

Periodic Table of the Elements

1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [277]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [282]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

General Chemistry

202-SN1-RE

with Olivia Bibollet-Bahena

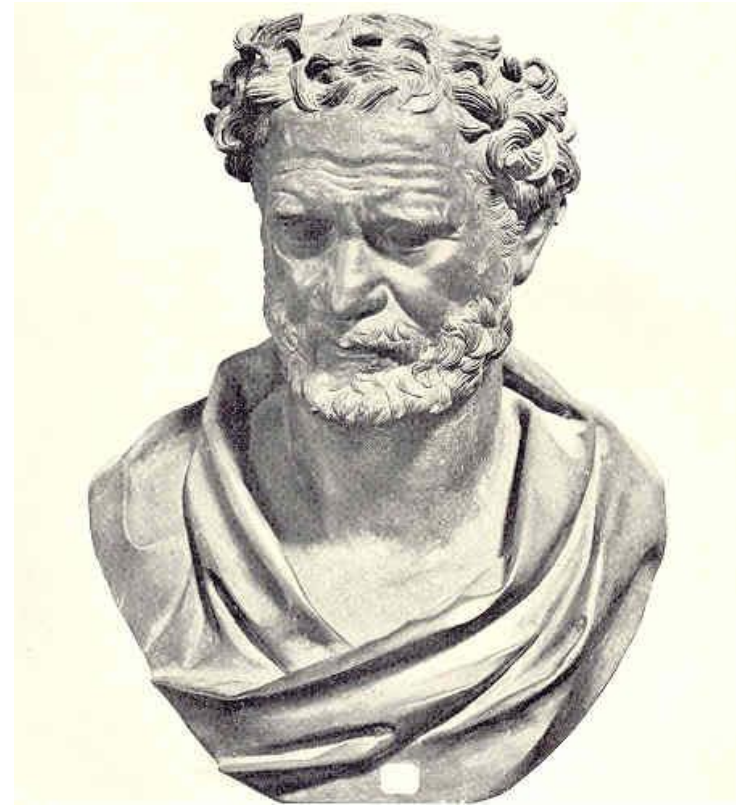
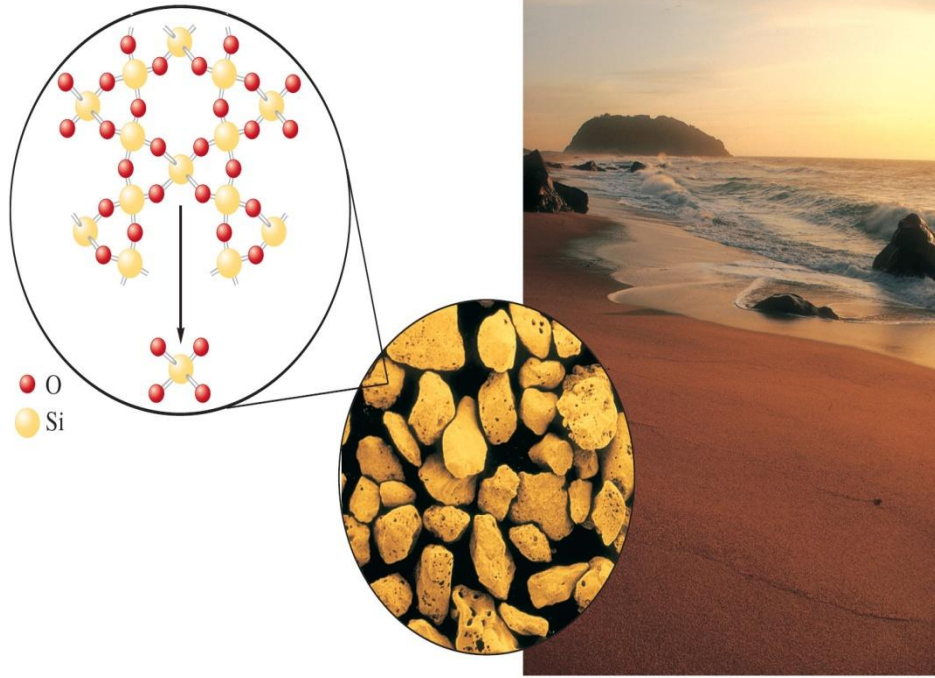
Office: 5th floor

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.06	71 Lu Lutetium 174.97
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Metalloid
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

Unit 4a – Early Atomic Structure

Atomic Structure of Matter



The idea of the atom goes back to Democritus and the Ancient Greeks at about 400 B.C.

