EXPLORING INTERACTIONS OF MATTER WITH LIGHT

LEARNING GOALS

- Describe how a set of example molecules interacts with light of varying energy
- Identify characteristics of molecules that are associated with an interaction with light
- Construct a set of guidelines that generalize how molecules react with light of varying energy
- Apply these guidelines to predict the reactivity with light for any small molecule

PART 1: GETTING STARTED

- Download the Molecules and Light simulation: http://phet.colorado.edu/en/simulation/molecules-and-light

- **Explore** all of the controls in the simulation for about 5 minutes. Click on different things and figure out what each one does. Discuss with your partners and decide on a brief (1-2 sentences) summary of what the simulation does and shows.

The simulation shows the effects that certain types of light particles have on different types of molecules.

PART 2: "LIGHT" IN THE SIMULATION

Rank the electromagnetic radiation in the simulation in terms of energy, wavelength, and frequency.

- Energy

Microwave - lowest energy
Infared - low energy
Visible light - higher energy
Ultra-violet - highest energy

- Wavelength

Microwave - longest wavelength
Infrared - long wavelength
Visible light - shorter wavelength
Ultra-violet - shortest wavelength

- Frequency

Microwave - lowest frequency
Infrared - low frequency
Visible light - higher frequency
Ultra-violet - highest frequency

PART 3: INTERACTION OF LIGHT AND MATTER

- Examine how different photons in the simulation affect each molecule. Record your observations for each combination in a few descriptive words.

	Microwave	Infrared	Visible Light	Ultraviolet
CO	Particles bounce off and jumbles	Particles bounce off	Does not affect CO matter	Does not affect CO matter

	matter			
N_2	Does not affect Nitrogen Matter	Does not affect Nitrogen Matter	Does not affect Nitrogen Matter	Does not affect Nitrogen Matter
O_2	Does not affect Oxygen Matter	Does not affect Oxygen Matter	Does not affect Oxygen Matter	Does not affect Oxygen Matter
CO_2	Does not affect Carbon Dioxide Matter	Particles bounce off frequently	Does not affect Carbon Dioxide Matter	Does not affect Carbon Dioxide Matter
H_2O	Particles bounce off and jumbles matter	Particles bounce off frequently	Does not affect Water Matter	Does not affect Water Matter
NO_2	Particles bounce off semi-frequently and jumbles matter	Particles randomly bounce off	Particles highlght the molecule and bounce off	Particles break apart molecules
O_3	Particles bounce off and jumbles matter	Particles bounce off	Does not affect Ozone Matter	Particles break apart molecules

- Which molecule(s) were **not** affected by **any** of the radiation in the sim? **Why** might this be important? (Hint: think about what molecules are commonly found in our air and atmosphere)

Nitrogen and Oxygen were found to no be affected in any way by any radiation, which makes sense because these types of molecules are what makes up most of Earth's atmosphere.

- Examine your observations above and summarize the effects of each kind of radiation on the molecules in the simulation.

	Microwave	Infrared	Visible Light	Ultraviolet
Effect(s) on Molecules	Particles jumble molecules while also frequently bouncing off the molecule	Particles bounce off molecules frequently	Doesn't afffect molecules	Doesn't affect molecules or breaks them apart

PART 4. MOLECULES IN THE SIMULATION

The interaction of light with a molecule depends on characteristics of the molecule. The presence of nonbonding lone-pair electrons or bond dipoles are two examples. Identify at least 2 more characteristics.

Another characteristic is conjugation, with a higher conjugation meaning a

greater shift in the electromagnetic spectrum. Intermolecular bonds also enhance this effect.

PART 5: GENERALIZED OBSERVATIONS

Return to your earlier classification and try to identify molecular characteristics associated with a particular interaction with electromagnetic radiation.

Type of Radiation	Which Molecules were affected? Hint: Drawing Lewis structures may help.	General Rule to Predict Activity
Microwave	• Carbon Monoxide • Dihydrogen Monoxide • Nitrogen Dioxide • Ozone	
Infrared	• Carbon Monoxide • Carbon Dioxide • Dihydrogen Monoxide • Nitrogen Dioxide • Ozone	
Visible	• Nitrogen Dioxide	
Ultraviolet	• Nitrogen Dioxide • Ozone	