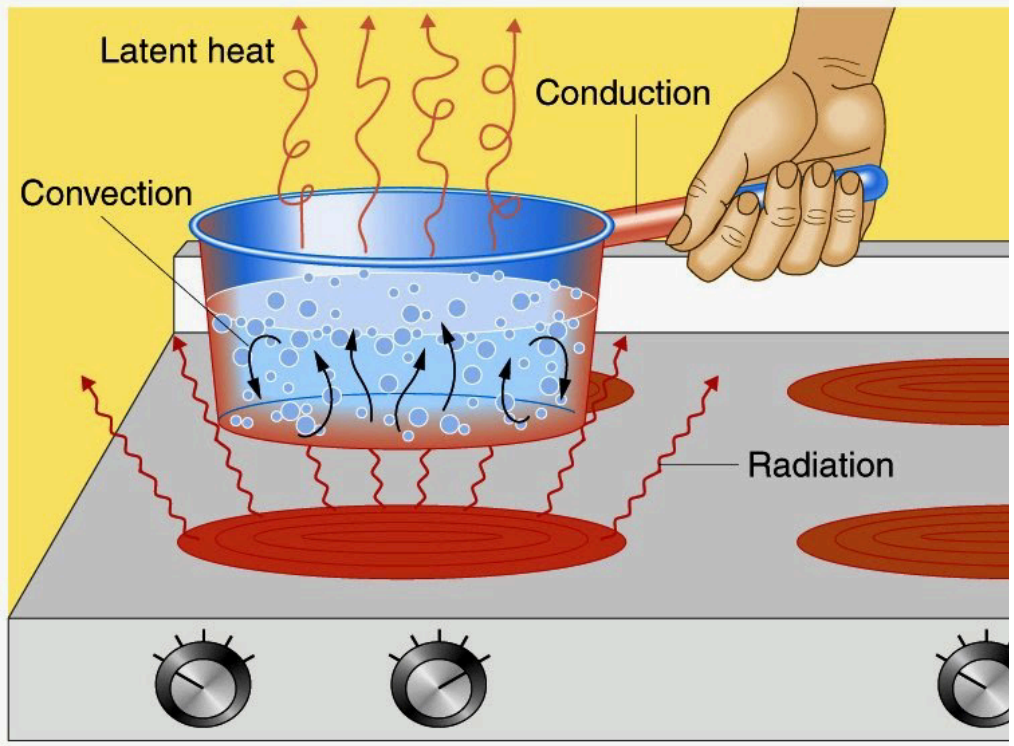
Global Warming
Lecture 3.1
Electromagnetic Radiation

