

Alternate forms of Energy

Solar Energy

Wind Energy

Geothermal Energy

Fuel Cells

Wind Energy

oldwindmill

In Denmark, 10% of electricity comes from wind

California's 2000 turbines in wind farms generate about 1.27 percent of the state's electricity; enough to light a city the size of San Francisco.

Geothermal energy is the heat contained below the Earth's crust. This heat is brought to the surface as steam or hot water—created when water flows through heated, permeable rock—and used directly for space heating in homes and buildings or converted to electricity. Most of the country's geothermal resources are located in the western U.S.

The Geysers Power Plant in northern California—the world's largest geothermal power plant—generates more than 1700 megawatts of electrical power, 7 percent of the total electricity Pacific Gas and Electric Company (PG&E) supplies to California.

Fuel Cells

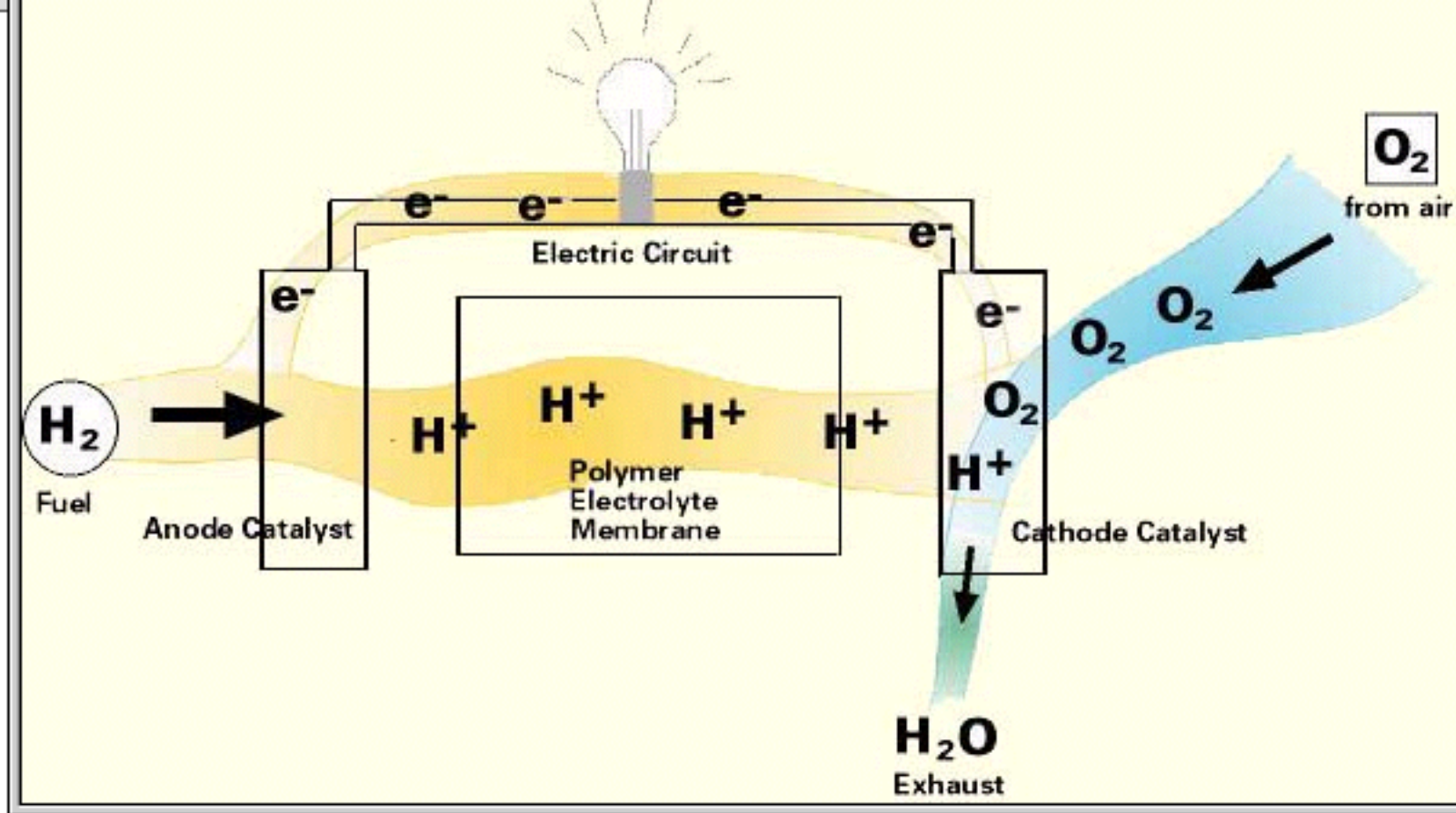
fuel cell

Fuel cells convert chemical energy to electricity. The simplest converts hydrogen and oxygen to water with the release of energy.

A fuel cell operates like a battery. Unlike a battery, a fuel cell does not run down or require recharging. It will produce energy in the form of electricity and heat as long as fuel is supplied.

Central park

Busses



A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.



Wavelength and Frequency are interconvertible

λ = wavelength

ν = frequency

c = speed of light = 3×10^8 m/sec

$$c = \lambda \times \nu$$

$$\lambda = \frac{c}{\nu}$$

$$\nu = \frac{c}{\lambda}$$

The Energy of Light is related to Wavelength and Frequency

Energy $E = h \times \nu$ (h is a constant)

