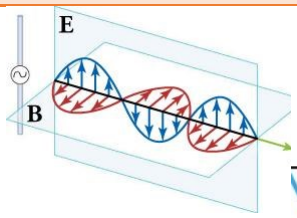
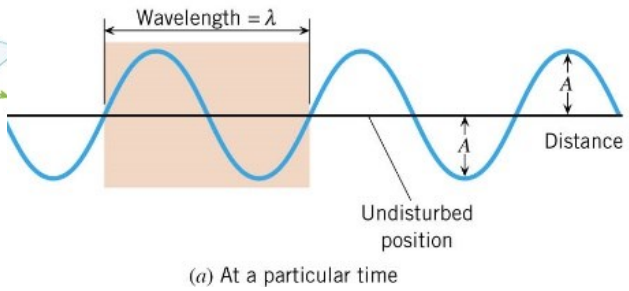
Physics 11-01 Electromagnetic Spectrum and Behavior **Name:** _____

How to create electromagnetic (EM) waves

- Move a _____(current)
- This creates an _____field
- Also creates a _____field
- These are _____ to each other





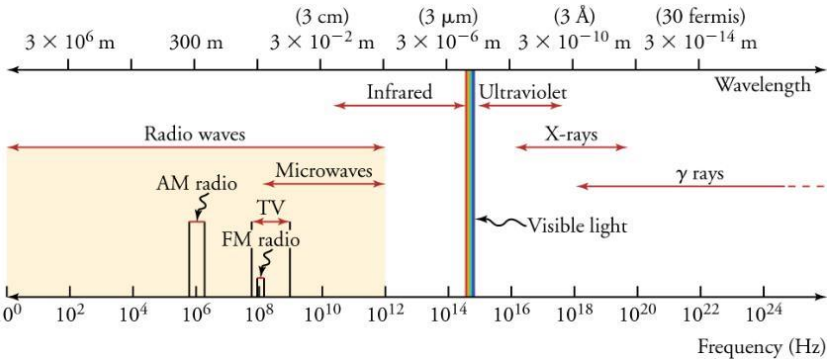
(a) At a particular time

EM Waves

- Wavelength – _____of one cycle
- Frequency – _____of cycles per second
- Amplitude – _____of a crest above the undisturbed position
- $v = f\lambda$

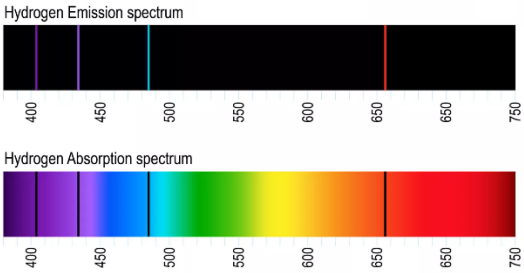
Types of EM radiation

- Based on the _____



Bohr model of the atom

- Electrons orbit the _____
- When an electron _____energy it gets excited, it _____out to a higher orbital
  - Electrons gain energy when they are _____by a _____
  - Photons are _____of light
  - Too much _____and electron completely removed from atom, ionizes, allows _____reactions
- When the excited electron _____back down to its orbital, it _____energy as a _____
- The energy released is based on the _____between the _____
- The frequency (and wavelength) of the released photon is based on the _____released
- So only a few certain _____are emitted



Emission spectrum

- Shows the wavelengths (or frequencies) of the _____light

Absorption spectrum

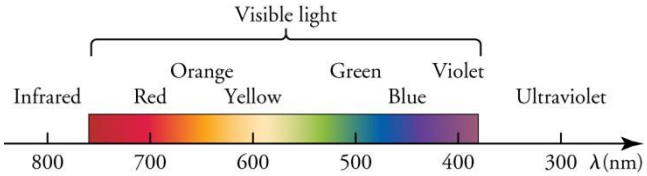
- Shows the wavelengths (or frequencies) of the _____light

De Broglie model

- The Bohr model only works for _____
- Electrons behave like waves with a set _____
- Each electron orbits the nucleus in _____waves
- This allows for orbitals in more _____atoms

Visible Light

- Between _____ Hz and _____ Hz
- 750 nm (end of red); 380 nm (end of violet)