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

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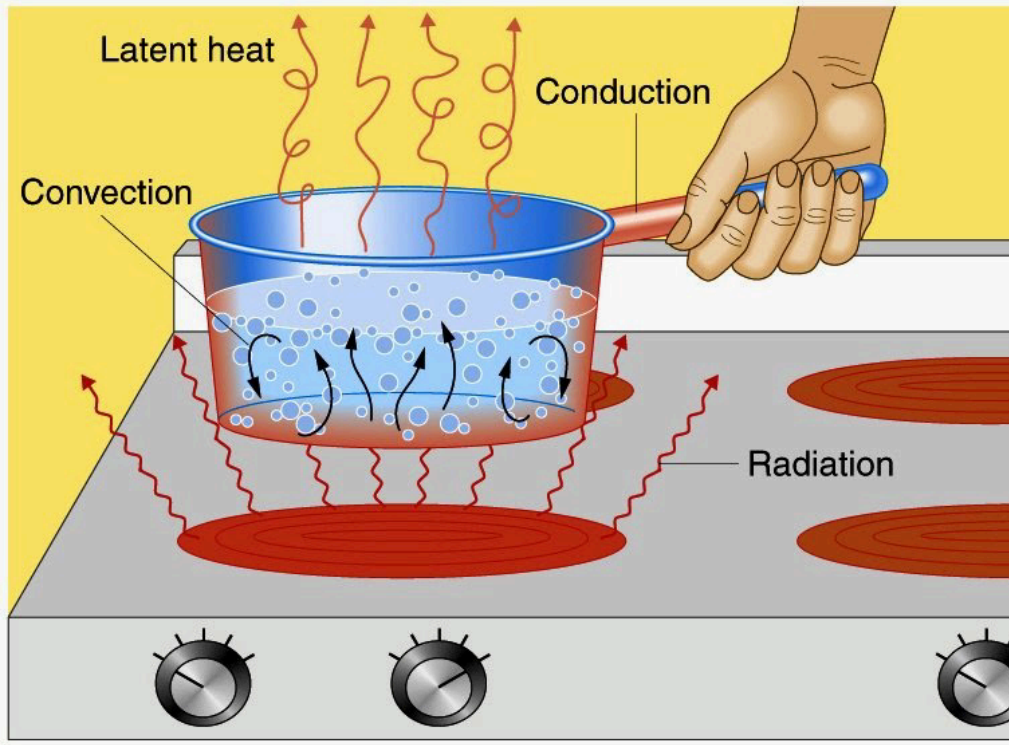
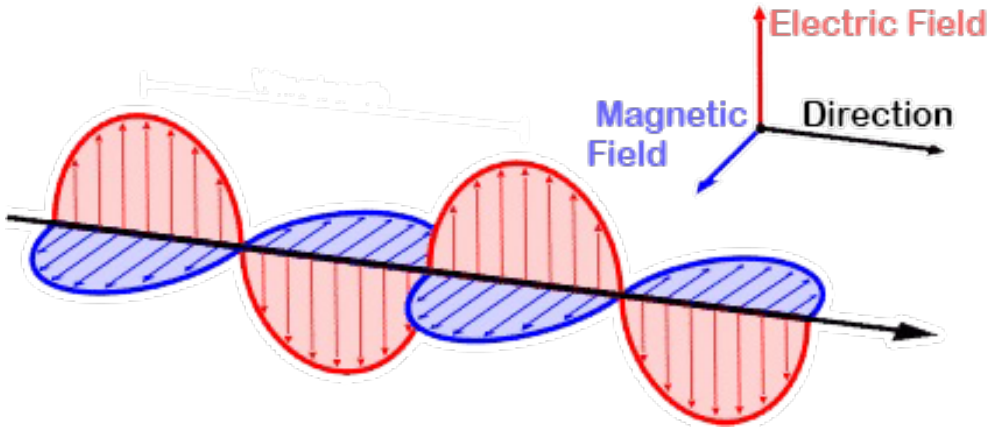
- **3. Latent heat**
  - phase change involves energy: e.g., evaporation takes energy and condensation releases energy
- **4. Electromagnetic radiation**



Electromagnetic radiation

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



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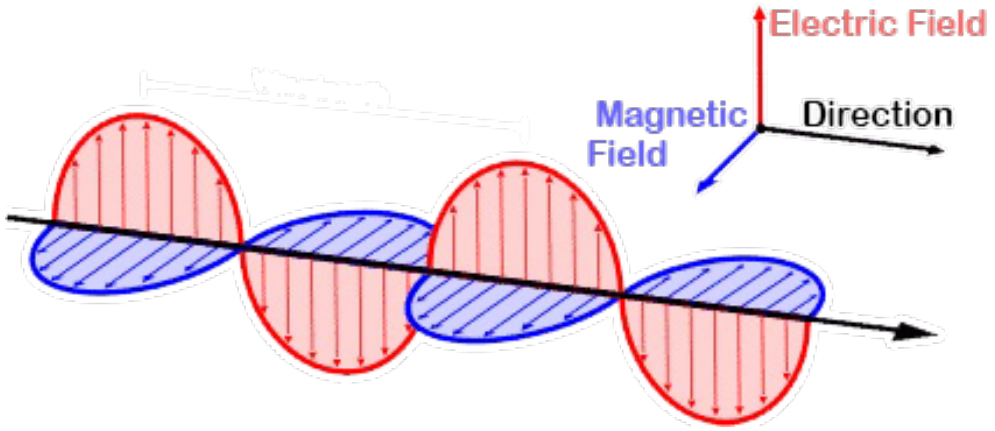
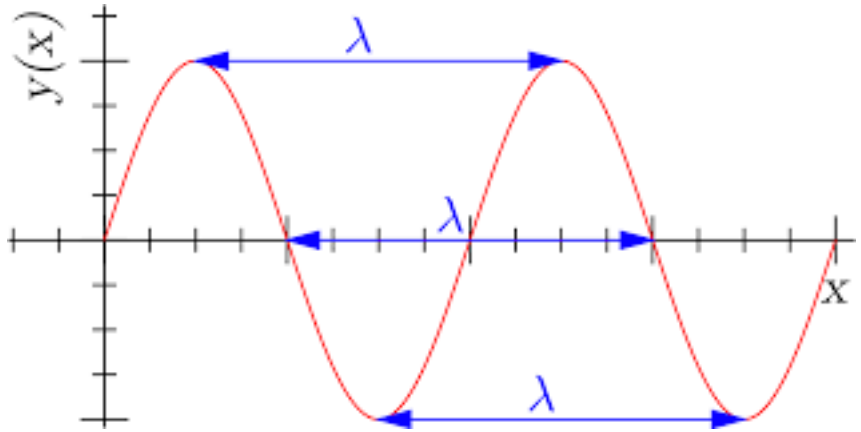


