Warm-up 07MAR2016

1. What do you think makes up Denver's Brown Cloud?

Logistics

Chapter a week from here on out.

Read Chapter 15, by tomorrow!

Read Silent Spring by Friday

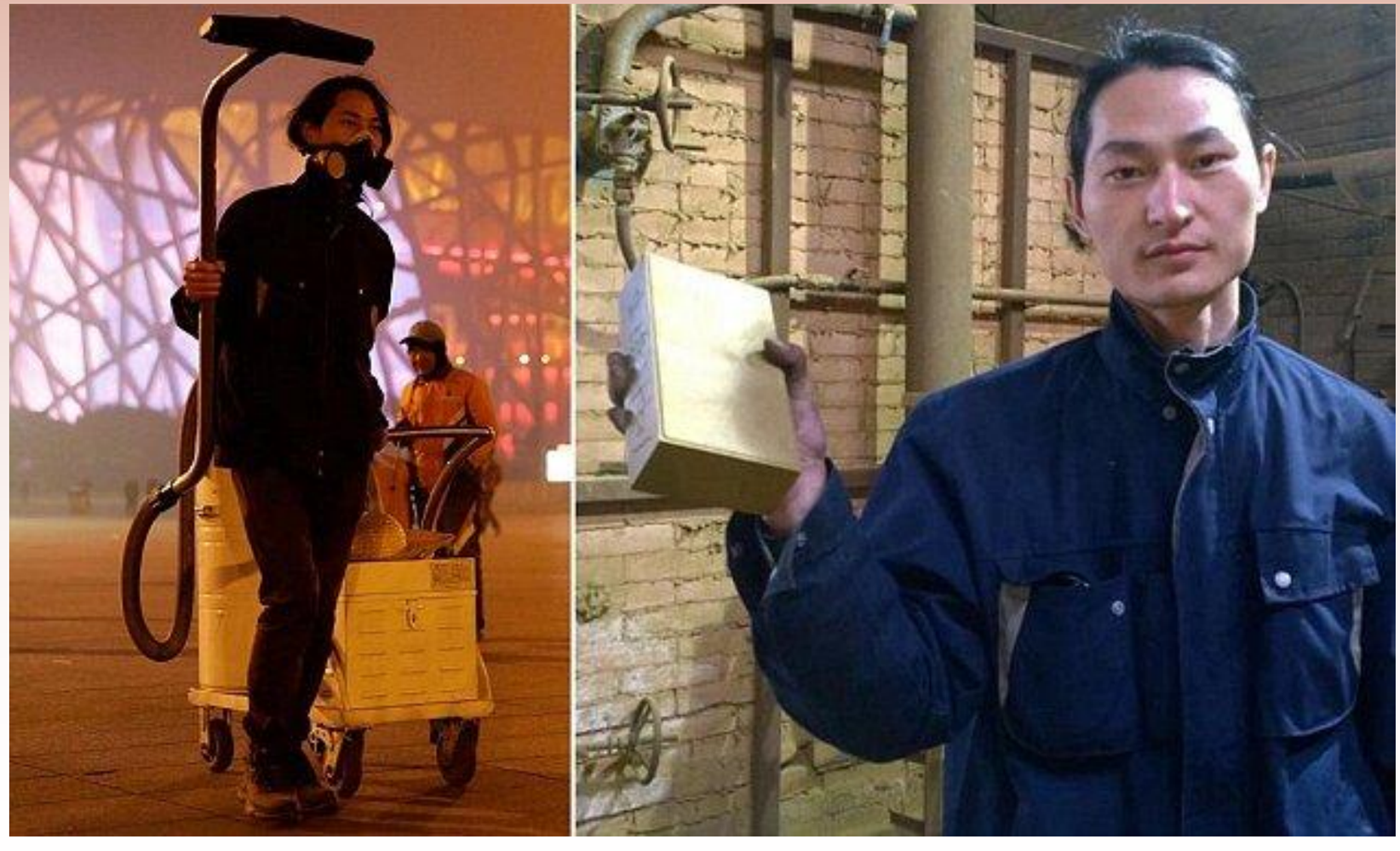
Read Klein Ch 13 by Monday

10 Vocabulary Due Friday

Air Pollution Lab Write-up Due Friday

Warm-Up 08MAR2016

1. List and explain the source for 3 anthropogenic air pollutants.



Logistics

Read Silent Spring by Friday (Forward – Ch 3)

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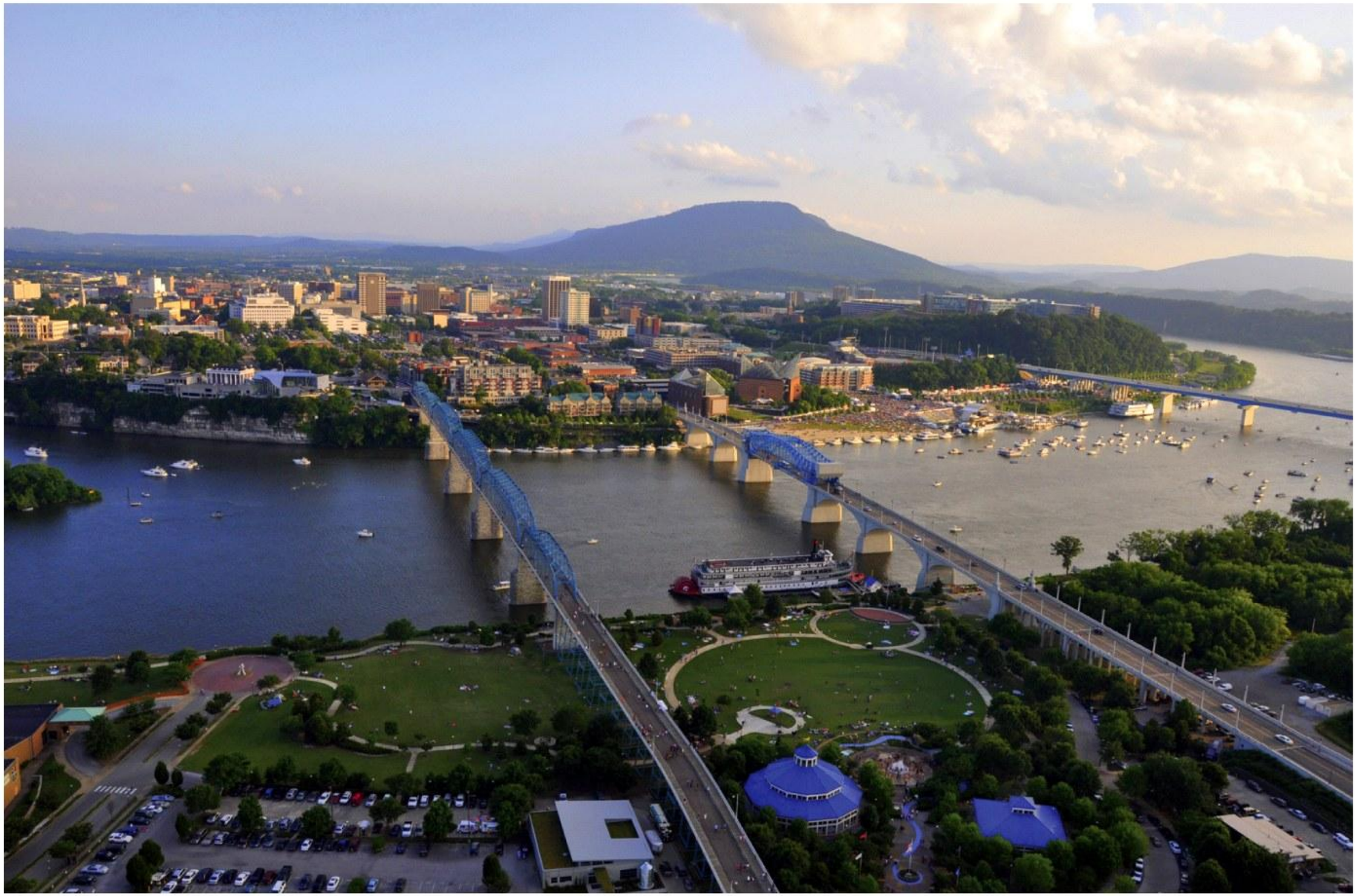
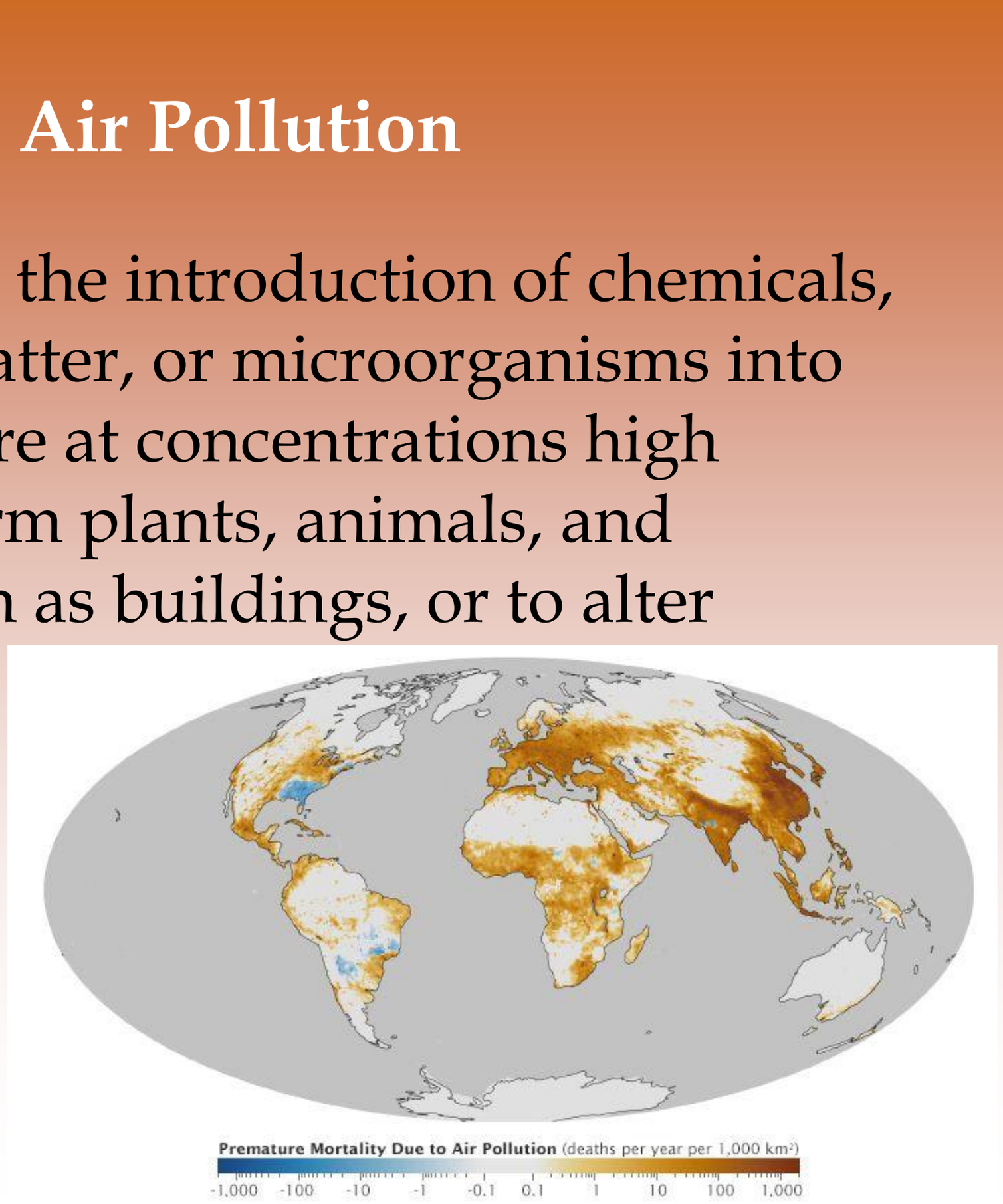


Chapter 15
Air Pollution and Stratospheric Ozone Depletion

Air Pollution

- Air pollution- the introduction of chemicals, particulate matter, or microorganisms into the atmosphere at concentrations high enough to harm plants, animals, and materials such as buildings, or to alter ecosystems.



Major Air Pollutants

- Sulfur Dioxide
- Nitrogen Oxides
- Carbon Oxides
- Particulate Matter
- Volatiles Organic Compounds
- Ozone
- Lead
- Mercury

TABLE 15.1 Major air pollutants

Compound	Symbol	Human-derived sources	Effects/impacts
Criteria air pollutants			
Sulfur dioxide	SO_2	Combustion of fuels that contain sulfur, including coal, oil, gasoline.	Respiratory irritant, can exacerbate asthma and other respiratory ailments. SO_2 gas can harm stomates and other plant tissue. Converts to sulfuric acid in atmosphere, which is harmful to aquatic life and some vegetation.
Nitrogen oxides	NO_x	All combustion in the atmosphere including fossil fuel combustion, wood, and other biomass burning.	Respiratory irritant, increases susceptibility to respiratory infection. An ozone precursor, leads to formation of photochemical smog. Converts to nitric acid in atmosphere, which is harmful to aquatic life and some vegetation. Also contributes to overfertilizing terrestrial and aquatic systems (as discussed in Chapter 3).
Carbon monoxide	CO	Incomplete combustion of any kind, malfunctioning exhaust systems, and poorly ventilated cooking fires	Bonds to hemoglobin thereby interfering with oxygen transport in the bloodstream. Causes headaches in humans at low concentrations; can cause death with prolonged exposure at high concentrations.
Particulate matter	PM_{10} (smaller than 10 micrometers) $PM_{2.5}$ (2.5 micrometers and less)	Combustion of coal, oil, and diesel, and of biofuels such as manure and wood. Agriculture, road construction, and other activities that mobilize soil, soot, and dust.	Can exacerbate respiratory and cardiovascular disease and reduce lung function. May lead to premature death. Reduces visibility, and contributes to haze and smog.
Lead	Pb	Gasoline additive, oil and gasoline, coal, old paint.	Impairs central nervous system. At low concentrations, can have measurable effects on learning and ability to concentrate.
Ozone	O_3	A secondary pollutant formed by the combination of sunlight, water, oxygen, VOCs, and NO_x.	Reduces lung function and exacerbates respiratory symptoms. A degrading agent to plant surfaces. Damages materials such as rubber and plastic.
Other air pollutants			
Volatile organic compounds	VOC	Evaporation of fuels, solvents, paints; improper combustion of fuels such as gasoline.	A precursor to ozone formation.
Mercury	Hg	Coal, oil, gold mining.	Impairs central nervous system. Bioaccumulates in the food chain.
Carbon dioxide	CO_2	Combustion of fossil fuels and clearing of land.	Affects climate and alters ecosystems by increasing greenhouse gas concentrations.

