Chapter 17

Air Pollution

Video

Air pollution Sources

Natural Sources of Air Pollution

- Volcanoes
- Lightning
- Forest fires
- Plants

Anthropogenic Sources of Air Pollution

- On-road vehicles
- Power plants
- Industrial processes
- Waste disposal




Intro to Air Pollution 7.1

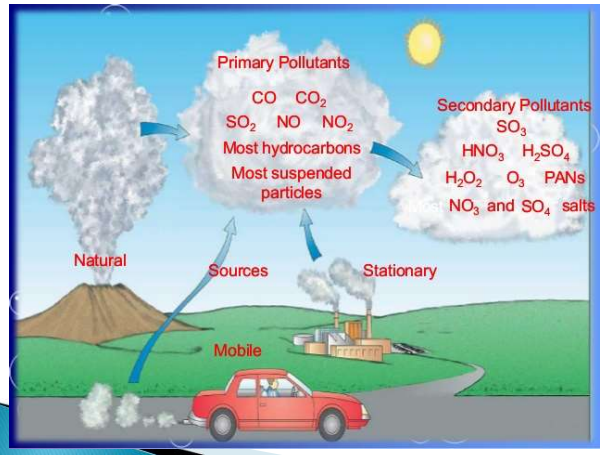
- **Air Pollution** – chemicals, particulate matter, or microorganisms found in the atmosphere at concentrations high enough to harm plants, animals, and materials such as buildings or to alter ecosystems

3

Major Air Pollutants

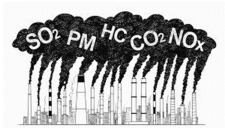
Pollutant	Composition	Source	P/S	Effects
Particulate matter	Various	Industry	P	Respiratory illness
Nitrogen oxides	NO_2	Cars, industry, fertilizer	P	Irritate respiratory
Sulfur oxides	SO_2	Coal-fire power plants	P	Irritate respiratory
Carbon oxides	CO, CO_2	Cars, industry	P	Reduces blood's ability to carry O_2
ozone	O_3	Photochemical	S	Irritate eyes, respiratory
Lead	Pb	Ore, metals processing, fuel	P	Neurological Cardiovascular effects

Types of Air Pollution

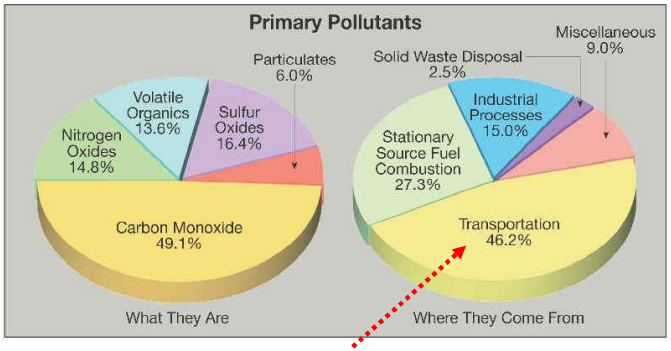


Primary Pollutants

- ***Primary pollutants***: polluting compounds coming directly out of smoke-stacks, exhaust pipes, or natural emission source
- **Main Types:**
  - Carbon Monoxide - *CO*
  - Carbon Dioxide - CO_2
  - Sulfur Dioxide- SO_2
  - Nitrogen Oxides- No_x
  - Volatile Organic Compounds -*VOCs*
  - Hydrocarbons
  - Particulate matter
  - Toxic Metals



Primary Pollutants

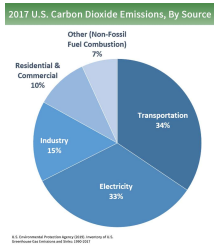


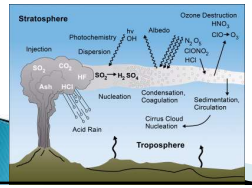
What is the biggest source of primary pollutants?

