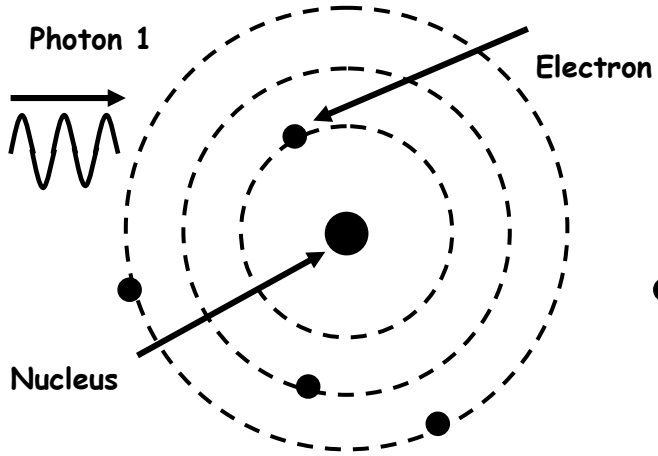
Name _____ Section _____

# Activity 3: Electromagnetic Waves – Radiant Energy II

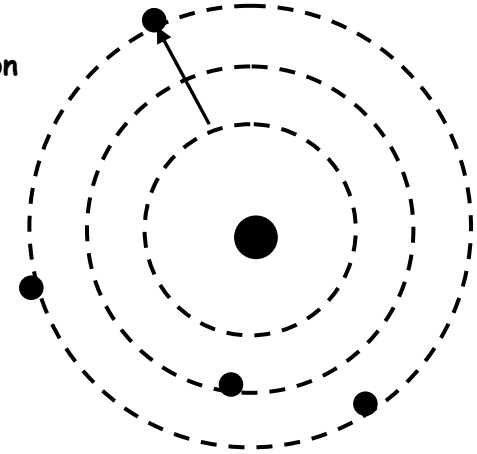
## 3.1 Applications of the Quantum Model of Radiant Energy

### 1) Photon Absorption and Emission

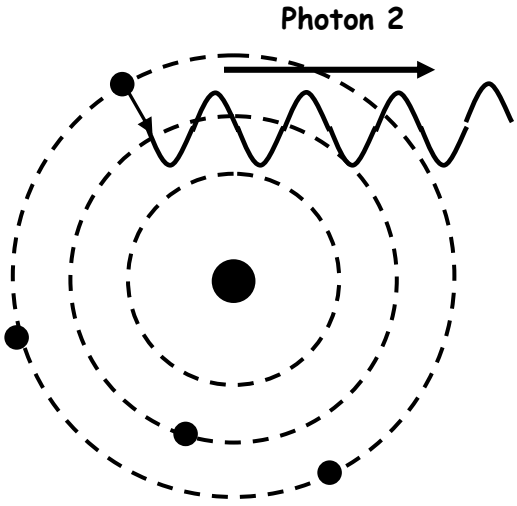
The diagrams below illustrate an atomic nucleus and energy levels of the atom's electrons (not drawn to scale). Diagram #1 shows a photon incident on an electron in an atom. In diagram #2, an electron in the atom has absorbed a photon and has moved to a higher energy level. Diagram #3 shows the atom emitting a photon of light and dropping to a lower energy level. Diagram #4 shows the same atom some time later, after the electron has emitted a second photon and dropped to an even lower energy level. Answer the questions below based on these diagrams.



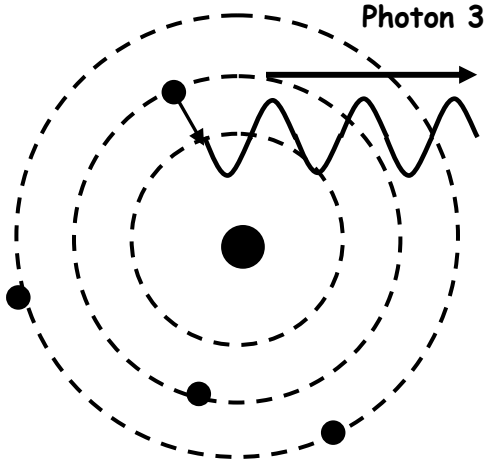

**Time 1: An ultraviolet light photon is absorbed by an electron.**



**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.**

a) Does the absorbed photon #1 or the emitted photon #2 have more energy? _____ How do you know?

b) Which photon has a larger frequency, the absorbed or either of the emitted photons? _____ How do you know?

c) Which photon has a longer wavelength – the absorbed or the emitted photon? _____ How do you know?

d) If the absorbed photon #1 is a photon of blue visible light, what color of light could emitted photon #2 be?

e) Compare the energy of photon #1 to the energies of photons #2 and #3.