Table 15.1
Environmental Science

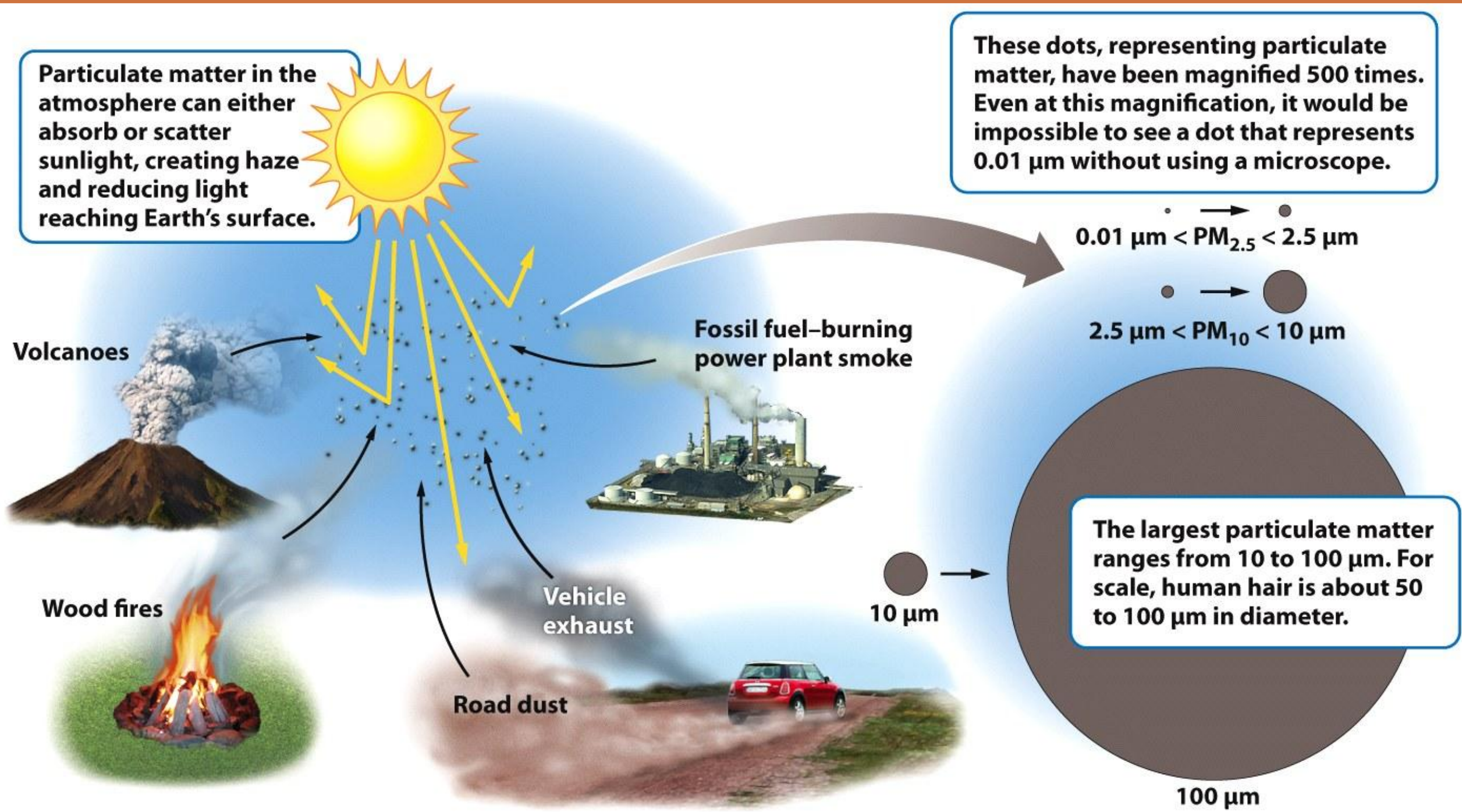


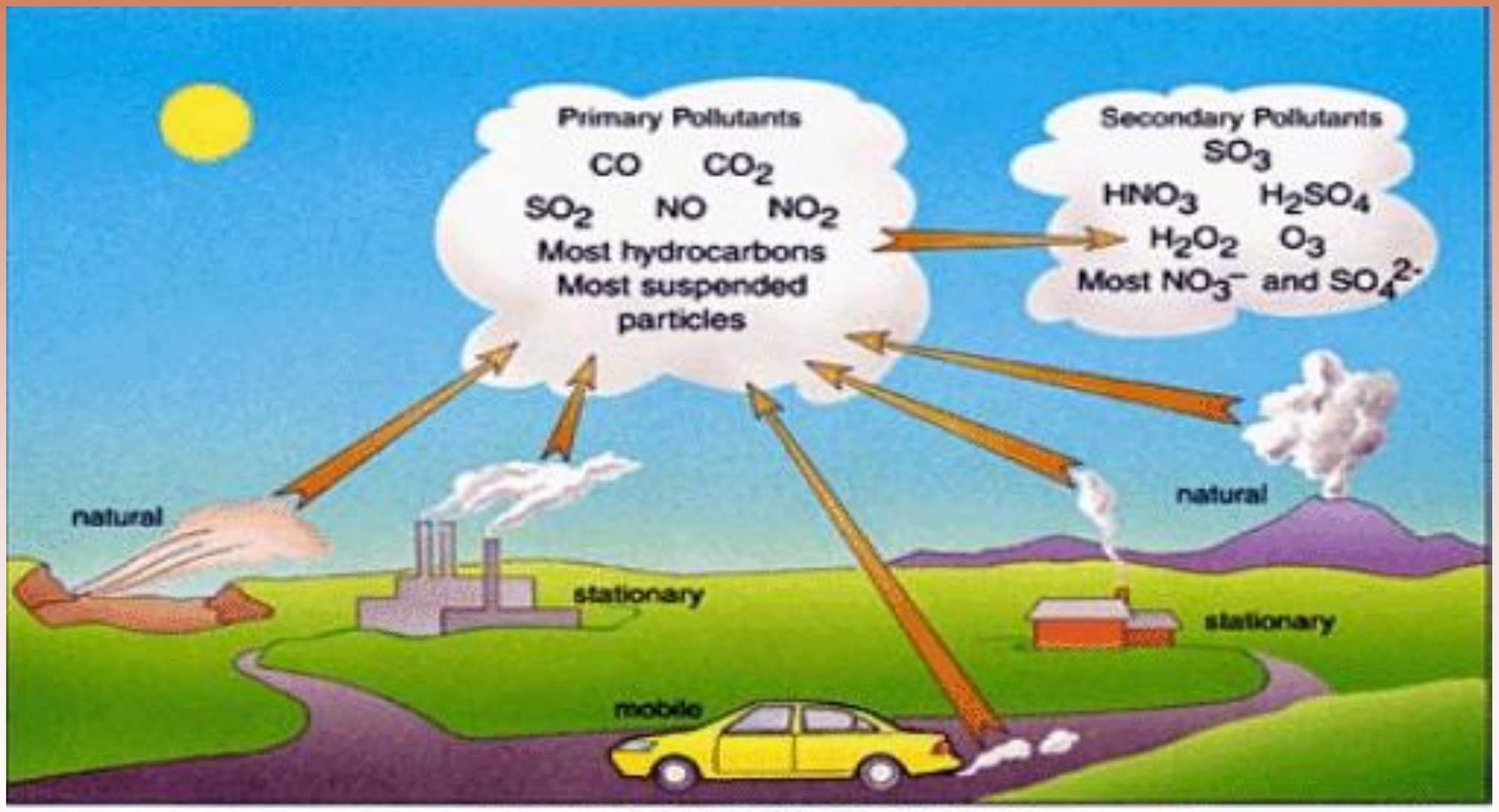
Figure 15.2
Environmental Science

Primary Pollutants

- Primary pollutants- polluting compounds that come directly out of the smoke-stack, exhaust pip, or natural emission source.
- Examples: CO, CO2, SO2, NOx, and most suspended particulate matter.

Secondary Pollutants

- Secondary pollutants- pollutants that have undergone transformation in the presence of sunlight, water, oxygen, or other compounds.
- Examples: ozone, sulfate and nitrate



Types and sources of air pollutants

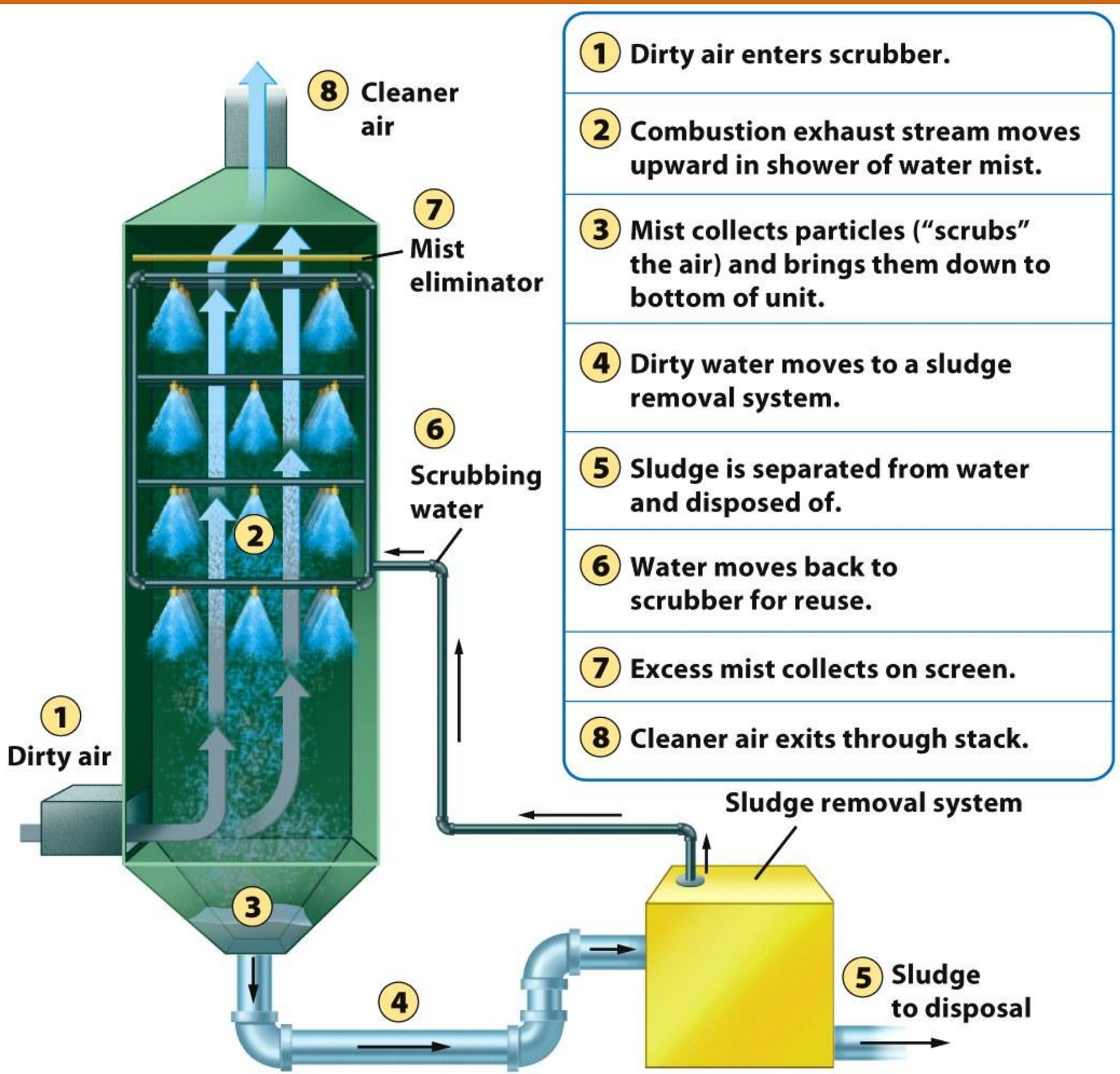


Figure 15.13
Environmental Science

- Why is air pollution considered a global system?
- What are the major air pollutants?
- What is the difference between a primary and a secondary pollutant?