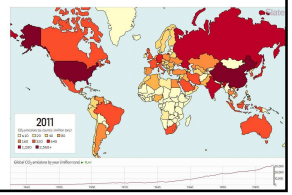
Transportation

7.4 CO_2 Levels Around the World

- **Where does all the CO_2 come from?**
  - CO_2 produced by human impact:
    - Power plants
    - Cars that burn fossil fuels
  - Natural Producers of CO_2:
    - Respiration by animals
    - Decomposition of organic matter
    - Volcanic Eruptions







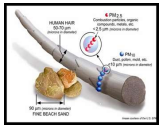
Primary Air Pollutant

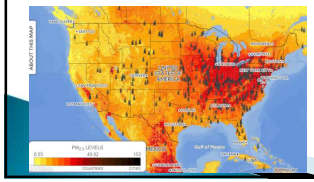
7.4

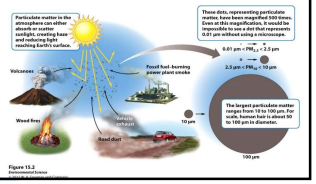
Particulate Matter (PM)–is a complex mixture of extremely small particles and liquid droplets

Ex: organic chemicals, metals, and soil or dust particles.

- EPA is concerned about particles that are 10 micrometers (PM_{10}) or lower.
- Go into your lungs and bloodstream.
- Major problem in developing nations, where fires are still used as major source of cooking

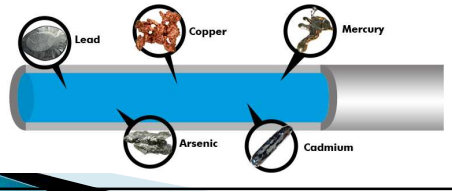






Toxic Metal Air Pollutant

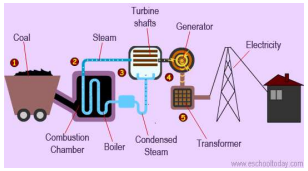
- Lead–(Pb)
  - Released by motor vehicles and industrial sources.
  - Also in paint, dust and soil
  - Neurological effects in children and cardiovascular effects
- Arsenic
- Mercury
- Cadmuim



Primary Pollutants

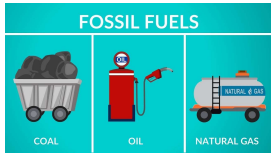
Released from Coal Combustion:

- Carbon Dioxide
- Sulfur Dioxide
- Toxic Metals
- Particulates



Released from combustion of fossil fuels:

- Nitrogen Oxides
- Carbon monoxide
- Hydrocarbons
- Particulate matter

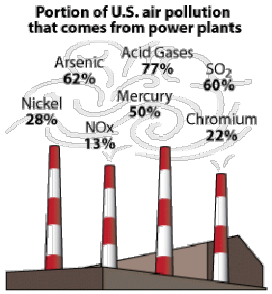


Primary Air Pollutant

- Industrial plants burn fossil fuels
- Burning releases – Sulfur Dioxide and Nitrous Oxide
- Coal Power Plants emit
  - 2/3 of ALL SO_2
  - 1/3 of ALL NO

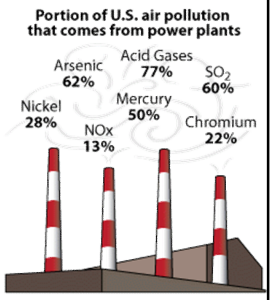
Coal-Burning Power

- Plant Scherer Georgia



Primary Air Pollutant

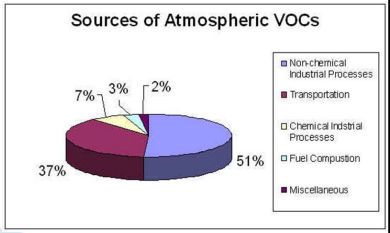
- Sulfur Dioxide
  - Released by burning of fossil fuels
  - Mainly through diesel fuels
  - Coal burning power plants
- Affects air quality .