$$E = h \times \nu$$

$$\nu = \frac{c}{\lambda}$$

$$E = h \times \frac{c}{\lambda}$$

Energy is directly proportional to frequency

Energy is inversely proportional to wavelength

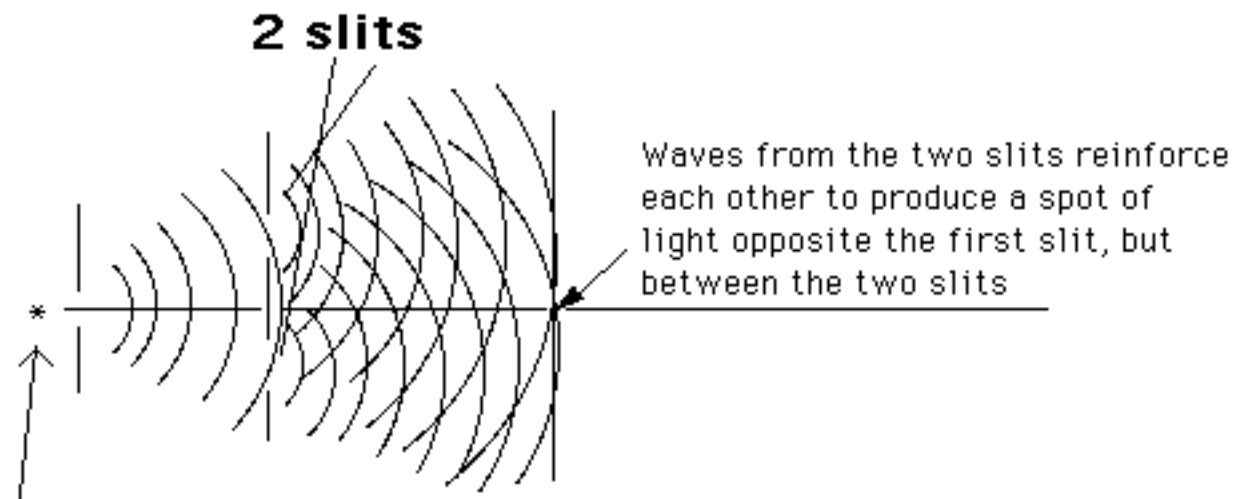
A popular radio station broadcasts at a frequency of 102.7 megahertz ($\nu = 102.7 \times 10^6$ /sec). What is the length of the radio waves in meters?

$$\lambda = c/\nu$$

$$\lambda = (3 \times 10^8 \text{ meter/sec}) / (102.7 \times 10^6 \text{ /sec}) = 2.92 \text{ meters}$$

Like the electron, light has wave-particle duality

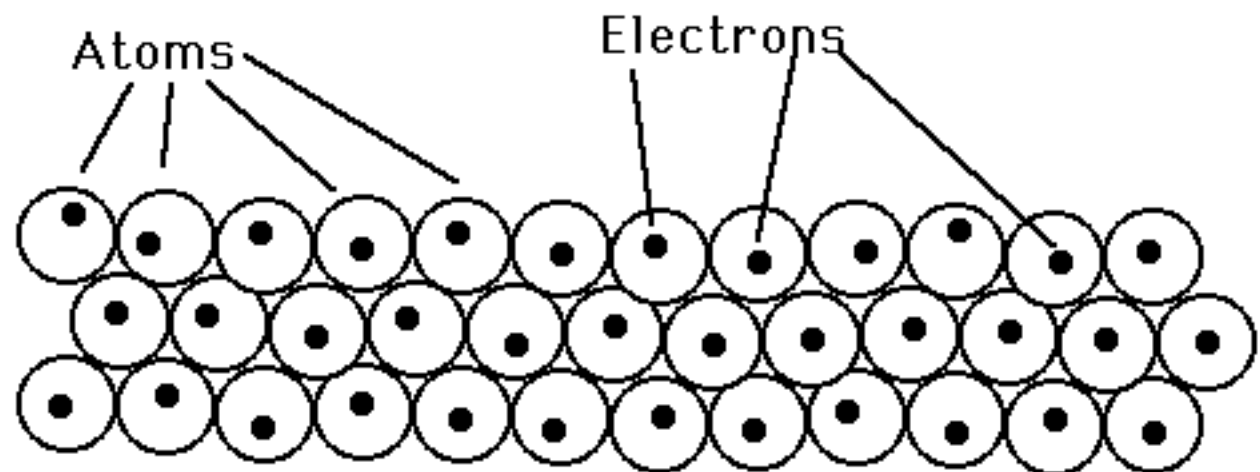
Experiments show the wave nature of light



Light source

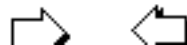
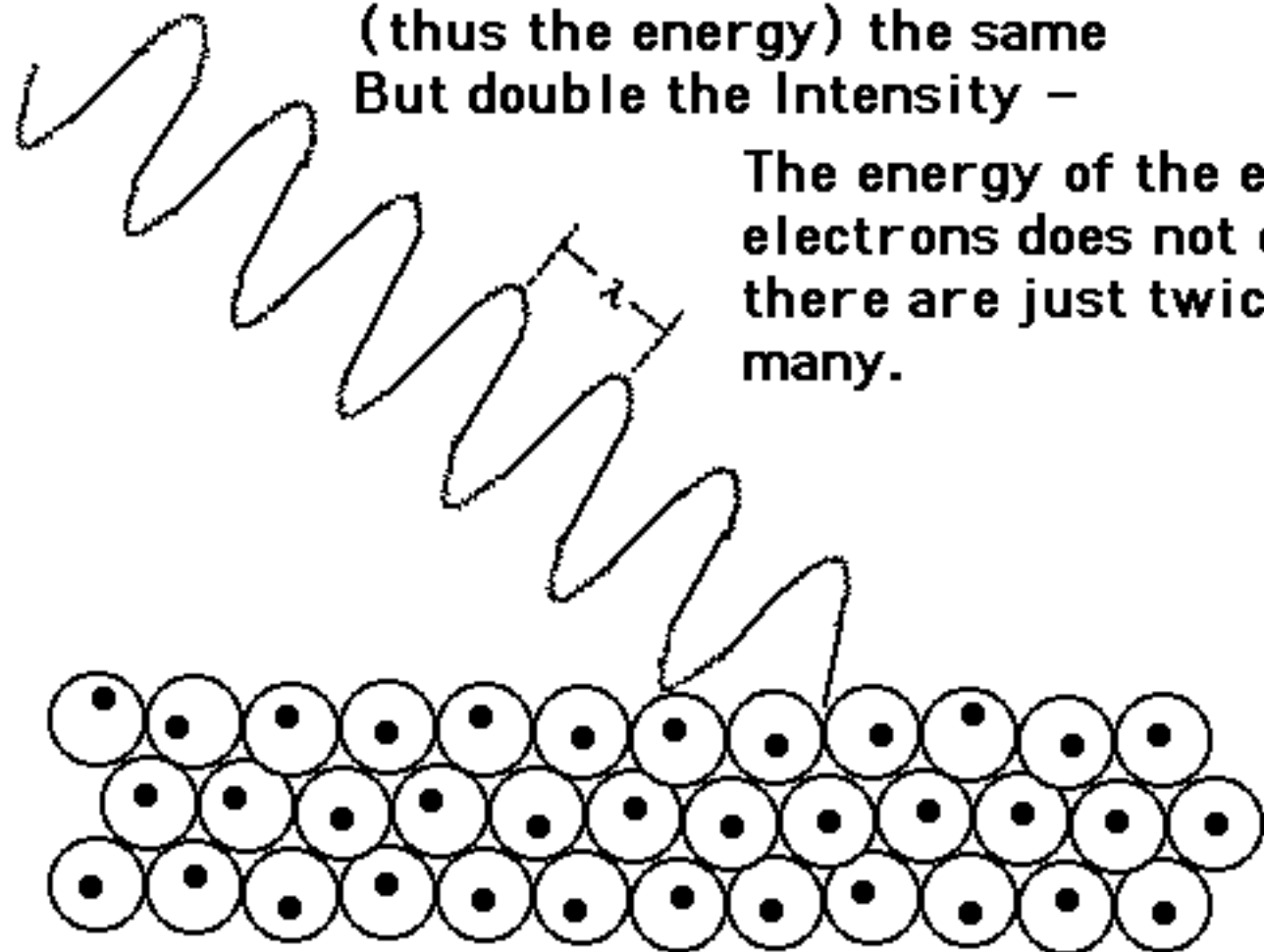
The photoelectric effect shows the particle nature of light:

In the photoelectric effect, a beam of light knocks electrons out of atoms generating an electric current



**When we keep the wavelength and frequency
(thus the energy) the same
But double the Intensity -**

**The energy of the ejected
electrons does not change
there are just twice as many.**



LASER

Light Amplification by Stimulated Emission of Radiation

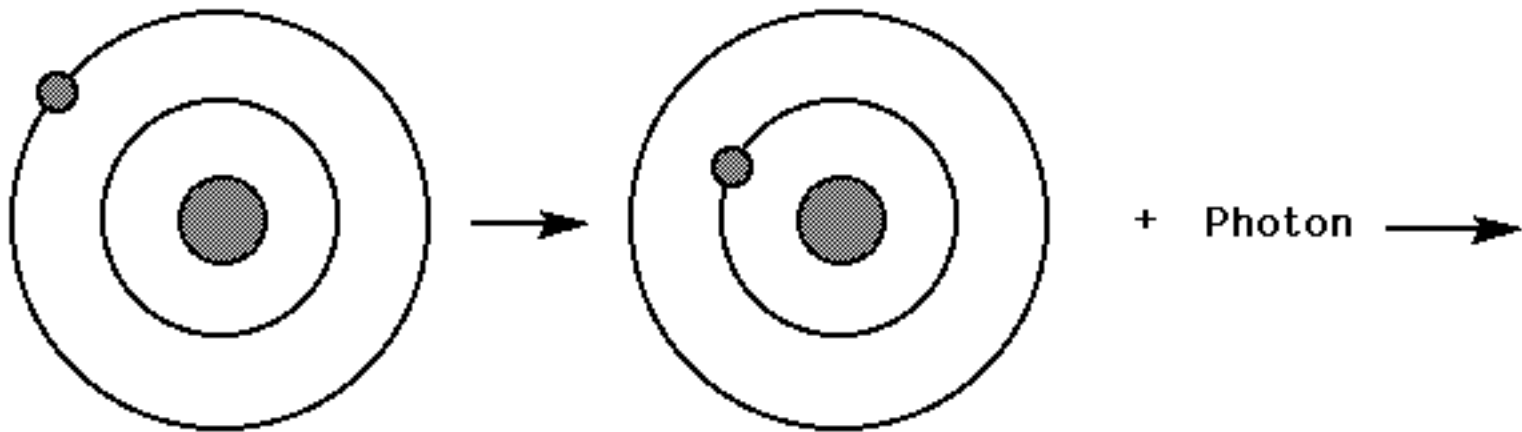


Incoherent light

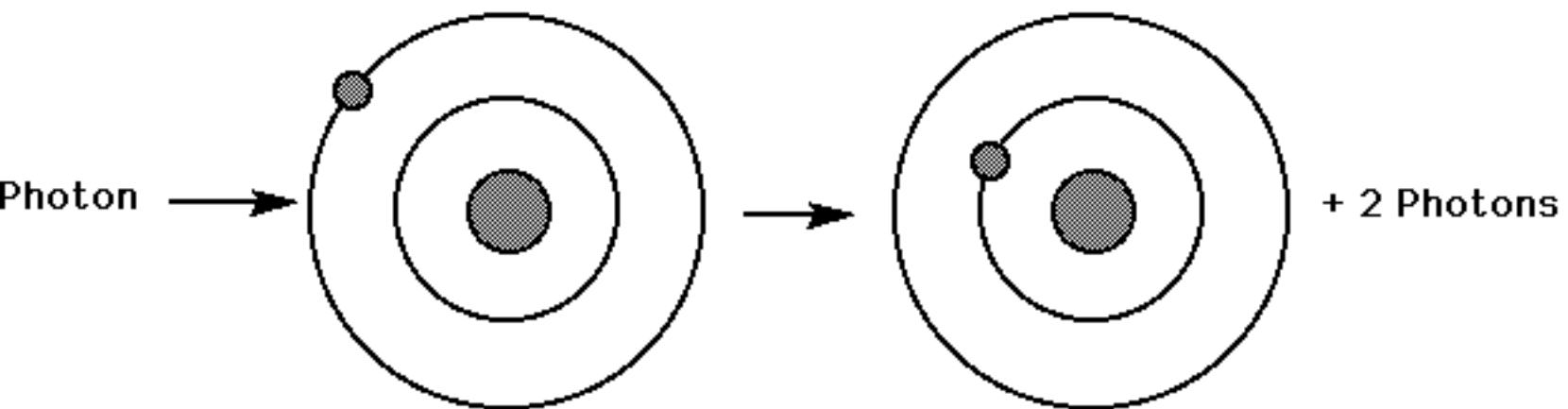


Coherent light

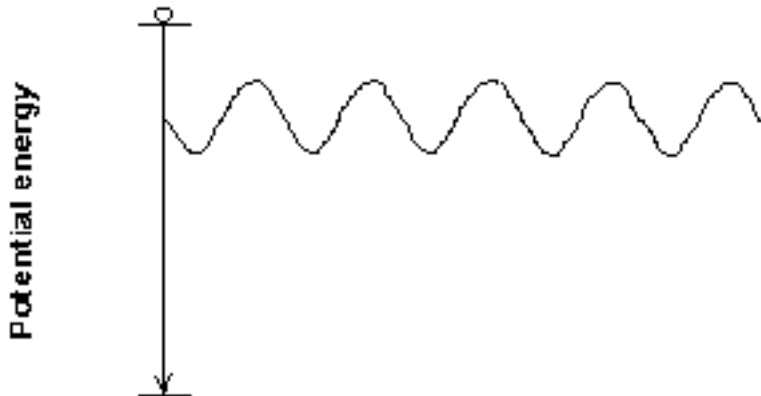
Emission from an excited state



Stimulated Emission from an excited state



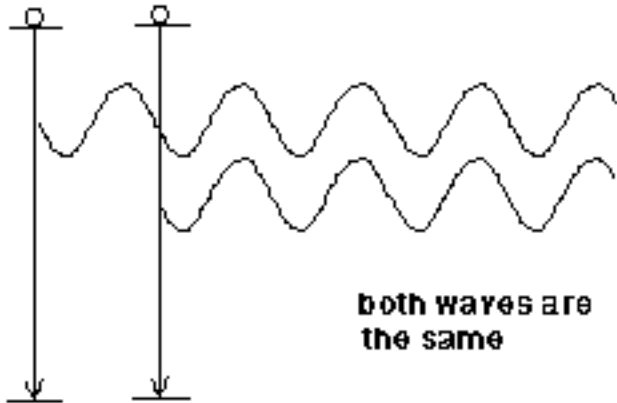
Monochromatic light emitted
Coherent light emitted