Natural Sources of Air Pollution

- Volcanoes
- Lightning
- Forest fires
- Plants

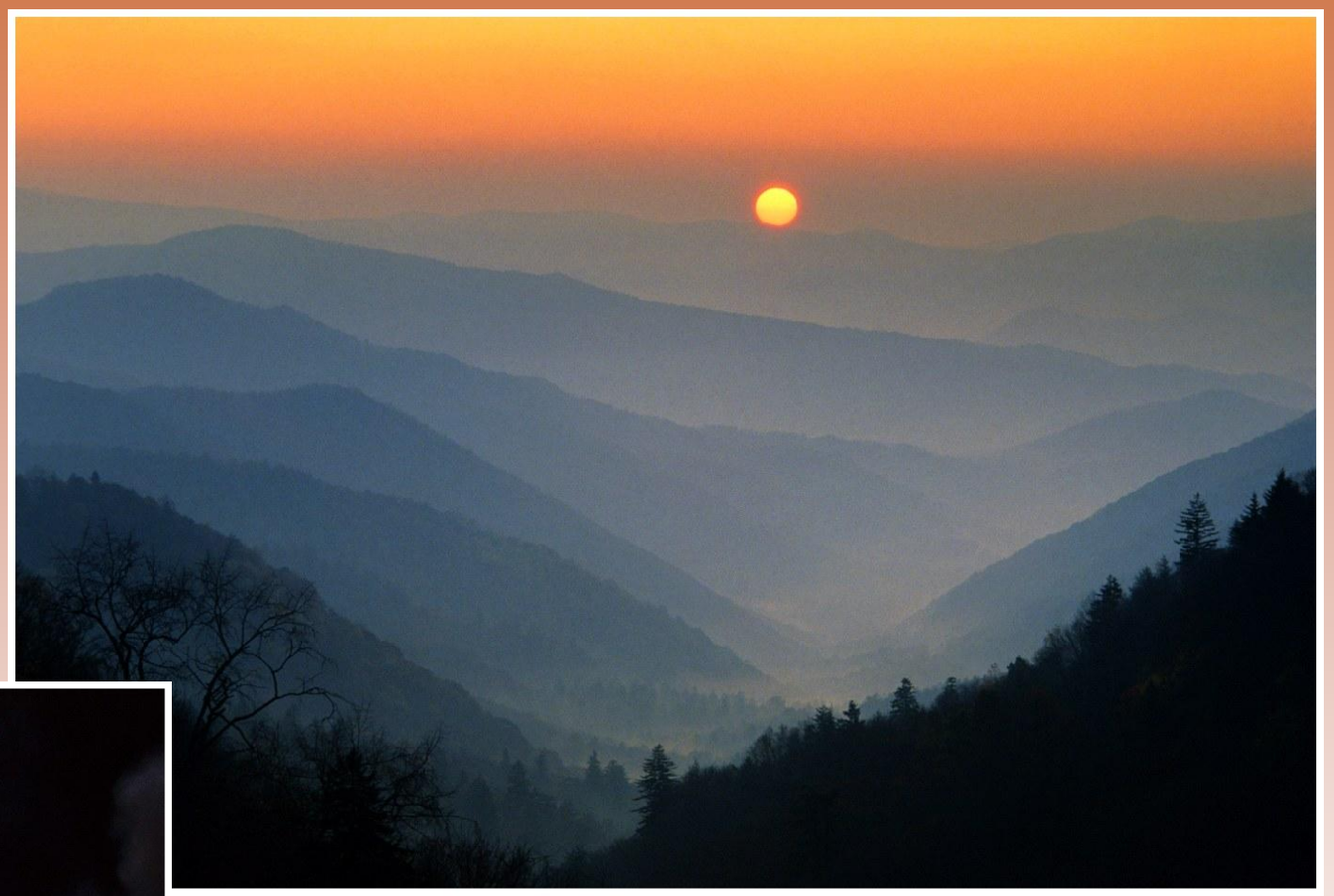


Figure 15.4a
Environmental Science

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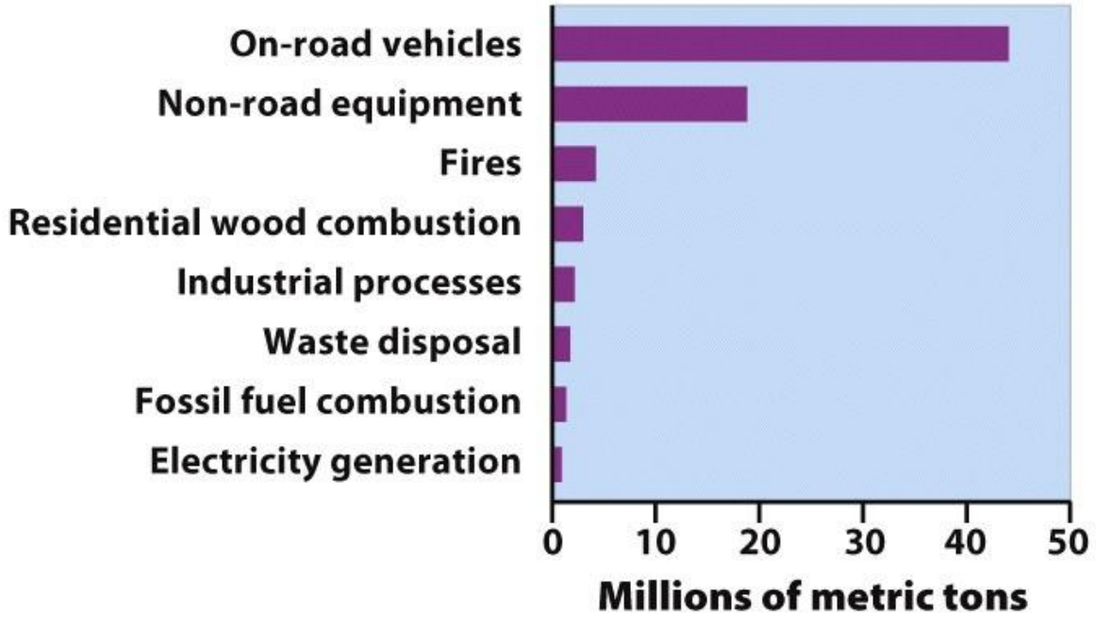
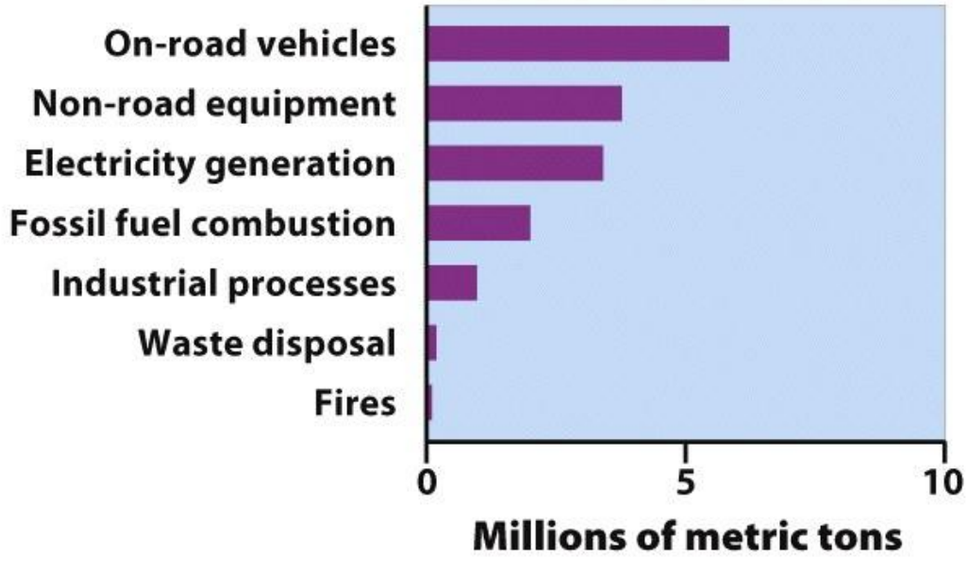
Anthropogenic Sources of Air Pollution

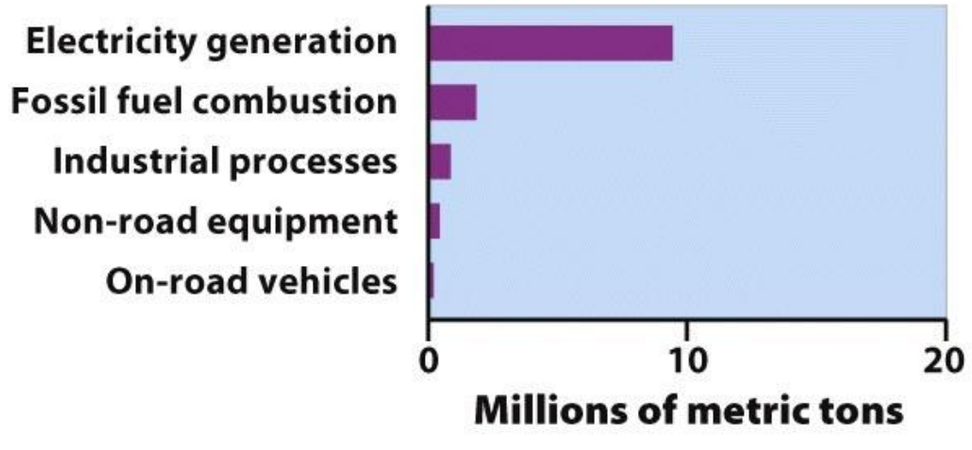
- On-road vehicles
- Power plants
- Industrial processes
- Waste disposal



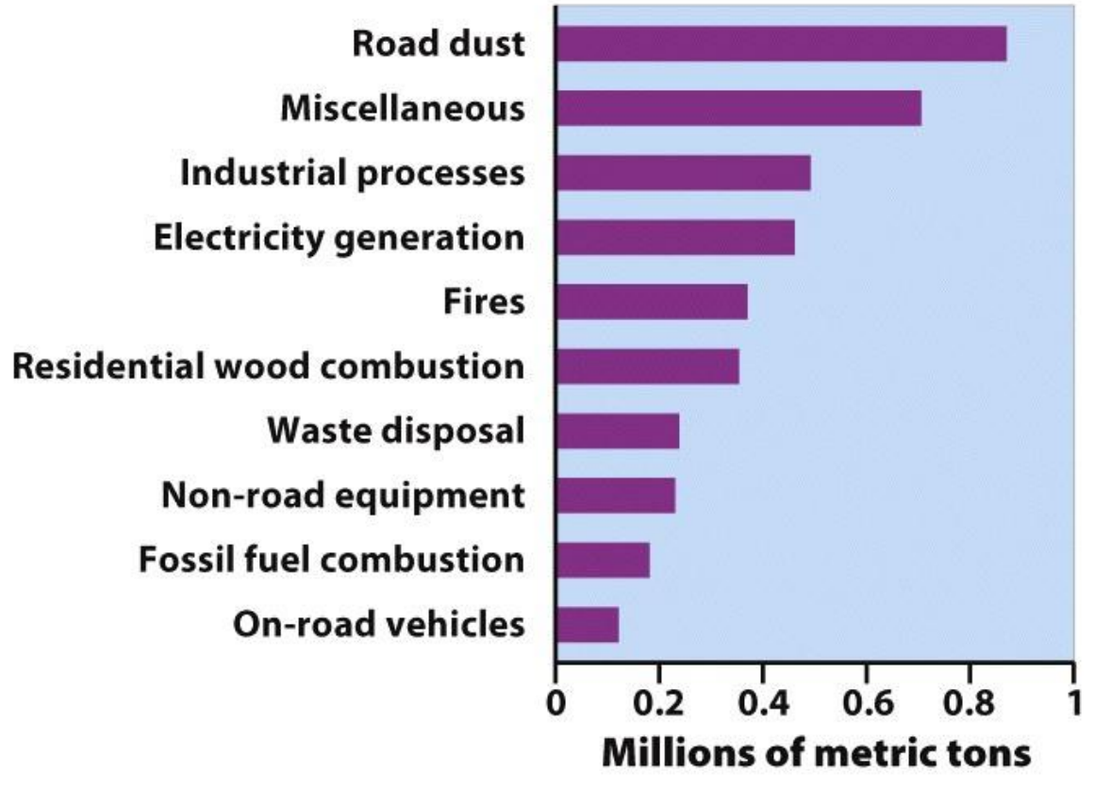
(a) Carbon monoxide



(b) Nitrogen oxides



(c) Sulfur dioxide



(d) Particulate matter ($PM_{2.5}$)

Figure 15.5
Environmental Science

- What are the major sources of air pollution?
- What are the major sources of *anthropogenic* air pollution?
- How does the Clean Air Act regulate anthropogenic emissions?

