Preview of Period 3: Electromagnetic Waves – Radiant Energy II

3.1 Radiant Energy from the Sun

How is light reflected and transmitted?

What is polarized light?

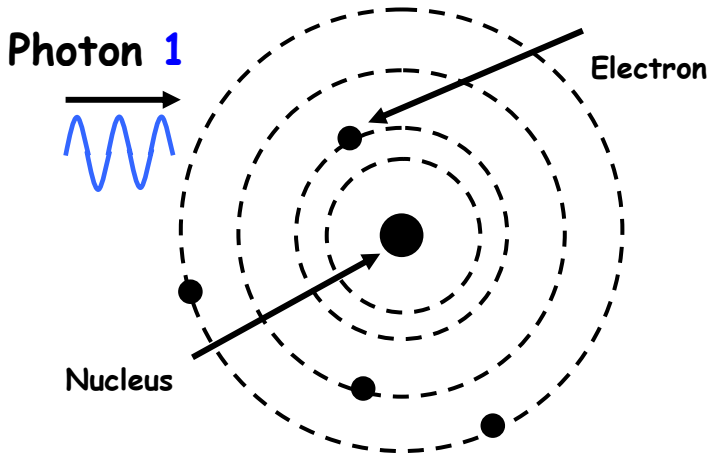
3.2 Energy Transfer with Radiant Energy

How can electromagnetic waves transfer energy and information?

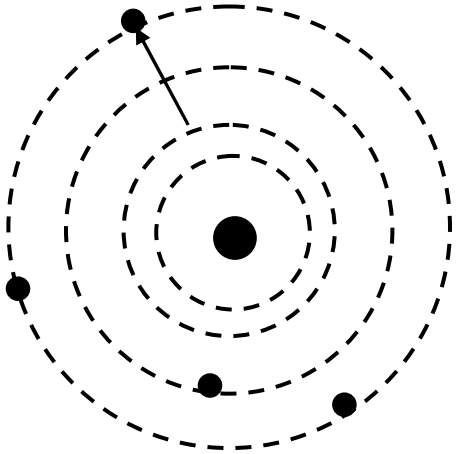
3.3 Radio and Television Broadcasts

What is the difference between AM and FM broadcasts?

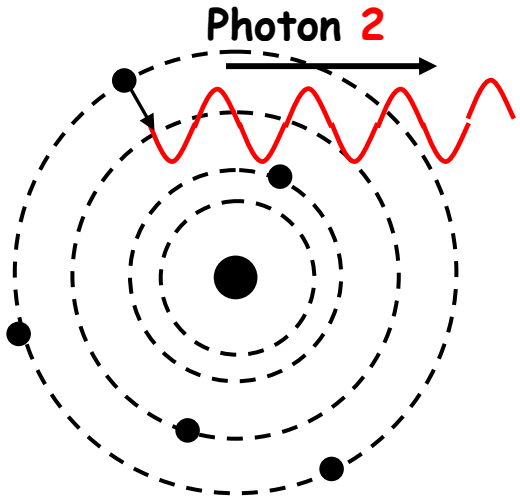
Photons absorbed by electrons



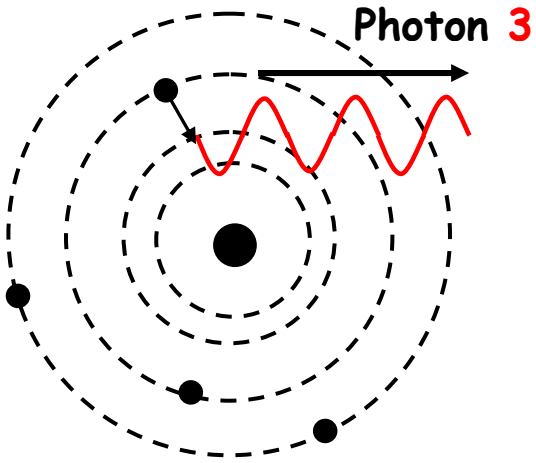
Time 1: An ultraviolet light photon is absorbed by an electron.



Time 2: The electron moves up two energy levels.



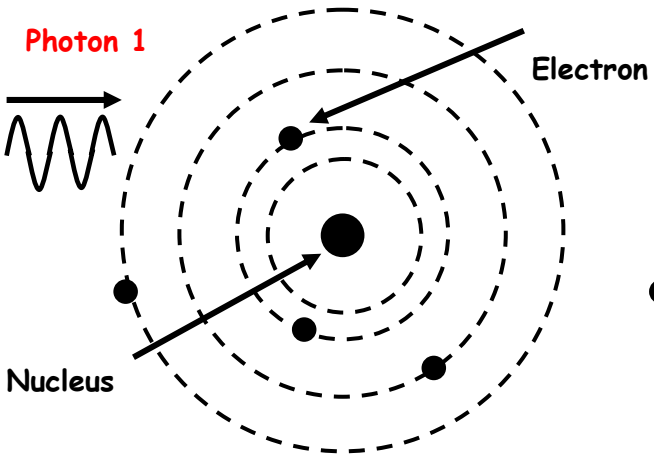
Time 3: The electron drops down one one energy level and emits one photon of visible light.