- Electromagnetic radiation has a frequency (v) and a wavelength (λ):
  - Wavelength (λ): The distance between two wave crests (or troughs)
  - Frequency (v) is number of wave crests that pass over the origin every second



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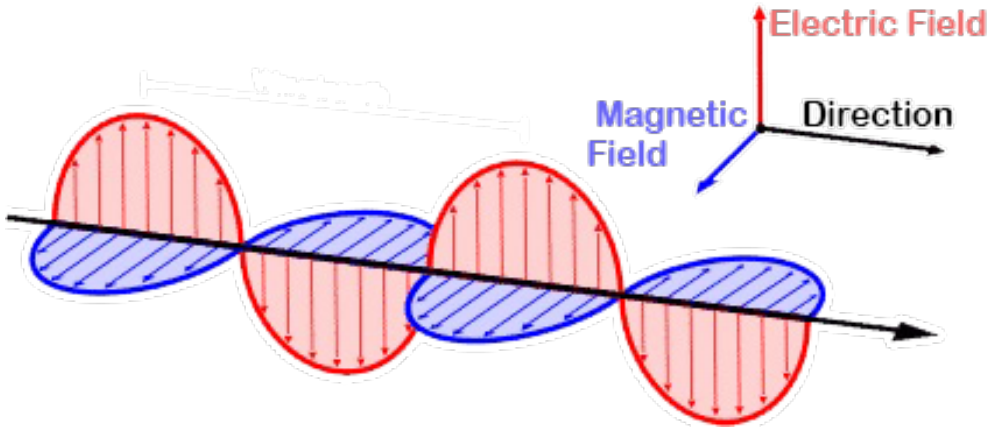

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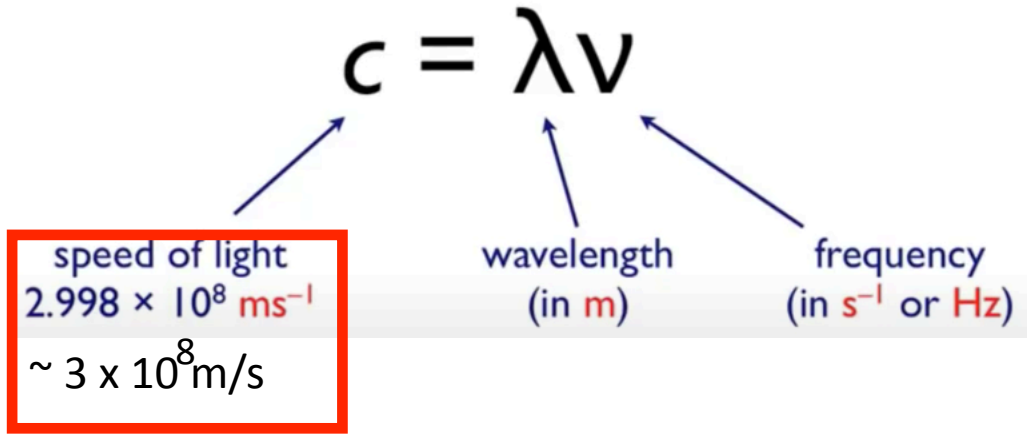
$$c = \lambda\nu$$

$$\nu = c/\lambda$$



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!

