<table>
<tr><td>Title</td><td colspan="5">Multiwavelength Astronomy Science Unit – Gamma Ray Science</td></tr>
<tr><td>Dates/Affiliated Unit</td><td colspan="5">250 minutes (set below as five 50 minute class periods) toward the end of a physics Electromagnetic Spectrum Unit</td></tr>
<tr><td>Student Prerequisites</td><td colspan="5">Understanding of photons, the Electromagnetic Spectrum, some knowledge of optics, relationship between frequency, wavelength, understanding of astronomical terms, e.g., neutron star, supernova, galactic nuclei</td></tr>
<tr><td>AAAS Project 2061</td><td colspan="5">1A/H1 Science is based on the assumption that the universe is a vast single system in which the basic rules are everywhere the same and that the things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study.</td></tr>
<tr><td>NSES</td><td colspan="5">INTERACTIONS OF ENERGY AND MATTER: Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.</td></tr>
<tr><td>Core Standards</td><td colspan="5">RST.11-12.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</td></tr>
<tr><td>Next Gen Standards</td><td colspan="5">HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy</td></tr>
<tr><td>Resources Needed</td><td colspan="5">Computer Lab or Laptop Cart for one of the Lab Days</td></tr>
<tr><td colspan="6">Module Schedule</td></tr>
<tr><td>Daily Objectives</td><td>Students will define gamma-ray bursts, recall the science of GRB and GRB dection</td><td>Students will synthesize a search for their passion and relate it to Deiter Hartmann’s journey</td><td colspan="2">Students with recall the concepts of EM spectrum and photons to apply to the search for GRBs Alternative lab is Hewett’s “Shine a Light”</td><td>Student will demonstrate mastery of module content</td></tr>
<tr><td>Daily Agenda</td><td>Reading Quiz and discussion of the material from the Web</td><td>Write “Your journey” paragraph
Peer editing</td><td>Lab: Day I</td><td>Lab: Day II</td><td>Demo over transparency/opacity?
Quiz over the science of Gamma Ray Astronomy</td></tr>
<tr><td>Grading</td><td>Quiz graded for correctness;
OR
Guide graded for completeness</td><td>Paragraph graded following rubric</td><td colspan="2">Lab graded for completeness, properly recorded data, thoroughly answered questions</td><td>Graded for correctness</td></tr>
</table>

Name____ Period ________ Date _________________

Reading Quiz (or reading guide)

1) What was Deiter Hartmann paid to do before he became an astronomer?
2) What is another name for an astronomer who looks at the very high-energy universe?
3) Complete the table below:

Band	Typical Wavelength	Approximate Size
Radio	1-100 m	Person, mountain
Microwaves		
	1 mm	
		Pinpoints
Visible Light		
		Molecules
	1 nm	
Gamma Ray		

4) Why might you want to observe the same object in several wavelengths of light?
5) With which satellites did we first discover gamma-ray bursts (GRBs)?
6) Where did we used to think GRBs came from?
7) Define *Cosmological*:
   Define *Galactic*:
8) A) A particle of Alpha radiation is ______________
   and it can be stopped by a barrier made of ______________
   B) A particle of Beta radiation is ______________
   and it can be stopped by a barrier made of ______________
   C) A particle of Gamma radiation is ______________
   and it can be stopped by a barrier made of ______________
9) What are six sources of gamma rays?
10) Define *Long GRB*:
    Define *Short GRB*:
11) Name five satellites that have done observations of GRBs
12) What are some non-astronomy uses for gamma-ray detectors?
13) Do we need to go above the atmosphere to observe in the gamma-ray wavelengths? Why or why not?

Name________________________________

Teacher_________________ Period_______

Please respond to one of the two prompts below in paragraph form

What would the world would be like if all of a sudden the world was without a specific form of energy? Examples include *electrical, gravitational, kinetic, spring, elastic, rotational, or chemical energy*

Or

Deiter Hartmann took a long and varied journey to his final goal of becoming an astrophysicist. Along the way he overcame obstacles and took temporary diversions.
Give an example of a long-term goal that you have had and give specific examples of obstacles that you overcame and diversions that you took on your way to your final goal

EC will be given for attending the Writing Center and getting writing help as shown by attaching your corrected rough draft to the final draft.

