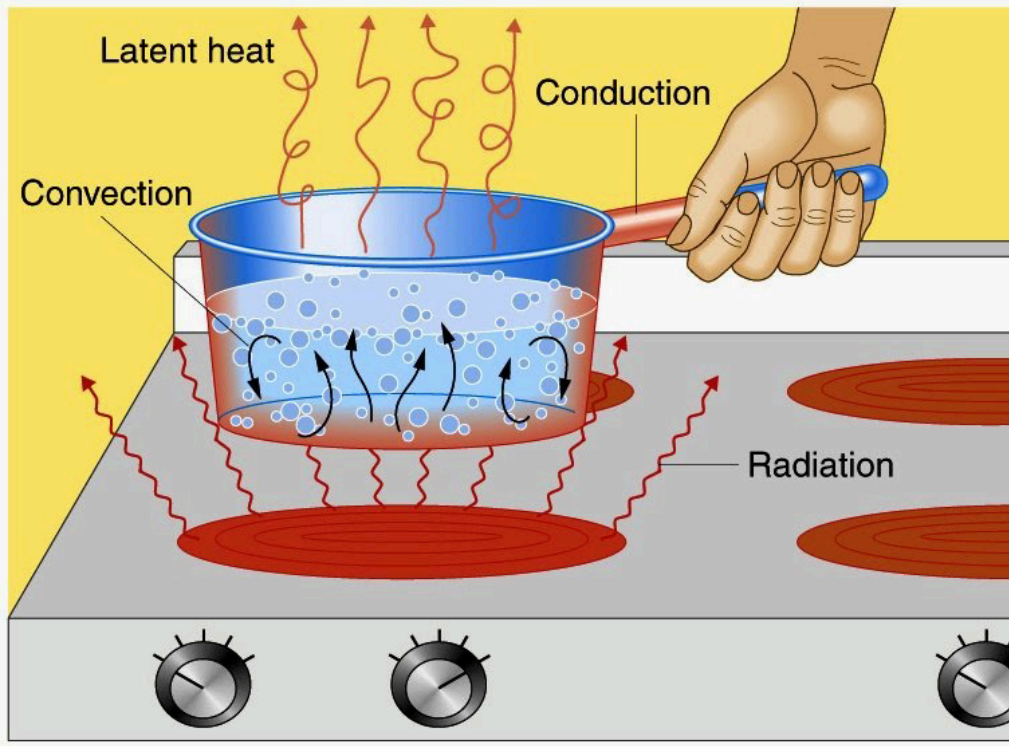
# Global Warming
# Lecture 3.1
# Electromagnetic Radiation

# Ways Energy can be moved

- **1. Convection**
  - Convection is when a fluid (either a liquid like water or a gas like the atmosphere) moves to carry heat from one place to another.
- **2. Conduction**
  - Conduction is when heat is moved through a material by its molecules jiggling together.

Difference between them?




