

Energy

Net Energy

$-70 + \rightarrow$
 - Negative Energy expended + energy gained
 - High Net Energy yields are preferred/profitable
 - AlCA NPP, which stops net

Electricity Generation



Renewable vs NonRenewable



Coal

+ $\text{H}_2\text{O} + \text{O}_2 = \text{CO}_2$
 organic matter + simple hydro-carb

3 types

- Lignite:** lowest heat
- Bituminous:** high sulfur, soft or waxy coal
- Anthracite:** high heat, low sulfur

Remember...

- "L" = lowest heat
- "B" = Bituminous
- "A" = Anthracite

Energy Math

Scientific Notation: $12,000 = 1.2 \times 10^4$
 Cross Units Out: Ex: How many liters of O_2 in 32 grams of O_2 ?
 $32 \text{g } \text{O}_2 \times \frac{1 \text{ mol}}{32 \text{g}} = 1 \text{ mol}$

Oil, Natural Gas, Nuclear, Solar Thermal, Biomass, & Geo thermal electricity - All of these types of energy sources are similar in the way that they are natural resources of an energy resource on earth that provides humans with the ability to do work.



Electric Cars???

PROS:
 They cars are designed so when brakes are applied, some energy is transferred from plates to recharge motor battery.
 produce far less CO2 pollution
 Cheaper to run
 simpler to maintain

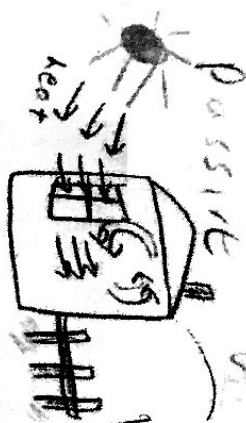
CONS:
 lack of refueling stations
 expensive to make
 expensive to repair
 limited range
 long recharging times

Units of Energy: Joule (J), Calorie (cal), British thermal unit (BTU)

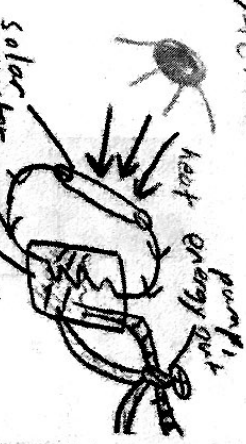
Energy Math:

1 gal = 8 lbs water
 1 BTU: amount needed to raise 1 lb, 1 temp 1 deg Fahrenheit = 3,400 BTUs
 Mass of water: (8 gal)(8 lbs/gal) = 64 lbs
 Total energy for dishwashing: $(64 \text{ lbs})(100^\circ\text{F}) \left(\frac{1 \text{ BTU}}{1^\circ\text{F}} \right) = 6400 \text{ BTU}$
 Total energy for dishwashing: $7200 \text{ BTU} + 1700 \text{ BTU} = 8900 \text{ BTU}$
 Total energy for dishwashing: 9600 BTU
 - less energy is used when we run the dishwasher because it heats water and conserves the energy. Whereas the handwashing this an amount of water

Active Solar Heating

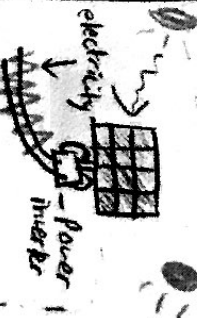


Sun heats buildings that absorb/trap heat via greenhouse effect

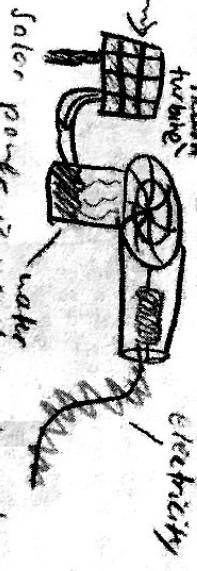


Sun heats collector, which converts and stores heat in a solar storage

Photovoltaic (PV) Solar Thermal Heating Cells



Photovoltaic convert solar energy to electricity directly



Solar power is used to heat water and power steam turbines, which turn generators and create electricity

Electric Vehicles

1st law: energy cannot be created or destroyed
2nd law: energy lost as heat between conversions
If energy use continues the way it is, the world's nonrenewable resources will quickly be depleted. We will face a very crisis