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

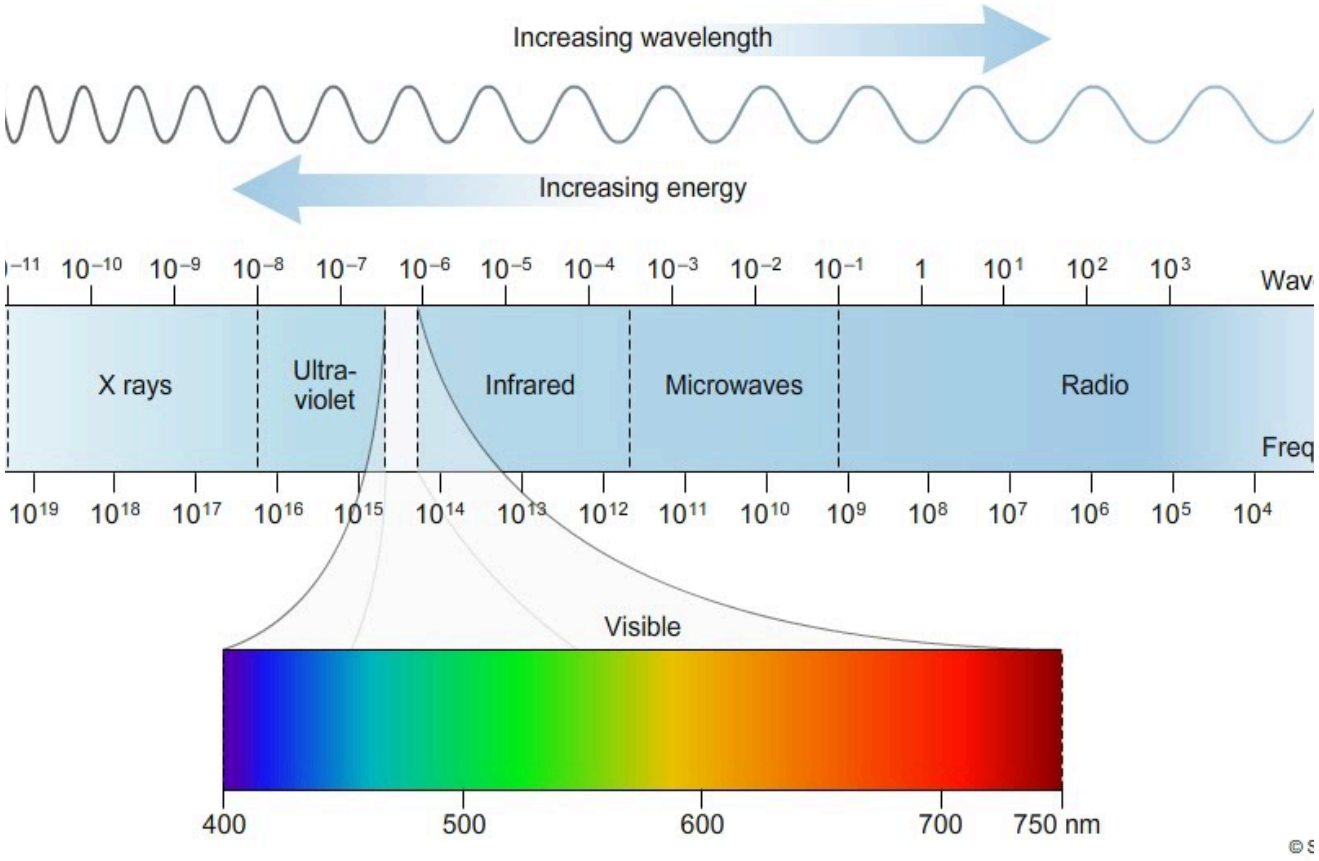
$$\lambda = \frac{c}{\nu}$$

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

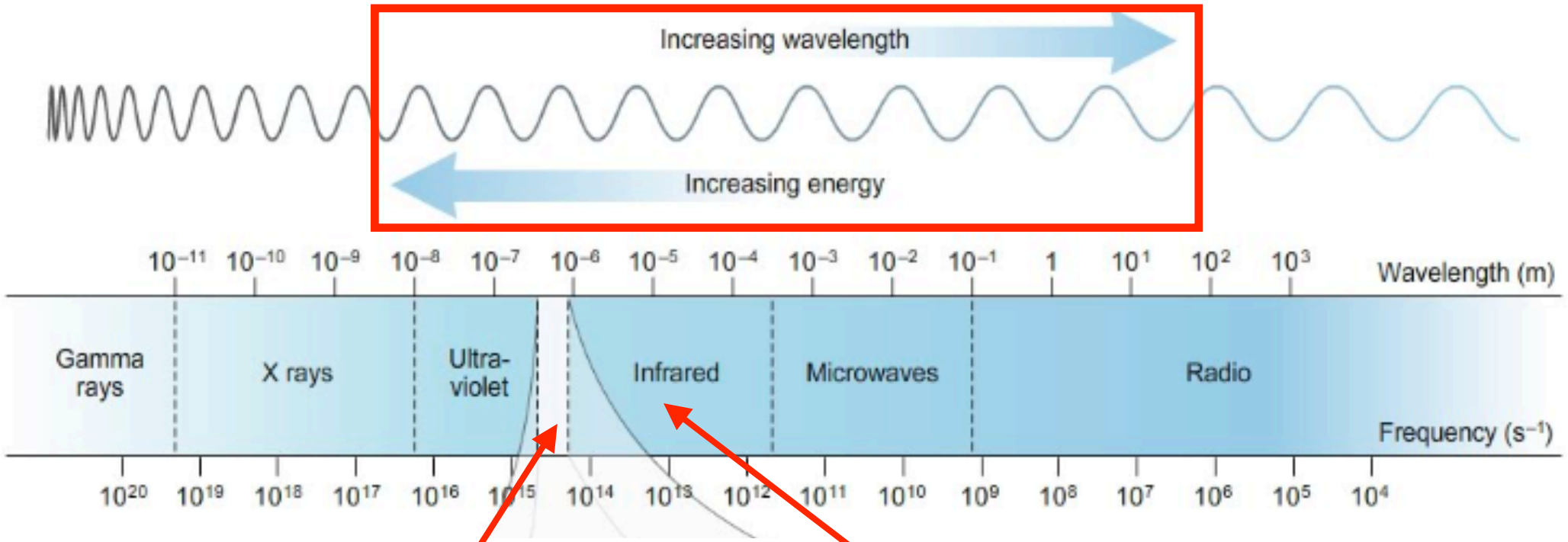
$$\left(\frac{\mathbf{3 \times 10^8\ m}}{\mathbf{1\ s}}\right) \times \left(\frac{1}{\mathbf{6.67 \times 10^{14}\ s^{-1}}}\right) \times \left(\frac{\mathbf{10^9\ nm}}{\mathbf{m}}\right) = \mathbf{450\ \ nm}$$

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

