**CHAPTER 18 Air Pollution**

**Core Case Study: South Asia’s Massive Brown cloud**

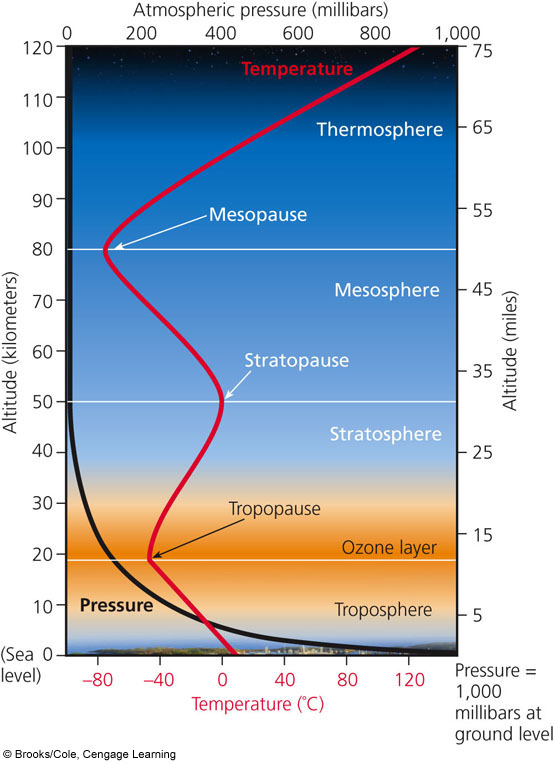
1. The Asian Brown Cloud covers India, Bangladesh, parts of China, and the open sea. What is in this brown cloud?
2. Describe 2 negative effects the Asian Brown Cloud has had on life in these areas and other areas.

**18-1: What Is the Nature of the Atmosphere?**

The layers of the atmosphere are characterized by abrupt changes in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, differences in absorption of \_\_\_\_\_\_\_\_\_\_\_\_ energy, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and atmospheric \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Air density and atmospheric pressure \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with altitude.

The Four Layers of the Atmosphere:



Stratosphere:

* Concentration of ozone (O3) is \_\_\_\_\_\_\_\_\_\_\_\_ here called the \_\_\_\_\_\_\_\_\_ layer
* Describe how stratospheric ozone is produced:
* Why is ozone called the “global sunscreen?”
* Ozone in this layer of the atmosphere protects us from:

Troposphere:

* \_\_\_\_\_\_% of earth’s air mass
* Closest to the surface of earth
* Air we breathe is 78% \_\_\_\_ and 21% \_\_\_\_
* Air currents and wind cause \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and climate to happen in this layer

**18-2: What Are the Major Outdoor Air Pollution Problems?**

Air pollution is the presence of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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| Natural Sources | Sources of Air Pollution | Human Sources |
| -dust blow from \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_  -\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (VOCs) released by plants | -most are generated by burning \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in industrial plants (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ source) and cars (\_\_\_\_\_\_\_\_\_\_\_\_\_ source). |

Case Study: Air Pollution in the Past- The Bad Old Days

Air pollution probably began when humans discovered \_\_\_\_\_\_\_\_\_\_ and were breathing in unhealthy smoke and soot.

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Revolution (late 1700’s) brought even worse air pollution when \_\_\_\_\_\_\_\_\_ was burned to power factories and heat homes. This brought an increase in cases of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

History of Air Pollution in London-

1880: prolonged \_\_\_\_\_\_\_\_\_ fog killed 2,200 people in London.

1905: the word \_\_\_\_\_\_\_\_ was invented to describe the mixture of \_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_

1952: a dangerous yellow fog lasted \_\_\_\_ days and killed nearly \_\_\_\_\_\_\_\_\_ Londoners

\*This tragedy prompted the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of 1956.

History of Air Pollution in the US-

1948: \_\_\_\_\_\_\_\_\_\_\_, Pennsylvania- pollution from coal burning factories, zinc smelter and a sulfuric acid plant became trapped in dense \_\_\_\_\_\_\_\_ that stagnated over the area for 5 days. 6,000 became ill and 20 died.