Emission. The transition (solid arrow) results in the production of a photon (wave)

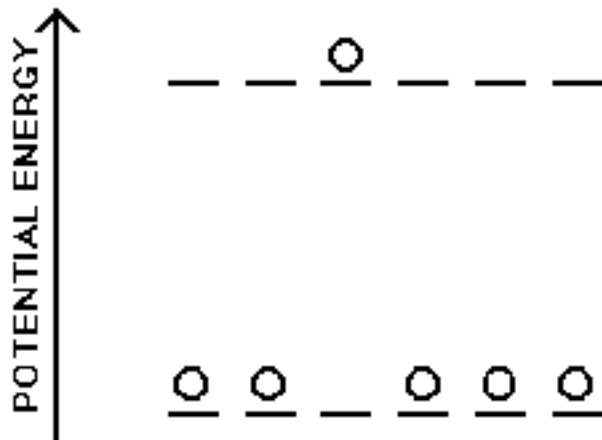
first second

Potential energy

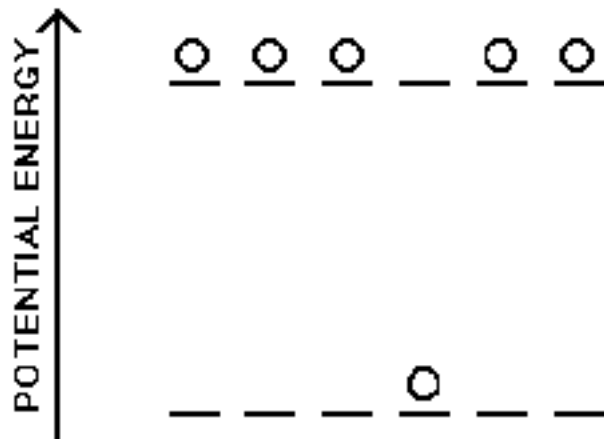


**both waves are
the same**

Stimulation of a second identical photon



a) equilibrium population



b) population Inversion

POTENTIAL ENERGY ↑

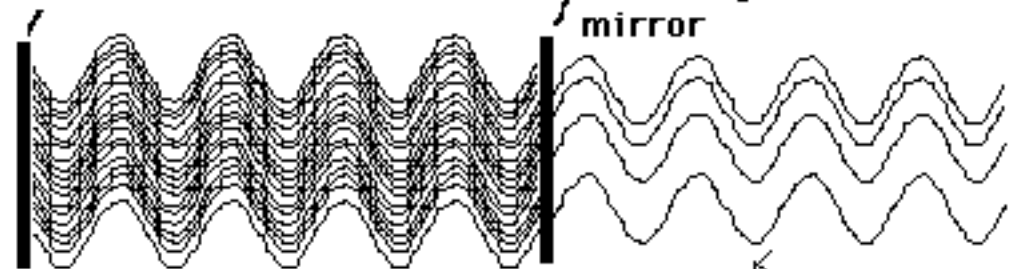


Light



a) equilibrium population