- Once we came to 'believe in' atoms, it was logical to ask: What is the nature of an atom? Does an atom have parts, and if so, what are they?
- Before examining the atomic structure, we must consider the revolution that took place in physics in the first 30 years of the twentieth century. A radical new theory called quantum mechanics was developed to account for the behavior of light and atoms.
- But first, let's look into electromagnetic radiation.

Electromagnetic Radiation

Watch this video:

[Les ondes lumineuses, visibles et invisibles -
Lucianne Walkowicz \(youtube.com\)](#)

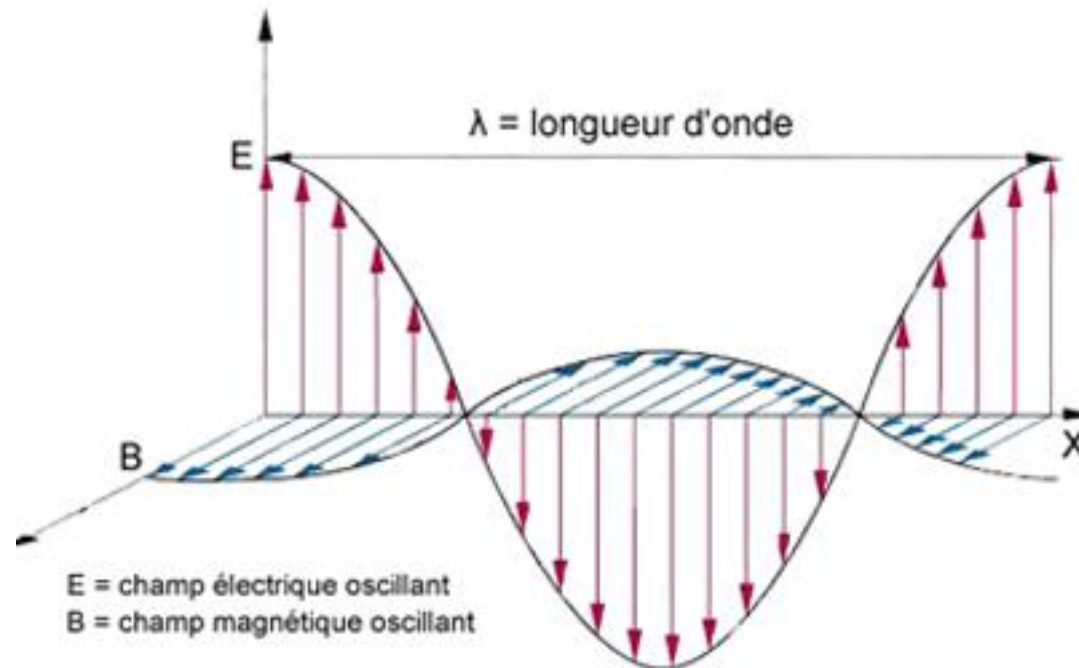
Electromagnetic Radiation

- One of the ways that **energy** travels through space is by electromagnetic radiation.
- Examples: visible light, microwaves, x-rays, radiant heat from a fireplace.
- All exhibit same type of wavelike behavior and travel at the speed of light in a vacuum.

Electromagnetic Waves

They are the result of electric charges moving, thus creating a magnetic field and an electric field.

Electromagnetic waves can travel in a vacuum (i.e. no medium required), contrary to sound waves or waves formed in water.



Read:

[Electromagnetic waves | National Oceanic and Atmospheric Administration \(noaa.gov\)](#)

Wave Properties of Radiant Energy and the Electromagnetic Spectrum

- Electromagnetic energy (“light”) is characterized by **wavelength, frequency, and amplitude.**