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| Primary Pollutants | Categories of Air Pollution | Secondary Pollutants |
| -harmful chemicals emitted \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from \_\_\_\_\_\_\_\_\_\_\_\_ processes and human activity | -happens when \_\_\_\_\_\_\_\_\_\_\_\_\_\_ pollutants \_\_\_\_\_\_\_\_\_\_\_\_\_\_ with each other and form \_\_\_\_\_\_ harmful chemicals |

If there are more factories and cars in urban areas, why do rural areas still have to deal with some primary and secondary pollutants? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Major Outdoor Air Pollutants** | | | |
| *Name* | *Characteristics* | *Sources* | *Effects* |
| Carbon Oxides | CO-  CO2- | CO-  CO2- | CO- reacts with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in red blood cells and reduces blood’s ability to transport \_\_\_\_\_\_\_\_. Chronic exposure leads to asthma, emphysema, mental impairment, coma, death  CO2- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ warming and climate change  Catalytic Converters- |
| Nitrogen Oxides and Nitric Acid | NO-  Nitric Acid- | NO-  Nitric Acid- | NO- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ smog, can irritate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, suppress \_\_\_\_\_\_\_\_\_\_\_ growth  Nitric Acid- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ smog, acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Sulfur Dioxides and Sulfuric Acid | SO2-  Sulfuric acid- | SO2-  Sulfuric acid- | Both SO2 and Sulfuric Acid- acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, reduce \_\_\_\_\_\_\_\_\_\_\_\_\_\_, aggravate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ problems, damage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, corrode \_\_\_\_\_\_\_\_\_\_\_\_\_, and damage paint and \_\_\_\_\_\_\_\_\_\_ on buildings and statues. |
| Particulates |  |  | Fine and Ultrafine Particles- |
| Ozone |  |  | Ozone in the TROPOSPHERE:  Ozone in the STATOSPHERE: |
| Volatile Organic Compounds (VOCs) |  |  | Can cause \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_ disorders, dizziness, death |

Case Study: Lead is a Highly Toxic Pollutant-

Lead (\_\_\_\_) is a potent \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that does \_\_\_\_\_\_\_ break down in the environment.

Exposure causes \_\_\_\_\_\_\_\_\_\_\_\_\_ system impairment, lowered \_\_\_\_\_, shortened attention span, etc.

Between 1976 and 2000, there has been a huge drop in lead poisoning cases because the government banned:

Some children are still being exposed because of:

Science Focus: Detecting Air Pollutants

One way to detect air pollutants is through a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ indicator- \_\_\_\_\_\_\_\_\_\_\_

Lichen forms from a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ relationship between \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_.

They are good indicators because they continually absorb \_\_\_\_\_\_\_.

Highly Polluted Area= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ lichen or none at all

Moderate Air Pollution= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ lichen

Clean Air Areas= \_\_\_\_\_\_\_\_\_ lichen on walls and trees

“Old Man’s Beard” Lichen and “Evernia” Lichen are sensitive to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Burning coal produces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:

-When coal and oil are burned: 1. Carbon is converted to \_\_\_\_\_\_ and \_\_\_\_\_\_

2. Sulfur reacts with O2 to produce \_\_\_\_\_\_\_

3. Some of the SO2 reacts with water vapor to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Some of the H2SO4 reacts with \_\_\_\_\_\_\_ to form solid ammonium sulfate

5. Unburned carbon goes into atmosphere is known as \_\_\_\_\_\_\_\_\_\_\_

\*All of these chemicals and particulates give smog the \_\_\_\_\_\_\_\_\_\_\_ color.

-Today Industrial smog is less of problem in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries because of pollution control, such as smokestacks to blow pollution downwind to \_\_\_\_\_\_\_\_\_\_\_ areas. It is still a problem in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries that still burn coal in houses and factories with inadequate pollution control. \_\_\_\_\_\_\_\_\_\_\_\_ has highest levels of industrial smog.