1. Let's think about the burner on top of a stove. When you turn it on high, it gets really hot. Once it gets hot, you can see red light coming from it, even if you do this at night with the lights turned off. If you turn the stove off, that light goes away. This red light must be coming from the burner, and it must only come from the burner when it is hot. Given that we can see a red color coming from hot burners, in what part of the spectrum are they emitting radiation?

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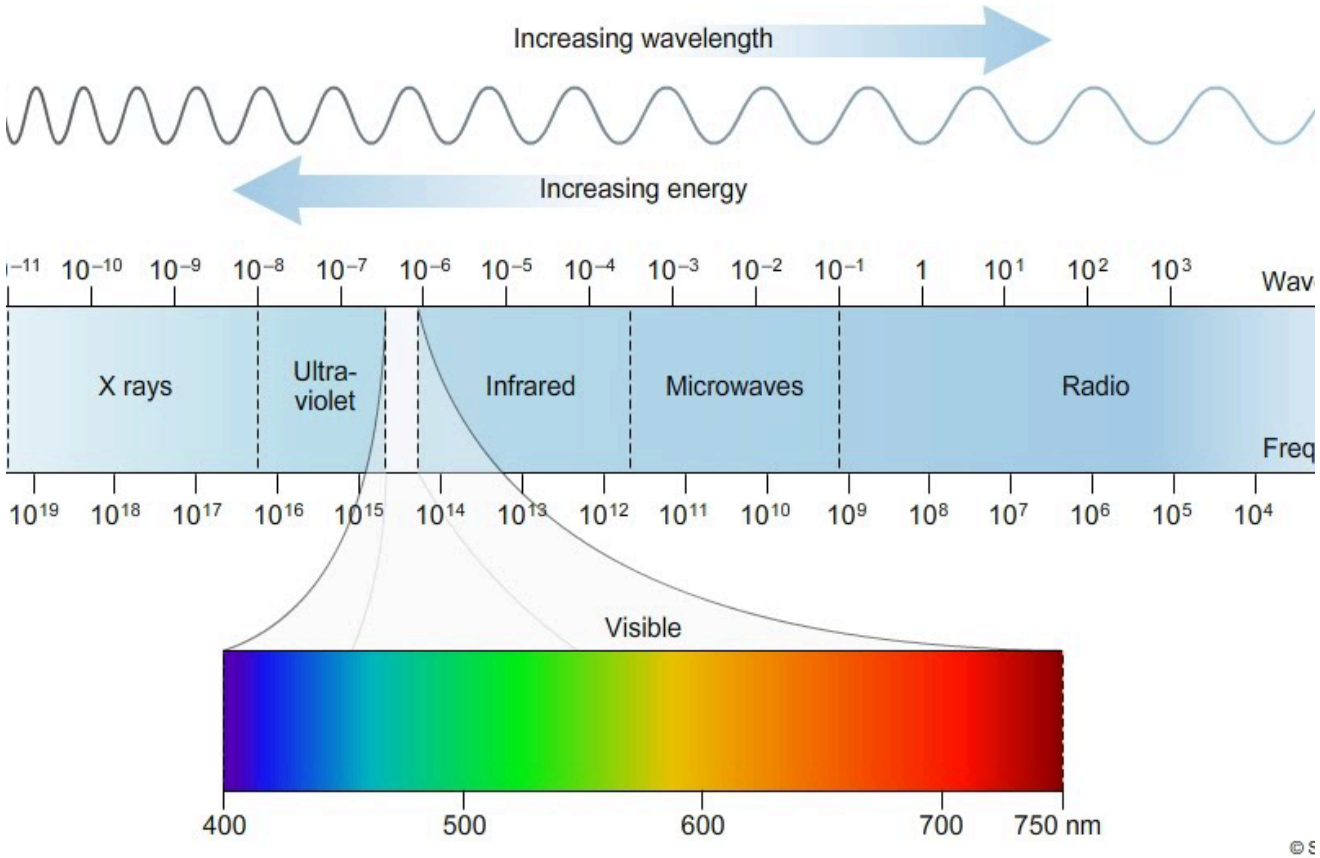