Please remember to include:

-Evidence (example, data, quote AN APPROVED ARTICLE or THE BOOK)
-Link (or an explanation) of that evidence
-You will be graded on the following rubric so I **HIGHLY** recommend looking it over:

4	3	2	1
PARAGRAPH FORM: Paragraph contains main idea, evidence (3), link (3) and conclusion.	Paragraph is missing one component.	Paragraph is missing 2 components.	Paragraph is missing 3 or more components.
Paragraph's explanations (LINKS) are well thought out and connect with the main idea.	Paragraph has development of links though some reasoning is sloppy.	Paragraph is a bit confused/LINKs do not support main idea.	Paragraph shows little to no development of LINKs.
Paragraphs contain no grammar, punctuation, spelling, or capitalization errors.	Paragraph contains 1-2 errors.	Paragraph contains 3-4 errors	Paragraph contains 5 plus errors.
Paragraphs use deep understanding to prove main idea and is convincing.	Paragraph uses somewhat deep understanding.	Paragraph uses shallow understanding.	Paragraph is not convincing.

Name ____ Period __________ Date __________

The Science of Astronomical Detection

Objectives:
Determine how astronomers quantify and detect the incoming light from astronomical objects

Theory:
In 1921 Albert Einstein received the Nobel Prize in Physics for "services to the field of modern physics and especially for his discovery of the photoelectric effect." Something that he discovered, or at least formalized, allowed todays scientists to measure the light coming from stars. Astronomers from ancient times until the early 1970s had to rely on their eyes, then cameras or something similar, but in 1969, AT&T Bell Labs created and refined a device that would use this principle to make astronomy digital.

Part I: The Photoelectric Effect

Procedure:
1. Use the computer to log into the PhET Simulations page from the University of Colorado, and navigate to Physics > Light & Radiation > Photoelectric Effect

2. Briefly describe the setup in the space below

3. Identify the metal target that is having the light shone on it.

4. While keeping the voltage in the battery at zero, vary first the intensity while keeping the frequency stable, then vary the frequency while keeping the intensity constant. Hint: Turn on *current vs. intensity* and *energy vs. frequency* graphs.

5. Record your general observations below for sodium.

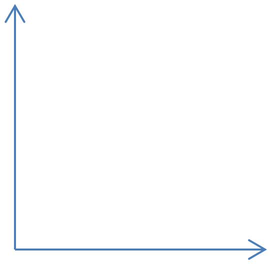
6. Repeat steps 3 – 5 for the other elements on the drop-down list.

Data:
Starting element ___________

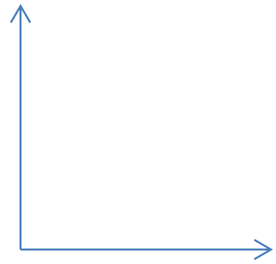
Describe the relationship between frequency and current

Describe the relationship between intensity and current

Sketch the relationship
of **intensity** vs. current



Sketch the relationship
of **frequency** vs. current



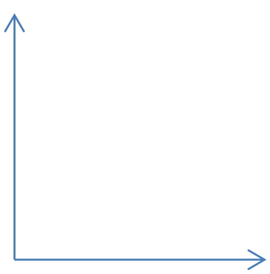
Be sure that your axes are labeled and that the sketches have important points labeled (max, min, asymptotes)

Next element ___________

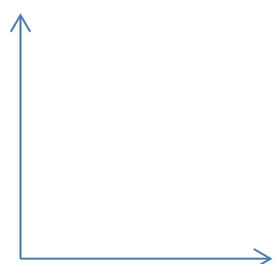
Describe the relationship between frequency and current

Describe the relationship between intensity and current

Sketch the relationship
of **intensity** vs. current



Sketch the relationship
of **frequency** vs. current



(Repeat this on the back for the other 3 elements)

Analysis:

1. Which metal gave up its electrons most easily? Which were the hardest to separate?

2. What is the relationship between electron energy and frequency? What about electron energy and intensity?

3. What do you think is actually happening inside of the metal that causes a current to be created?

4. What happened to the current if you applied a positive voltage? What about if you were to apply a negative voltage?

5. Is there anything special about metals that would make them better photovoltaic targets than other materials?

6. What would happen if we repeated this experiment with (a) non-metals? (b) different foams? (c) different woods?

7. If we were to use what you learned in question 1 and the lab, what would be the characteristics of a material that would be the best detector for a star that gives off primarily Green light? UV light? Red light? Why?