\_\_\_\_\_­­­­­­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_- mixture of primary and secondary pollutants under the influence of \_\_\_\_\_\_\_ radiation.

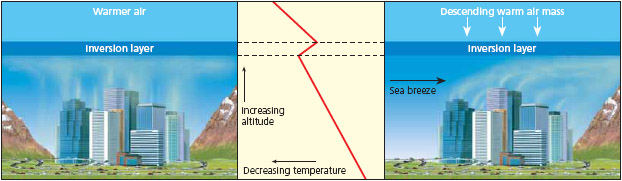
1. Exhaust from car releases \_\_\_\_\_\_ & \_\_\_\_\_\_\_, and the NO is converted to a \_\_\_\_\_\_.
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ causes a reaction between NO2 and VOCs
3. The resulting photochemical smog is a mixture of \_\_\_\_\_\_\_\_\_\_, nitric acid, aldehydes, PANs.

Collectively, these chemicals oxidize certain compounds in the atmosphere & your \_\_\_\_\_\_\_\_\_\_\_!

\*\_\_\_\_\_\_\_\_\_\_ days leads to higher levels of smog. \*Cities in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ climates with lots of cars have higher levels of smog. Ex: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| *DECREASE Air Pollution* | Natural Factors That Influence Outdoor Air Pollution | *INCREASE Air Pollution* |
| 1. Particles \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than air settle due to gravity  2. Rain and snow \_\_\_\_\_\_\_\_\_\_\_\_ the air of pollutants  3. Salty sea spray from oceans wash out pollutants from air that flows over the ocean  4. \_\_\_\_\_\_\_\_\_\_ sweep pollutants away, diluting it with cleaner air  5. Some pollutants are removed by  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | 1. Urban buildings can \_\_\_\_\_\_\_ wind speed and reduce dilution of pollutants  2. Hills and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reduce flow of air in valleys so pollutants build up at ground level  3. High \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ promote photochemical smog  4. Emissions of \_\_\_\_\_\_\_ from certain trees and plants helps form photochemical smog  5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Effect- air pollutants are transported by evaporation and winds to the \_\_\_\_\_\_\_\_\_ regions  6. Temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (see below) |

TEMPERATURE INVERSION



Cities that are built in \_\_\_\_\_\_\_\_ are subject to temperature inversions that can \_\_\_\_\_\_\_\_ pollutants over a city for days or weeks. This occurs when a layer of \_\_\_\_\_\_\_\_\_ air sits atop cooler \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ air over a city and prevents the \_\_\_\_\_\_\_ air from rising and dispersing the pollutants. Cities with a sunny climate, light winds, and mountains on \_\_\_\_ sides (ex: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) are also vulnerable.

**18-3: What is Acid Deposition (aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) and Why Is It a Problem?**

Acid Deposition is the result of humans disrupting the \_\_\_\_\_ and \_\_\_\_\_ cycles.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are used to emit \_\_\_\_\_, particulates, and \_\_\_\_\_ high into the air where \_\_\_\_\_\_\_\_\_\_\_ can mix, dilute, and disperse them. Reduce \_\_\_\_\_\_\_\_\_\_\_\_\_\_ air pollution, but increases \_\_\_\_\_\_\_\_\_\_\_\_\_\_ air pollution

* These \_\_\_\_\_\_\_\_\_\_\_\_ substances remain in the air for days and can descend to the earth’s surface in 2 ways:

1. \_\_\_\_\_\_\_\_\_ Deposition – acidic rain, snow, fog, cloud vapor with a pH <5.6
2. \_\_\_\_\_\_\_\_\_ Deposition- acidic particles