Convection: both medium and heat “move” around on a human scale

Conduction: only heat “moves” around

# Ways Energy can be moved

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- **2. Conduction**
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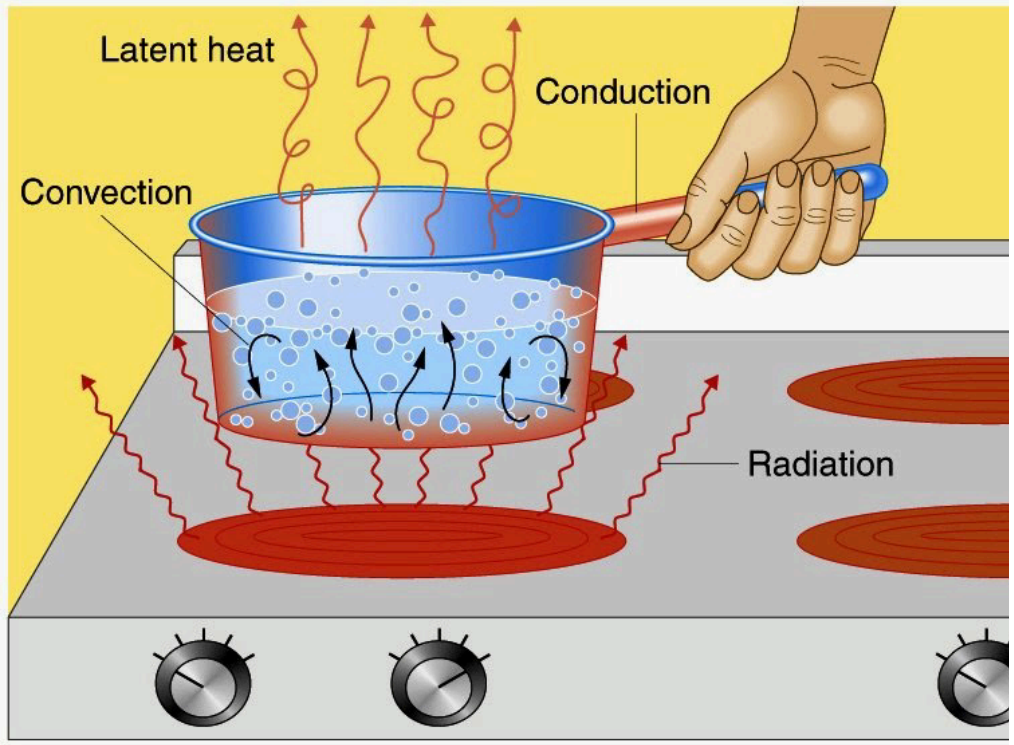
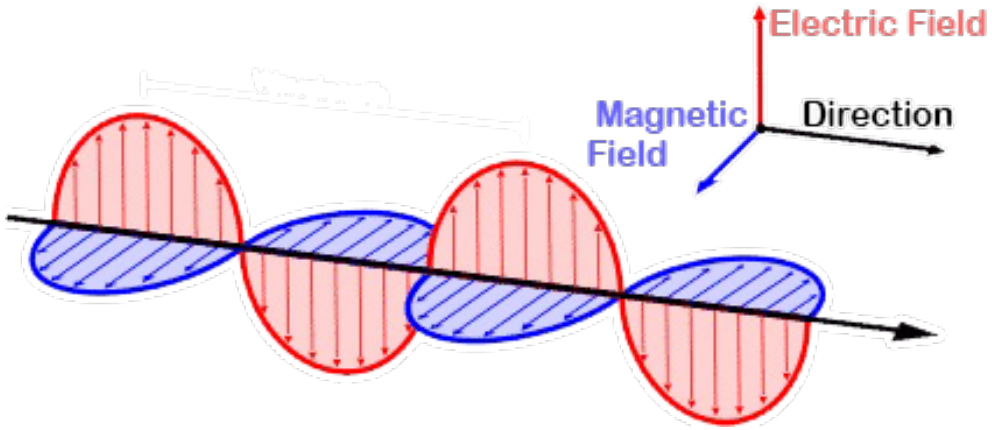
- **3. Latent heat**
  - phase change involves energy: e.g., evaporation takes energy and condensation releases energy
- **4. Electromagnetic radiation**



# Electromagnetic radiation

- Propagating oscillations (or waves) in electric and magnetic fields. (Waves carrying energy propagates)