## 2) Ultraviolet Light and Fluorescence

Your instructor will demonstrate the results of shining several types of radiant energy on fluorescent materials.

a) What happens when an atom fluoresces?

b) Which light source works the best? _____

c) Will a glow coil provide suitable light for the materials to fluoresce? _____

Why or why not?

d) "Write" on the Write and See boards using light from the red pen and then light from the blue pen. Does the red pen leave an impression on the board? _____ Does the blue pen? _____

e) Explain the different effects when red and blue photons strike the fluorescent board. (Hint: How can the visible light given off by fluorescing materials be explained in terms of the energy of photons?)

## 3) Visible Light Spectra from Gases

a) Observe the tube of glowing mercury vapor through a diffraction grating. Describe what you see.

b) What do you see when you view the glass tube with neon vapor?

c) Why do you see bright emission lines when viewing gases?

## 4) Visible Light Spectra from Solids

a) Your instructor will again demonstrate the glowing solid light bulb filament you observed in Period 1. Observe the bulb through a diffraction grating and describe what you see.

b) How does the spectrum of a glowing solid compare to the spectrum of a glowing gas?

c) What happens when the white light from the filament bulb shines through a prism?

d) Your instructor will reduce the power to the bulb filament. Reducing the bulb brightness results from lowering the temperature of the filament. Describe what you see when viewing the dimmed bulb through a diffraction grating.

e) When the power to this bulb is reduced until no visible light is seen, does the filament still emit photons? If so, what type of photons?

### 5) Polarized Radiant Energy

Your instructor will discuss polarization of light.

a) Look at the classroom ceiling lights through a polarizing filter. What happens to the light from the ceiling bulbs when it passes through the filter?

b) Look at the ceiling lights through two polarizing filters. What happens when you rotate one of the filters?

c) Light reflected from a horizontal surface, such as a mirror, becomes polarized.

Look at the OHIO sign and the reflection of the sign. Now view the sign and its reflection through a polarizing filter. Describe what happens when you rotate the polarizing filter. Why does rotating the filter have this effect?

## 3.2 Information Transferred with Radiant Energy

### 6) Requirements for information transfer

a) Your instructor will discuss information transfer. What are the requirements for the transfer of information?

b) Any energy source that combines with the signal in any way is known as noise. Watch the demonstration of noise in a signal with a slide projector. List two changes that improve the signal-to-noise ratio.

c) If the average energy of the noise is doubled, what must happen to the average energy in the signal if the signal-to-noise ratio is to remain unchanged?

d) Your instructor will discuss what is meant by encoding information for transfer.

List at least 3 schemes for encoding information.

**7) Digital transfer of information**

a) What is a pixel? Look for pixels in the pictures on your table.

b) Using Morse code and telegraph keys, have a contest between two groups at your table. Try to send and successfully receive your mother's first name. Is Morse code an analog or a digital signal? Why?

**8) Transferring information with electromagnetic radiation**

Your instructor will discuss how electromagnetic signals are transferred.

a) What is a carrier wave?

b) List 3 common mediums through which an electromagnetic signal can be transmitted.

c) How does a fiber optic cable transmit information? How is it possible for a signal to be transmitted through a bent cable?

d) How do coaxial cables transmit information?

## 3.3 How Are Signals Broadcast? – Commonly Used Carrier Waves

### 9) Microwave transmissions

a) Microwave transmissions are usually sent between a source and a single receiver. Use a microwave transmitter to send microwaves to the microwave receiver.

Try to shield the signal using a sheet of aluminum, a glass plate, and a metal grid. Try to reflect the microwave signal using the same materials. Record your results below.

| | **Shields waves?** | **Reflects waves?** |
|---|---|---|
| Aluminum sheet | _____ | _____ |
| Glass plate | _____ | _____ |
| Grid held horizontally | _____ | _____ |
| Grid held vertically | _____ | _____ |

b) Why do different orientations of the metal grid give different results?

c) Group Discussion Question: Why does a microwave oven have a glass door with metal gratings?

### 10) Visible light transmissions

a) Connect a solar cell to the white amplifier/loudspeaker. What happens when an LED flashlight connected to a radio shines on the solar cell? What type of radiant energy transfers information?

b) Your instructor will show you how to use a laser beam to send a modulated signal to a solar cell.

1) How is energy transferred from the radio to the laser beam?

2) How does the modulated laser beam produce sound in the second loudspeaker?

3) What is this type of modulation called? _____

**11) Radio wave transmissions**

Your instructor will discuss broadcasting.

a) How is it possible that every radio station transmits its signal at a distinct frequency while sending a signal made up of a variety of frequencies (musical pitches)?

b) A radio station transmits radio waves with a wavelength of 3.3 meters. What is the frequency of the station?

c) Information can be encoded on a carrier wave by modulating the wave's amplitude. What other feature of a wave could be modulated?

d) Which type of modulation is less likely to be affected by noise in a radio broadcast?