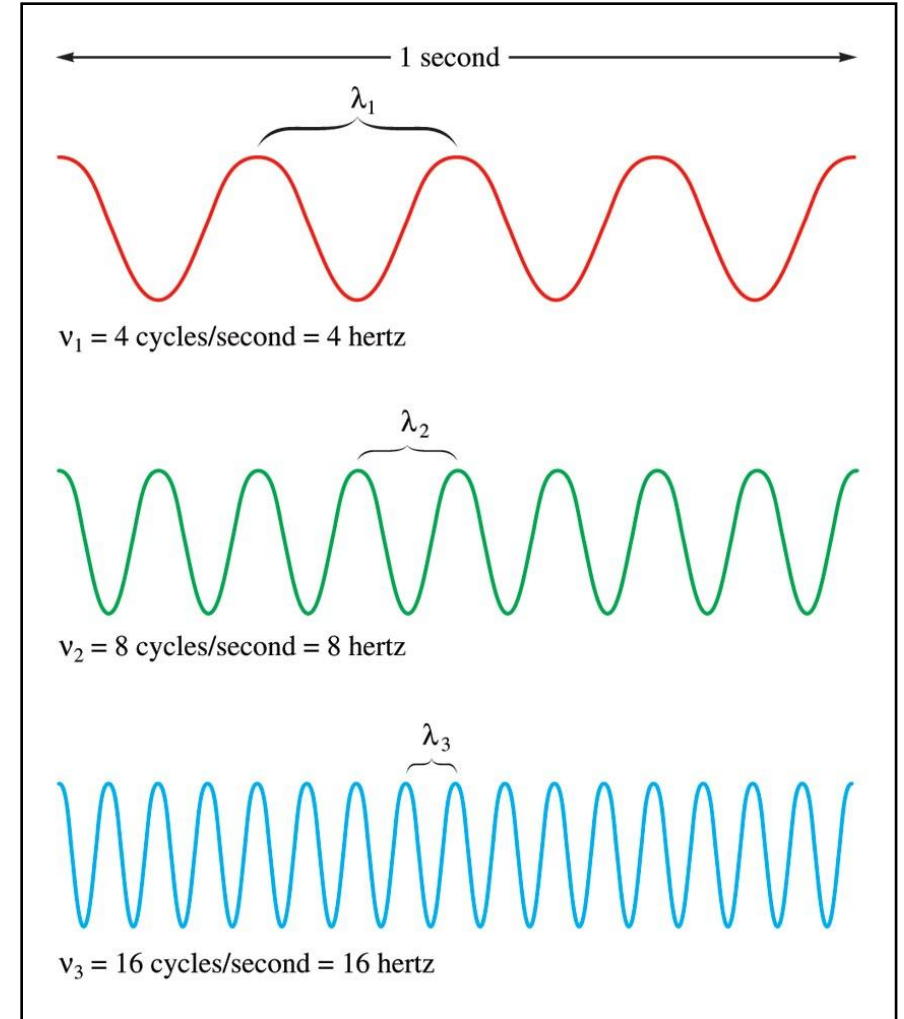


The Nature of Waves

- Three characteristics of electromagnetic radiation:

1. **Wavelength (λ , *Greek lambda*)** – distance between two peaks or troughs in a wave (m, meters).
2. **Frequency (ν , *Greek nu*)** – number of waves (cycles) per second that pass a given point in space (Hz, Hertz, or s^{-1} , cycles/second)
3. **Speed (c)** – speed of light (2.998×10^8 m/s)