- Pros**
- cheap to operate, tax credit
 - less CO2, NOx
 - multiple emission energy
 - Greater energy efficiency
- Cons**
- limited range
 - still requires
 - charging stations

Global Warming, Ozone, Pollution

Kevin Lin

Creation of Tropospheric ozone:
 $CO + 2O_2 + hv \rightarrow CO_2 + O_3$
 - Tropospheric ozone forms when nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with sunlight in the atmosphere

Stratospheric ozone production:

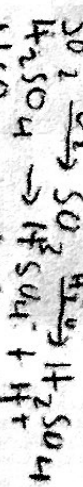


Reaction: $3O_2 \xrightarrow{\text{sunlight}} 2O_3$

Nitric Acid Rain:



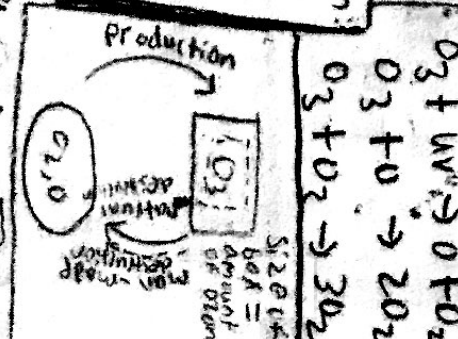
Sulfuric Acid Rain:



NOT The Greenhouse Effect:



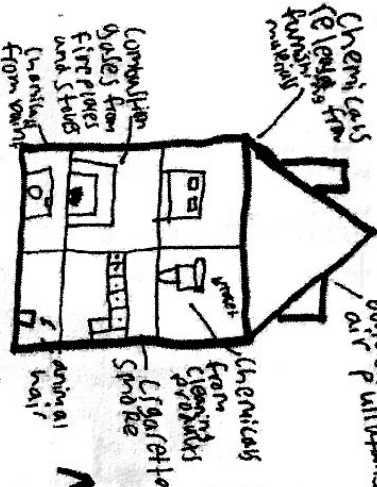
Stratospheric ozone destruction:
 $O_3 + UV \rightarrow O + O_2$
 $O_3 + O \rightarrow 2O_2$
 $O_3 + O_2 \rightarrow 3O_2$



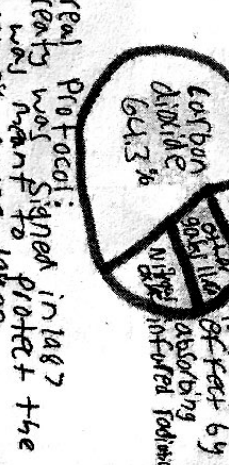
Brown Air Smog:
 VOCs + NOx + Heat + Sunlight →
 - Mixture of primary/secondary pollutants under radiation

Some particles radiatively cool, some absorb and reemit in all directions. Some particles radiatively cool, some absorb and reemit in all directions. Infrared radiation is emitted

Sources of major pollutants:



Sick Building Syndrome: A combination of effects on workers especially marked by headache and respiratory irritations attributed to pollutants or stressful factors in the working environment such as poor ventilation.



Greenhouse gases contribute to the greenhouse effect by absorbing and re-emitting radiation.

Montreal Protocol: The treaty was signed in 1987 which was meant to protect the stratospheric ozone layer.

UVB: 280-315nm, longer wavelength, less penetration, causes sunburn.
 UVA: 315-380nm, UV cluster, deep penetration, causes aging and skin cancer.
 Ozone thinning: Chlorine and bromine compounds.

Photochemical pollution: Ozone and other pollutants are formed from primary pollutants such as volatile organic compounds (Hydrocarbons) and nitrogen oxides (NOx) in the presence of sunlight.

Clean Air Act: Authorized the development of comprehensive federal and state regulations to limit emissions from major sources.

Primary U.S. Secondary pollutants: primary pollutant reacts with other primary pollutants to form secondary pollutants. Example: ground level ozone.

Public health: Acid rain, respiratory irritation, eye irritation, damage to plants and animals.

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CH 14 & 17 Review

Volcanic eruptions inject ash and aerosol clouds into the atmosphere and produce more than 100 million tons of carbon dioxide each year. This adds to all of the pollution in the troposphere which can warm the earth.

