

Green Houses

(a) Draw and annotate a figure detailing the greenhouse effect.

(b) The Moon is (to order of magnitude) the same distance from the Sun as Earth. Why is it so much colder?

(c) Try to think of a “representative temperature” for the Earth. Start with whatever units you feel comfortable with (e.g. Fahrenheit), then convert to Kelvin.

(d) Ruhee, your astrophysicist friend, uses her spectrometer to (somehow) measure the peak wavelength of the Earth’s thermal radiation. What wavelength does she measure?

(e) Explain the greenhouse effect for Earth once more; this time, incorporate the peak wavelength that you calculated. Use the below table as a reference if necessary.

Region	Sub-region	Frequency (Hz)	Wavelength	Energy (eV)
Radio wave		$< 10^9$	$> 0.3\text{m}$	$< 7*10^{-7}$
Microwave		$10^9 - 0.003*10^{14}$	0.3m - 1mm	$7*10^{-7} - 0.0012$
	<i>Far infrared</i>	$0.003*10^{14} - 0.2*10^{14}$	1mm - 20 μm	0.0012-0.08
	<i>Long-wave infrared</i>	$0.20*10^{14} - 0.37*10^{14}$	20 μm - 5 μm	0.08-0.15
Infrared	<i>Mid-wave infrared</i>	$0.37*10^{14} - 10^{14}$	5 μm - 3 μm	0.15-0.41
	<i>Shortwave infrared</i>	$10^{14} - 2.14*10^{14}$	3 μm - 1.1 μm	0.41-0.88
	<i>Near infrared</i>	$2.14*10^{14} - 4*10^{14}$	1.1 μm - 0.78 μm	0.88-1.6
	<i>Red</i>	$3.8*10^{14} - 4.8*10^{14}$	789nm - 625nm	1.6-1.9
	<i>Orange</i>	$4.8*10^{14} - 5*10^{14}$	625nm - 600nm	1.9-2.1
Visible	<i>Yellow</i>	$5*10^{14} - 5.2*10^{14}$	600nm - 577nm	2.1-2.2
	<i>Green</i>	$5.2*10^{14} - 6.1*10^{14}$	577nm - 491nm	2.2-2.4
	<i>Blue</i>	$6.1*10^{14} - 6.59*10^{14}$	491nm - 455nm	2.4-2.8
	<i>Violet</i>	$6.59*10^{14} - 8*10^{14}$	455nm - 390nm	2.8-3.1
Ultra Violet		$8*10^{14} - 2.4*10^{16}$	390nm - 8.82nm	3.1-20
X ray		$2.4*10^{16} - 5*10^{19}$	8.82nm - 6pm	$20 - 3*10^4$
Gamma ray		$> 5*10^{19}$	$< 6\text{pm}$	$> 3*10^4$

Tides/Waves

- (a) Draw and annotate a figure detailing the mechanism of the tides.
- (b) While exploring the lovely California beaches, your tour guide cautions against the dangers of tidal waves. Are they referring to tsunamis? What's the difference?
- (c) A **galactic tide** is experienced by a body in the vicinity of a galaxy such as the Milky Way. How would nearby satellite galaxies experience galactic tides from the Milky Way? Wouldn't our bodies respond in a similar manner?
- (d) The Oort Cloud is a supposedly loose collection of dust and gas surrounding the Solar System from which comets originate. How would the Oort Cloud respond to galactic tides from the Milky Way? What about galactic tides from Andromeda?
- (e) **Challenge:** Let's imagine that Earth has another Moon orbiting it — let's call it the Noom. The Noom is 3 times as far from Earth as the Moon, but it's massive enough that it exerts the same tidal force on the Earth as the Moon. How often would we see very large high tides on Earth, and how often would we see comparatively small high tides on Earth? Assume that the Moon and the Noom don't interfere with one another's orbit. For a more challenging challenge, consider the effect of the Sun.