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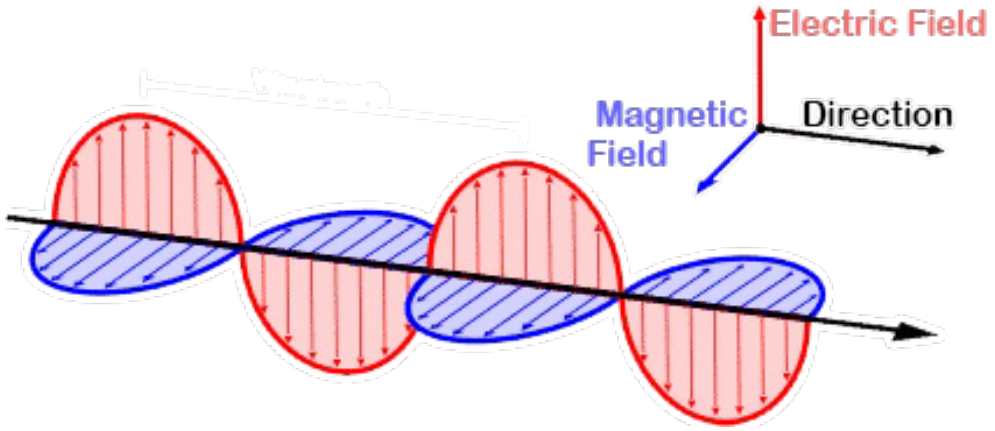
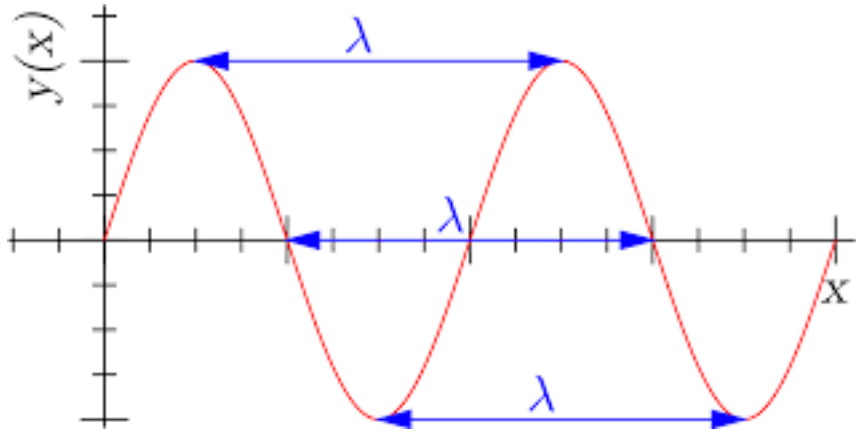



- Electromagnetic radiation has a frequency (v) and a wavelength (λ):
  - Wavelength (λ): The distance between two wave crests (or troughs)
  - Frequency (v) is number of wave crests that pass over the origin every second



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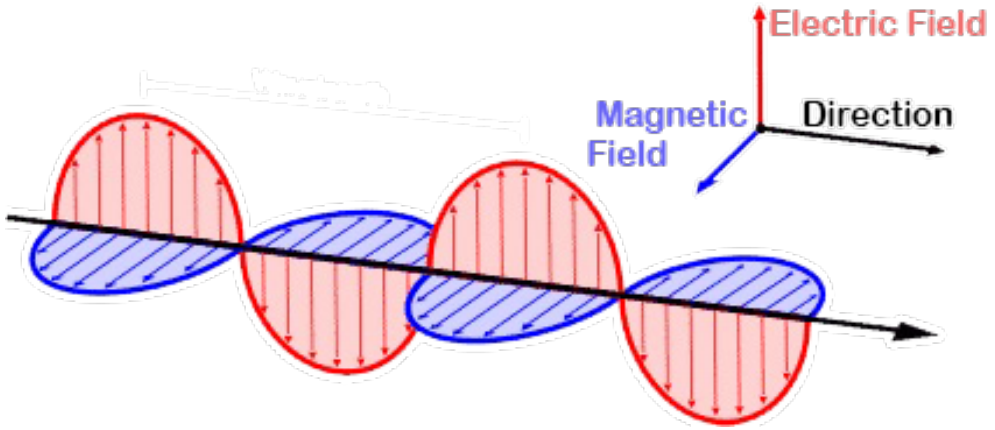


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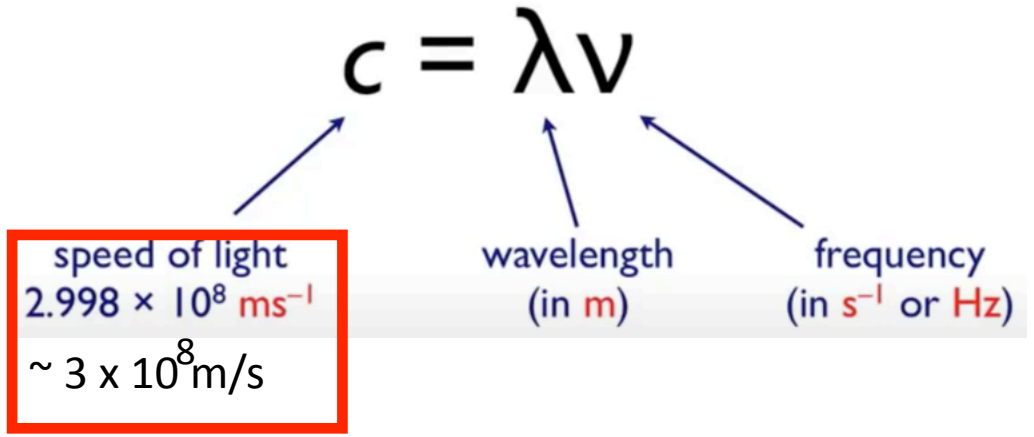
$$c = \lambda\nu$$

$$\nu = c/\lambda$$




constant for all wavelengths in vacuum!