Time 4: The electron drops down one more energy level and emits a second photon.

An Atom Fluorescing

Fluorescence is the absorption of radiant energy and the re-emission of radiant energy at longer wavelengths.



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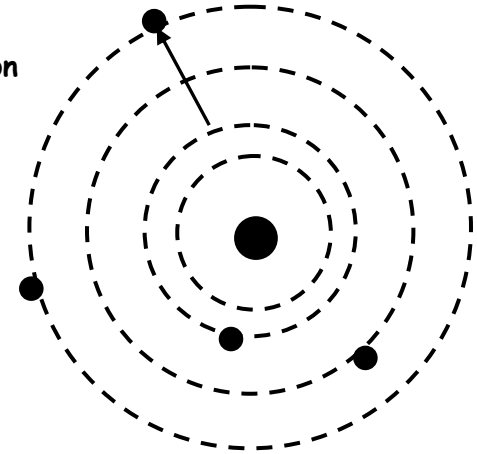

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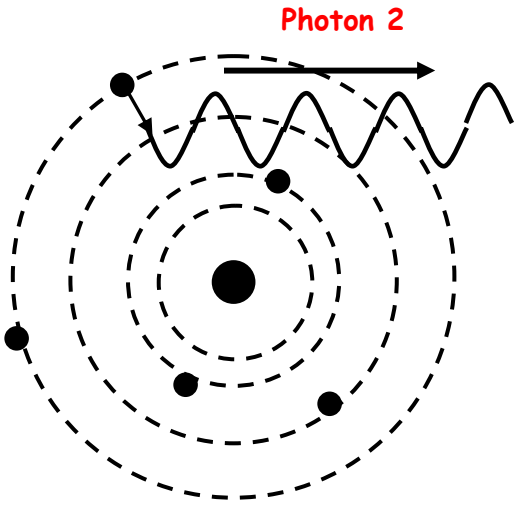

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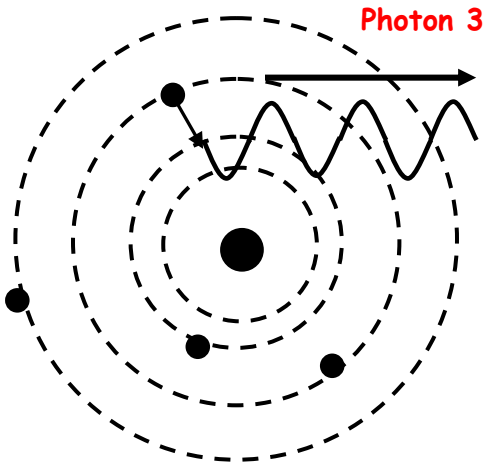


Time 4: The electron drops down one more energy level and emits a second photon.

Polarized Radiant Energy

- Electromagnetic waves of radiant energy vibrate in all directions perpendicular to the direction of the wave.
- A polarizer absorbs all of the electromagnetic waves expect those that vibrate in one direction.
- Waves that vibrate in one direction are called polarized.
- When non-polarized light reflects off of a horizontal surface (such as a mirror or water), the light becomes polarized.

Information Transfer

Communication is the transfer of information

Transferring information requires .....

- **a source of information (a person or device)**
- **a signal (the information)**
- **a receiver**
- **modulation (changing) of the signal**

Encoding Information

- **Information must be encoded for transfer.**
- **Encoding modulates the signal in a way meaningful to the sender and receiver.**
- **Examples of encoded information:**

  Spoken and written language

  Computer languages

  Sign language

  Morse Code

Signal to Noise ratio

$$\text{SNR} = \frac{\text{average energy in the signal}}{\text{average energy in the noise}}$$

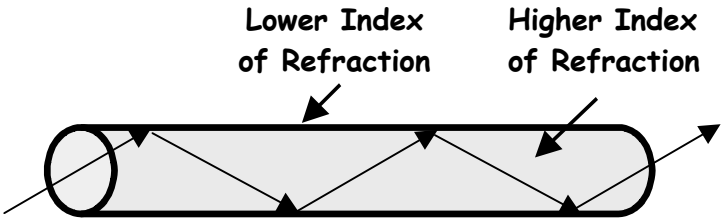
A large signal to noise ratio is better

(Example)

If the average energy in the noise of a signal is 250 joules and the average energy in the signal is 750, what is the signal to noise ratio?

