Science Objectives

- Students will study the relationship between wavelength, frequency, and color.
- Students will calculate wavelengths and frequencies.
- Students will calculate the energy of electromagnetic radiation using Planck's constant.
- Students will study the energy changes as electrons change energy levels in an atom.
- Students will learn about the Balmer, Paschen, and Lyman series.
- Students will calculate the energy change that an electron undergoes when changing energy levels using the.

Vocabulary

- Balmer series
- electromagnetic radiation
- frequency
- Lyman series
- Paschen series
- photons
- Planck's constant
- Rydberg constant
- speed of light
- visible spectrum
- wavelength

About the Lesson

- This lesson involves the relationship between waves and electron energy jumps within the atom.
- As a result, students will:
  - Study the relationship between wavelength, frequency, and color.

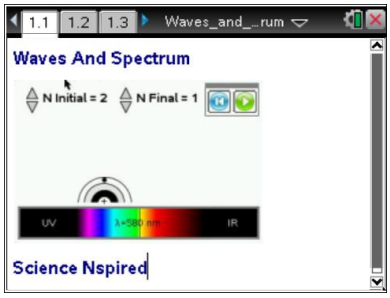
Study the energy changes as electrons change energy levels in an atom.

TI-Nspire™ Navigator™

- Send out the *What_Makes_an_Animal.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Waves_and_Spectrum_Student.doc
- Waves_and_Spectrum_Student.pdf

TI-Nspire document

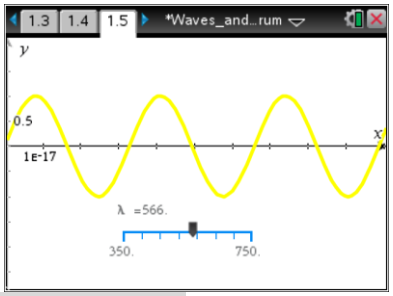
- Waves_and_Spectrum.tns

Discussion Points and Possible Answers

Have students read the background information on pages 1.2 - 1.4 of the .tns file.

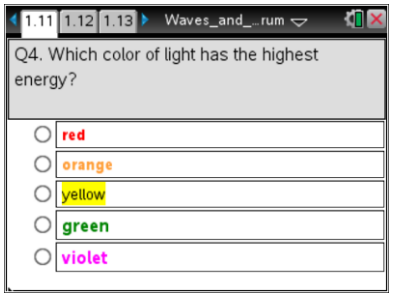
Move to page 1.5.

1. Have students grab and drag the slider to change the wavelength of the electromagnetic wave. As the wavelength changes, the waveform changes color to show the corresponding color of light.



Tech Tip: Students can grab and drag the slider to adjust the wavelength. The slider may lag behind their finger as they drag it.

Move to pages 1.6 - 1.14. Have students answer questions 1 - 7 on the .tns file and/or on their student activity sheets.



Q1. Which wavelength of light has the highest frequency?
Answer: violet

Q2. Calculate the frequency of light with a wavelength of 400nm.
Answer: 7.49 x10^{14}/s

Q3. Calculate the wavelength of light in nm if the frequency is 1.5 x10^{18} Hz.
Answer: 2.0x10^{-1} nm

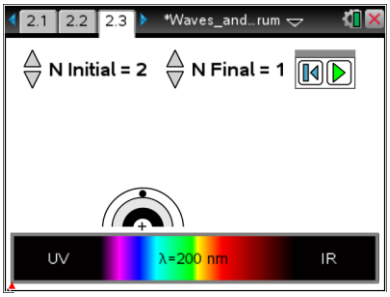
Q4. Which color of light has the highest energy?
Answer: violet

Q5. Calculate the energy for red light with a frequency of 4.15 x1014 Hz.
Answer: 2.75 x 10-19 J

Q6. How much energy is released from a photon with a wavelength of 555 nm?
Answer: 3.58 x 10-19 J

Q7. What is the frequency of a photon that releases 4.00x10^{-21} J?
Answer: 6.04 x10^{12} Hz

Move to pages 2.1 - 2.4.



2. Have students read the background information on pages 2.1 - 2.2. On page 2.3, **N Initial** is the initial energy level where the electron starts, and **N Final** is the energy level where the electron lands.
3. Have students set **N Initial** to 10 using the up/down arrows. They can select the Play button to start the animation.
4. Have students select the Reset button to reset the simulation and repeat step 2 for all values of **N Initial** from 9 to 2.
5. Change **N Final** to 2, and repeat steps 3 and 4 for all values of **N Initial**.
6. Continue to increase the value of **N Final** and repeat step 5,to see each of the electron drops. Note: wavelengths within the range of 200 nm to 950 nm will appear. Visible light wavelengths range from about 400 nm to 700 nm. All wavelengths and transitions will appear in the spreadsheet on page 2.4.

Move to pages 2.5 - 2.9. Answer questions 8 - 10 on the .tns file and/or below.

Q8. What electron movements produce visible light?

Sample Answers: Suggested responses: 3-2, 4-2, 5-2, 6-2

Q9. Calculate the energy for the 4 wavelengths of light generated in the graph which is known as the Balmer series.

Sample Answers: Suggested responses: 3.03×10^{-19}J, 4.09×10^{-19}J, 4.58×10^{-19} J, 4.84×10^{-19} J

Q10. Calculate the ΔE for an electron moving from the n=4 to n=3.

Answer: 1.06×10^{-19} J

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate energy changes for the Balmer, Paschen, and Lyman series. Throughout the lab, discuss the activity with students using Slide Show. At the end of the lab, collect the .tns files and save to Portfolio.

Wrap Up

When students are finished with the activity, collect the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions by opening it in Review Workspace.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is collected. The Review Workspace will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.