$$c = \lambda \nu$$



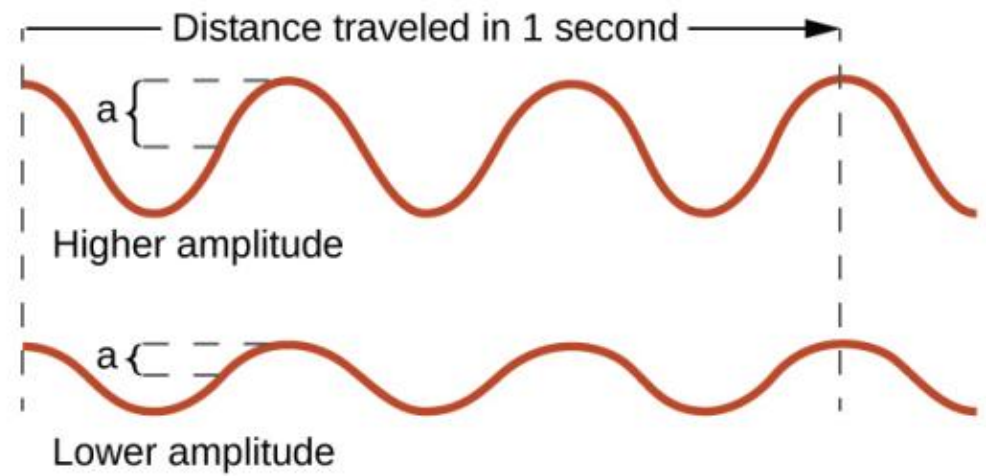
