AP® Environmental Science
1999 Sample Student Responses

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a) Although the ozone concentration varies from year to year, the average concentration remains about the same. The amount of ozone in the atmosphere has not experienced a drastic change. Its percentage change over 10 years is only (.132-.155)/.155 x100%: -14.8%. The levels of lead, however, have decreased drastically. From 1977 on lead experienced a constant decline. Its percent change over the same interval* is (.12-1.5)/1.5 x 100% :-92%. This shows a significant improvement.

*as ozone

b) The major sources of lead, before it was realized that it needed to be erradicated, were numerous and widespread. The biggest contributor was leaded gasoline. Lead was added as an anti-knock agent, but when the gasoline burned, the lead was released into the atmosphere. Lead was also present in many paints and was used in pipes and other metal products. However, it was discovered in the late 1970's that lead was detrimental to human health as well as the environment, causing birth defects, mental retardation and slow development, and respiratory problems. Mostly children were affected.

c) Particulates enter the atmosphere in many different ways. One of the biggest polluters is incinerators, which release fly ash unless an

electrostatic precipitator is used. Many other industries release particulates from their smokestacks, often containing toxic materials. The burning of biomass as fuel also creates numerous irritating particulates. The contribution that many humans make is by smoking. To reduce the amount of particulates in the atmosphere, it is necessary to find their source and determine some way of containing the smoke (or other byproduct) so that the particulates are not dispersed as widely. It is often difficult to remove particulates that are already in the atmosphere.

a) The concentration of ozone in the atmosphere has fluctuated from 1976 to 1995, but the overall trend is a gradual decrease in ozone concentration in ppm. The percentage change of ozone from 1978 to 1988 is -10% (10% decrease).

$$\% \text{ change} = \frac{\text{conc. in 1988} - \text{con. in 1978}}{\text{conc. in 1978}} \times 100$$

$$= \frac{0.140 \text{ ppm} - 0.155 \text{ ppm}}{0.155 \text{ pm}} \times 100$$

$$= -10\%$$

The concentration of lead in the atmosphere has decreased dramatically from 1978 to 1988.

$$\% \text{ change} = \frac{0.100 \text{ ug m}^{-3} - 1.500 \text{ ug m}^{-3}}{1.500 \text{ ug m}^{-3}} \times 100 = -93.3\%$$

The percentage change is -93.3%, or a 93.3% decrease.

b) The major sources of ozone include the UV rays penetrating the stratosphere and ionizing O_2 into O_3. The main physiological effects on humans include respiratory and eye irritations.

c) The major source of particulates include volcanic eruptions producing ash, fossil fuel burning, biomass burning, automobile exhaust and rubber pieces from vehicle tires. The most effective method of reducing the concentration of particulater is to install scrubbers or electrostatic precipitators in smokestacks to prevent particulater from escaping into the atmosphere.

(a) although the concentrations for both lead and ozone have dropped from 1978 to 1988, lead has dropped much more significantly. Lead dropped from $1.30 \mu g\ m^{-3}$ to $0.100 mg\ m^{-3}$, which is over a 10% change. The drop in ozone was from 0.150 ppm to 0.145 ppm, a 0.9% change.

(b) The atmospheric drop in ozone is caused by the extra releasing of carbon dioxide and CFC's. The more CO_2 we release, the less O_3 there will be in the atmosphere. Since ozone is what protects humans from the ultraviolet rays of the sun, we will be exposed to more UV rays as the ozone depletes. Some possible health risks could include increased chances of skin cancer, possible brain damage from high, daily amounts of radiation, and other problems unknown to scientists.

(c) Carbon monoxide comes from the burning of fossil fuels, such as petroleum, and from cigarette smoke. If stricter laws were placed (and enforced) on how much carbon monoxide could be released from cars and trucks, or even if laws were made specifing how frequently cars and trucks could be driven, then less carbon monoxide would be released. Also, if the smoking population quit smoking, the amount of atmospheric carbon monoxide would be greatly decreased.