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| Harmful Effects of Acid Deposition |
| - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ disease  - damages statues, monuments, buildings, metals, car finishes  - decrease \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  - can \_\_\_\_\_\_\_\_\_\_\_\_\_ toxic metals (lead and mercury) from soils and rocks into \_\_\_\_\_\_\_\_\_\_\_\_\_ and  accumulates in the tissues of organisms (pregnant women shouldn’t eat fish for risk of mercury  contamination)  - makes some aquatic ecosystems too \_\_\_\_\_\_\_\_\_\_\_- most fish can’t live below a pH of \_\_\_\_\_\_  - harm \_\_\_\_\_\_\_\_ if soil pH is below \_\_\_\_\_\_\_  - affects forests by leaching essential plant nutrients (\_\_\_\_\_\_ and \_\_\_\_\_\_) from soils and releasing aluminum, lead, and mercury which are \_\_\_\_\_\_\_\_\_\_ to trees- weakens the trees; mountain top trees are the hardest hit |

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| **SOLUTIONS TO ACID DEPOSITION** | |
| Prevention | Clean Up |
| 1. Reduce \_\_\_\_\_\_\_\_\_\_\_\_\_ use 2. Increase use of renewable energy sources 3. Remove SO2 and NO from \_\_\_\_\_\_\_\_\_\_\_\_\_\_ gases 4. Remove NO from \_\_\_\_\_\_\_ exhaust 5. \_\_\_\_\_\_\_ emissions of SO2 | 1. Add lime to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acidified lakes 2. Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fertilizer to neutralize acidified lakes |

**18-4: What Are the Major Indoor Air Pollution Problems?**

Indoor Air Pollution:

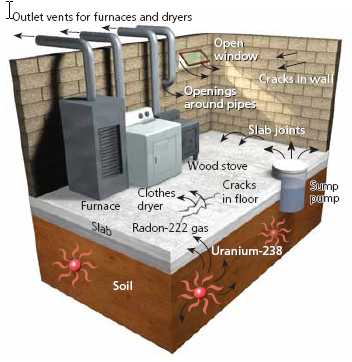
- Biggest pollution threat to the \_\_\_\_\_\_\_\_\_ in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries

- caused by \_\_\_\_\_\_\_\_\_wood, charcoal, etc.in poorly ventilated areas

- \_\_\_\_\_\_\_\_\_\_\_ Building Syndrome- buildings that have air pollutant counts high

enough to cause \_\_\_\_\_\_\_\_\_\_\_\_ issues

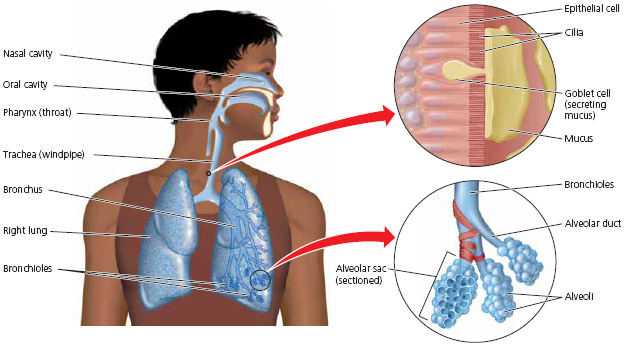
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| Examples of Indoor Air Pollutants  Description: 1805 |
| 1. Pesticides and lead brought in your \_\_\_\_\_\_\_\_\_\_\_ 2. Living organisms and their excrements  * \_\_\_\_\_\_\_ mites , cockroach droppings  1. Airborne spores of \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ smoke 3. Formaldehyde- causes most difficulty in people in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries 4. Radioactive \_\_\_\_\_\_\_\_\_\_\_\_\_ gas 5. Very fine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |



Case Study- Radioactive Radon Gas

* Produced by natural radioactive \_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in rocks and soils
* Enters a home through the \_\_\_\_\_\_\_\_\_\_\_\_ in the foundation and walls
* Constant exposure can lead to \_\_\_\_\_\_\_\_ cancer

**18-5: What Are the Health Effects of Air Pollution?**



The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ System is a good line of defense against air pollution:

- \_\_\_\_\_\_\_ filters large particles

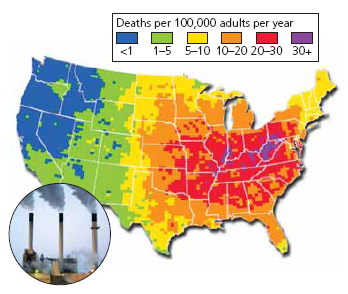
- \_\_\_\_\_\_\_\_ captures smaller particles

- \_\_\_\_\_\_\_\_\_\_\_\_\_ and coughing expel air pollutants too

- small, hair-like \_\_\_\_\_\_\_\_

Prolonged exposure to air pollutants can overload or break down these natural defenses.

Fine and Ultrafine (most dangerous) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ get lodged deep in the \_\_\_\_\_\_\_\_\_\_ and contribute to lung cancer, asthma, and emphysema.



Air Pollution is a Big Killer:

- The World Health Organization (\_\_\_\_\_\_) estimate

that \_\_\_\_ million people die each year due to the

effects of air pollution.

- 2.2 million of those deaths are due to \_\_\_\_\_\_\_\_\_\_\_

air pollution.

**18-6: How Should We Deal with Air Pollution?**

EPA has established

\*The 6 outdoor criteria air pollutants:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\*Hazardous Air Pollutants (HAPS)- emissions standards

\*Toxic Release Inventory (TRI)- factories, mines, refineries must report their release

of toxic chemicals

Congress has passed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but there is room for improvement:

1. US relies mostly on pollution \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, rather than \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. We have failed to increase \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in cars
3. Little regulation of oceangoing ships
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are exempt from regulations
5. Laws don’t regulate emissions of \_\_\_\_\_\_\_\_\_\_
6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ particles are not regulated
7. Does not deal with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ air pollution

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| Outdoor | Air Pollution Solutions | Indoor |
| 1. Emissions Trading (aka:   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) allows major “polluters” to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ emissions allotments to help reduce \_\_\_\_\_\_\_ emissions   1. Burn low \_\_\_\_\_\_\_\_\_\_\_\_\_ coal 2. Disperse emissions above \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ layer with tall smokestacks. 3. Use mass transit 4. Give large \_\_\_\_\_\_\_ breaks for those who buy low polluting vehicles 5. Inspect car \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ throughout the year 6. Rely more on \_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy sources 7. Improve energy efficiency | 1. Ban \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. Stricter \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ emissions from carpet and furniture companies 3. Use office machines in well \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ areas 4. Less polluting \_\_\_\_\_\_\_\_\_\_\_\_\_ supplies 5. Circulate buildings air through \_\_\_\_\_\_\_\_\_\_\_\_\_ greenhouses 6. Use exhaust hoods for stoves 7. Prevent \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ infiltration 8. Distribute cheap, efficient stoves or solar cooker to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries 9. Develop cheap \_\_\_\_\_\_\_\_\_ for indoor air pollutants 10. \_\_\_\_\_\_ detectors |

**CHAPTER 19 Climate Change and Ozone Depletion**

**Core Case Study: Studying a Volcano to Understand Climate Change**

1. In 1991, Mount \_\_\_\_\_\_\_\_\_\_\_\_\_\_ erupted, which allowed scientists to further study global \_\_\_\_\_\_\_\_\_\_\_\_ change.
2. Scientists studied that amount of \_\_\_\_\_\_ released by the volcano to determine if pollutants would indeed change the

climate of the Earth on a larger scale. It does.

**19-1: How Might the Earth’s Temperature and Climate Change in the Future?**

For the past 900,000 years the Earth has experienced period of global \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and global \_\_\_\_\_\_\_\_\_\_\_\_\_\_. For the past 1,000 years the temperature has been \_\_\_\_\_\_\_\_\_\_\_\_\_, but has begun to \_\_\_\_\_\_\_\_\_\_\_ in the last century when people began \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How are past temperatures determined?