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2. If you touch the ground on a typical day, does it feel hotter or colder than the burner?

   colder

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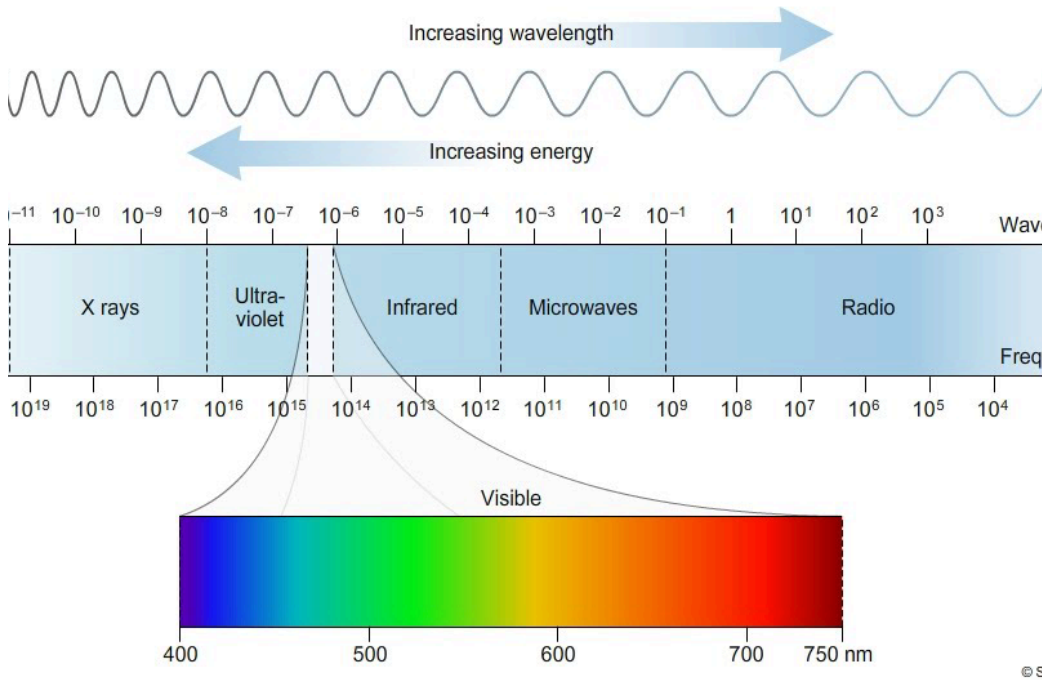
We can see visible electromagnetic radiation from the ground and from the burner. We already determined that the burner is directly emitting visible radiation. Since the ground is much colder than the burner, and temperature determines the wavelength something emits at, it can't be directly emitting the visible radiation that we see.