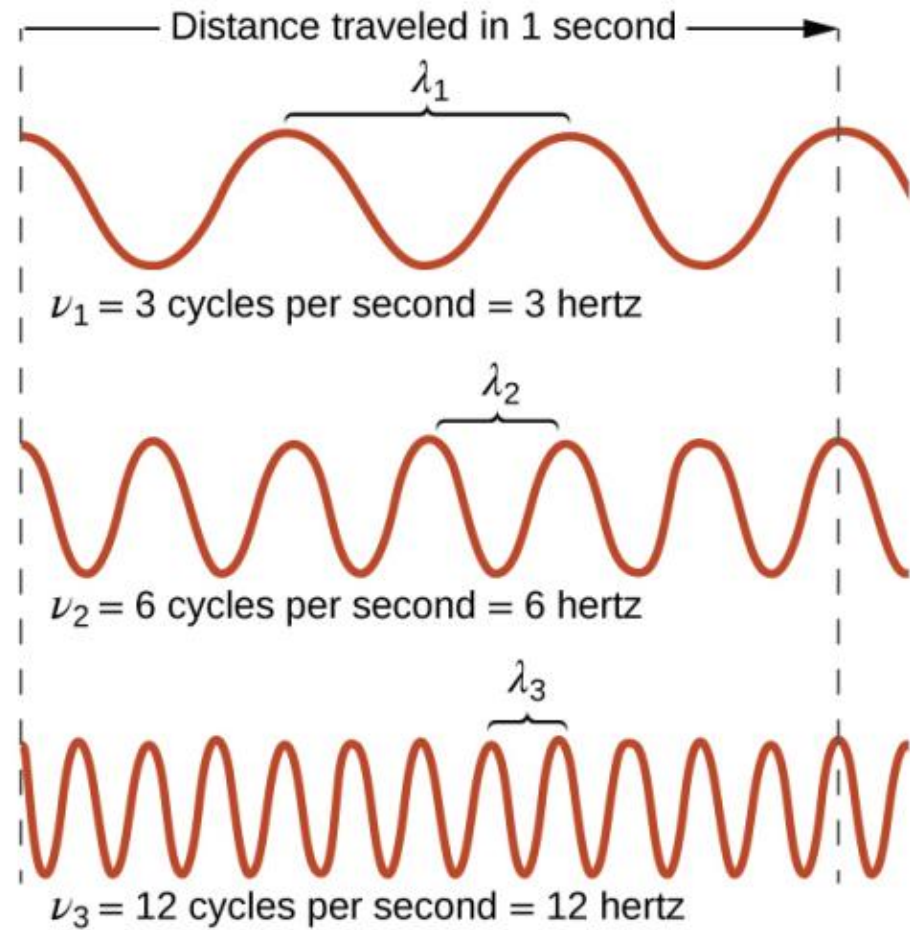
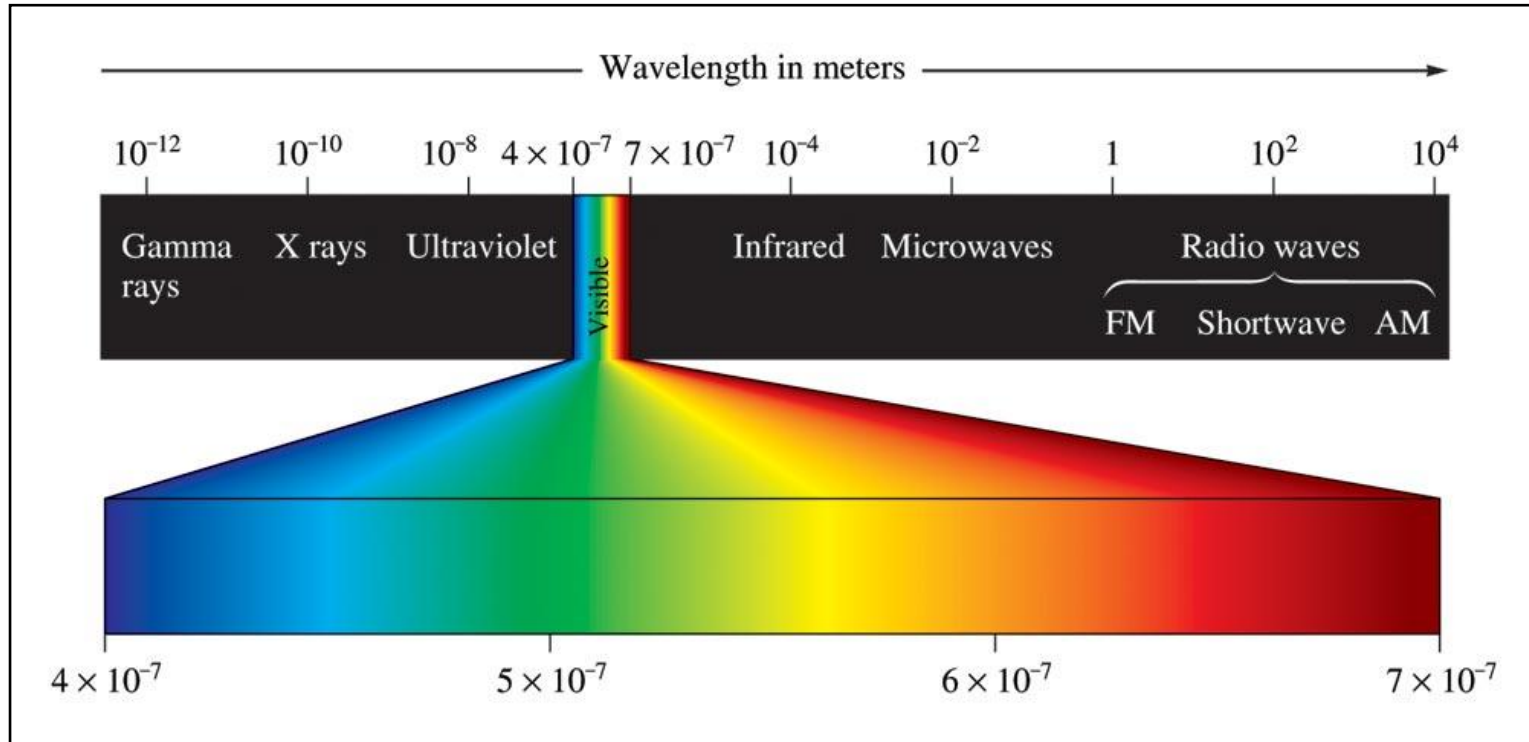