* Radioisotopes in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Bubbles of ancient \_\_\_\_\_\_\_ in ice cores
* Temperature taken at different depths in Earth
* Historical records

Life on Earth wouldn’t be possible without the natural \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:

* \_\_\_\_\_\_\_\_\_\_\_\_\_ the Earth’s lower atmosphere and surface due to greenhouse gasses like \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that trap heat from the sun

The problem is when we have \_\_\_\_\_\_\_\_\_\_\_\_\_ greenhouse gases and \_\_\_\_\_\_\_\_\_\_\_\_ activities have led to this increase.

- Mainly due to agriculture, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and burning \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

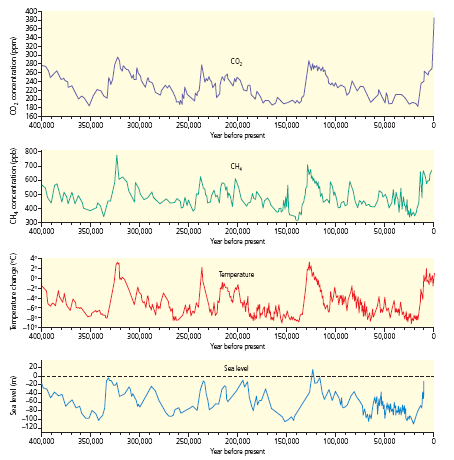
- At our current rate of emission of CO2 we will have a concentration of \_\_\_\_\_\_ ppm by 2050, and according to research the \_\_\_\_\_\_\_\_\_\_ point is \_\_\_\_\_\_ ppm.

\* Top 2 CO2 emitting countries:

1. \_\_\_\_\_\_\_ (25%) 2. \_\_\_\_\_\_\_ (5%)

- Data from \_\_\_\_\_\_\_ cores also shows that 60% of \_\_\_\_\_\_\_\_\_\_\_\_\_ emissions is due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ activity from extracting fossil fuels, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and livestock.

- Nitrous Oxide levels have also increased due to use of Nitrogen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



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| Evidence that Supports Climate Change: | Evidence For and Against Climate Change | Arguments Against Climate Change: |
| 1. Between 1906-2000, average global surface temp has increased by \_\_\_\_\_\_\_\_\_ 2. Greenhouse gas emissions has risen \_\_\_\_% since 1970 3. \_\_\_\_\_\_\_\_\_ temps have risen twice as fast in the past 50 years 4. \_\_\_\_\_\_\_\_\_\_\_\_\_ are and floating sea ice are melting 5. Rainfall patterns are changing 6. Sea level has risen by \_\_\_\_\_\_\_ inches |  |

What Role Does the Ocean Play?

* Oceans absorb \_\_\_\_\_\_\_ of all of the \_\_\_\_\_\_ released and help moderate temperature
* Some Carbon is \_\_\_\_\_\_\_\_\_\_\_\_\_ salts that are buried in the sediments for millions of years
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of CO2 decreases with \_\_\_\_\_\_\_\_\_\_\_\_\_\_ temperature
* As water heats, the CO2 could be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and amplify global warming= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ feedback loop
* Higher levels of CO2 increases the \_\_\_\_\_\_\_\_\_\_\_ of the ocean, which decreases the ability of \_\_\_\_\_\_\_\_\_\_\_\_ to make calcium carbonate shells

\*\*Bottom Line: Temperature, acidity, and ability to absorb CO2 from atmosphere are changing as a result of human activities

**19-2: What are Some Possible Effects of a Warmer Atmosphere?**

Sea Levels are Rising:

Ice and Snow are Melting:

Browning of the Earth:

Extreme Weather:

Ocean Currents Changing:

Permafrost is Likely to Melt:

Health:

Agriculture:

Threat to Biodiversity:

**19-3: What Can We Do to Slow Climate Change?**

Why this complex problem is difficult to tackle:

1. The problem is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_- much international cooperation
2. Effects of climate change will last a long time- CO2 stays in atmosphere \_\_\_\_\_\_\_\_\_
3. It is a long term \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ issue.
4. Impacts of climate change are not spread \_\_\_\_\_\_\_\_\_\_\_\_ across the globe.
5. Phasing out changing our lifestyles would disrupt \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and lifestyles.