Ozone

- Always irritates
- Wheezing
- Asthma
- Information

Troposphere

Sources of greenhouse gases: Transportation, agriculture, industrial processes, power stations.

Greenhouse gases: Transport, agriculture, industrial processes, power stations.

Major greenhouse gases from Project Aardvark

THE GREENHOUSE EFFECT

Human health effects of ozone in Stratosphere: lets more UV rays pass through can cause skin cancer or sunburn.

Troposphere: Breathing ozone can trigger a variety of health problems including chest pain, coughing, and throat irritation.

Lichens - Simple slow growing plant that forms a crustlike, leaflike, or branching growth on rocks, walls, and trees.

This plant can indicate pollution in the area because it gets all of its nutrients from rain water. If the water is contaminated they plant will not grow in that environment.

Urban sources: cars, factories, power plants, etc.

Water Treatment

Primary Treatment: Consists of temporarily holding sewage in a basin where heavy solids settle to the bottom and lighter solids flow to the top.

Secondary Treatment: Removes settleable solids and organic compounds in a water treatment plant.

Tertiary Treatment: Removes remaining inorganic compounds to send water to be reused, recycled or discharged.

Anaerobic Digestion: Uses micro organisms to break down organic material in the absence of water.

Water Concepts

Role of Wetlands & Estuaries: Provides home to many different species as it has salt and freshwater. These areas help naturally clean polluted water for the environment.

Watersheds: Area of land that separates water to different streams, without water sheds many rivers would be left dry not having water flowing to them.

Water Transportation (Positives & Negatives)

Canals, Aqueducts, Reservoirs, Dams: Canals helps agriculture but siphon river water, Aqueducts provides access to water in areas without it but disrupt ecosystems, reservoirs collects water for human use but takes water away from underground aquifers, Dams help provide electricity and water to nearby towns but stop naturally river flow.

Central Valley Project & State water Project: Central Valley Project helps provide water to the valley through the use of dams, reservoirs, canals, and hydro electric powerplants but disrupts naturally river flow, damaging ecosystems. The Statewater Project takes water from the rivers in Northern California to Southern California through aqueducts helps Southern California get water but disrupts the ecosystem with aqueducts.

Lake, Owens Lake, The Aral Sea, Colorado River: All these rivers and lakes were taken advantage of through human use of canals siphoning off the water until they can not continue to flow to the ocean (Colorado River) or end up dried up (The Aral Sea).

Aquifers

Confined, Unconfined, Water table: Confined water table is an aquifer that is sealed from intrusion, Unconfined water table is an aquifer that has intrusion.

Salt Water Intrusion: Salt water enters an aquifer contaminating the freshwater making undrinkable.



Laws

Safe Water Drinking Act: Set the standard of drinking water quality in the U.S.

Clean Water Act: Regulated pollutant discharges into water in the U.S.

Water Conservation

Greywater: Relatively clean water from household uses.

Water Conserving Technology used in the home: New faucets, toilets, showerheads, and other appliances help reduce total water usage in the home.

Potable Reuse Water: Puts treated water straight into drinking water rather than into a reservoir or aquifer.

Desalination (Positives & Negatives): Produces clean water for consumption from undrinkable water but is very expensive.

Biological Assessment Leading to a Water Quality Assessment

Benthic Macroinvertebrates as Biological indicators: The use counting the number of small organisms to gauge the water quality of the water.

BPT/Midge Ratio: Compares certain organisms to gauge the water quality.

Water Quality

Dissolved Oxygen, Biochemical Oxygen Demand, pH, Temperature, Total Suspended Solids (Turbidity), Nitrates, Phosphates: These categories help determine the water quality depending of the levels of each.

Relationship between Dissolved Oxygen & Temperature: Inverse relation ship, when temperature goes up Dissolved Oxygen goes down and vice-versa.

Oxygen Sag Curve: The curve represent the amount of oxygen in a river which has sewage which because of the sewage looses much of the oxygen but then increases its biochemical oxygen demand.

Eutrophication: When water becomes overly enriched with nutrients which produces excessive plant growth which then depletes the oxygen in the water.



Water and Water Pollution

Safe Water Drinking Act

public drinking water throughout the nation and sets standards for drinking water quality.

1974

Water Conservation

- Greywater:** relatively clean waste water from sinks, toilets, and other appliances that can be used to water lawns and plants
- Portable Toilets:** the process of treating waste water for drinking water (can be indirect or direct)
- Dissolved Oxygen:** process of extracting nutrients from water. Dissolved oxygen is critical for aquatic life. **Algal blooms:** excess algae in drinking water and can be used for biofuel, but can also be toxic.

Water Quality

- Ducks to test water quality:**
 - Dissolved Oxygen:** if water is stagnant and has too much organic material, ducks will be less healthy.
 - Temperature:** increase in temperature will reduce dissolved oxygen levels.
 - Biological Oxygen Demand:** amount of DO needed by aerobic biological organisms to break down organic material.
 - pH:** acidity level of water, 7 is neutral, 8 is basic, 6 is acidic.
 - Temperature:** general health of a water body. Regulates DO concentration, nutrient cycling, and species composition.
 - Turbidity:** suspended solids (silt/clay) - clouding in lakes or a fluid, shows how dirty or clean water is.
 - Microbes:** determine whether water is safe to drink.
 - Invertebrates:** determine whether water is safe to drink.

Clean Water Act

regulates the discharge of pollutants into the nation's surface waters, including lakes, rivers, streams, wetlands, and coastal areas.

1972

How do we conserve water?

- Small water bottles - please use about 1/3 of the bottle per plastic food trucks.
- Take shorter showers and take showers instead of baths.
- The average:** uses 100 gallons per person per day.
- American habit:** a mostly new generation, 25% of water per day.

Biological Test of Water Quality

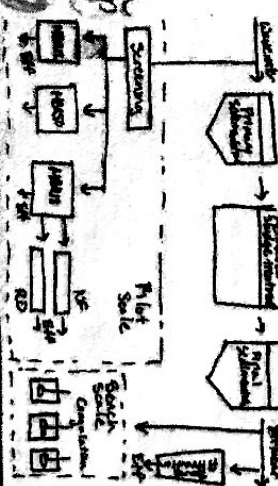
- Biotic macroinvertebrates** are often used to indicate the biological condition of a body of water.
- Benthic macroinvertebrates** are small aquatic animals and the aquatic larvae of insects.
- EPT Index:** Ratio metric compares both number of invertebrate organisms.

More About Water Quality

- DO & Temperature:** the lower the temperature of the water, the more DO is present. This is because the solubility of a gas in a liquid is an equilibrium phenomenon. gas in a liquid is more soluble in a colder liquid.
- Oxygen Day Curve:** observed when concentration of DO in a river just below a dam or other point has been disrupted. It plots against the distance down from the dam or other point.
- Competition:** excessive nutrients of nutrients in a lake or river lead to eutrophication, causing dense growth of algae and other plants.

Wastewater Treatment

- Primary:** temporarily holds sewage in tanks.
- Secondary:** removes dissolved and suspended biological matter.
- Tertiary:** is only used when water needs to be further treated after primary & secondary.
- Anaerobic Digestion:** a collection of processes by which microorganisms break down biodegradable material in place of oxygen.



Water Concepts

- Groundwater:** prevents flooding by holding water. It is the water that is held in the pores of the ground.
- Estuaries:** are partially enclosed coastal bodies of water. They are in a transition zone between rivers and oceans.
- Water sheds:** areas of land that drain rain, water, or snow into one location.

Aquifers

Unconfined: water seeps from the ground surface directly above the aquifer.

Confined: impermeable dirt / ice / layer that prevents water from seeping into the aquifer from the ground surface located directly above.



Control Valley Field: groundwater resources.

State Water Project: California water from rivers in the Central Valley.

Water Transpiration

Positives: easier to ship goods, easier transportation.

Negatives: expansive, use of land.

Hydrologic Cycle: water evaporation, condensation, precipitation, infiltration, runoff.

Reservoirs: store water, can be used for drinking water.

Dams: hydroelectric power, flood control, water storage.

Tule Lake: water treatment, use of residual sludge, a biological treatment process for separating wastewater.

