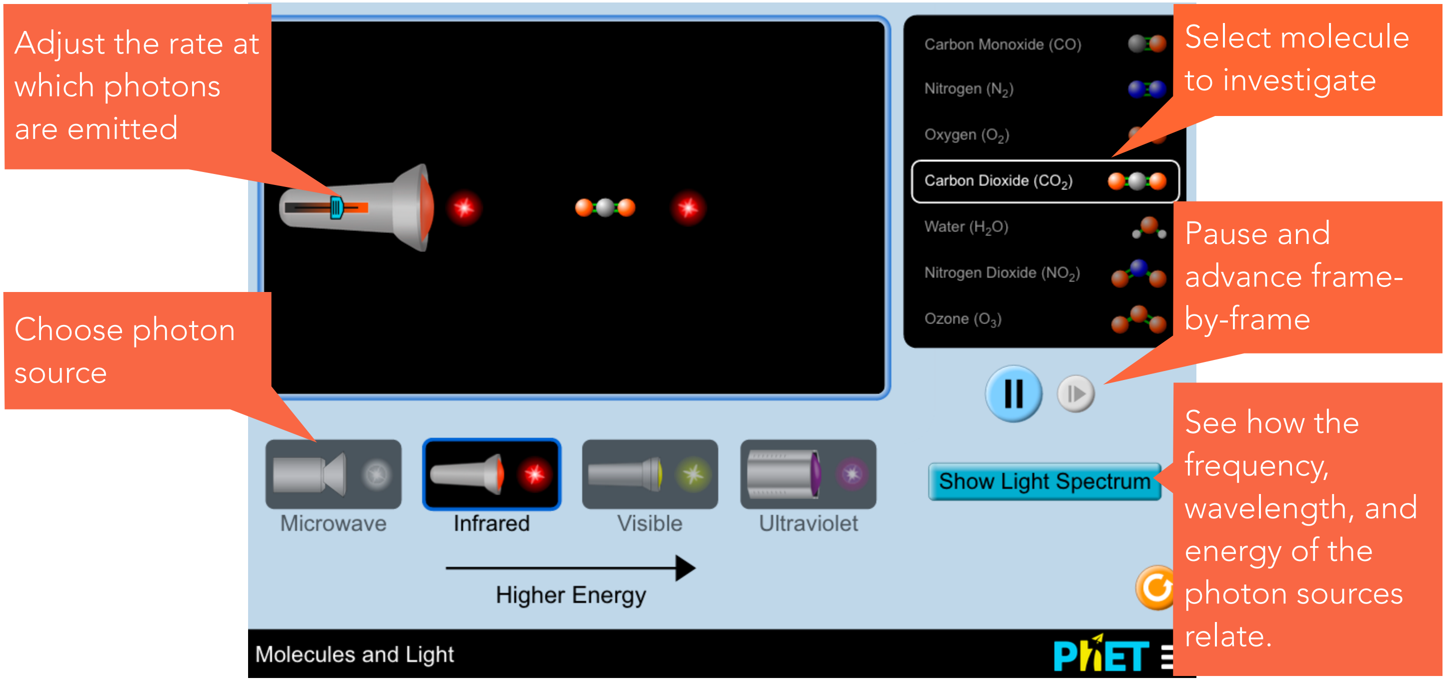
PhET Tips for Teachers

Molecules & Light

The ***Molecules and Light*** simulation explores how light interacts with molecules in our atmosphere.



Insights into Student Use

- Many students will systematically explore the sim without being given any direction (e.g. investigating how IR interacts with all molecules before moving onto the next photon source).
- The photons are not emitted from the source until you move the slider. Some students may not immediately find the slider, though many do.
- Words students used for photons in interviews included: light, energy, waves, rays, dots, beads, and particles of light (the word "photon" does not appear in the sim).
- Water prompted a couple of students to connect to what they already knew – microwaves heat up water, light is distorted in water, etc.
- When the light was not as intense (i.e. the rate of photons was slow) students were more likely to say that the molecules "take in" the photon, and not that the photon "bounces off" the molecule. Only two students used the word "absorb." Students may need more guidance to understand that photons do not collide with the molecule.
- A couple of students equated more motion with more energy, and thus thought microwave and infrared had more energy than visible. We added the light spectrum to reinforce the correct energy order.

Rouinfar, August 2015

Model Simplifications

- The sim only shows the basic absorption process for each class of radiation (e.g. IR = vibration). In reality, absorption of IR can excite rotations along with vibrations, and absorption of visible (denoted in the sim by the "glow") can excite vibrations and rotations.
- Each photon represents a range of energy, but not all absorptions in that range are shown. Some examples of what is not included: CO_2, H_2O, NO_2 and O_3 all have stretch vibrational modes in the IR, O_3 absorbs weakly in the visible, and absorption of visible light by NO_2 is dissociative at some wavelengths (blue or violet). The UV photon comes from the UV-B region (290-320 nm), which is the range absorbed by the earth's ozone layer; at shorter wavelengths the other molecules also absorb UV.
- Photodissociation often produces excited state products. In the case of O_3, the O_2 fragment would vibrate and/or emit a photon (in UV regions of high energy). The same is true for the NO fragment of NO_2. These are not shown in the sim.
- The sim randomly picks a single resonance structure for NO_2 and O_3 rather than showing delocalized bonds.
- For the case in which absorbance does occur, the probability is simply set to 50% so that students experience the idea that not every photon will be absorbed. In reality, the probabilities vary with wavelength and molecule identity.

Suggestions for Use

Connect to the real world: Ask students to use their observations to explain

- why a microwave oven heats up food
- which gases are considered greenhouse gases
- why the ozone layer is important
- which gases do not react with any of the radiation and why that might be important (e.g. O_2)

Predicting the reactivity of a new molecule: Provide students with a molecule not found in the sim such as HCN, CH_2O, NH_3, or CH_4 and ask students to predict how it will interact with the different types of radiation. It may be helpful to have students first explore the shape and polarity of this molecule using the Molecule Polarity simulation.

See all published activities for Molecules and Light here.
For more tips on using PhET sims with your students, see Tips for Using PhET.