pollution forms as a result of it? c) What can be done to correct incomplete combustion?

   Any reaction in which the products can further react with the oxygen in the air is said to be incomplete. For instance, any hydrocarbon (wood, oil, gasoline, etc.) that burns completely in oxygen will create carbon dioxide and water (vapor).

   If a hydrocarbon does not react completely it may form another hydrocarbon, carbon monoxide or just carbon, all of which can further react with oxygen. Carbon is a source of particulate matter (soot). Carbon monoxide can be fatal in high enough concentrations and it is colorless and odorless. (Malfunctioning furnaces may produce dangerously high levels of carbon monoxide. Furnaces should be checked regularly. Life saving carbon monoxide detectors are available and are relatively inexpensive.) Automobiles may also produce a lot of carbon monoxide, which can be remedied by additional combustion of exhaust gasses in catalytic converters.

4. a) Why is carbon monoxide dangerous? b) How can it get into your home? c) How can it be detected?

   High enough levels of carbon monoxide can result in chemical asphyxiation. CO combines with available hemoglobin in the blood, lowering the oxygen-carrying ability of the blood. At very low parts per million levels, the body is quickly affected by oxygen starvation. Symptoms of significant concentrations and headaches, nausea, and fatigue (flu-like symptoms) and at higher levels, drowsiness, confusion, convulsions, unconsciousness, and even death. Carbon monoxide

is colorless and odorless and is produced by automobiles and malfunctioning furnaces. Never run an automobile in a closed garage. If you have any symptoms of carbon monoxide poisoning, get out of the house and call the fire department or heating and cooling expert who can check out your furnace. As mentioned above, carbon monoxide detectors (which look a lot like smoke detectors) are available for as little as $20.

5. a) What is acid rain and what causes it? b) What harm does it do?

Oxides of sulfur and oxide of nitrogen can combine with water to form sulfuric acid and nitric acid, respectively. When present in the atmosphere, this can make rain acidic. Acid rain can harm living things and damage inanimate structures. Automobiles are sources of nitrous oxides and high-sulfur coal burning is a source of sulfur dioxide.

6. What is photochemical smog and what causes it? What harm does it do?

When exposed to ultraviolet radiation from the sun, nitrous oxides and hydrocarbons can react with ozone and oxygen to form photochemical smog, which is harmful to plants and animals (including people).

7. Is ozone helpful or harmful or both? Explain.

The ozone layer in the higher atmosphere (stratosphere) is helpful in that it shields us from ultraviolet rays (which can cause skin cancer). Ozone in the lower atmosphere (troposphere) is harmful to plants and animals (including people) and plays a part in forming photochemical smog.

8. a) On a sunny day, how does the temperature of air near the ground compare with the temperature of air higher up? Why? b) Does hot air sink or rise and what role does this motion play in the temperature structure of the atmosphere? c) What is an inversion and why are inversions an important consideration in the study of pollution?

   a. **Normally on a sunny day, the air nearer the ground is warmer since the ground is heated by the sun and that heat is then transferred to the air. (More solar energy is absorbed by the ground than by the air.)**

   b. **Hot air rises(since it is less dense than cold air) and this is what causes convection currents in the air. As the hot air rises, it transfers the thermal energy from the ground to the air higher up. As the air rises it cools (and eventually sinks and is reheated). Thus, the general sunny day temperature structure for the**

lower atmosphere (troposphere) is that the higher you go, the cooler it is. (Generally it gets 3.6 ^{o}F for each 1000 ft. increase in height.)

c. An inversion results when warmer air is above cooler air (which often happens at night.) As seen in our class experiment, an inversion layer can trap pollution below the inversion layer (since cooler, more dense, polluted air will not rise above the hotter, less dense air in an inversion layer).