

APES Unit 7 Study Guide

Ultimate Review Packet (7.1 - 7.3)

7.1 - Introduction to Air Pollutants

- a. **Describe** the power given to the EPA by the Clean Air Act **the ability to set, monitor, and enforce acceptable limits for six criteria air pollutants**
- b. Fill out the table below to review the sources and effects of each of the six criteria air pollutants

Pollutant	Sources	Effects
SO _x	Coal combustion for electricity production, volcanic eruptions	Acid precipitation, resp. irritant,
NO _x	All FF combustion, especially gasoline, biomass combustion, forest fires	Acid precipitation, resp. irr, O ₃ → photochemical smog
CO	Incomplete combustion of FF, biomass	Asphyxiation (suffocation)
PM	FF/biomass combustion, construction, agriculture, industrial production	Resp. irr., reduced visibility, thickens smog formation
Tropospheric O ₃	Reaction of NO ₂ + Sunlight + O ₂	Resp. irr., photochem. smog precursor, plant tissue damage
Lead	Coal combustion, ore metal processing plants, lead smelting factories	Neurotoxicant, damages central nervous system

- c. **Explain** why carbon dioxide is NOT considered an air pollutant in APES **CO₂ does not decrease air quality from a human health standpoint, meaning it doesn't directly cause health consequences as its levels rise in the air we breath**
- d. **Explain** the difference between a primary and secondary air pollutant, using an example **primary air pollutants are released directly from emission sources, such as SO₂ or PM coming from a coal fired power plant. Secondary air pollutants are formed when primary air pollutants undergo some transformation in the atmosphere when exposed to sunlight, water, or oxygen. An example is the formation of sulfuric acid when SO₂ combines with water in the atmosphere.**