Photochemical Smog

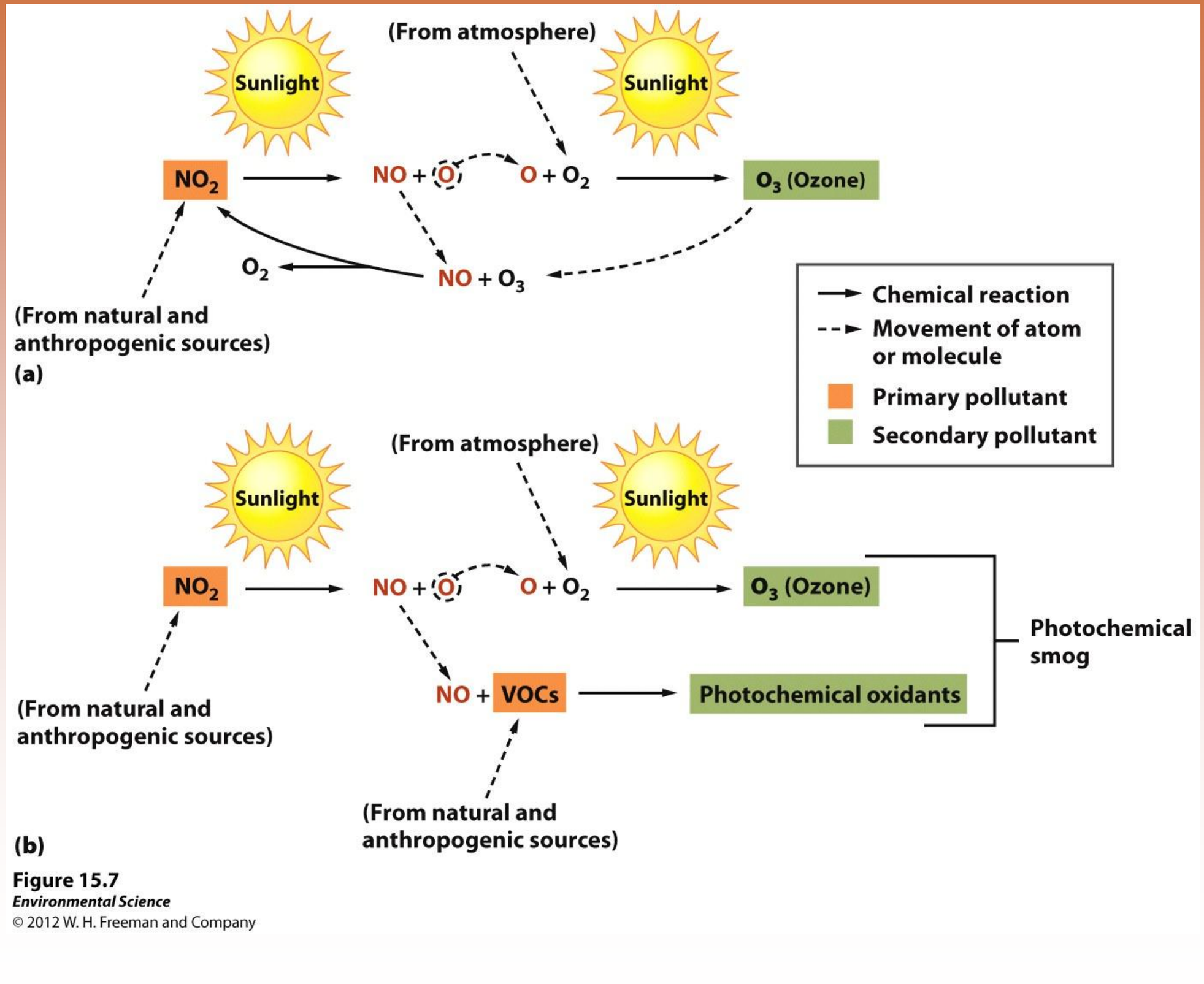
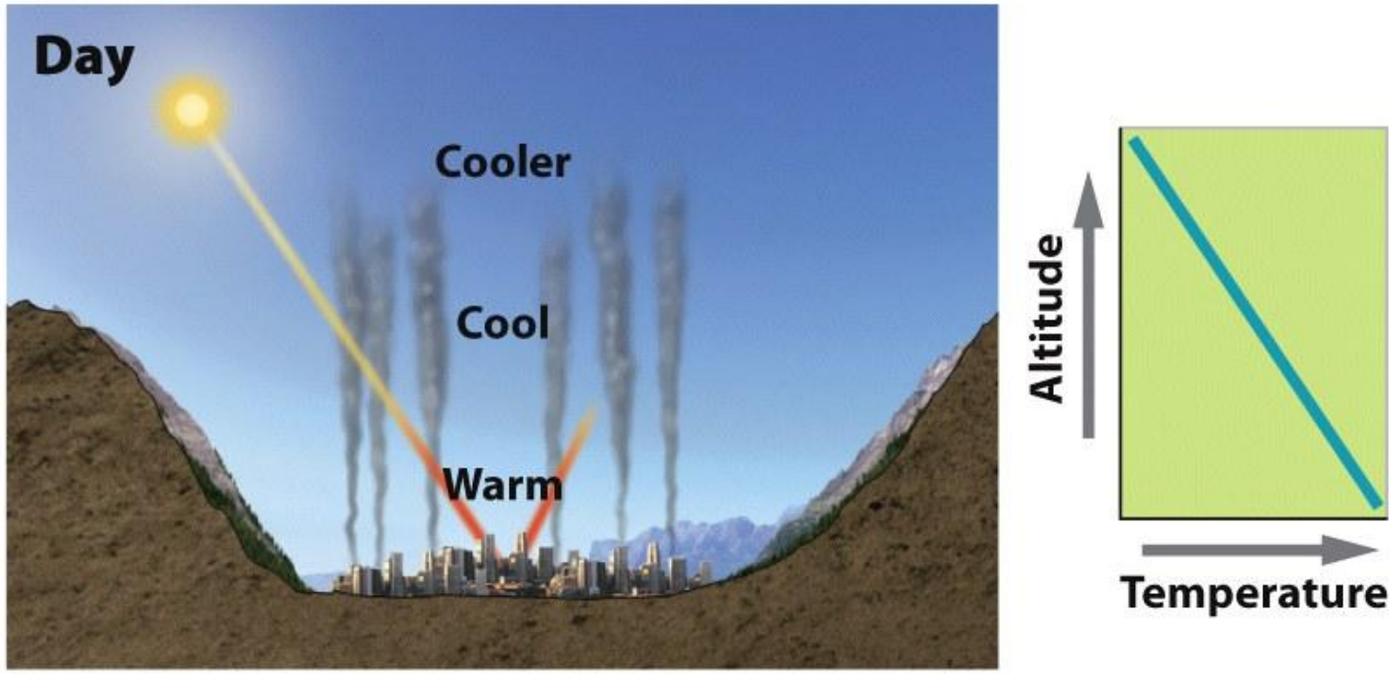


Figure 15.7
Environmental Science

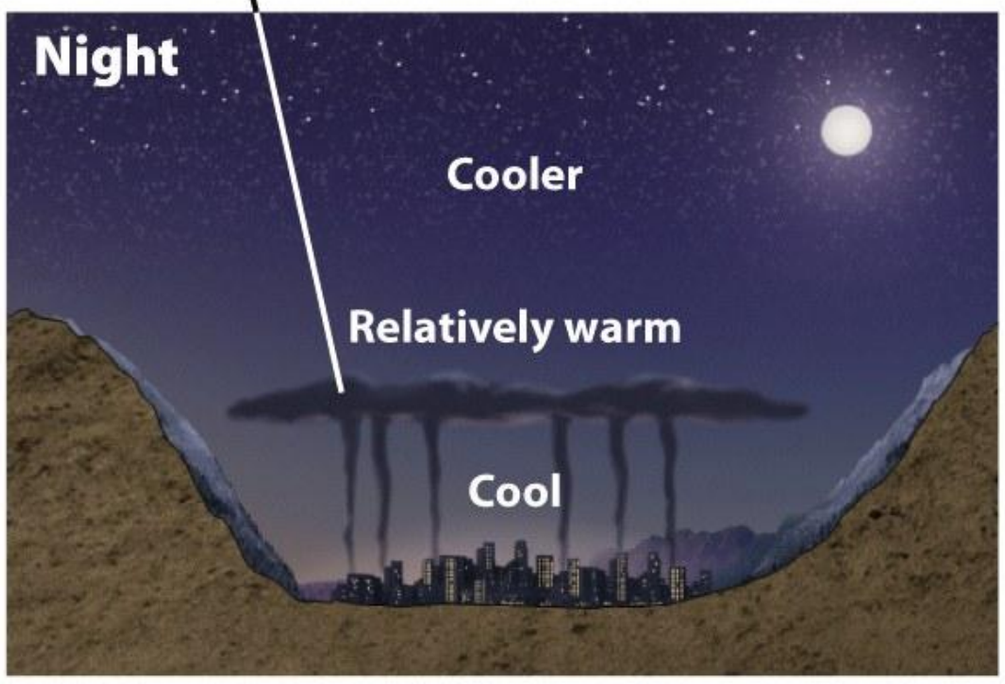
Thermal Inversions

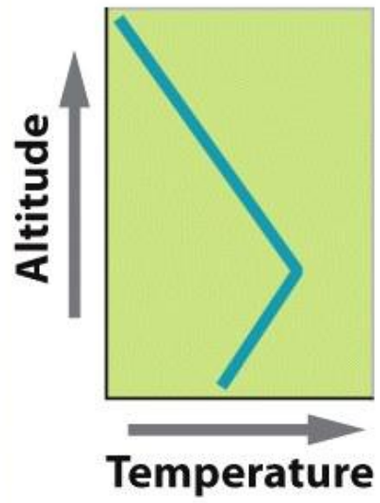
- Thermal Inversion- when a relatively warm layer of air at mid-altitude covers a layer of cold, dense air below.
- The warm inversion layer traps emissions that then accumulate beneath it.



(a) Normal conditions

Air pollution
trapped near surface





(b) Thermal inversion

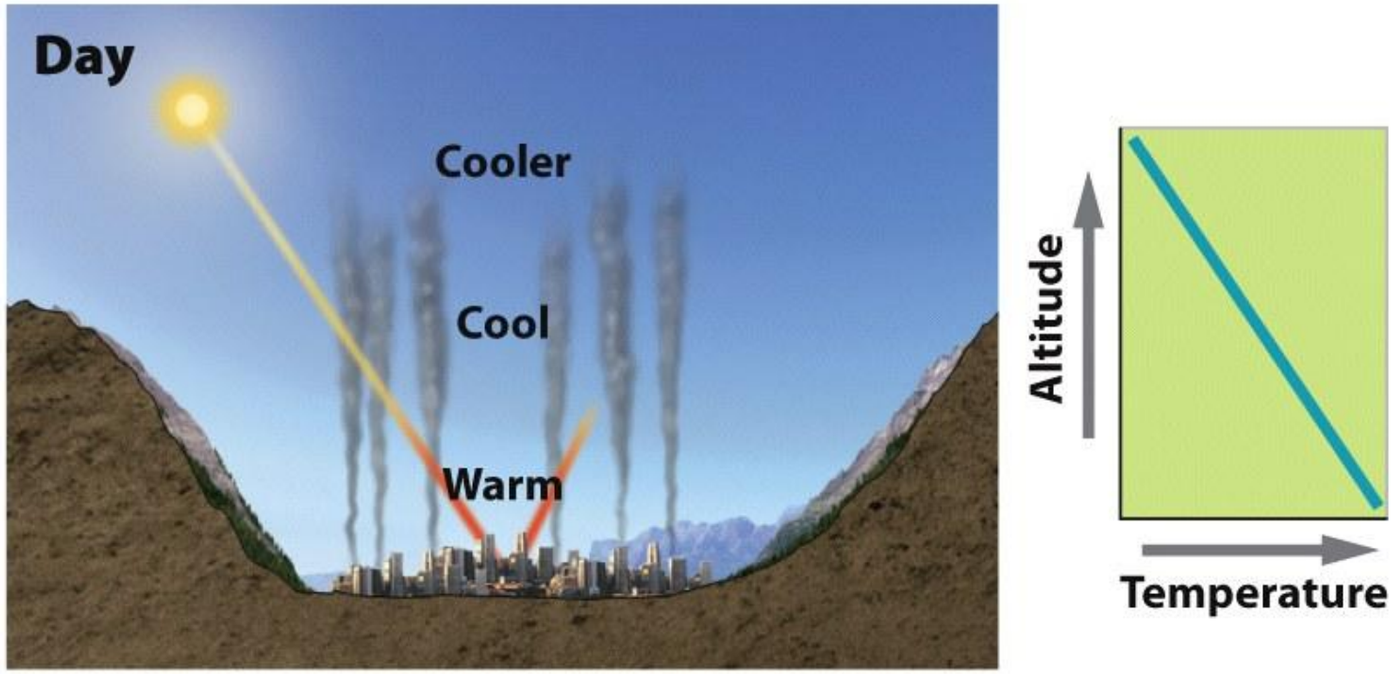
Figure 15.8
Environmental Science

Denver's Brown Cloud

- What is photochemical smog?
- How does photochemical smog form?
- How does an inversion layer influence pollution events?

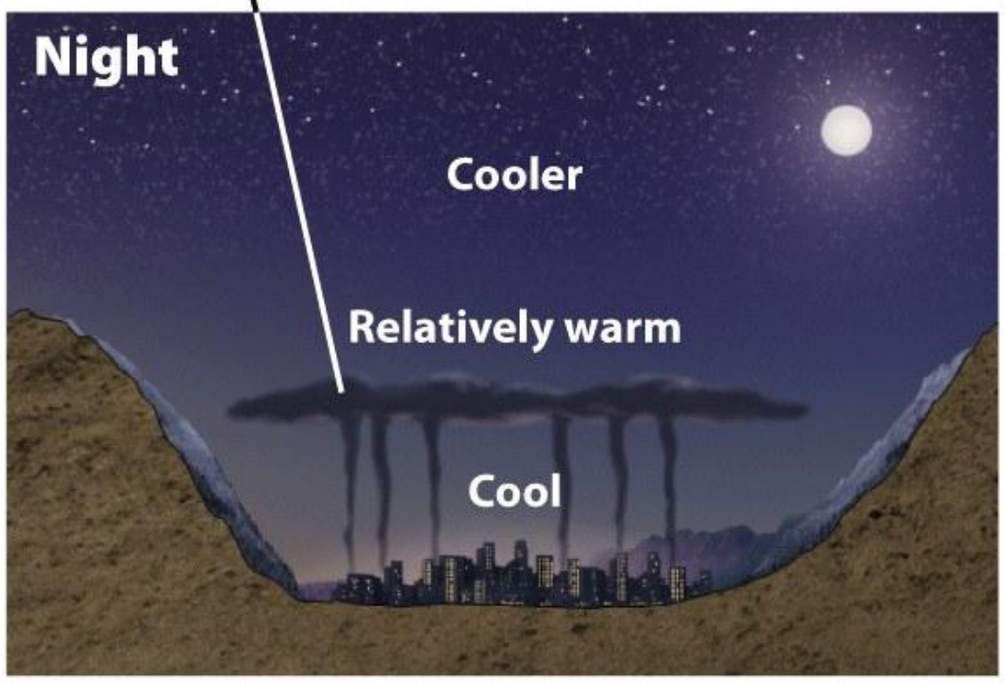
Warm-up 09MAR2016

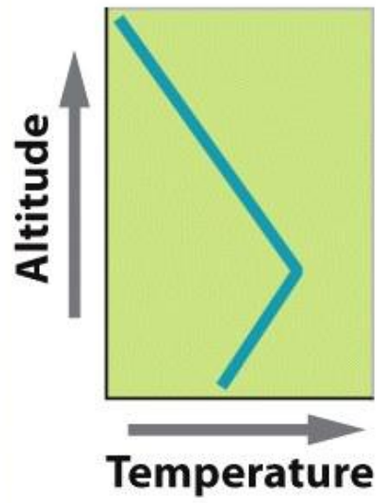
- What is photochemical smog?
- How does photochemical smog form?
- How does an inversion layer influence pollution events?