Arad Sea: water treatment, use of residual sludge, a biological treatment process for separating wastewater.

Colorado River: water treatment, use of residual sludge, a biological treatment process for separating wastewater.

RISK AND HAZARDOUS WASTE

Risk: a situation involving exposure to danger

WARNING!

- 1. leading causes of DEATH
- 2. Cancer
- 3. Chronic Lower Respiratory Disease

Risk Assessment

1. hazard
2. Dose-response assessment
3. Exposure assessment
4. risk characterization

Bioaccumulation: The accumulation of a toxic chemical in the tissue of a particular organism

Bioamplification: The increased concentration of a toxic chemical that higher an animal is on the food chain



Transmissible Disease: Disease that is caused by living organisms and can be spread from one person to another by air, water, food, or body fluids.

Non-Transmissible: Disease that is not caused by living organisms and does not spread

Acute Exposure: short-term exposure to toxic substances.

Chronic Exposure: long-term exposure to toxic substances

Dose-Response Relationship: relating to the pattern of physiological response to a varied dosage (of a drug or radiation).

LD50: A measure of the lethal dose of a toxin, radiation, or pathogen

Toxic Substance: A substance that can be poisonous and cause health effect
ex: mercury; snake venom

Teratogen: chemicals, radiation, and viruses that cause birth defects
ex: alcohol

Ionizing Radiation: any radiation causing atoms to become ionized; impairs the functioning of tissues and/or organs
ex: x-rays

Asphyxiant: a gas that causes death or to lose consciousness by impairing normal breathing
ex: nitrogen, argon, helium, methane

Hormone Mimic/Endocrine Disruptor: chemicals that attack to target cells like hormones, causing cells to respond
ex: PCBs, dioxins, phytoestrogens

DEADLY INFECTIOUS DISEASES

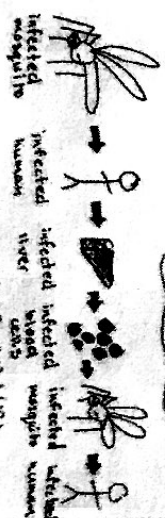
- HIV/AIDS
- Plague
- hepatitis B
- Malaria
- Pneumonia
- Influenza

THE BLACK DEATH

In the 14th century, a devastating epidemic had struck Europe and Asia. It killed more than 20 million people. The disease was spread by fleas and rats on infected ships.



MALARIA CYCLE



LOVE CANAL

Love Canal was caused Hooker Chemical Company dumping toxic chemicals in a canal near a neighborhood. The effects were birth defects, rasues, genetic damage, and cancer.

1. Refuse, Deter, Treat and Dispose: a type of waste. MSW: Municipal solid waste; trash or garbage; items that are disposed by public. consisting of everyday items that are food waste

largest components: Paper and food waste
incineration
EPRs: better waste management, savings on waste transportation, energy byproduct
L: low; not affordable, bad for environment, long term challenges

Hazardous wastes are wastes that exhibit any one or more of the following properties: ignitability, corrosivity, reactivity, or toxicity.

closed-loop recycling: waste of one process is used in making another product.

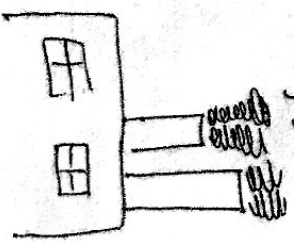
Open loop recycling: the conversion of material from one or more products into a new product.

Sanitary Landfill:

- bottom liner: separates trash from leaching into groundwater
- cells: trash is stored within landfill

storm water drainage: collects rain water that falls on the landfill.

Landfill Leaching: a liquid that passes through a landfill and has extracted dissolved and suspended matter, contaminating groundwater.



Superfund Program

part of a federal government effort to clean up land in the US that has been contaminated by hazardous waste and was identified by EPR as a candidate for clean up.

Brownfield
former industrial and commercial site where future use is affected by real or perceived environmental contamination

GOALS of TSCA and EPCRA:
- to regulate pesticides in the US to protect applicators, consumers, and the environment

Ocean Dumping Ban Act
1988: prohibits all municipal sewage sludge and industrial waste dumping into the ocean after December 31, 1991.