Primary Air Pollutants: Hydrocarbons

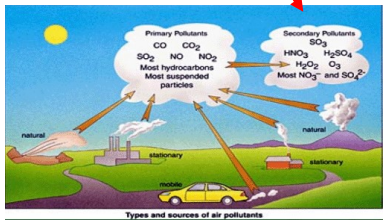
- VOCs (Volatile Organic Compounds) – chemical compounds that form toxic fumes (Hydrocarbon)
  - Given off by – Oil refineries, Dry Cleaners, Chemical plants, car emission
- Hydrocarbons are organic compounds made of C and H.

- They can be gases (methane and paropane), liquids (hexane and benzene). Waves (paraffin wax), or polymer (polyethylene).
- They can be processed to create plastics.



Secondary Pollutants

- ***Secondary pollutants:*** pollutants transformed in the presence of sunlight, water, oxygen or other compounds (Nitrogen oxides or VOCs).
- Examples:
  - Ground level ozone
  - Photochemical smog
  - Acid rain

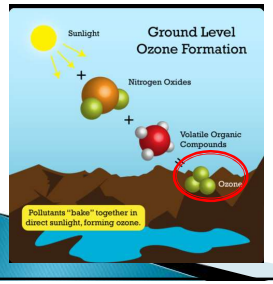


Types and sources of air pollutants

Secondary Pollutants

- Ground Level Ozone – is formed when car emissions (primary) interact with oxygen and UV rays (both natural)
- Contribute to thermal inversions and smog

Major factors are H_2O and Sunlight



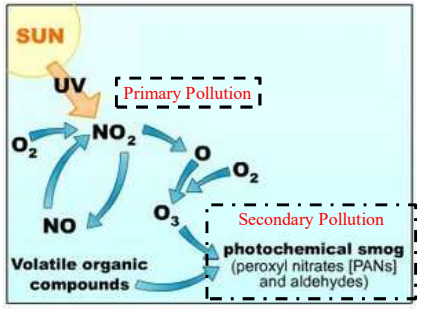
AKA: Tropospheric Ozone

Secondary Pollutants 7.2

- **Photochemical smog** is still an environmental problem in the United States.
- Sunlight + Nitrogen Oxides + VOCs produced Ozone.

Nitrogen Oxides are essential in producing photochemical smog

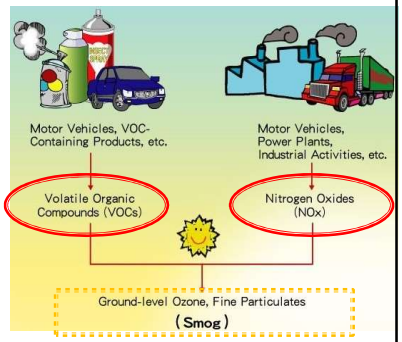
Includes:
- PANs
- Aldehydes
- Ozone
- CO



Photochemical Smog

- Decrease use of nitrogen oxides and VOCs.

- Human Health Risk:
  - Respiratory problems
  - Eye irritation



Photochemical Smog

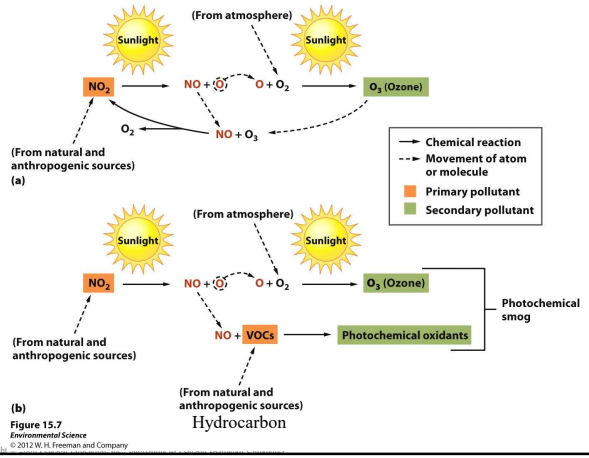
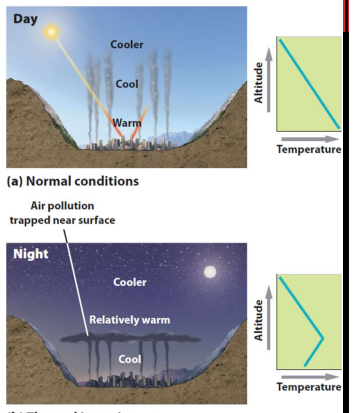