(a) Normal conditions

Air pollution
trapped near surface





(b) Thermal inversion

Figure 15.8
Environmental Science

Car Exhaust and Air Pollution

- We will measure the composition of exhaust in Ms. Leigh 2014 Subaru and Ethan’s car???
- We will compare this to the air surrounding a plant ☺

Warm-UP 10MAR2016

1. Why was the Nissan NOx so much higher than the Subaru?
2. What did the Car Exhaust Lab tell us about the brown cloud?

Logistics
(all of these will go on this quarter)

Read Silent Spring by Friday (Forward – Ch 3)

Read Klein Ch 13 by Monday (Kalynn and Jennifer R. will be the final presenters)

10 Vocabulary Due Friday

Air Pollution Lab Write-up Due Friday

Acid Deposition

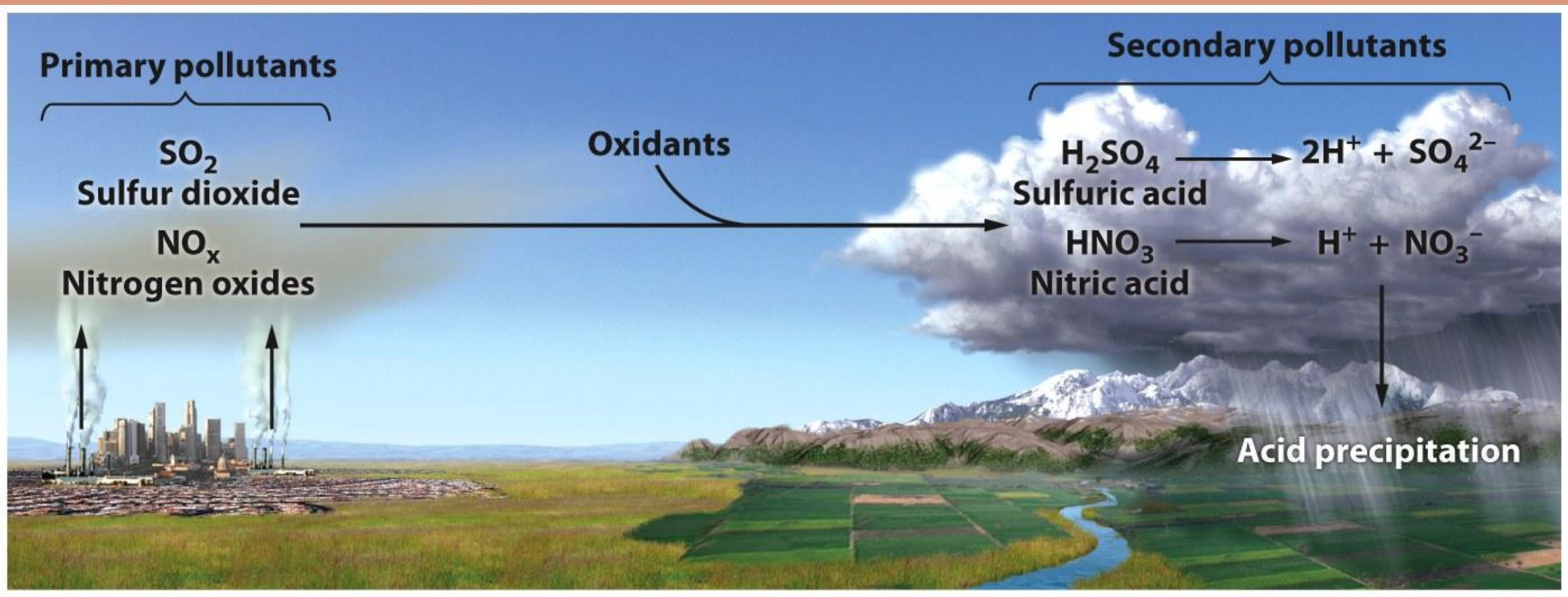


Figure 15.9
Environmental Science

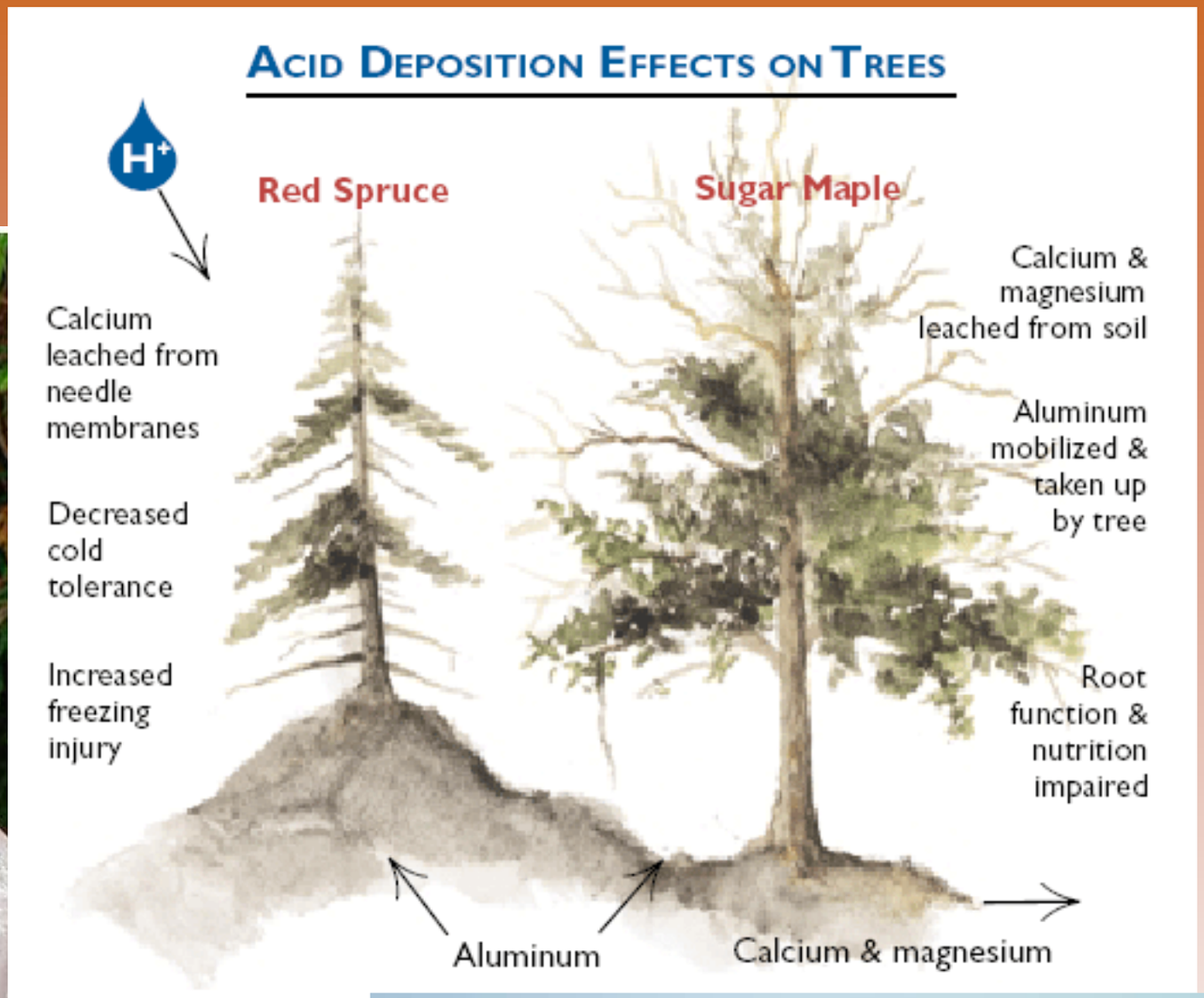
Acid Deposition

- Acid deposition- occurs when nitrogen oxides and sulfur oxides are released into the atmosphere and combine with atmospheric oxygen and water. These form the secondary pollutants nitric acid and sulfuric acid.
- These secondary pollutants further break down into nitrate and sulfate which cause the acid in acid deposition.

Effects of Acid Deposition

- Lowering the pH of lake water
- Decreasing species diversity of aquatic organisms
- Mobilizing metals that are found in soils and releasing these into surface waters
- Damaging statues, monuments, and buildings

St. Francis of the Acid Rain ***by Melody Murray***



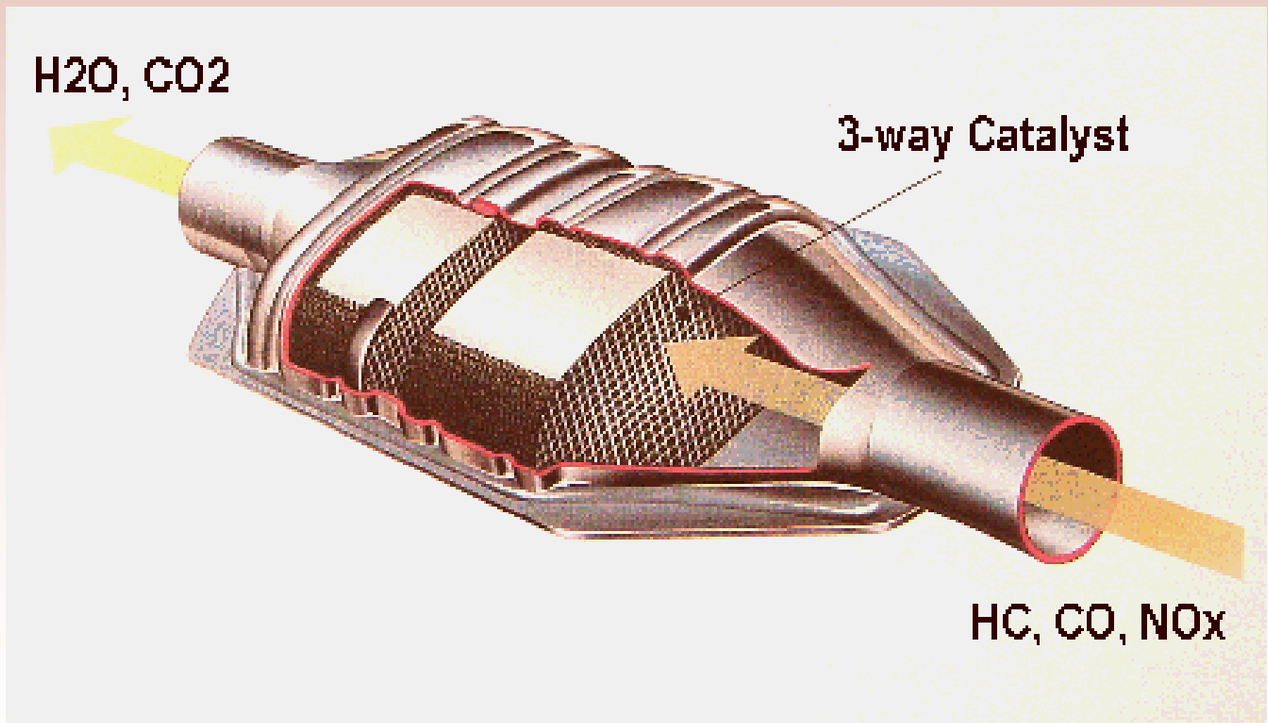
- What is Acid deposition
- What are the primary pollutants that lead to the formation of acid deposition?
- What are the major effects of acid deposition?

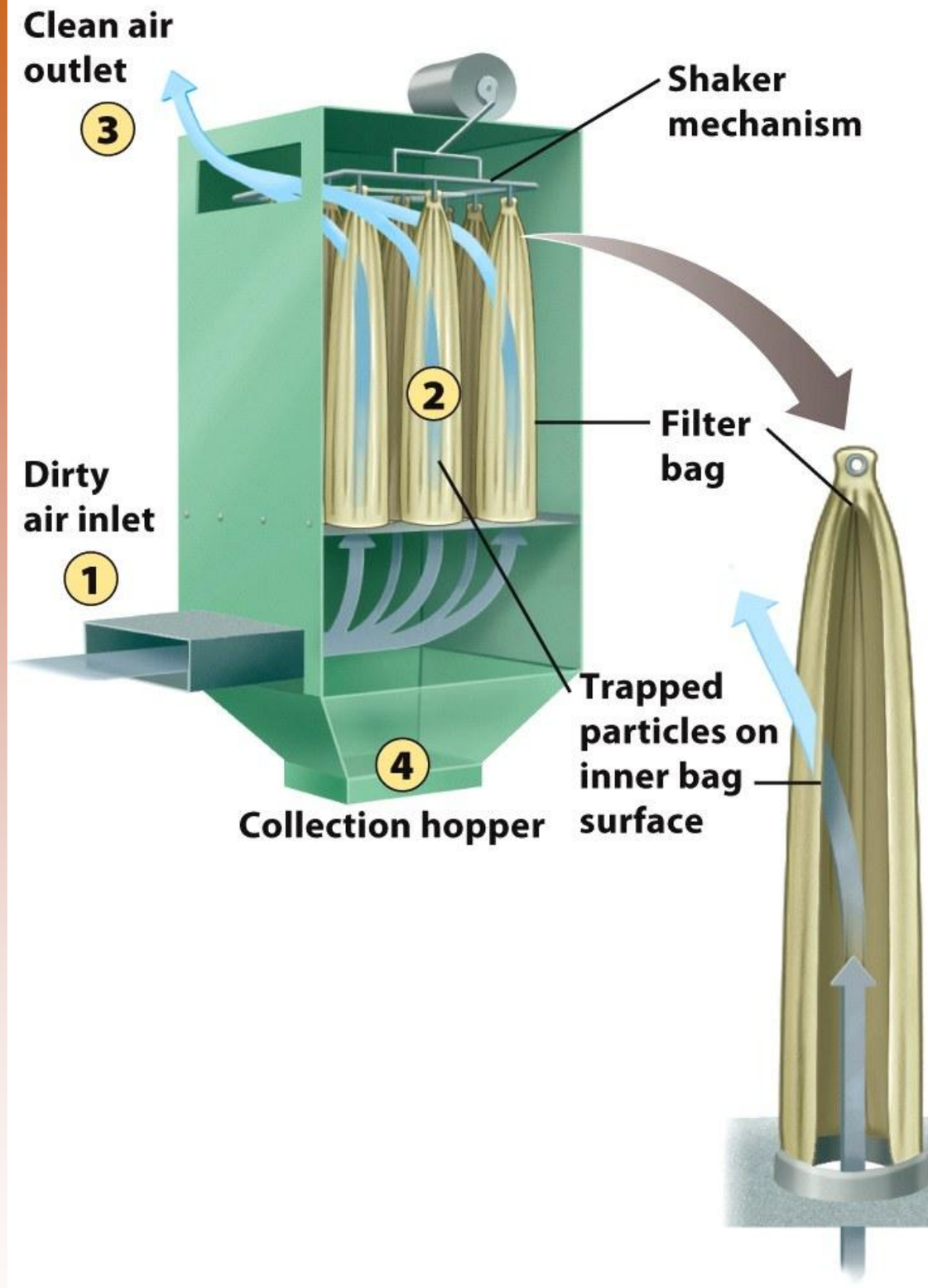
Ways to Prevent Air Pollution

- Catalytic converters on cars
- Scrubbers on smoke stacks
- Baghouse filters
- Electrostatic precipitators
- REDUCE Driving!

