The Electromagnetic Spectrum

For our own convenience (and due to historical reasons), we usually divide all "light" – electromagnetic radiation – into several different wavelength bands according to their wavelength:

Gamma Rays

X-Rays

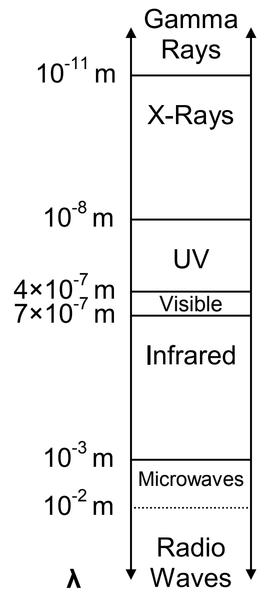
Ultraviolet

Visible Light

Infrared

Microwaves
(type of radio wave)

Radio Waves



In this exercise, each group will select a different wavelength band to "investigate". At the end of the period, each group will summarize their results to the class (the above space is if you wish to take notes during this last part; doing so is optional). Do all your numerical calculations *on the board*!

Write the name of your group's wavelength band down here: ________________________

1. What are the *minimum* and *maximum* wavelengths that this band is defined as? Use the units that are most appropriate for your answer (cm, mm, μm, or Å – *not meters!*). Do your conversion calculation explicitly on the board, and write the answers below.

λ_{min} = λ_{max} =

2. What are the minimum and maximum *frequencies*? (That is, how many wavelengths of your radiation, which travels at the speed of light, would pass through a given place in one second? $c = 3 \times 10^8$ m/s)

ν_{min} = ν_{max} =

Note: ν, used in astronomy to denote frequency, is the Greek letter 'nu' (not the English letter 'v').

3. *How many times* per second would you have to swing a magnet back and forth to produce a steady wave of this kind of radiation? How about a charged particle? [You don't have to explain this answer to the class.]

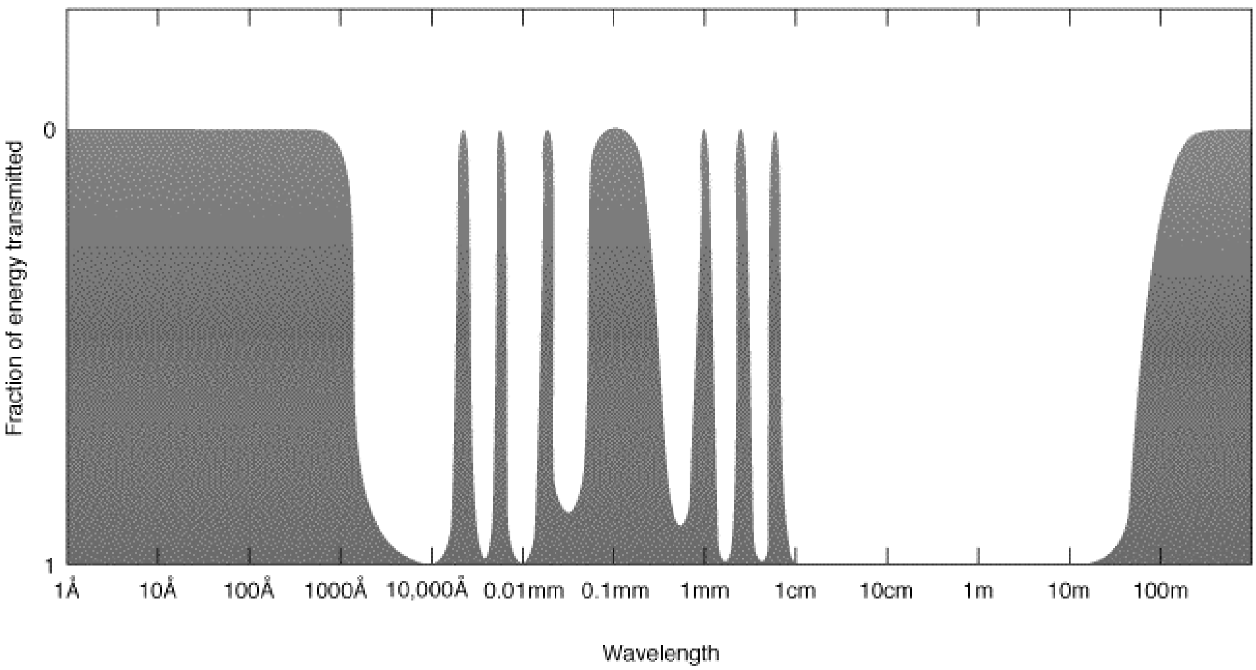
4. Name some things that generate electromagnetic waves in this band. (Feel free to ask your GSI for help for this question, especially if you have a "weird" band.)

5. List a few purposes that humans use this kind of radiation for here on Earth.

(**continued on back**)

Original worksheet by D. Perley

The below graph plots the fraction of energy (roughly) that is able to get through our atmosphere at each wavelength. In regions of the graph where the fraction transmitted is near zero, incoming radiation is almost all absorbed; where the fraction transmitted is near one incoming radiation can easily reach the surface. (The fraction transmitted is zero off the left and right sides of the graph.)



source: http://www.etsu.edu/physics/bsmith/fall03/images/f06.26.gif

6. Can electromagnetic radiation penetrate the atmosphere in your region of the spectrum? (If so, does the radiation get through across your entire waveband – or just a fraction of it?)

7. If an astronomer wants to make an observation of a celestial object in your waveband, can she use an Earth-based telescope? (If not, what's the alternative?)

8. As will be discussed in lecture, all objects emit electromagnetic waves by a process called "blackbody radiation". The majority of the energy is emitted around the peak wavelength λ_{peak}, which depends on temperature and is found via the formula:

$$\lambda_{peak} \times T = 2.9 \times 10^{-3} \text{ m} \cdot \text{K}$$

About what temperature range does an object have to be to emit most of its (thermal) radiation in your waveband?