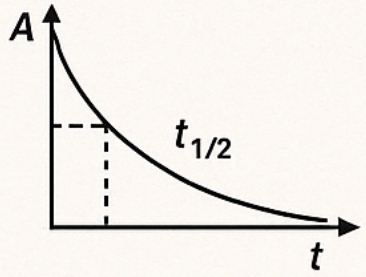
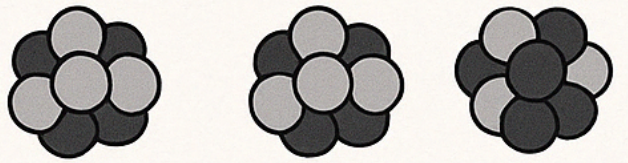
College-Level Environmental Science Problems + Diagrams

Exponential Decay (Radioactive Elements



A scientist begins with 100 grams at a radioactive isotope with a halt-life of 5 years.

Isotopes



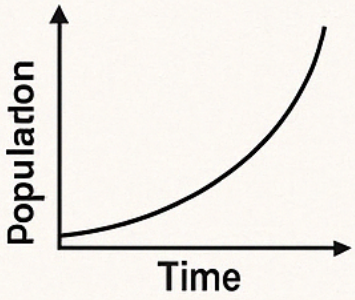
Carbon-12 6 protons

Carbon-14 6 protons

Carbon-14 6 protons

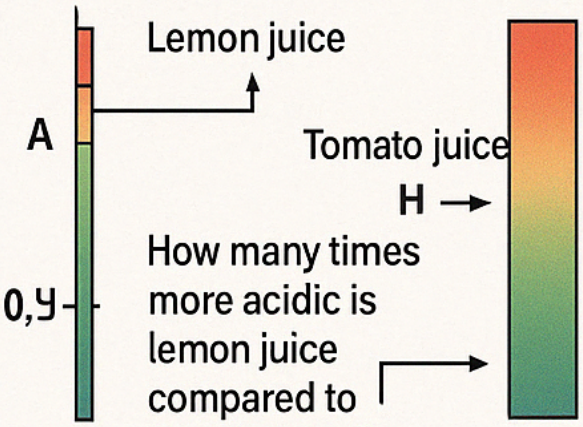
What do they have in common, and how are they different in terms of protons and neutrons?

Exponential Growth (Rule of 70)



A country has a population growth rate of 2% per year. Use the Rule of 70 to estimate how many years it ill take for the population to double.

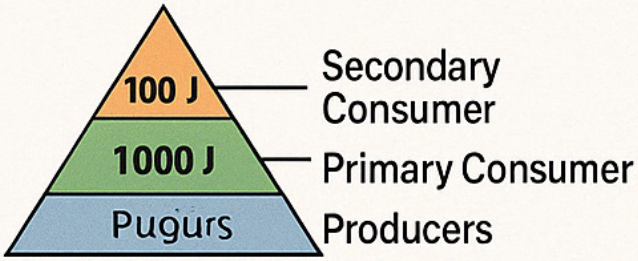
pH (Log Scale)



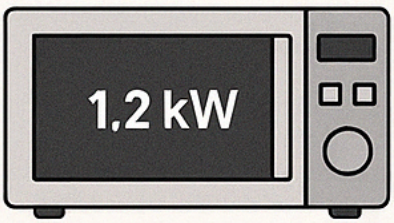
How many times more acidic is lemon juice compared to tomato juice?

If a plant produces 10.000 Joules of energy.

Trophic Pyramids (10 % Rule)



If a plant produces 10.000 Joules of energy, How much energy is available to a secondary consome?



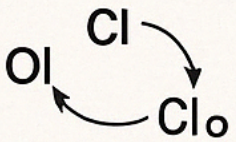
A microwave uses 1.2 kilowatts (kW) of power. If it runs for 30 minutes, How much energy (in kilowatt-hours) does it use?

Ocean Aciditication

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \leftrightarrow H^+ + HCO_3$$

Explain what happens to the pH of ocean water as more CO_2 is absorbed from the atmosphere

Ozone Depletion (Tracking Chlorine)



One chlorine atom from CFCs can destroy thousands of ozone moleules. How does chlorine act as a catalyst

College-Level Environmental Science Problems + Diagrams

College-Level Environmental Science Problems with Answers

1. Exponential Decay (Radioactive Elements)

Uranium-238 has a half-life of 4.5 billion years. If a rock originally contained 1 gram of U-238, how much would remain after 13.5 billion years? Show the number of half-lives and calculate the remaining mass.