**Units!**

**Example:**

Speed of light in a vacuum: $c = 3.0 \times 10^8\ m\ s^{-1}$ constant for all wavelengths!

$\nu \sim s^{-1}$

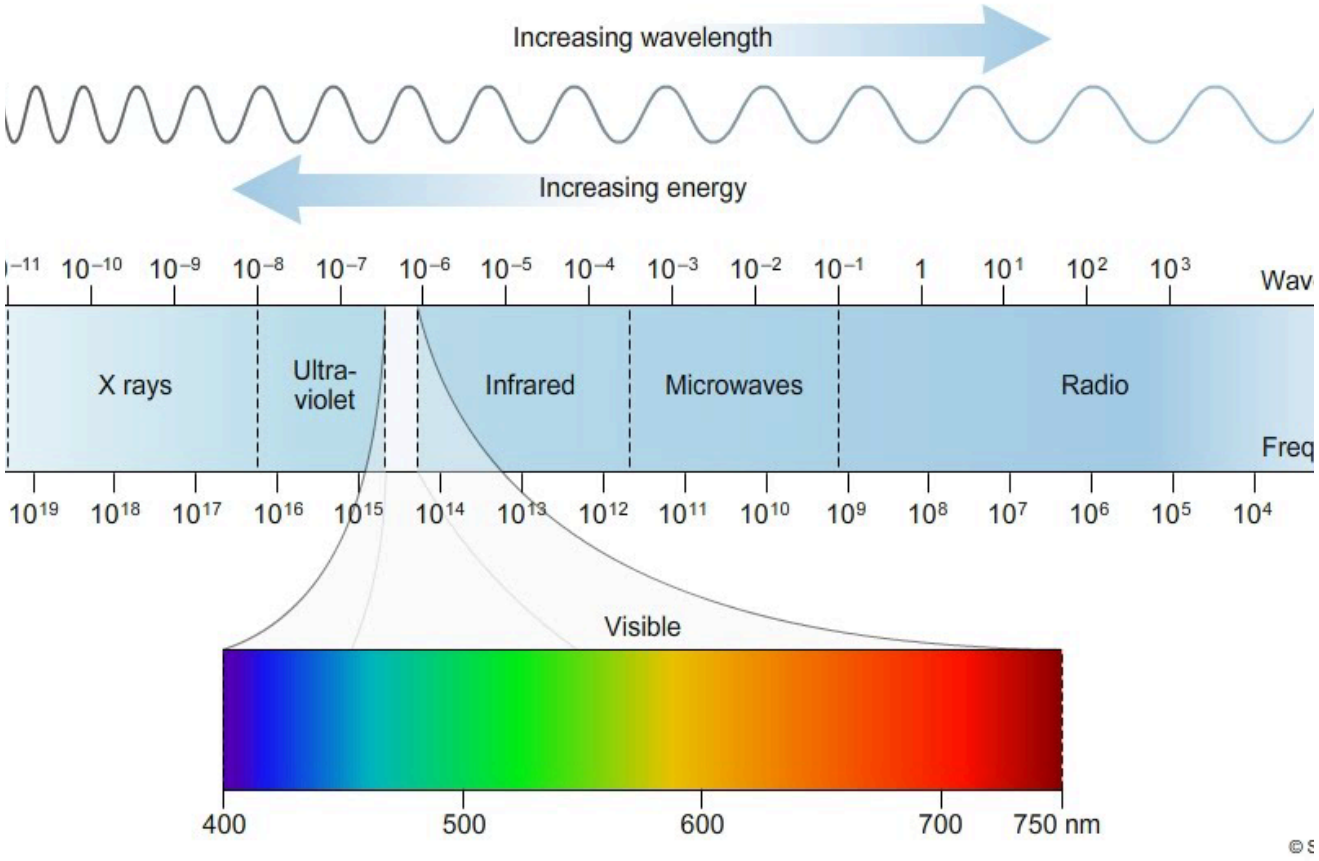
$$\lambda = \frac{c}{\nu}$$

Blue light has a frequency of $6.67 \times 10^{14}\ \mathrm{s}^{-1}$.
What wavelength does this correspond to (in nm)?