Catalytic Converter

- Reduces unburned fuel
- Reduces NOx
- Reduces CO

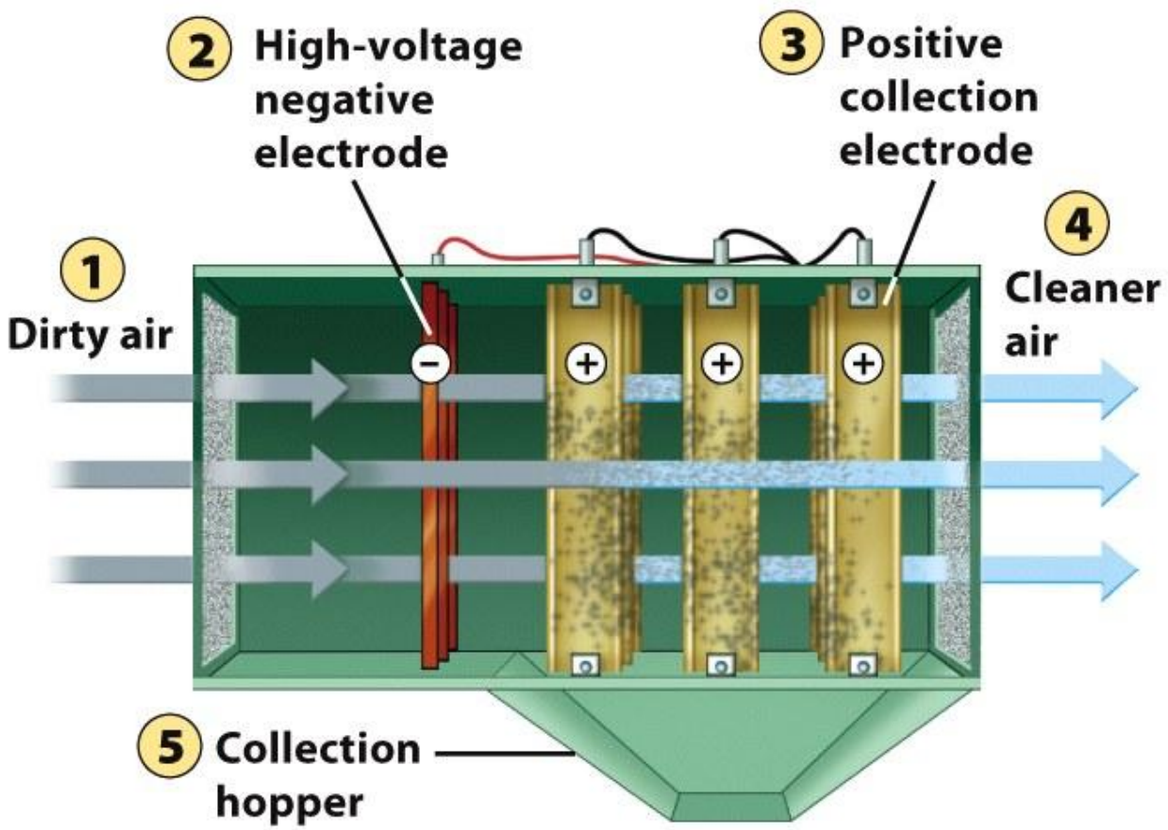




1. Dirty air enters housing.
2. Combustion exhaust stream moves through and dust particles are trapped in a series of filter bags.
3. Cleaner, filtered air moves out of unit.
4. A shaker mechanism is activated periodically to dislodge trapped particles, which can then be collected from beneath the unit.

Figure 15.11
Environmental Science

The Baghouse Filter



1. Dirty air enters precipitator unit.
2. Particles in combustion exhaust stream pass by negatively charged plates, which gives them a negative charge.
3. The negatively charged particles are attracted to positively charged collection plates.
4. Cleaner air moves out of the unit.
5. The positive collection plates are periodically discharged, which causes the particles to fall off so that they can be removed from the system.

Figure 15.12
Environmental Science

Electrostatic Precipitator

The Scrubber

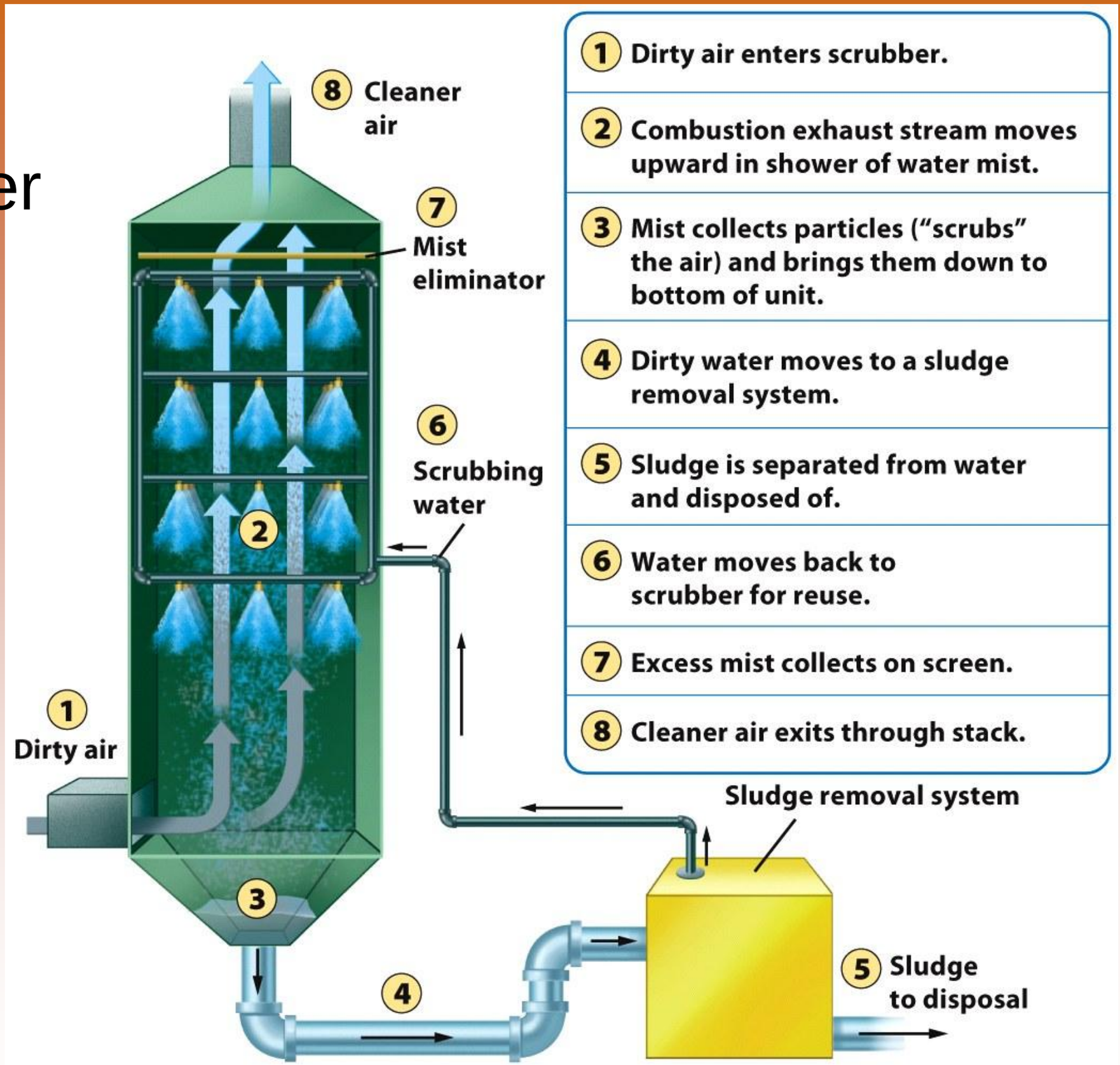


Figure 15.13
Environmental Science

Smog reduction

- Reducing automobile use!
- Mexico City allows alternate day driving
- Beijing Olympics increased public transportation
- Carpooling incentives
- Amendments to CAA to allow “free market” decide best ways

Sulfur Allowances

- Limits the amount of sulfur a company can emit into the atmosphere
  - 1 ton of SO_2 per year (allotment per company is reduced over time)
- Companies can trade their allowances in the “free market”

- This system is one of the proposed ways to reduce CO_2 emissions

- What do you think?

- Describe pollution control methods for sulfur dioxide, nitrogen, oxides, and particulates?
- What are some approaches to smog reduction?
- Explain the purpose of sulfur allowances and how they work.


30 miles
Good Ozone
PROTECTIVE OZONE LAYER
STRATOSPHERE
Bad Ozone
10 miles
TROPOSPHERE
SMOG
EARTH