Figure 15.7
Environmental Science
© 2012 W. H. Freeman and Company

Thermal Inversion 7.3

- Normal temperatures in the atmosphere is changed.
- Thermal Inversion causes cooler air at the Earth's surface and warmer air at higher altitude.
- (Hot air rises, right? Hot smoke rises, but if atmosphere is just as warm, the smoke stays put)
- Inversions trap pollution near the Earth's Surface. Specifically smog and particulates.

Video



Secondary Air Pollutant: Acid Rain 7.7

•***Acid Rain:*** nitrogen oxides and sulfur oxides released into the atmosphere combine with atmospheric oxygen and water.

•These become the secondary pollutants **nitric acid** and sulfuric acid.

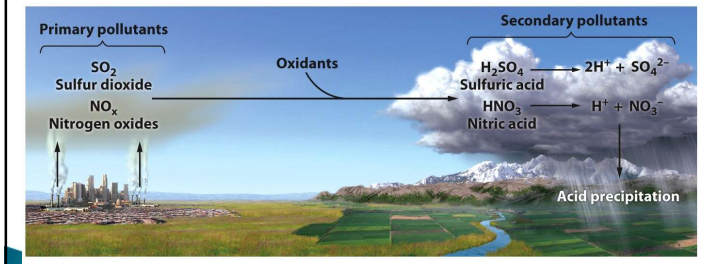
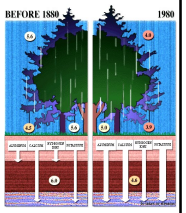


Figure 15.9
Environmental Science

Acid Deposition 7.7

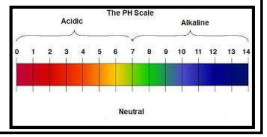


•**Nitric acid cause it**
- •From motor vehicles & coal-burning power plants.

•**Sulfur dioxide also cause it.**
- •Come from coal-burning power plants

•Lowers the pH of bodies of water and soil
- •Acid Shock-mass killing of aquatic organisms

•Mobilizes metals (aluminum) found in soils and releases these into surface waters
- •Metals accumulate in fish bodies until reach toxic levels



Acid Rain Effects on Buildings 7.7

Acid rain may dissolve human-made structures made from calcium carbonate found in concrete , marble, and limestone.

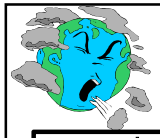
Solution: Neutralize effects of acid rain by using limestone bedrocks. Soil acidity (pH) of the soil increased by the addition of lime/limestone (calcium carbonate) and similar compounds that have been ground fine for use.

Types of lime-like sources:
- Dolomitic limestone
- Chalk
- Oyster shell
- Wood ashes

Lime treats acidity by combining with carbon dioxide gas, water, and hydrogen ions to form free calcium ions and carbonic acid (weak acid). The carbonic acid then dissociates to form carbon dioxide gas and water, ridding the soil of hydrogen ions.

Controlling Acid Rain

- Acid rain is hard to regulate because the pollution that causes it blows with the wind.
- One country's pollution could float into another country causing acid rain there.
- Countries are signing Air Quality agreements with each other to help reduce polluting emissions



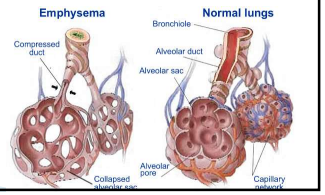
Air Pollution on Health

Acute-short term effects

Can be reversed when exposure is decreased
- Nausea
- Headaches
- Eye Irritations
- Coughing
- Upper respiratory infections (bronchitis, pneumonia)
- Greatest effect on children ages 5 and lower

Chronic- long term effects

Cannot be reversed when exposure is decreased
- Emphysema
- Lung Cancer
- Heart Disease
- May damage lungs of young children