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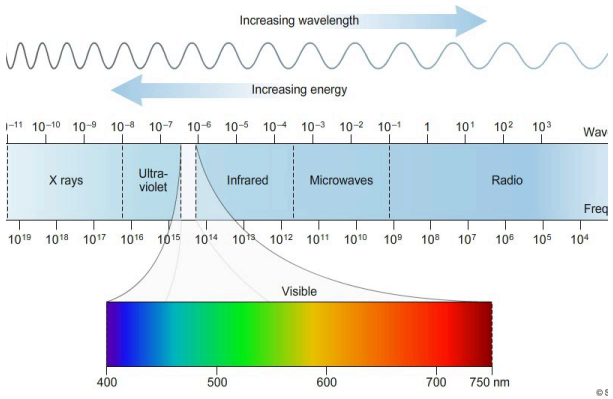

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We see the ground by the visible light from the Sun that reflects off of it.

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Distance /Speed Time

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   If it's cold outside, the walls should be colder than the floor and ceiling and the windows should be colder than the walls.

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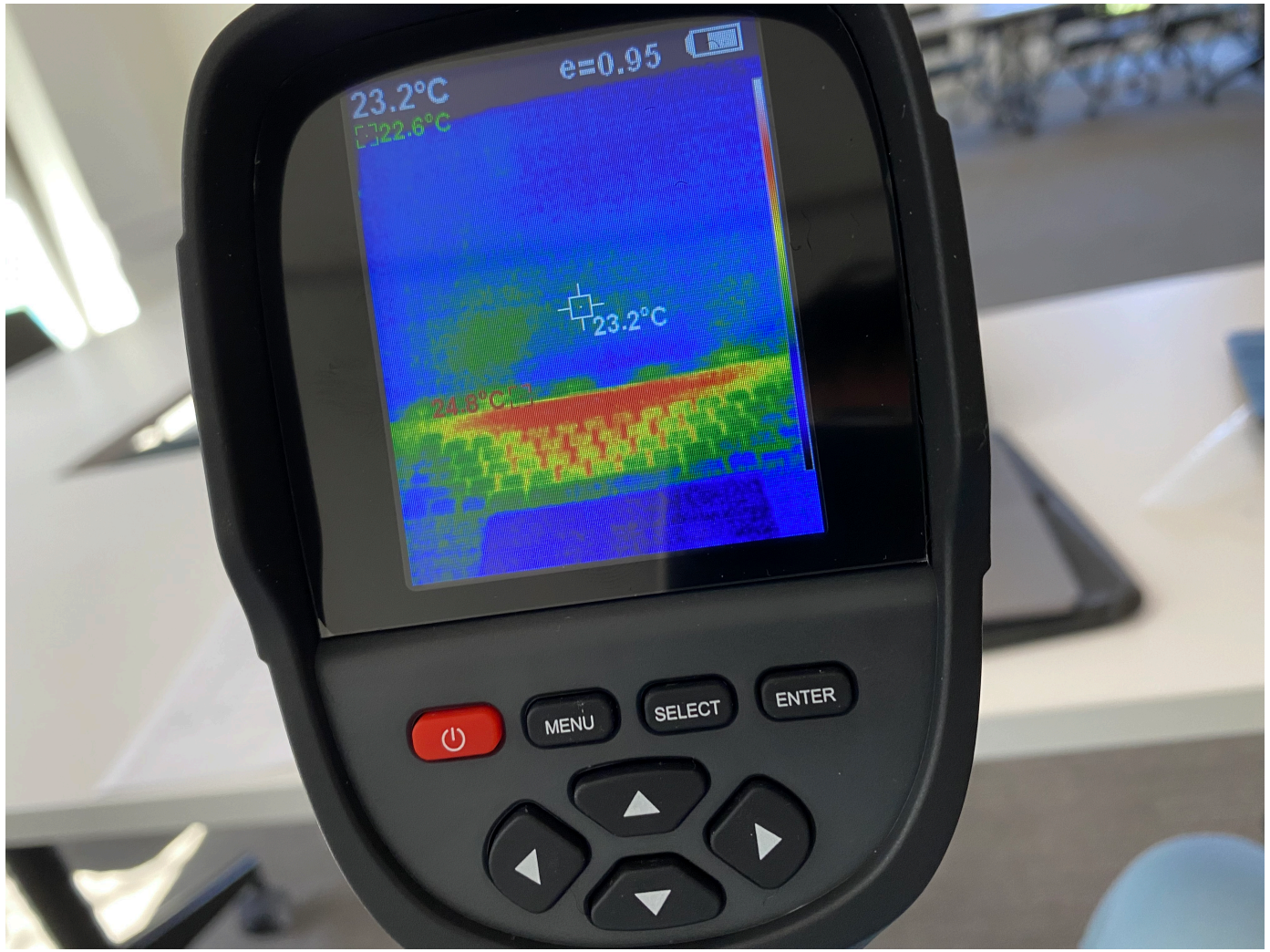
Computers that have been running should be pretty hot



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5. Pick up the piece of glass in your hand and look at it with the camera. We can see through glass so it lets visible light through it. Does glass let infrared light through it?