Solutions: Three Major Prevention Strategies-

1. Improve energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to reduce fossil fuel use.
2. Shift from nonrenewable \_\_\_\_\_ based fossil fuels to a mix of Carbon \_\_\_\_\_\_\_\_ renewable energy resources.
3. Stop cutting down tropical \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

\*\* Effectiveness of these strategies would be enhanced by reducing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and reducing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Output Strategies for Reducing Climate Change:

1. Massive \_\_\_\_\_\_ planting on degraded land in the tropics.

2. Plant fast growing perennial plants like switchgrass- stores CO2 in \_\_\_\_\_\_\_ to be harvested for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. Carbon Capture & Storage (CCS)- removing

CO2 from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and pumping it deep into \_\_\_\_\_\_\_\_\_\_\_\_ or abandoned oil or gas fields

-CCS is expensive and could raise prices

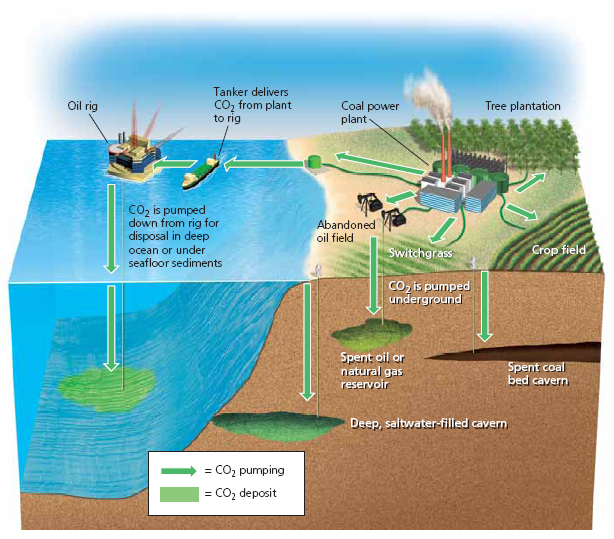
-require large inputs of \_\_\_\_\_\_\_\_\_\_\_\_ to operate= counterproductive

-earthquakes, war, etc could cause a

\_\_\_\_\_\_\_\_; even a small leak would be disastrous

Random Suggestions:

1. Inject sulfate particles into \_\_\_\_\_\_\_\_\_\_\_ -reflects \_\_\_\_\_\_\_\_\_\_ to cool troposphere
2. “Re-ice” the \_\_\_\_\_\_\_\_\_\_\_
3. Deep sea \_\_\_\_\_\_\_\_ to bring up nutrients for algal blooms which can take in \_\_\_\_\_



**19-4: How Have We Depleted Ozone in the Stratosphere and What Can We Do About It?**

What Can the Government Do to Slow Climate Change?

1. Strictly regulate \_\_\_\_\_\_\_ and \_\_\_\_\_\_ pollutants.
2. Carbon \_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Approach
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to businesses who use green technologies
5. Technology transfer to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ countries

\*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Protocol- a treaty to slow climate change (2005)

-requires countries to cut emissions of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by 5.2%

of their 1990 levels by 2012.

-countries can \_\_\_\_\_\_\_\_\_\_\_ greenhouse gas emissions- the “cap and trade” system

-174 countries agreed to this. The US \_\_\_\_\_\_\_\_\_\_.

\*George W. Bush decided not to comply because he felt it would harm the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and he did not like how rapidly developing countries (like \_\_\_\_\_\_\_\_\_\_\_\_\_) were exempt.

Who’s been successful?