Mirror

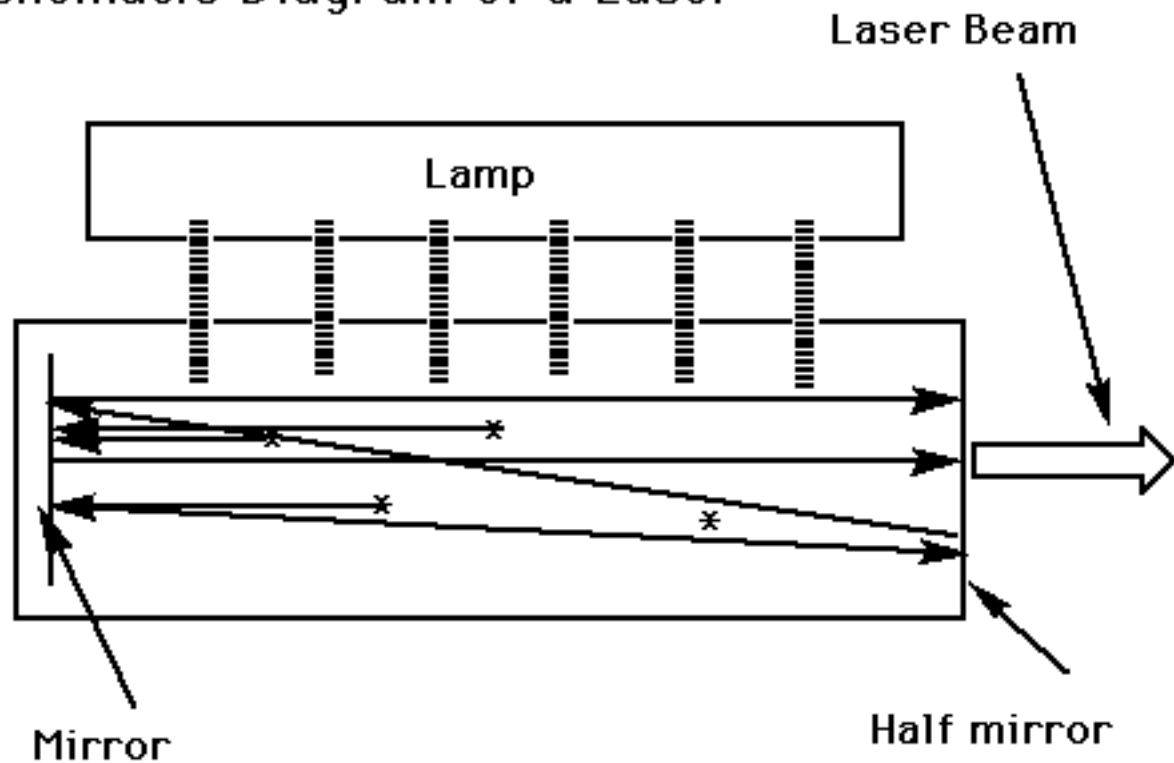


**Partially transparent
mirror**

**Light bounces back and forth
inside the laser**

Light from laser

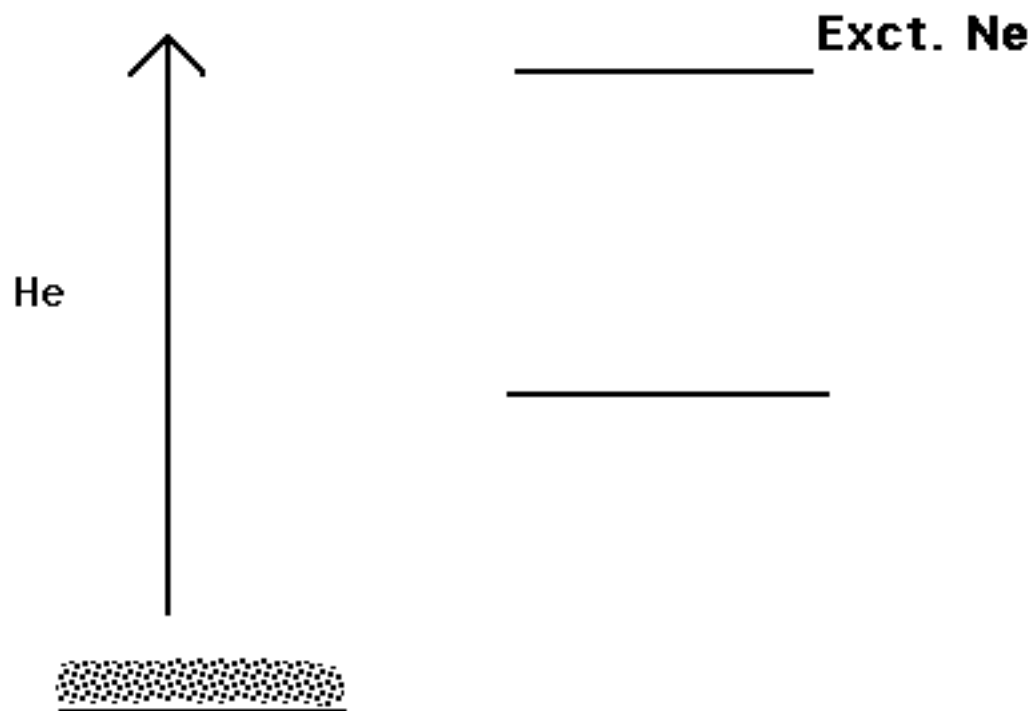
A Schematic Diagram of a Laser



A Helium - Neon Laser

The He is excited and transfers its energy to Ne

Exct. He _____



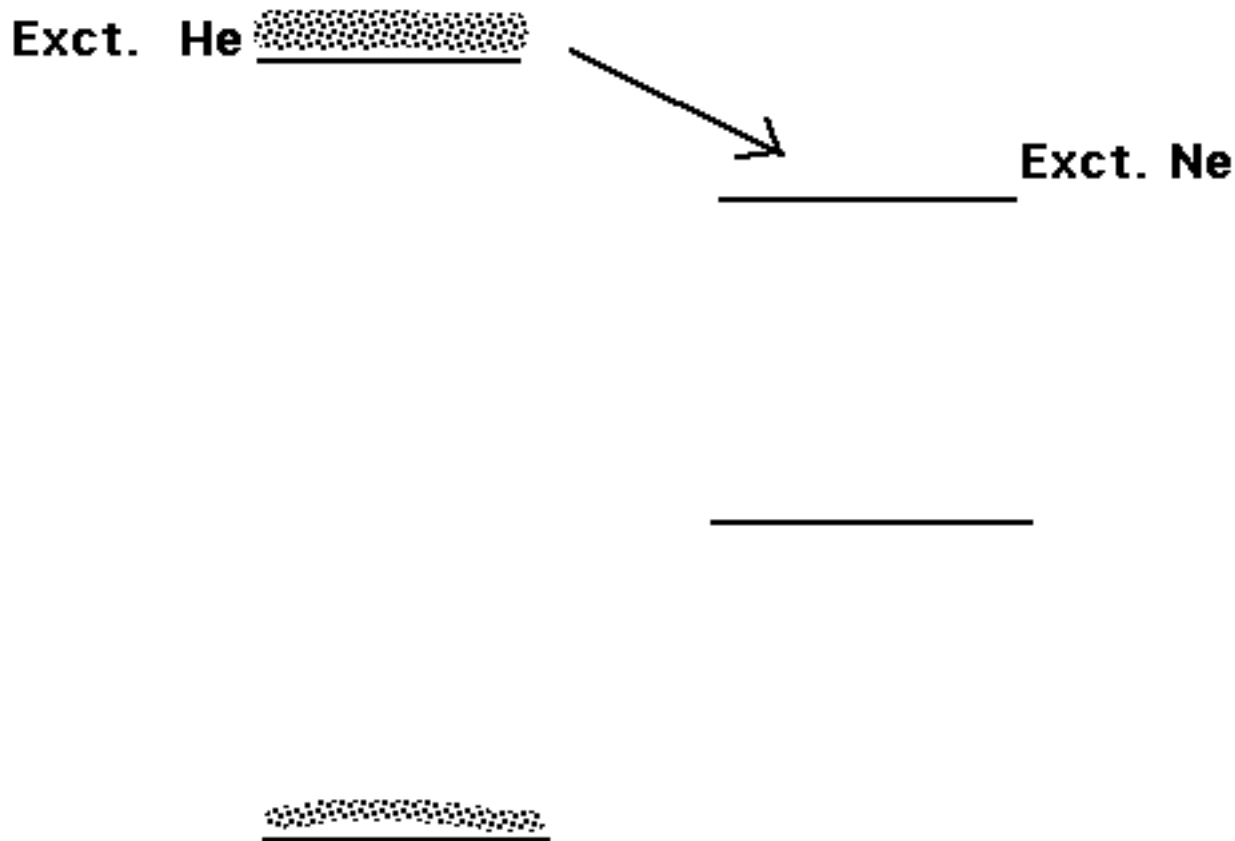
A Helium - Neon Laser

Exct. He 

Exct. Ne