7.5

Indoor Air Pollution

- Air inside a building is sometimes WORSE than air outside
  - Natural sources, human-made, and combustion
- Sick Building Syndrome – buildings with very poor air quality
  - Buildings that are sealed have very poor air quality

Preventing bad indoor air pollution
- Remove the source of the pollution
- Remove carpet, new paint
- Good ventilation to mix the indoor air with outdoor air
- Decreases the amount of pollution per unit of air

7.5

Indoor Air Pollution

Natural Sources of Indoor Pollutants:
- Radon, mold, and dust

Radon Gas
- Radon-222 is a radioactive gas produce by uranium decay on rocks and soil
- Colorless, odorless gas – 2nd leading cause of lung cancer in America
- Can seep into houses in basements
- Dissolves in groundwater and into wells
  - Have a radon detector in the house

7.5

Indoor Air Pollution

Indoor Particulates: Asbestos, dust and smoke

Asbestos
- A fire resistant substance used in building materials before the 1970s.
- When inhaled the fibers can cut and scar the lungs leading to breathing difficulties and heart failure. (Mesothelioma).

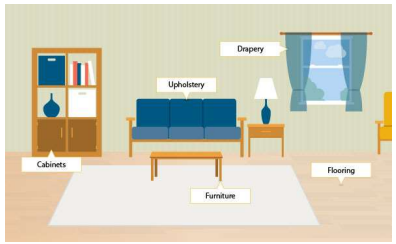
Indoor combustion:
- **Carbon monoxide – kills people by asphyxiation.**
- **Nitrogen oxides**
- **Sulfur dioxides**
- **Particulates**
- **Tobacco smoke**

7.5

Indoor Air Pollution

VOCs

- Found in furniture
- Carpets & paneling
- Formaldehydes from building materials, furniture, upholstery, carpeting
- Lead from paints



7.8

Noise Pollution

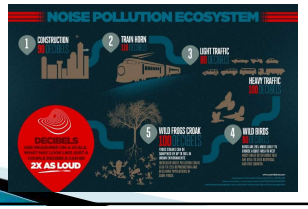
- Defined as **unwanted sound**
- Permanent hearing loss (12% of teens)
- Causes physiological stress

Sources of Noise Pollution

- Transportation
- Construction
- Domestic activity
- Industrial activity

Animals affected by human noise:

- Masks sounds for hunting
- Communicate with each other
- Changes migratory routes



7.6

Reduction of Air Pollutants

- Method include regulating practices, conservation practices, and alternative fuels.
- **Vapor-recovery nozzle** prevents fumes from escaping when you are fueling your car.

·**Catalytic converters** controls air pollution for internal combustion engines that convert pollutants (*CO*, NOx, and hydrocarbons) in exhaust into less harmful molecules (CO_2, N_2, O_2, and H_2O).

Reduction of Air Pollutants

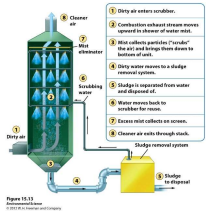
7.6

Methods used to reduce air pollutions from Coal-burning Power Plants

1. Electrostatic Precipitators
2. Scrubbers.

·**Electrostatic precipitators** - uses static charges to get particulate matter to clump together and collect, clean gas continues on. (used in cement factories/coal burning plants)

- **Scrubbers** control devices that remove particulates and gases from industrial exhaust streams.



Clean Air Act 1970

7.1

Federal law that **regulates air emissions**. This law authorizes EPA to establish **National Ambient Air Quality Standards (NAAQS)** to protect public health and the environment.

The **setting of maximum pollutant standards** was coupled with directing the states to develop state implementation plans (SIP's) applicable to appropriate industrial sources in the state.

Overseen by Environmental Protection Agency (EPA)

The EPA required the gradual elimination of lead in gasoline. To date lead pollution has been reduced by more than 90 % in US.

California – Zero Emission Law – Is that possible? Battery operated vehicles are the only "true" ZEVs (zero emission vehicles)