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ aims to be the first carbon \_\_\_\_\_\_\_\_\_\_ country. They currently generate 78% of their electricity from renewable \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ power and 18% from \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy!
* Some US States are tired of waiting on the federal government to take charge.
  + Portland, Oregon- 1st city to cut greenhouse gas emissions back to \_\_\_\_ levels.
    - The city promotes energy efficient \_\_\_\_\_\_\_\_\_\_\_ and use of electricity from \_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_ sources.
    - Has built many bicycle trails & has greatly expanded \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - This has actually produced an economic \_\_\_\_\_\_\_\_\_ and has saved the city $\_\_\_\_\_\_\_\_\_\_\_\_\_/year in energy costs!
  + California- 12th largest producer of greenhouse gases (GHG) in the world!
    - 2006- CA passed a law to cut GHG to \_\_\_\_\_ below 1990 levels by 2020.
    - Set fuel efficiency and carbon emissions standards and let the free market find the best ways to meet standards- EPA refused this request. CA and 17 other states are now suing the federal government to allow states to set tougher CO2 emission standards.
  + Companies and Schools are reducing their Carbon Footprints
    - DuPont, IBM, Toyota, & Walmart have cut GHG emissions

What Can You Do to Reduce Your CO2 emissions? Pick 3

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Preparing for the Harmful Effects of Climate Change:

Global climate models say we must make a \_\_\_\_\_\_\_\_\_% cut in GHG emissions by 2050 so prevent Earth from heating up more than 3.6°F, which will likely be difficult to do. Therefore, analysts have compiled a list of things we need to do to prepare for the long-term effects of climate change. See Picture.

**19-4: How Have We Depleted Ozone in the Stratosphere and What Can We Do about It?**

Not only is there considerable thinning of the ozone in thepolar regions, but there is overall thinning everywhere as well.

Ozone depletion in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ poses a serious threat to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, animals, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Chlorofluorocarbons (CFCs)**

\*Discovered in \_\_\_\_\_\_\_\_\_ and use expanded rapidly

\*Trade name = \_\_\_\_\_\_\_\_\_\_\_\_\_

\*Thought to be the dream chemical because it is chemically unreactive, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, nontoxic, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\*Became popular as \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in ACs, refrigerators, cleaners for electric parts, propellant in spray cans, etc.

\*Too good to be true: 1974- “CFCs destroy \_\_\_\_\_\_\_\_\_\_\_ in stratosphere” said Rowland and Molina

-CFCs rise and remain in atmosphere

-Once CFCs reach atmosphere, it breaks

down under the influence of the \_\_\_\_\_\_

which releases a highly reactive \_\_\_\_\_\_

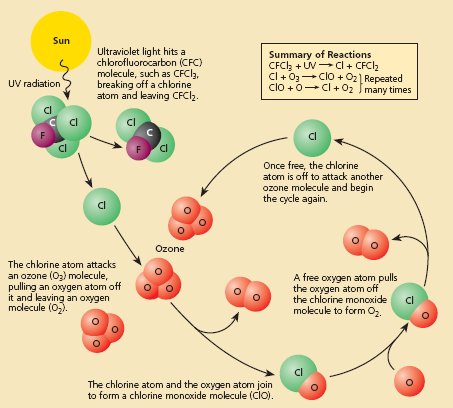
which break O3 into O2 and O

-CFCs persist in atmosphere for \_\_\_\_\_\_\_\_\_

years

-It took Rowland and Molina 14 years to

convince DuPont to stop production



Why Should We Worry about Ozone Depletion?

1. More damaging \_\_\_\_\_\_ and \_\_\_\_\_

radiation reaches the Earth’s surface.

1. Sunburns, skin \_\_\_\_\_\_\_\_\_\_\_\_\_
2. Destroy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_- they play a key role in removing \_\_\_\_\_ and are

the base of ocean food web

How Can We Reverse Stratospheric Ozone Depletion?

1. Stop use of all \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ chemicals
2. Montreal Protocol- treaty’s goal is to cut \_\_\_\_\_\_\_\_\_ emissions by 35%