FIGURE 6.2 One-dimensional sinusoidal waves show the relationship among wavelength, frequency, and speed. The wave with the shortest wavelength has the highest frequency. Amplitude is one-half the height of the wave from peak to trough.

Classification of Electromagnetic Radiation



Energy from the sun reaches the earth mainly in the form of visible and UV radiation, whereas the flowing coals of a fireplace transmit heat energy by infrared radiation.

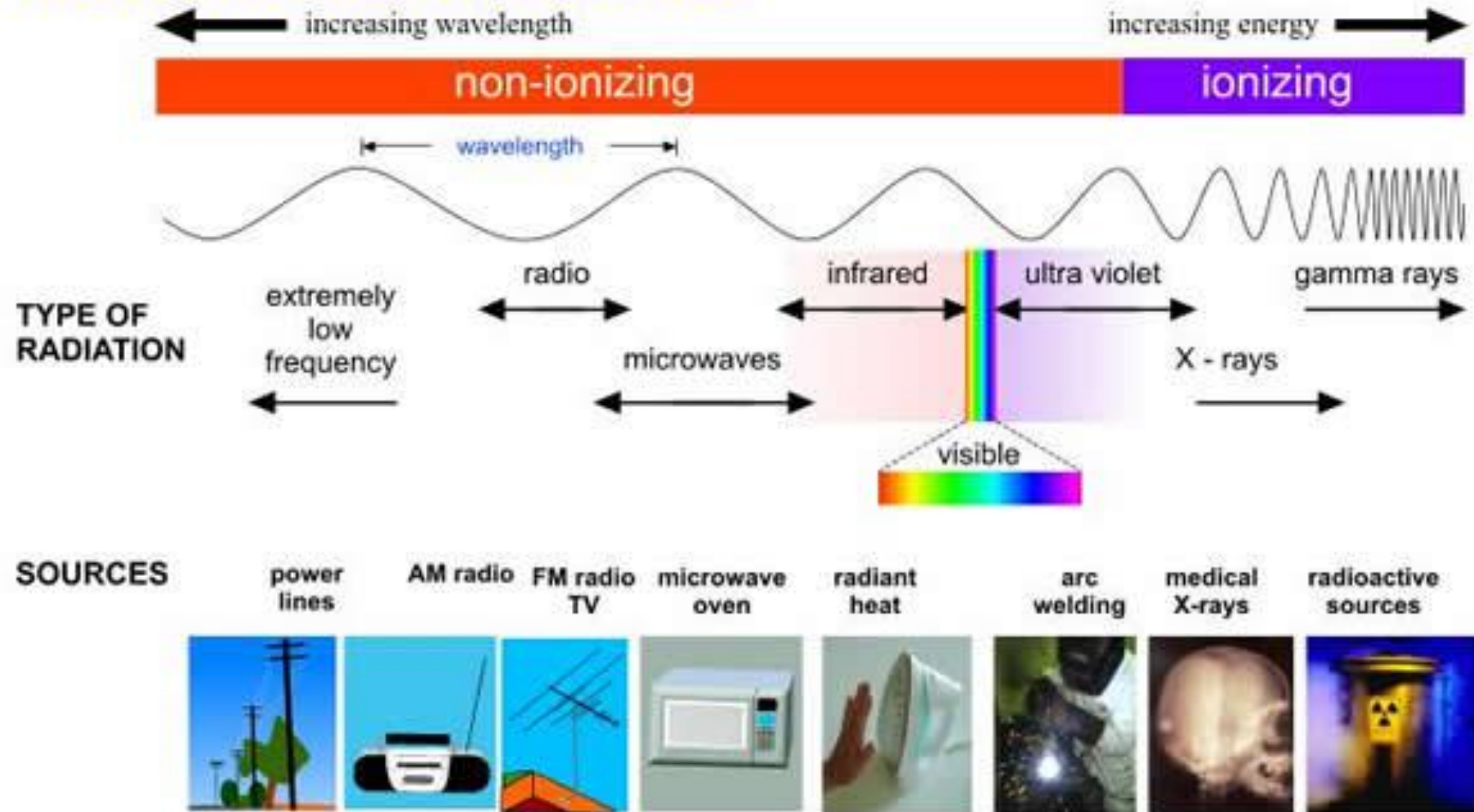
Fun fact: Practically all the fuels that modern society uses – gas, oil and coal – are stored forms of energy received from the sun as electromagnetic radiation millions of years ago. Only energy from nuclear reactors does not originate from the sun.

Britannica: [Electromagnetic radiation | Spectrum, Examples, & Types | Britannica](#)