A Helium - Neon Laser



A Helium - Neon Laser

Exct. He _____

Population Inversion



Ext. Ne



A Helium - Neon Laser

Exct. He _____

Population Inversion



Ext. Ne



+ LIGHT



A Helium - Neon Laser

Exct. He _____

_____ Ext. Ne

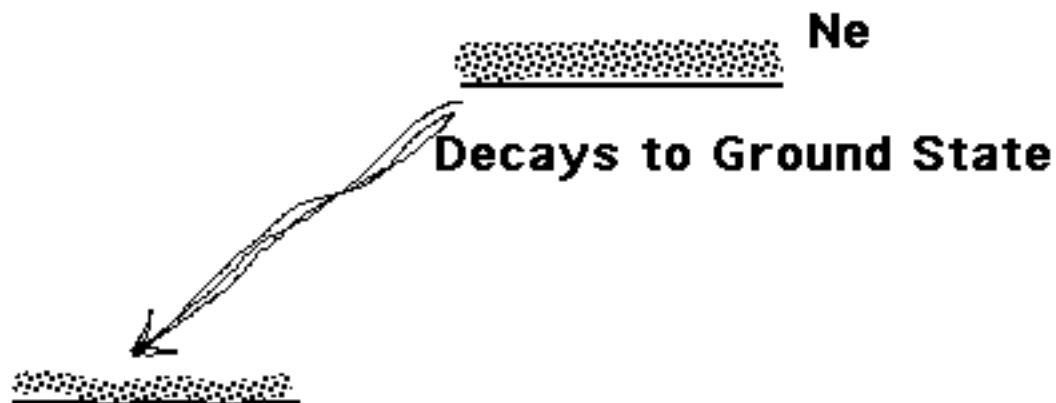
 Ne



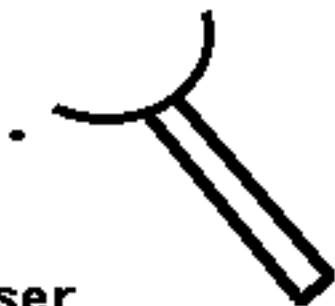
A Helium - Neon Laser

Exct. He _____

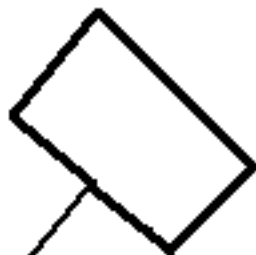