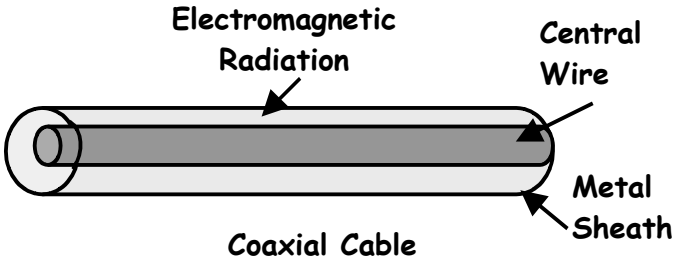
$$\text{SNR} = \frac{\text{average energy in the signal}}{\text{average energy in the noise}} = \frac{750\ \text{J}}{250\ \text{J}} = 3$$

Total Internal Reflection of Light in an Optical Fiber



Many of these optical fibers are combined into a cable.

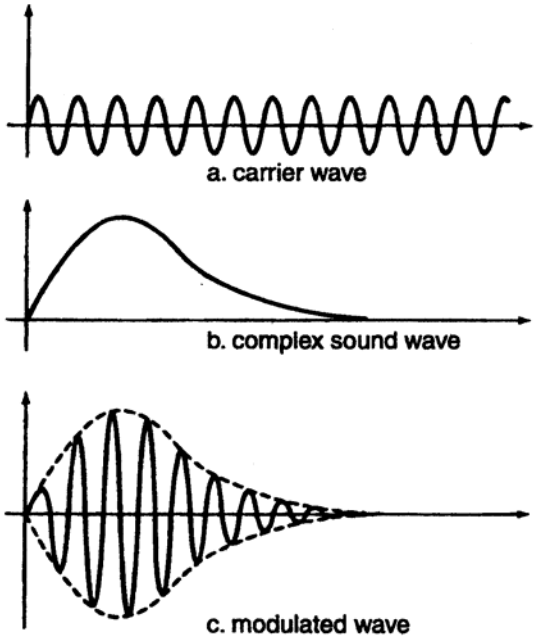
Electromagnetic Radiation Traveling in a Coaxial Cable



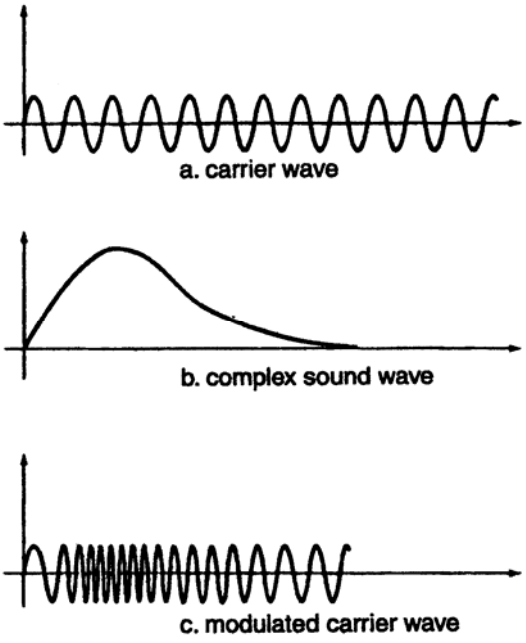
AM and FM Broadcasts

Radio and TV broadcasts use a carrier wave that is modulated to encode information.

- **AM modulates the amplitude (the height) of the carrier wave.**
- **FM modulates the frequency of the carrier wave.**



Amplitude Modulation



Frequency Modulation

Period 3 Summary

3.1: The quantum model describes radiant energy as composed of small packets of energy called photons or quanta.

If an electron in the shell of an atom absorbs a photon, the electron is raised to a higher energy level. The electron can emit one or more photons by dropping back to a lower energy level.

An electron fluoresces if it absorbs an ultraviolet photon and emits a visible light photon.

When a glowing gas is viewed through a diffraction grating, bright spectral emission lines characteristic of the gas are seen. When a glowing solid object is viewed through a diffraction grating, a continuous spectrum of color is observed.

Waves of polarized light travel in a single plane. Polarizing filters can block polarized light, such as the glare of reflected light.

3.2: Information transfer involves a sender, a receiver, and the modulation of energy in a meaningful way to produce a signal.

Period 3 Summary, Continued

The signal-to-noise ratio can be improved by increasing the energy in the signal or by decrease the energy in the noise.

A digital signal is produced by sequentially stopping and starting the energy being transferred. Morse Code is an example of a digital signal.

3.3: A carrier wave is a continuous sine wave of a single amplitude, wavelength, and frequency that is modulated to carry information from radio and TV broadcasts.

Modulating the amplitude of a carrier wave produces AM signals. Modulating the frequency produces FM signals.

Period 3 Review Questions

R.1 What is fluorescence? What causes an atom to fluoresce?

R.2 You view a glowing gas and a glowing solid through a diffraction grating. What is the difference between the images you see through the grating?

R.3 Microwave manuals tell owners that they can test dishes to see if they will work in the microwave by filling them with water and putting them in the microwave for a certain length of time. If the water gets hot, and the dish does not, then the dish is safe to use. Explain this.

R.4 Describe the differences between information transfer using electrical energy and using radiant energy. Give examples of each type of transfer.

R.5 How does an AM radio signal differ from an FM signal? Does an AM or FM signal contain photons with greater energy per photon? Which signal uses radio waves with a higher frequency?