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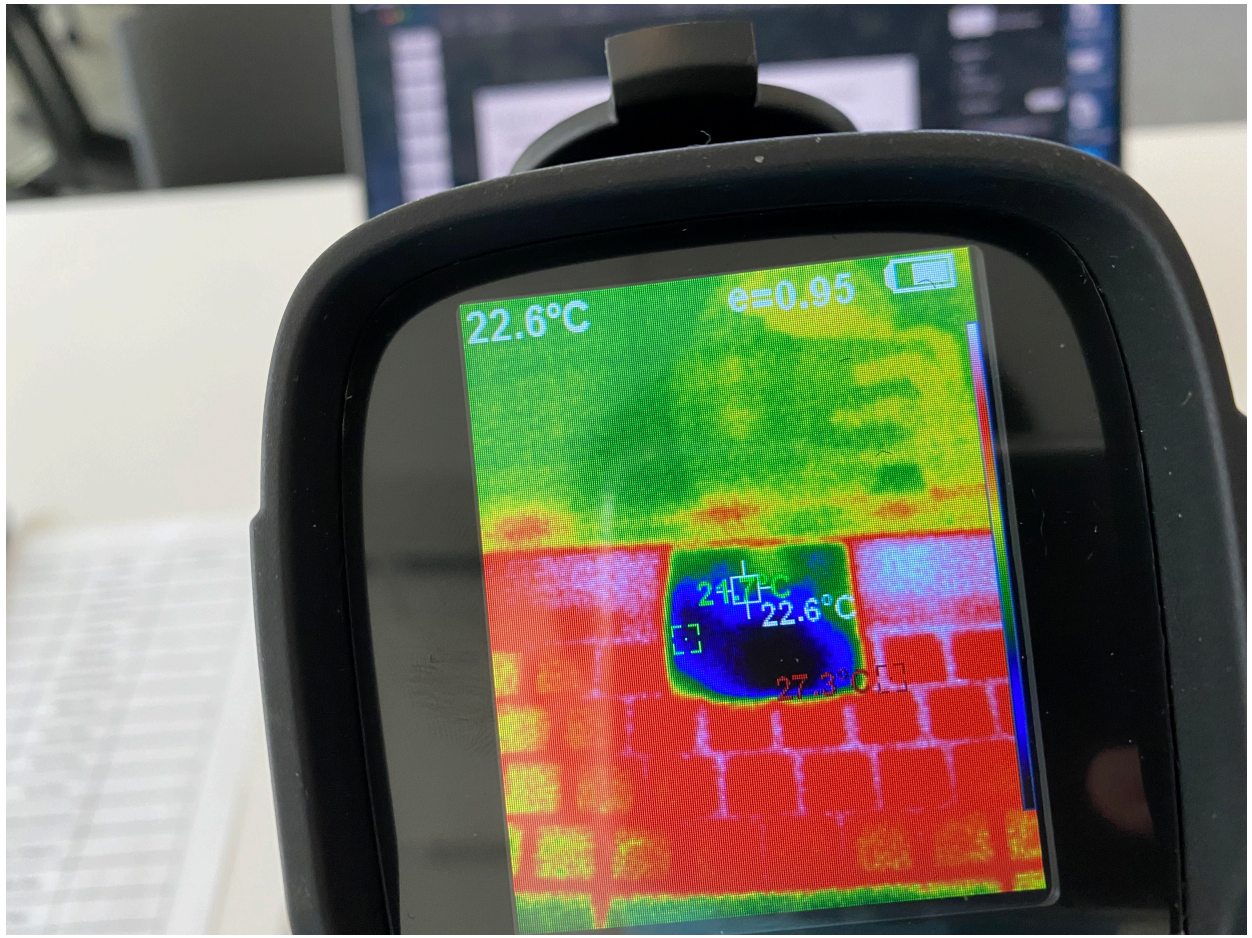

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6. Now put the piece of glass on a table in front of you. Use one hand to hold the camera and look at the piece of glass at an angle and put your other hand at a similar angle behind across from the glass. You should be able to position your free hand so that you see its reflection in the camera. What sort of household object is glass like in the infrared?

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