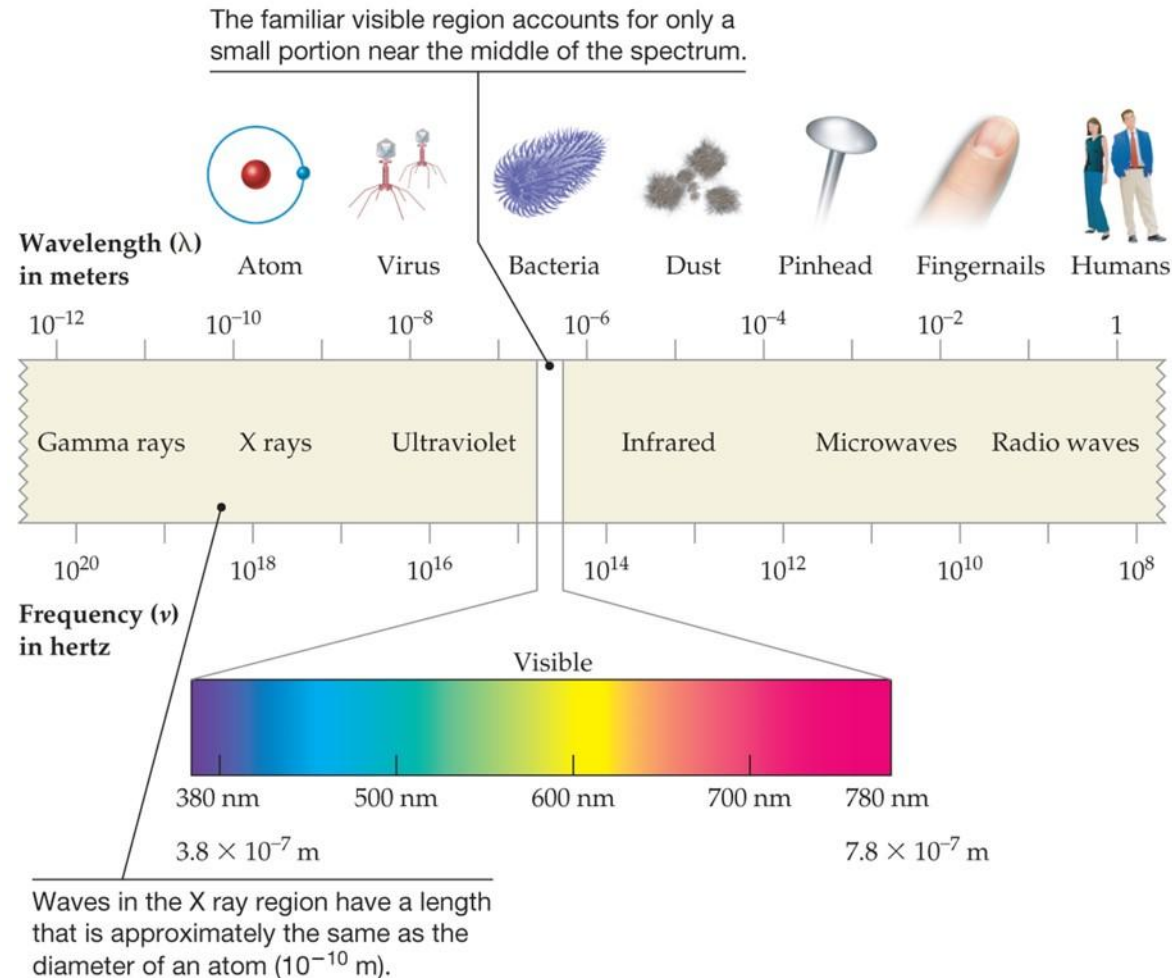
Radiation provides an important means of energy transfer.

Classification of Electromagnetic Radiation

THE ELECTROMAGNETIC SPECTRUM



Wave Properties of Radiant Energy and the Electromagnetic Spectrum – Frequency Is Inversely Proportional to Wavelength



$$\nu \uparrow \lambda \downarrow$$

Wave Properties of Radiant Energy and the Electromagnetic Spectrum

$$\begin{array}{ccccccc} \text{Wavelength} & \times & \text{Frequency} & = & \text{Speed} \\ \lambda & \times & \nu & = & c \\ \text{m} & & \frac{1}{\text{s}} & & \frac{\text{m}}{\text{s}} \end{array}$$

c is defined to be the rate of travel of all electromagnetic energy in a vacuum and is a constant value—**speed of light**.