_____ Ext. Ne



Laser



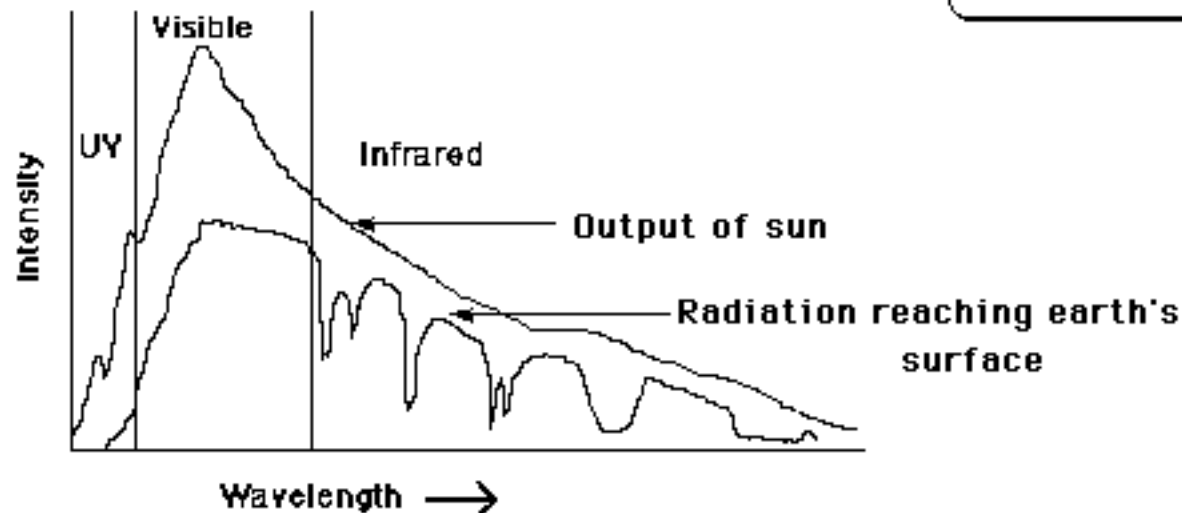
Bar Code



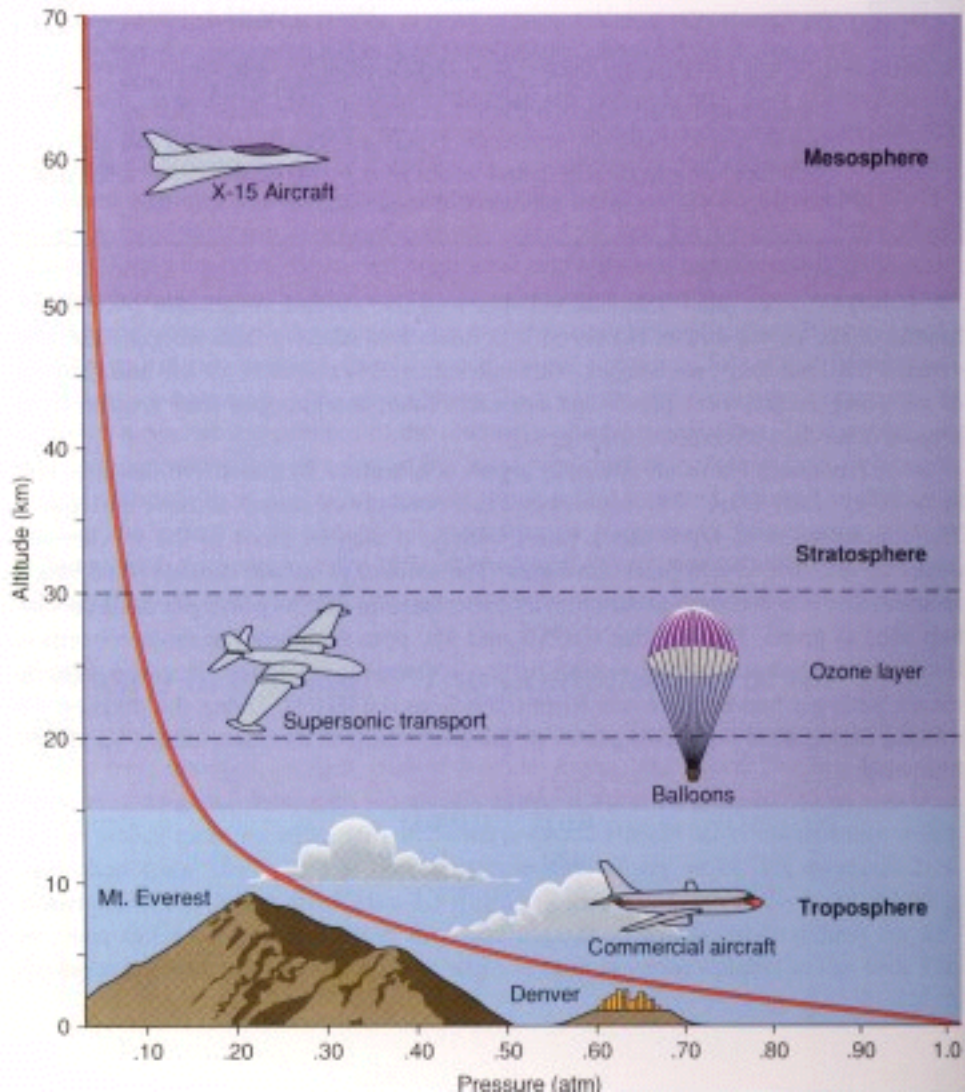
Detector

The Earth's Atmosphere absorbs some Electromagnetic Radiation

Atmosphere



Solar spectral difference due to absorption by the earth's atmosphere



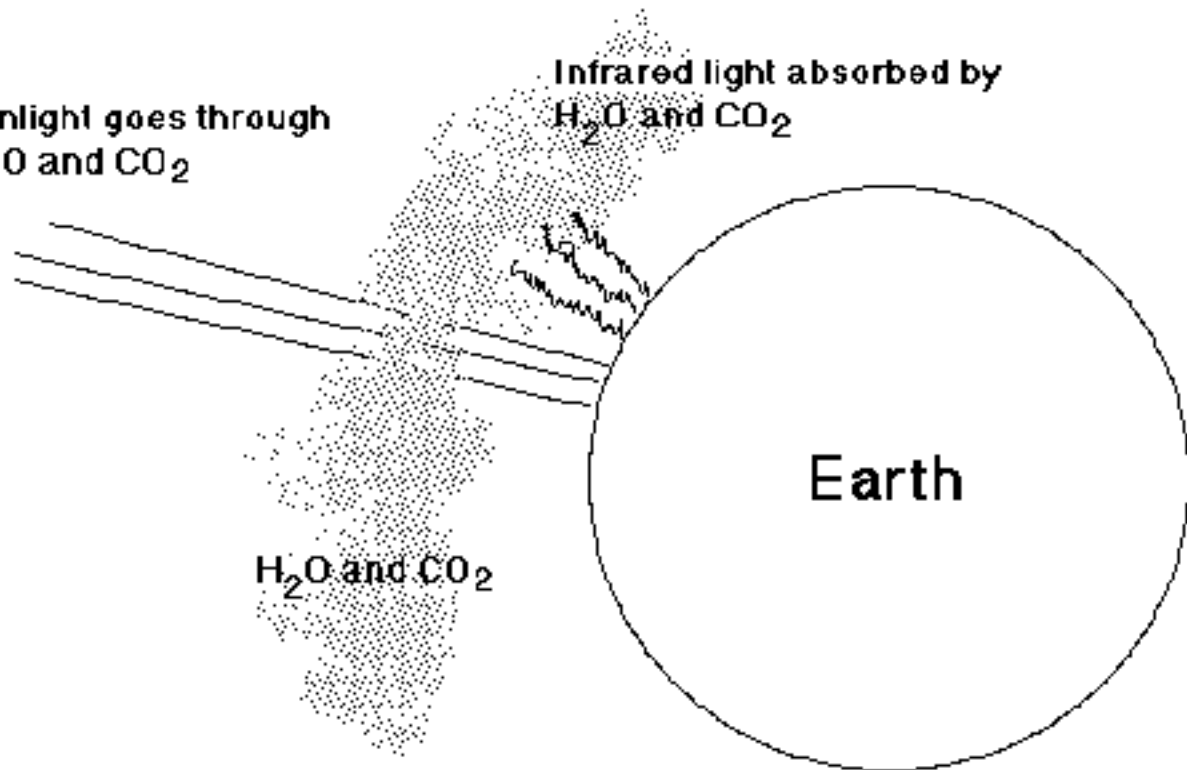
Sunlight goes through
 H_2O and CO_2

Infrared light absorbed by
 H_2O and CO_2

H_2O and CO_2