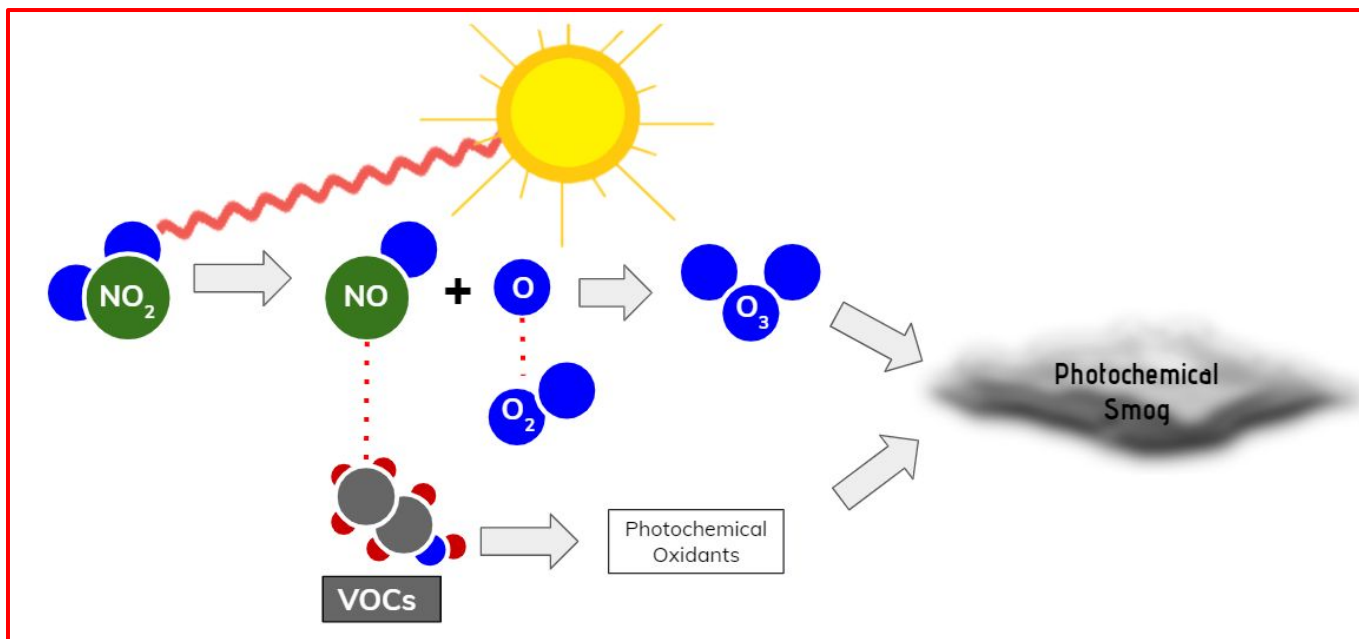
7.2 - Photochemical Smog

- a. **Identify** the precursors or reactants of photochemical smog formation **NO₂, VOCs (volatile organic compounds), O₃ (ozone)**
- b. **Identify** the environmental conditions that increase photochemical smog formation **sunlight and heat**
- c. **Describe** how tropospheric ozone forms **energy from the sun causes NO₂ to split into NO and a free oxygen atmo. This free oxygen atom then combines with O₂ in the troposphere to form O₃**

APES Unit 7 Ultimate Review Packet (7.2 - 7.3)

7.2 - Photochemical Smog (cont.)

- d. **Explain** why tropospheric ozone levels normally decline overnight when the sun goes down, it no longer drives the breakdown of NO_2 into NO and O . Ozone reacts with the free NO in the atmosphere to reform NO_2 and O_2 .
- e. **Describe** the the role VOCs play in preventing tropospheric ozone levels from decreasing overnight when present in the atmosphere, VOCs bind to NO , preventing O_3 from reacting with free NO in the atmosphere and reverting back to NO_2 and O_2
- f. Draw a picture to represent the formation of photochemical smog



- g. **Describe** an environmental and human health impact of photochemical smog respiratory irritation, worsening of asthma/bronchitis/COPD, eye irritation, reduced photosynthesis rate for plants, damage to plant tissue (especially stomata) from ozone

7.3 - Thermal Inversion

- a. **Identify** the normal temperature-altitude relationship in the troposphere and **explain** why this relationship exists as altitude increases, temperature decreases (in the troposphere) because air is under less atmospheric pressure. It is also further away from the infrared radiation (heat) released from earth's surface
- b. **Describe** how this temperature-altitude relationship normally helps disperse air pollutants near Earth's surface because Earth's surface releases heat due to the incoming solar radiation it receives, air near the surface is warmed. This causes it to rise, carrying pollutants near ground level up and away from Earth's surface
- c. **Explain** how the conditions of a thermal inversion impact the normal temperature-altitude relationship in the troposphere during a thermal inversion, a colder, more dense air mass is trapped beneath a warmer, mid-latitude air mass, which causes a reversal of the normal temperature-altitude relationship near earth's surface
- d. **Describe** how a thermal inversion impacts ground-level air pollutant levels thermal inversions prevent the upward movement of air away from Earth's surface, concentrating/trapping air pollutants near ground level
- e. **Explain** the urban heat island effect urban areas have higher temperatures due to a greater concentration of dark/low albedo surfaces that absorb sunlight and release infrared radiation (heat), they also have less vegetation which means less evapotranspiration cooling

APES Unit 7 Ultimate Review Packet (7.4 - 7.5)

7.4 Atmospheric CO₂ and Particulates

- Identify** THREE natural sources of carbon dioxide **cellular respiration, aerobic decomposition, forest fires, volcanic eruptions**
- Explain** how decomposition can produce both CO₂ and CH₄ **in oxygen-rich conditions, aerobic decomposition produces CO₂. In oxygen-poor conditions, anaerobic decomposition produces CH₄**
- Describe** the relationship between PM particle size and human health risks **the smaller a particle is the deeper into the respiratory tract it can penetrate and the more damage/irritation it is capable of causing/larger particles are more easily filtered out by respiratory structures and are less likely to penetrate more deeply**
- Identify** THREE sources of natural particulate matter (PM) **forest fires, wind-borne soil/dust, pollen, ash, sea salt, mold**

7.5 - Indoor Air Pollutants

- Describe** the major source of indoor air pollution in developing countries and **identify** TWO indoor air pollutants released by this source **indoor biomass combustion for heating/cooking releases indoor air pollutants like CO, PM, VOCs, NO₂**
- Identify** TWO human health impacts of indoor biomass combustion **headaches, eye damage, respiratory irritation, lung damage/impaired function, worsening of asthma/bronchitis/COPD**
- Propose a solution** to reduce the impacts of indoor air pollutants in developing countries **better ventilation in homes (chimneys, open windows, fans) to disperse pollutants, cooking outdoors, greater access to gas or electric stoves for cooking**
- Fill out the table below to review the sources and effects of each of these indoor air pollutants

	Sources	Effects	Abatement/Mitigation of Exposure
Asbestos	Old insulation (attic, water heaters, ceiling tiles)	Lung cancer	Professional removal (ventilation equip.)
CO	Faulty furnace ventilation	asphyxiation/suffocation	Repair furnace ventilation
VOCs	Cleaners, deodorizing sprays, furniture adhesives	Headaches, eye/lung irritation	Organic cleaning products, ventilation
Radon	Radioactive decay of uranium rocks (enters through cracks in foundation), well water	Lung cancer (2nd leading cause in America)	Sealing foundation cracks, improving ventilation if radon is detected
PM	Mold, dust, cigarette smoke,	Resp. irritation, worsening asthma/COPD/bronchitis	Disinfectant (for mold) and increased ventilation
Lead	Old paint chips/dust, lead water service lines	Neurotoxicant, learning disabilities in young children	Professional lead paint abatement/replacement, replacing lead water lines with copper or other non-lead material

APES Unit 7 Ultimate Review Packet (7.6 - 7.8)

7.6 - Reduction of Air Pollutants

- Identify** an individual-scale and a government-scale method for reducing air pollutants (ind): drive less by using public transit/walking/biking/carpooling, purchase an electric vehicle. (Gov): raising CAFE vehicle standards, subsidies/tax credits for non pollution-emitting power plants, rebates/tax credits for individuals purchasing electric vehicles, pollution credit system, stricter enforcement of clean air act standards/setting lower acceptable levels of criteria air pollutants
- Identify** the air pollutant that vapor-recovery fuel nozzles reduce: VOCs/hydrocarbons/benzene
- Describe** how catalytic converters reduce air pollutants emitted from vehicles metals inside the catalytic converter like palladium or platinum convert CO, hydrocarbons, and NO_x into CO₂, N₂, O₂, and H₂O.
- Explain** how wet and dry scrubbers reduce air pollutants from factory/power plant emissions the air stream from combustion reactions or other industrial processes passes through a column that traps PM, SO_x, NO_x, VOCs. Wet scrubbers use a mist sprayer and mist eliminator screen at the top of the column to trap pollutants in droplets of water that fall into a sludge collector at the bottom of the column. Dry scrubbers use a chemical agent such as calcium oxide to bind to air pollutants like SO₂ and trap them in the column.
- Describe** an additional method for reducing PM from power plant or industrial emissions baghouse filters are cloth/fabric bags that a waste air stream passes through, trapping PM, electrostatic precipitators use an electrode to give all the particles in a waste air stream a negative charge so that they then stick to positively charged metal plates as they pass through the device

7.7 - Acid Deposition

- Identify** the TWO primary pollutants that lead to acid deposition and **identify** a major source of each pollutant sulfur dioxide/SO₂ (coal power plants), nitrogen dioxide/NO₂ (coal power plants, vehicle emissions)
- Describe** the transformation that these two primary pollutants undergo in order to become secondary pollutants that contribute to acid deposition NO₂ and SO₂ react with water and oxygen in the atmosphere, forming nitric acid and sulfuric acid, which contribute to acid deposition
- Describe** how the dissociation of nitric acid and sulfuric acid in water leads to acid deposition sulfuric and nitric acid dissociate into sulfate and nitrate ions and H⁺ ions in the presence of water. Increased H⁺ ion concentration makes precipitation more acidic
- Describe** an environmental consequence of acid deposition soil acidification leading to aluminum toxicity/plant or soil organism mortality/stunted root growth, acidification of surface water leading to aluminum toxicity/stunted plant growth/plant or aquatic organism mortality or reduced growth/reproduction

7.8 - Acid Deposition

- Identify** TWO sources of noise pollution traffic, construction, lawn mowers, industrial processes, ships/tankers, seismic surveying ships
- Identify** TWO specific effects of noise pollution on organisms difficulty communicating, migratory disruption, predator-prey distraction/disruption, increased heart rate, headaches