Answer: 1. 13.5 billion years / 4.5 billion years = 3 half-lives; 1g -> 0.5g -> 0.25g -> 0.125g remains.

2. Isotopes (Atomic Number and Mass)

A sample contains 92 protons and 143 neutrons. Identify the isotope and write its atomic symbol. Explain how you determined this.

Answer: 2. 92 protons = uranium; 92 + 143 = 235, so the isotope is U-235.

3. Exponential Growth (Rule of 70)

A city's population increases at an annual rate of 1.4%. Calculate how long it will take for the population to triple using the Rule of 70. Is this method accurate for long-term predictions? Why or why not?

Answer: 3. Tripling is about 1.585 doublings; 70 / 1.4 = 50 years per doubling; ~79 years to triple. Rule of 70 becomes less accurate with non-constant growth.

4. pH (Log Scale)

The hydrogen ion concentration in a solution is 1 x 10^-6 M. Calculate the pH of the solution. Then determine how many times more acidic it is compared to a solution with a pH of 8.

Answer: 4. pH = -log(1 x 10^-6) = 6; pH 6 vs. pH 8 = 100x more acidic.

5. Trophic Pyramids (10% Rule)

A trophic pyramid has 1,000,000 J of energy at the producer level. Estimate the energy available at the tertiary consumer level, and describe how this limits ecosystem structure.

Answer: 5. Each level drops by 10%, so tertiary = 1,000 J. Energy loss limits higher trophic levels.

6. Energy vs. Power

A solar panel array generates 3.5 kW of power continuously for 5 hours. Calculate the total energy produced in kilowatt-hours. Then convert this to joules.

Answer: 6. 3.5 kW × 5 h = 17.5 kWh; 17.5 kWh × 3.6×10^6 J = 63,000,000 J.

7. Photosynthesis (Tracking Carbon)

In photosynthesis, trace the transformation of carbon from atmospheric CO2 into a glucose molecule. How many CO2 molecules are needed to synthesize one C6H12O6 molecule?

Answer: 7. 6 CO2 molecules are needed to form one glucose (C6H12O6).

8. Ocean Acidification

Describe how increased atmospheric CO2 leads to ocean acidification. Include the chemical equilibrium reactions: CO2 + H2O <-> H2CO3 <-> H+ + HCO3-. Explain the impact on marine organisms with calcium carbonate shells.

Answer: 8. CO2 dissolves in water to form carbonic acid, which dissociates into H+ and bicarbonate. Increased H+ lowers pH, dissolving calcium carbonate shells.

9. Ozone Depletion (Tracking Chlorine)

Explain the catalytic role of chlorine from CFCs in ozone layer depletion. Include the reactions involved and describe why this process is particularly harmful in the polar stratosphere.

Answer: 9. Cl + O3 -> ClO + O2; ClO + O -> Cl + O2. Net: O3 + O -> 2O2. Cl acts as a catalyst and persists in the stratosphere.

10. Respiration and Combustion

Compare the enthalpy change of glucose combustion with the energy released during cellular respiration. Why is cellular respiration considered more efficient in energy capture?

Answer: 10. Combustion releases ~2800 kJ/mol; respiration captures ~60% of this in ATP. Respiration is more efficient due to controlled enzymatic steps.

11. Aerobic vs. Anaerobic Respiration

Under anaerobic conditions, muscle cells produce lactic acid. Compare the ATP yield per glucose molecule in anaerobic vs. aerobic respiration and explain the implications for athletic performance.

Answer: 11. Aerobic = ~36 ATP; Anaerobic = ~2 ATP. Anaerobic is less efficient, causing fatigue and lactic acid buildup.

College-Level Environmental Science Problems + Diagrams

12. Efficiency (Work Out / Work In)

A geothermal power plant inputs 5000 kJ of thermal energy and outputs 1100 kJ of electrical energy. Calculate the efficiency. What factors might contribute to the low efficiency in this system?

Answer: 12. Efficiency = (1100 / 5000) × 100 = 22%. Heat loss and energy conversions reduce overall efficiency.