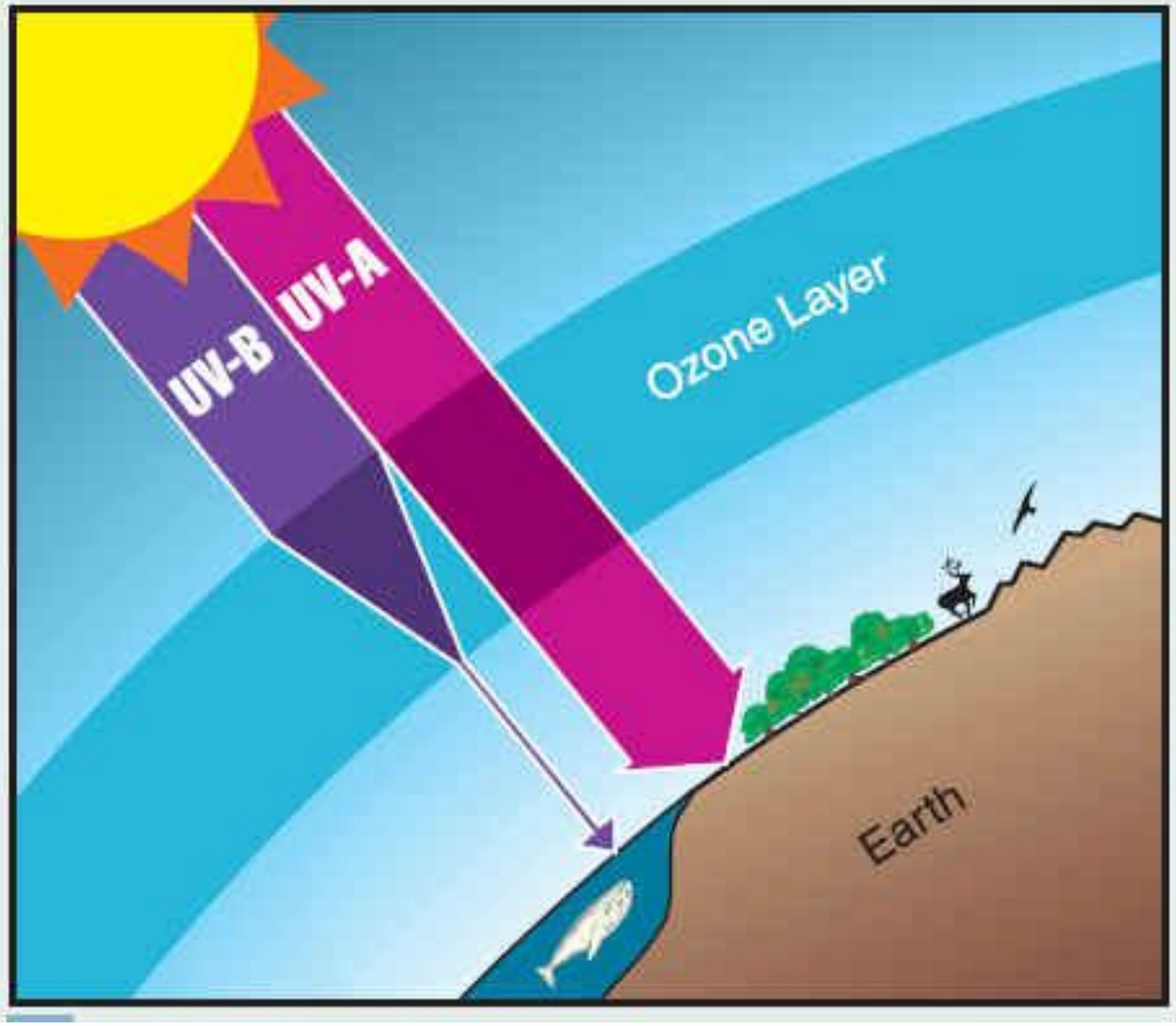
Tropospheric Ozone

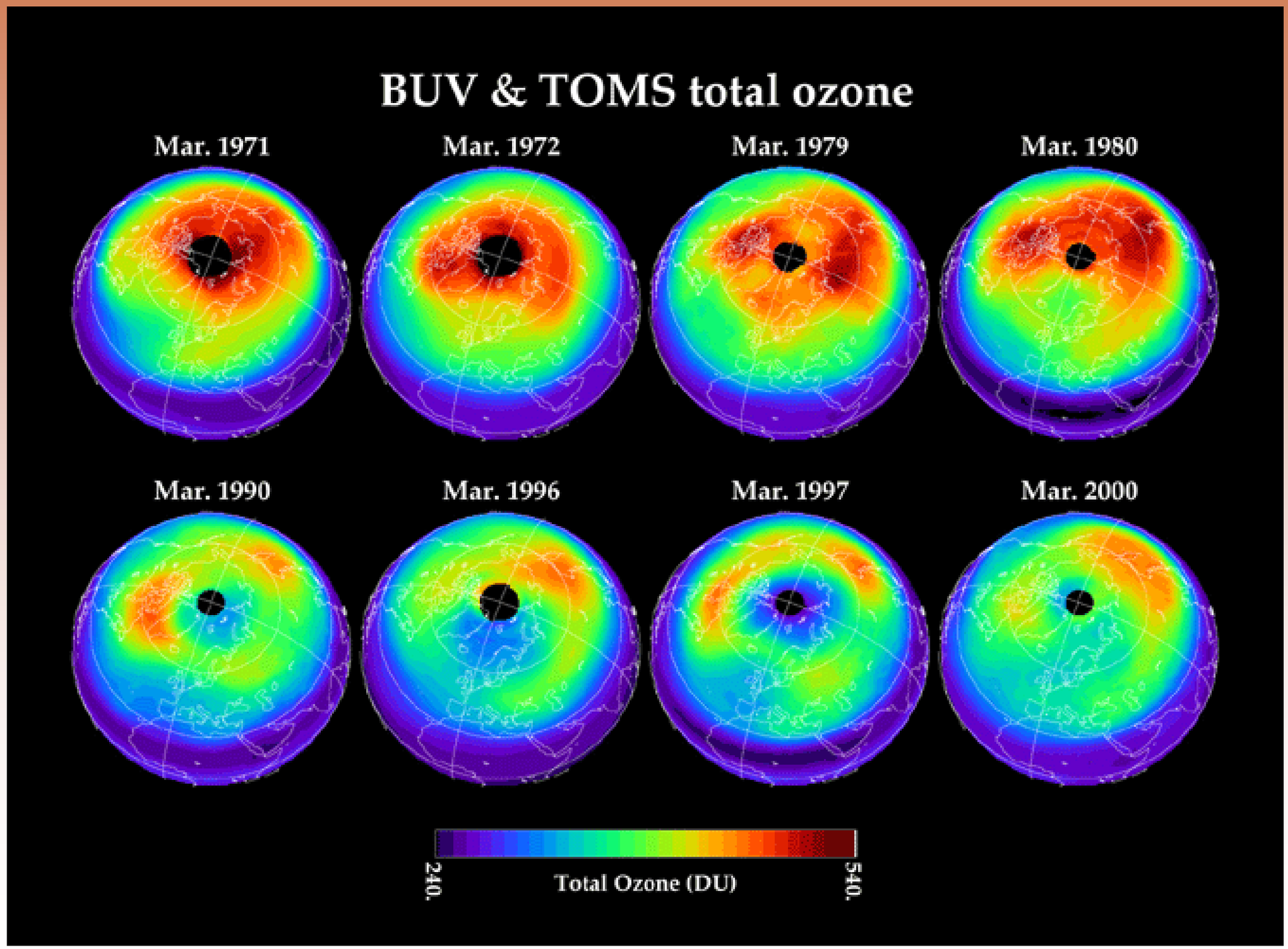
- BAD ozone is produced in the lower levels of the atmosphere as a result of anthropogenic activities
- What we are measuring with our homemade KI strips

Stratospheric Ozone

- The stratospheric ozone layer exists roughly 45-60 kilometers above the Earth.
- Ozone has the ability to absorb ultraviolet radiation and protect life on Earth.

UV Protection by the Ozone Layer




BUV & TOMS total ozone
Mar. 1971
Mar. 1972
Mar. 1979
Mar. 1980
Mar. 1990
Mar. 1996
Mar. 1997
Mar. 2000
240.
Total Ozone (DU)
540.

Formation and Breakdown of Stratospheric Ozone

- First, UV-C radiation breaks the bonds holding together the oxygen molecule)2, leaving two free oxygen atoms:
  O2 + UV-C -> 2O
- Sometimes the free oxygen atoms result in ozone:
  O2 + O -> O3
- Ozone is broken down into O2 and free oxygen atoms when it absorbs both UV-C and UV-B ultraviolet light:
  O3 + UV-B or UV-C -> O2 + O

Anthropogenic Contributions to Ozone Destruction

- Certain chemicals can break down ozone, particularly chlorine.
- The major source of chlorine in the stratosphere is a compound known as chlorofluorocarbons (CFCs)
- CFCs are used in refrigeration and air conditioning, as propellants in aerosol cans and as “blowing agents” to inject air into foam products like Styrofoam.
- (found in hairsprays and other aerosol products)


BEARD BUSTER
Barbasol
THICK & RICH SHAVING CREAM
ORIGINAL
NET WT. 11 OZ.
BEARD BUSTER
Barbasol
THICK & RICH SHAVING CREAM
SOOTHING ALOE
NET WT. 11 OZ.
BEARD BUSTER
Barbasol
THICK & RICH SHAVING CREAM
SKIN CONDITIONER
NET WT. 11 OZ.

Anthropogenic Contributions to Ozone Destruction

- When CFCs are released into the troposphere they make their way to the stratosphere.
- The ultraviolet radiation present has enough energy to break the bond connecting chlorine to the CFC molecule.
- which can then break apart the ozone molecules.

Anthropogenic Contributions to Ozone Destruction

- First, chlorine breaks ozone's bonds and pulls off one atom of oxygen, forming a chlorine monoxide molecule and O2:
  $O3 + Cl \rightarrow ClO + O2$
- Next, a free oxygen atoms pulls the oxygen atom from ClO, liberating the chlorine and creating one oxygen molecule:
  $ClO + O \rightarrow Cl + O2$
- One chlorine atom can catalyze the breakdown of as many as 100,000 ozone molecules before it leaves the stratosphere.

Depletion of the Stratospheric Ozone Layer

- Global Ozone concentrations had decreased by more than 10%.
- Depletion was greatest at the poles
- Decreased stratospheric ozone has increased the amount of UV-B radiation that reaches the surface of Earth.
- Montreal Protocol = Stopped production of CFCs

- video

Warm-up 11MAR2016

- Describe pollution control methods for sulfur dioxide, nitrogen, oxides, and particulates?
- What are some approaches to smog reduction?

Logistics
(all of these will go on this quarter)

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10 Vocabulary Due Friday

Air Pollution Lab Write-up Due Friday

TRASH CARRY

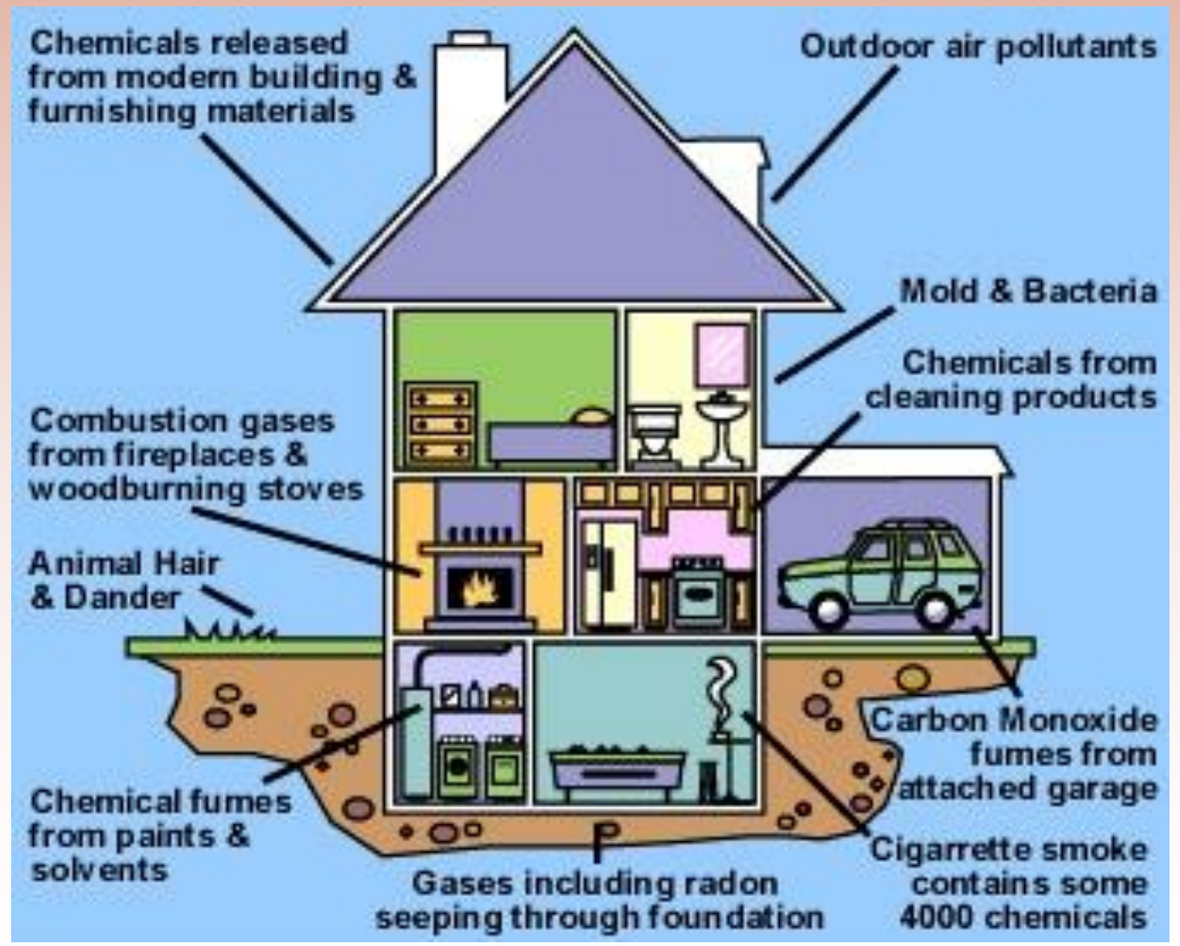
- Students will collect ALL of the trash they create in a week.
- Please bring your trash to class each day
- Students will craft a reflective essay due on Friday 3/25 (day before spring break)
- Separate the compostables and recyclables in your bag
  - I do not want to see…

- Humans are spending more time inside
- Houses are becoming more “tightly sealed”
- This can trap and circulate indoor pollutants
- Ew!

Indoor Air Pollutants

- Wood, animal manure or coal used for cooking and heating in developing countries.
- Asbestos
- Carbon Monoxide
- Radon
- VOCs in home products

- There is a huge difference between indoor pollution in developing and developed countries



- Efforts to provide improves stoves to developing countries

PRIMARY SOURCES OF INDOOR AIR POLLUTION

ATTIC

- Asbestos
- Insulation
- Fibreglass
- Dust and dust mites

BATHROOM

- Excess humidity
- Personal hygiene products (aerosols, sprays, etc.)
- Mold spores