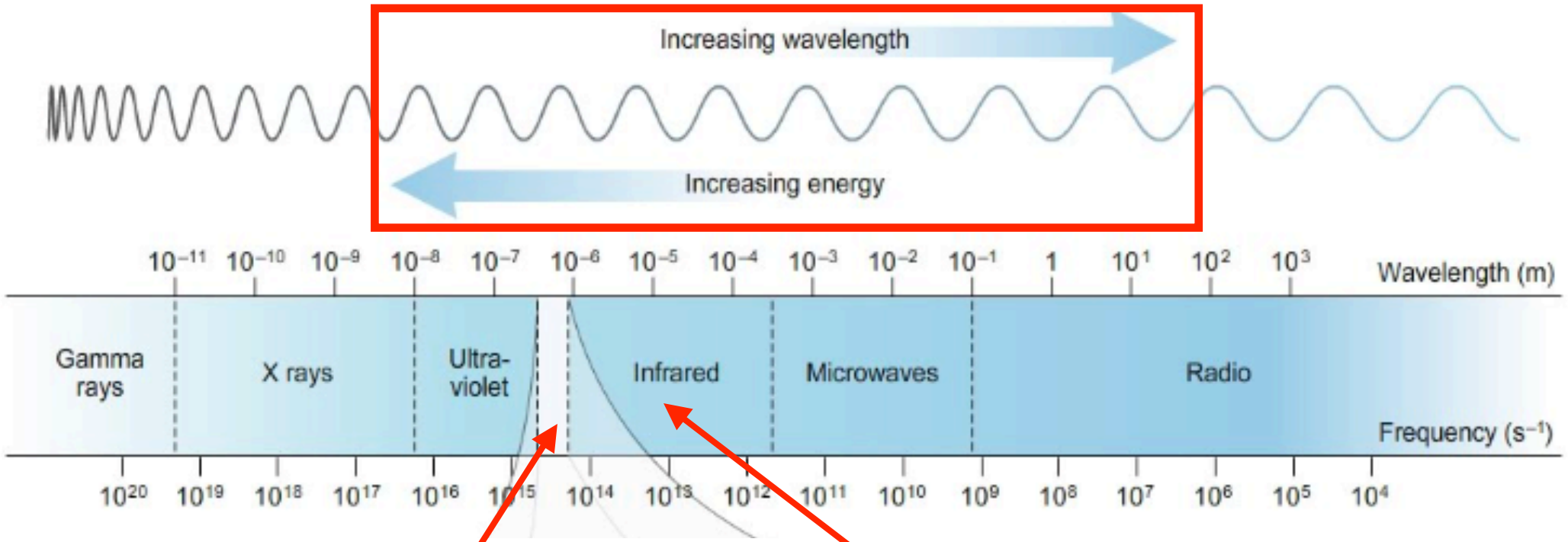
$$\left(\frac{\mathbf{3 \times 10^8\ m}}{\mathbf{1\ s}}\right) \times \left(\frac{1}{\mathbf{6.67 \times 10^{14}\ s^{-1}}}\right) \times \left(\frac{\mathbf{10^9\ nm}}{\mathbf{m}}\right) = \mathbf{450\ \ nm}$$

# EVERYTHING is emitting electromagnetic radiation! But with different types (different wavelength)

- Visible Light:
  - Wavelength: 400- 750nm
- Ultraviolet Radiation
  - Wavelength: 0 nm to 400 nm
- Infrared radiation:
  - Wavelength: 700 (nm) to 1 (mm).



# Longwave and shortwave radiation




Sun: shortwave radiation
visible and near infrared

Earth: longwave radiation
infrared

Radiation lab:

1. Human bodies
2. Classroom, computers
3. Glass