$$c = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$$

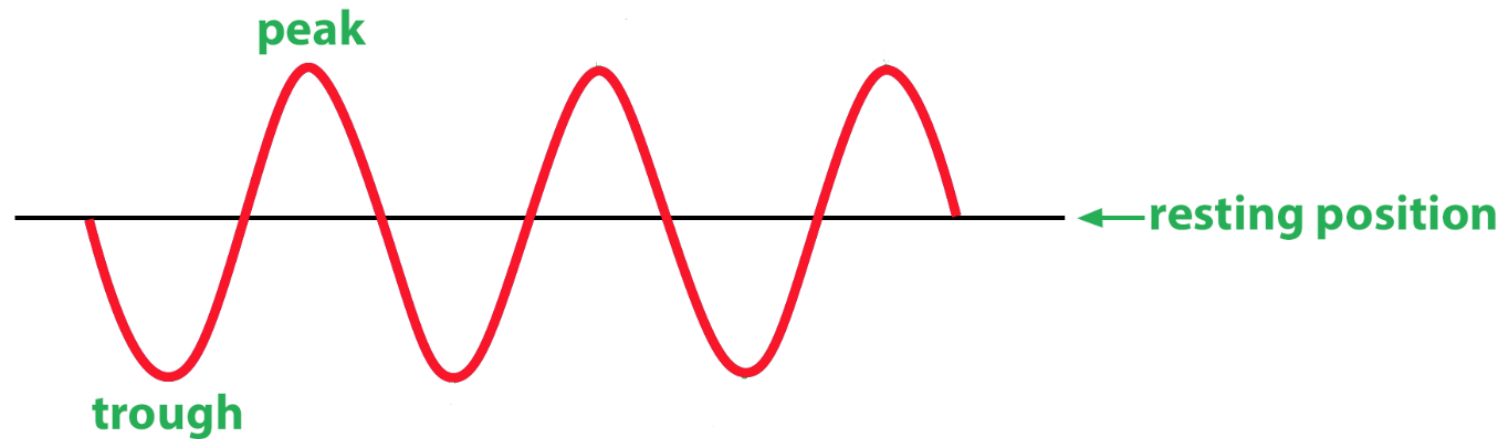
End of the 19th Century

- It was thought that all major problems in physics had been solved.
- That matter and energy were distinct
 - **Matter** was thought to consist of particles that had a measurable mass and easily specified position.
 - **Energy** in the form of light (electromagnetic radiation) was described as a wave that had no mass and its position could not be precisely defined.
 - There was no overlap in characteristics!

Is any of this true today?

Exercise 1

Identify the following terms on the transverse wave shown below:
amplitude and wavelength.



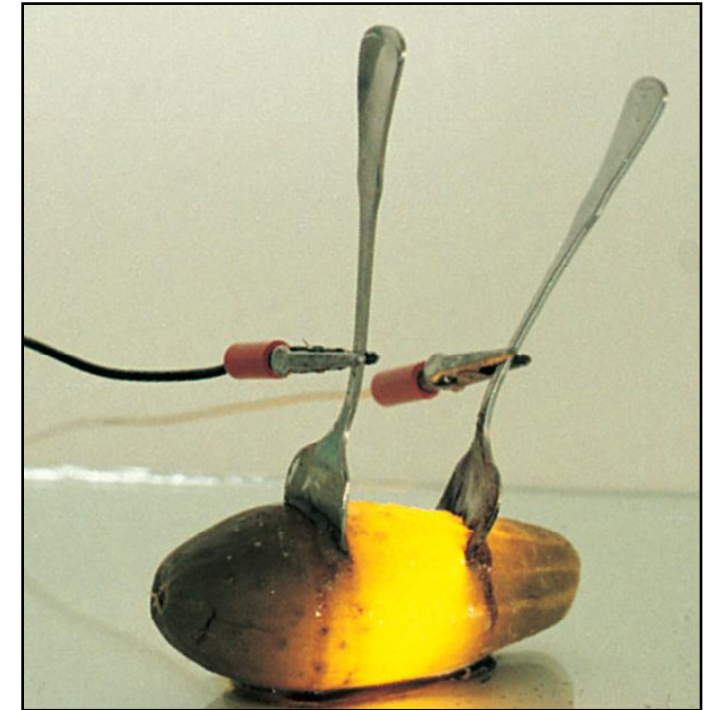
Exercise 2

The brilliant red colours seen in fireworks are due to the emission of light with wavelengths around 650 nm when strontium salts, such as $\text{Sr}(\text{NO}_3)_2$ and SrCO_3 , are heated. Calculate the **frequency** of red light of wavelength 6.50×10^2 nm.



Exercise 3

When an alternating current of 110 volts is applied to a pickle, a current is conducted due to the high concentration of NaCl present, resulting in a glowing light, an emission at 589 nm. Calculate the **frequency** of light at this wavelength.



Exercise 4

Streetlamps filled with mercury gas emit a blue light. Sodium lamps emit yellow light.

- a. Light from sodium has a wavelength of ~ 589 nm. If a mercury streetlamp has a frequency of $6.88 \times 10^{14} \text{ s}^{-1}$ (or Hz), what is its wavelength in nanometers?
- b. Does blue light correspond to a longer or shorter wavelength than yellow?