HOME OFFICE

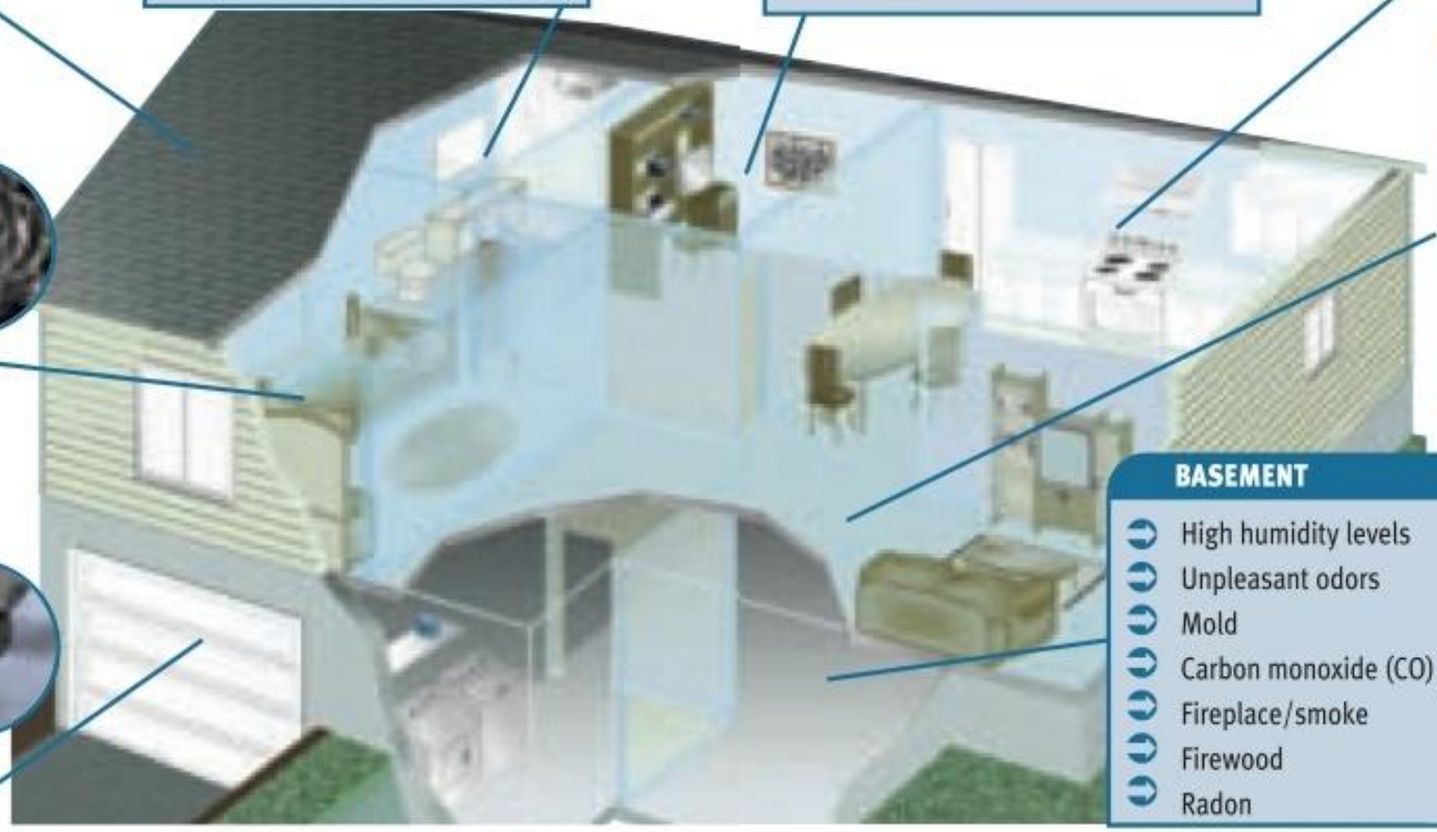
- Printers, photocopiers: ozone, volatile organic compounds (VOC)
- Melamine furniture (harmful vapors, VOC, formaldehyde)

KITCHEN

- Lingering odors
- Bacteria
- Cooking pollutants

BEDROOM

- Allergens
- Dust and dust mites
- Pet hair and dander
- Carbon dioxide (CO_2)
- Carpet



LIVING ROOM

- Fireplace
- Dust and dust mites
- Allergens
- Second-hand smoke
- Humidifiers
- Pet hair and dander
- Carpet

GARAGE

- Carbon monoxide (CO)
- Gas
- Solvents
- Pesticides and herbicides
- Dust
- Paint and chemicals
- Cleaning agents

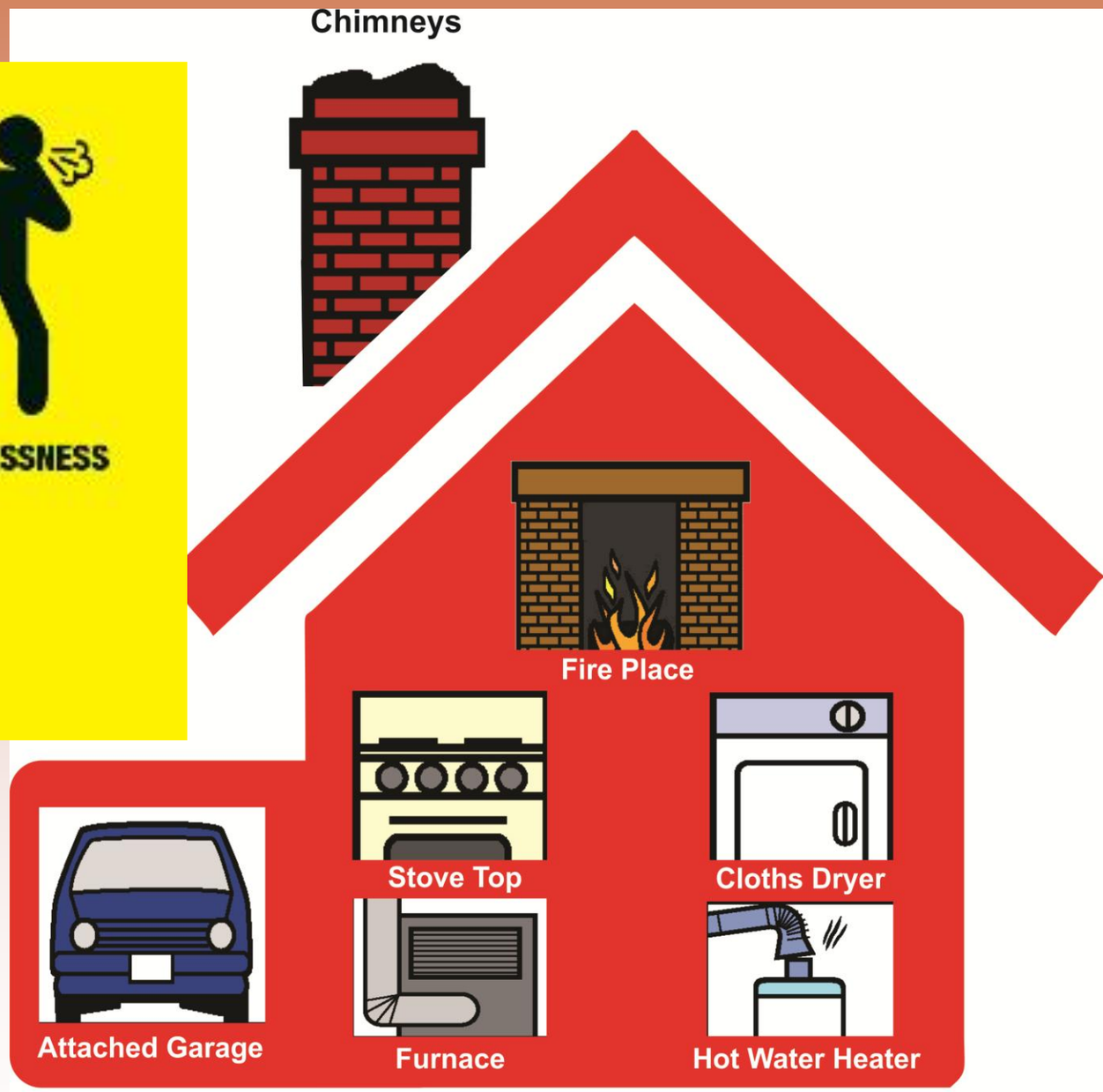
BASEMENT

- High humidity levels
- Unpleasant odors
- Mold
- Carbon monoxide (CO)
- Fireplace/smoke
- Firewood
- Radon
- Solvents
- Woodstove
- Dust and dust mites
- Combustion system
- Paint and chemicals
- Household cleaners

Asbestos

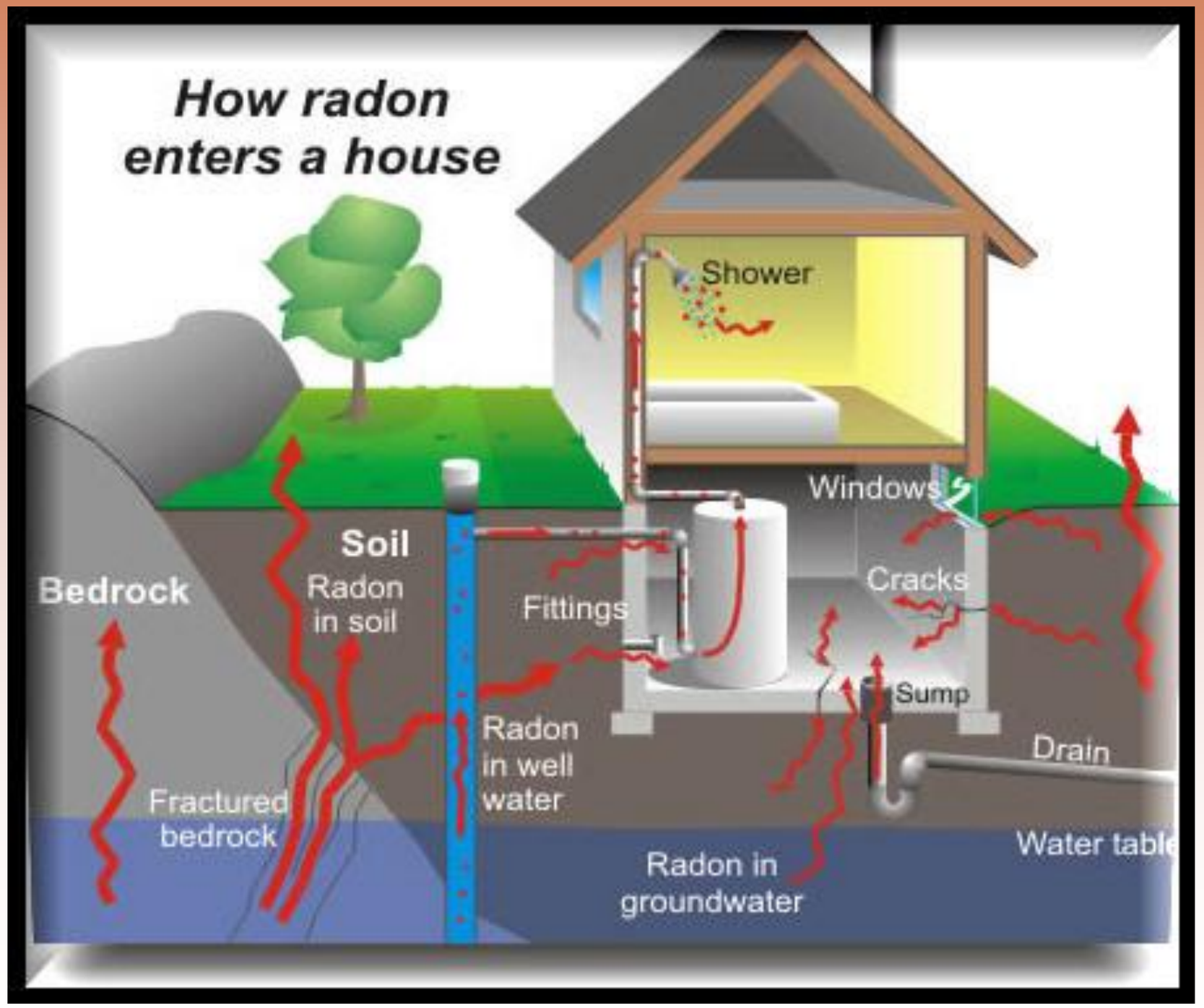
- Is relatively harmless until it begins to degrade or gets broken

Carbon Monoxide



Common Household Locations That May Leak Carbon Monoxide (CO)

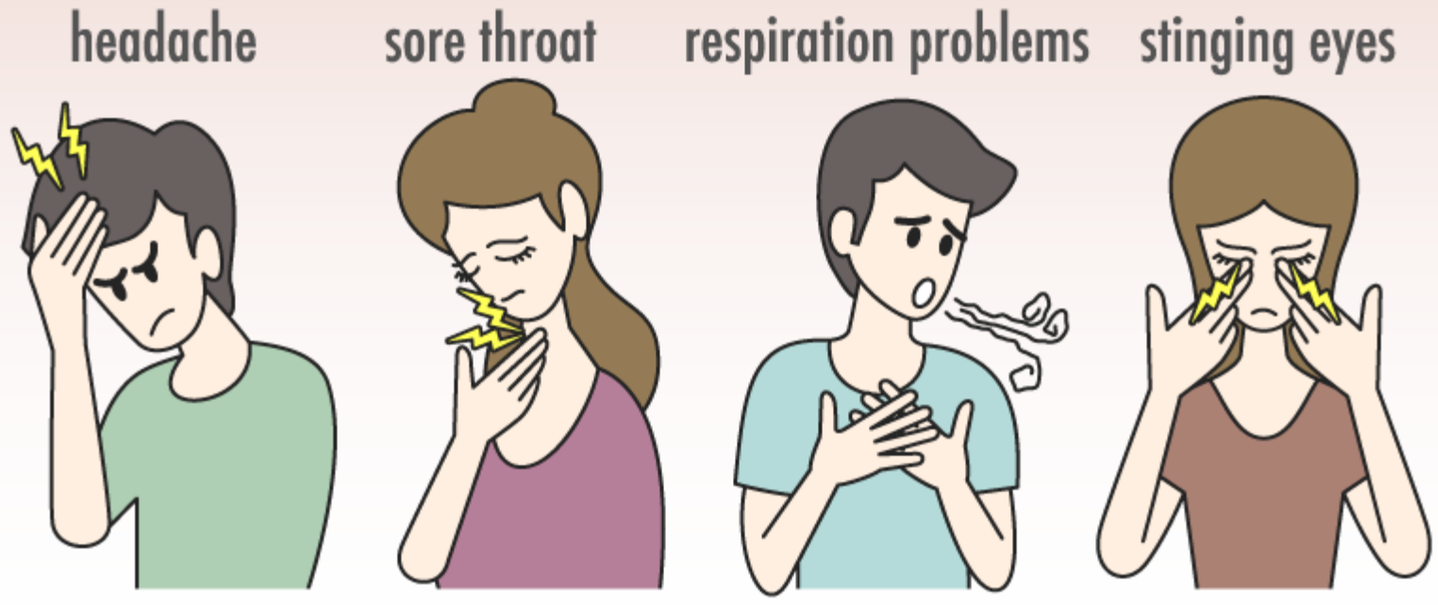
Radon


How radon enters a house
Shower
Windows
Soil
Bedrock
Radon in soil
Fittings
Cracks
Sump
Radon in well water
Drain
Fractured bedrock
Water table
Radon in groundwater

VOCs

Sick Building Syndrome

- Common in office buildings
- Any of the previously listed pollutants are at high levels



- What are the main sources of indoor pollution in the developing world?
- List common sources of indoor pollution in the developed world?
- What is sick building syndrome?

Schoenbein Chart