Speed of light in a vacuum (space)

- $c = 3.00 \times 10^8\ m/s$
- $c = f\lambda$
- When light travels through a material it _____down due to the _____and _____of the photons

Physics 11-01 Electromagnetic Spectrum and Behavior *Name:* _____

Measurements of light

- Luminous flux
  - _____at which light is radiated from a source
  - Unit: _____(lm)
- Illuminance
  - Lumens per _____
  - $illuminance = \frac{P}{4\pi r^2}$
  - Unit: _____(lx)

Practice Work

1. Explain how atoms (a) absorb light and (b) produce light. (RW)
2. Can a single microwave photon cause cell damage? (HSP 21.7)
3. Shortly after the introduction of photography, it was found that photographic emulsions were more sensitive to blue and violet light than they were to red light. Explain why this was the case. (HSP 21.12)
4. Give an example of energy carried by an electromagnetic wave. (OpenStax 24.8)
5. Why does the emission spectrum of an isolated gas differ from the emission spectrum created by a white light? (HSP 22.5)
6. Why do Bohr's calculations for electron energies not work for all atoms? (HSP 22.21)
7. (a) Two microwave frequencies are authorized for use in microwave ovens: 900 and 2560 MHz. Calculate the wavelength of each. (b) Which frequency would produce smaller hot spots in foods due to interference effects? (OpenStax 24.6) **33.3 cm**, **11.7 cm**
8. A radio station utilizes frequencies between commercial AM and FM. What is the frequency of a 11.12-m-wavelength channel? (OpenStax 24.8) **26.96 MHz**
9. Combing your hair leads to excess electrons on the comb. How fast would you have to move the comb up and down to produce red light? (OpenStax 24.10) $\mathbf{4.0 \times 10^{14}}$ **Hz**
10. Some radar systems detect the size and shape of objects such as aircraft and geological terrain. Approximately what is the smallest observable detail utilizing 500-MHz radar? (OpenStax 24.14) **0.600 m**
11. Determine the amount of time it takes for X-rays of frequency 3×10^{18} Hz to travel (a) 1 mm and (b) 1 cm. (OpenStax 24.15) $\mathbf{3 \times 10^{-12}}$ **s,** $\mathbf{3 \times 10^{-11}}$ **s**
12. If you wish to detect details of the size of atoms (about 1×10^{-10} m) with electromagnetic radiation, it must have a wavelength of about this size. (a) What is its frequency? (b) What type of electromagnetic radiation might this be? (OpenStax 24.16) $\mathbf{3 \times 10^{18}}$ **Hz, X-rays**
13. If the Sun suddenly turned off, we would not know it until its light stopped coming. How long would that be, given that the Sun is 1.50×10^{11} m away? (OpenStax 24.17) **500 s**
14. Conversations with astronauts on lunar walks had an echo that was used to estimate the distance to the Moon. The sound spoken by the person on Earth was transformed into a radio signal sent to the Moon and transformed back into sound on a speaker inside the astronaut's space suit. This sound was picked up by the microphone in the spacesuit (intended for the astronaut's voice) and sent back to Earth as a radio echo of sorts. If the round-trip time was 2.60 s, what was the approximate distance to the Moon, neglecting any delays in the electronics? (OpenStax 24.25) $\mathbf{3.90 \times 10^{8}}$ **m**
15. Lunar astronauts placed a reflector on the Moon's surface, off which a laser beam is periodically reflected. The distance to the Moon is calculated from the round-trip time. (a) To what accuracy in meters can the distance to the Moon be determined, if this time can be measured to 0.100 ns? (b) What percent accuracy is this, given the average distance to the Moon is 3.84×10^{8} m? (OpenStax 24.26) **1.50 cm,** $\mathbf{3.91 \times 10^{-9}}$ **%**
16. (a) Neil Armstrong was the first person to walk on the moon. The distance between the earth and the moon is 3.85×10^{8} m. Find the time it took for his voice to reach earth via radio waves. (b) Someday a person will walk on Mars, which is 5.6×10^{10} m from earth at the point of closest approach. Determine the minimum time that will be required for that person's voice to reach earth. (Cutnell 24.2) **1.28 s, 190 s**