Earth

greenhouse effects



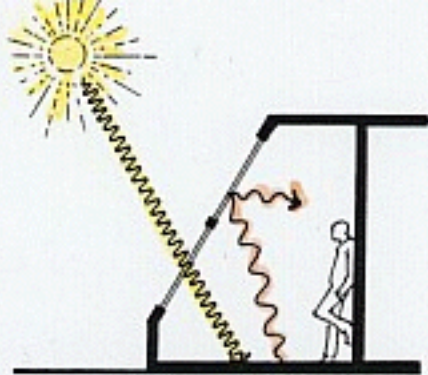
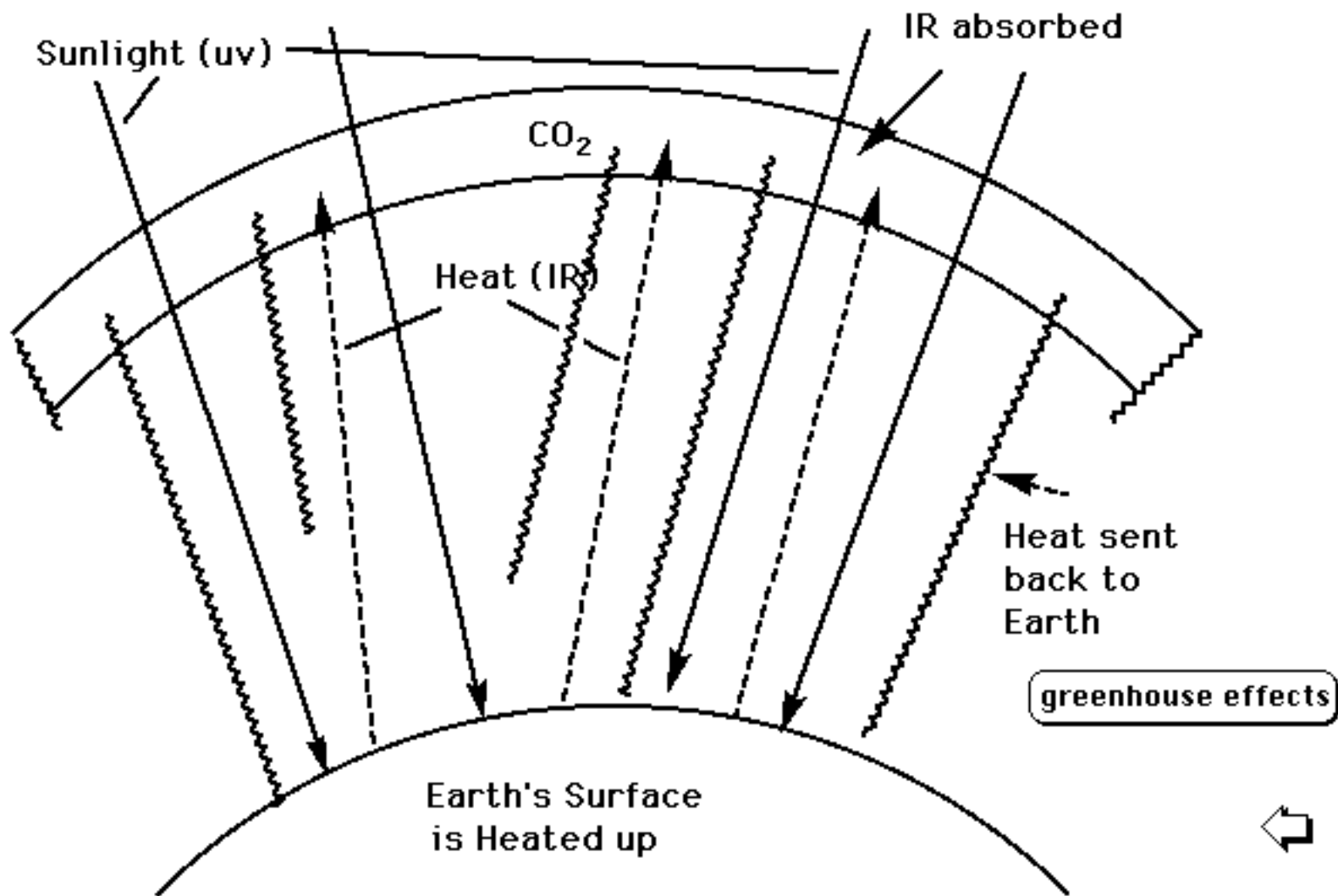
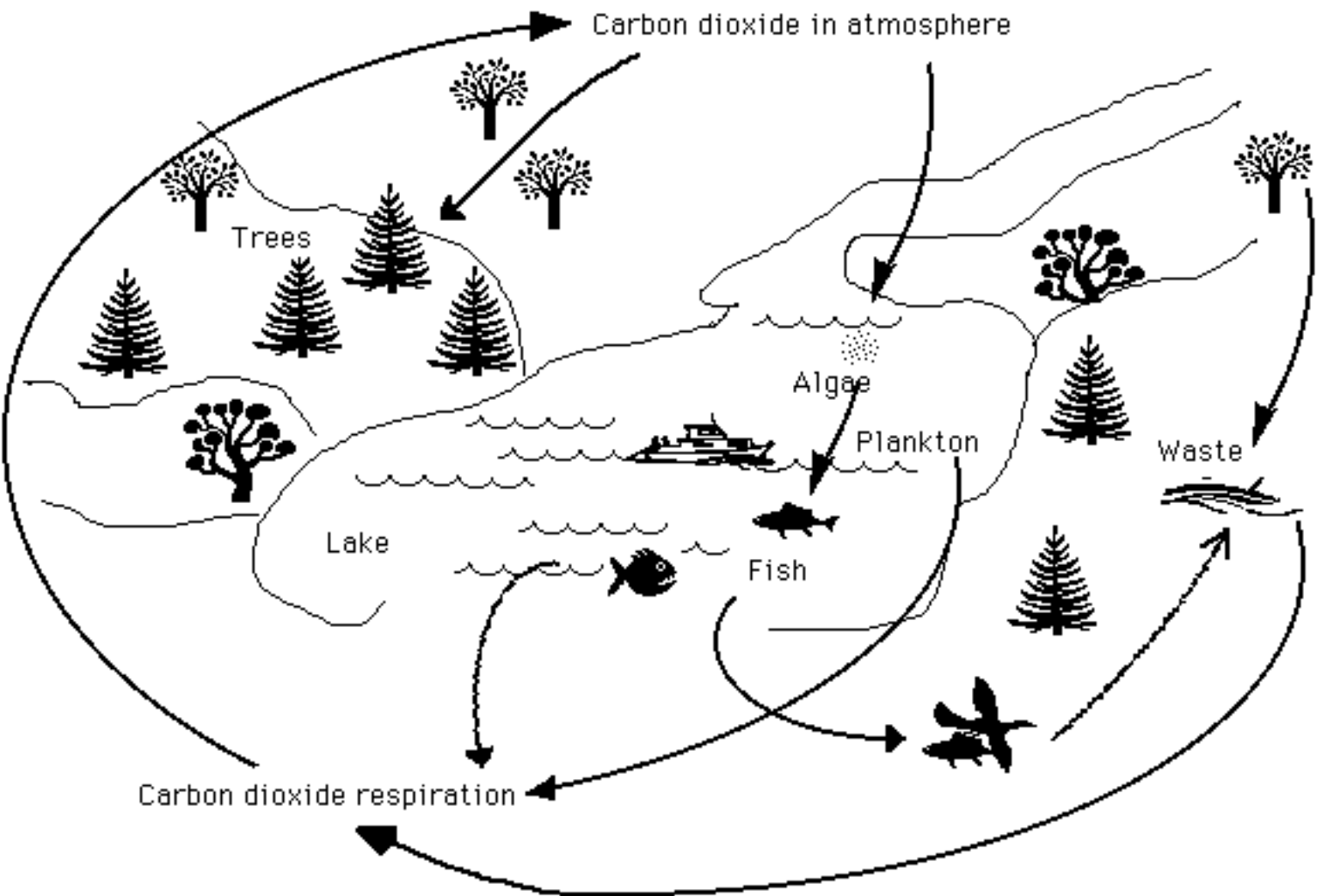


FIGURE 2.10 a

The "greenhouse" effect is partly a consequence of the fact that glazing transmits short-wave, but blocks long-wave radiation.

The Greenhouse Effect





The Global Carbon Cycle



Studies show that carbon dioxide concentration is increasing:

