Name:_____

8th Grade Space Science Final Project:
Using Digital Astrophotography to Image and Explore Space

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Project Launch: Gallery Walk

STATION #_____

What do you OBSERVE?	What QUESTIONS do you have?

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What do you OBSERVE?	What QUESTIONS do you have?

Gallery Walk Debrief Questions

1. Which image or graphic that you looked at today did you find most interesting? What made it interesting to you?	2. Our Essential Question for this unit is: "How have humans imaged and imagined space throughout history?" What connections can you make between our gallery walk and this question?
3. What connections can you make between the some of what you studied in our gallery walk and what we've already learned in science class this year?	4. Considering the types of images and documents that you looked at in our gallery walk today, what do you think some of the topics or themes will be for our final project?
5. What is one thing you want to learn more about after looking at the different images and diagrams displayed in our gallery walk?	6. Think of one image you looked at today where you also read some text about that image. How did the text help you better understand the image?

Project Overview

Goals

- *To image objects in our Universe, from the Earth-Sun-Moon System, to Galaxies.*

- *To explore the ways that scientists use technology to visualize information about space.*

Essential Question

> *"How have humans **imaged** and **imagined** space throughout history?"*

Standards

Science Content Standards	Computer Science & Data Literacy Standards	Science and Engineering Practices
6.MS-ESS1-5(MA). *Use graphical displays to illustrate that Earth and its solar system are one of many in the Milky Way galaxy, which is one of billions of galaxies in the universe.* **MS-PS4-1.** *Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.* **MS-PS4-2** *Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.* **MS-PS4-3** *Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.*	**6-8.DTC.a.4** *Individually and collaboratively use advanced tools to design and create online content (e.g., digital portfolio, multimedia, blog, webpage).* **6-8.CS.c.3** *Describe how information, both text and non-text, is translated and communicated between digital devices over a computer network.* **6-8.CT.c.2** *Describe how computers store, manipulate, and transfer data types and files (e.g., integers, real numbers, Boolean Operators) in a binary system.*	**NGSS Practice 2** *I can create and use models when learning science.* **NGSS Practice 5** *I can apply my knowledge of mathematics when learning science.* **NGSS Practice 8** *I can obtain, evaluate, and communicate scientific information.*

Part 1: A History of Seeing into Space

How do telescopes "see" on Earth and in space?

By NASA, adapted by Newsela staff

Text Level **6**

03/29/2017

Word Count **942**

Almost all telescopes use mirrors to gather and focus the light from objects in the night sky. Mirrors reverse the image, though. So why use mirrors instead of lenses like those in magnifying glasses to focus the light?

The most important reason is that a good telescope must be nearly perfect. The mirror or lens must be just the right shape and the surface must be perfectly smooth and polished. The perfect mirror or lens guarantees that the light taken in from space will result in the clearest picture.

> *Stop and Jot #1:* *Most telescopes use mirrors to focus incoming light into an image. These telescopes are taking advantage of which wave behaviour that you learned about in the previous reading?*

The History Of Telescopes

In 1609 an Italian astronomer named Galileo became the first person to point a telescope toward the sky. Although that telescope was small and the images fuzzy, Galileo was able to make out mountains and craters on the moon.

Astronomy, the study of space, flourished as a result of larger and better telescopes after Galileo. With advancing technology, astronomers discovered many new stars and the distance between planets and stars.

> *Stop and Jot #2:* *What was Galileo's contribution to early astronomy?*

A Telescope In The Sky? Why?

The next time you gaze up at the night sky, you're likely to spot a twinkling star -- but is it really twinkling? What looks like a twinkling star to our eyes is actually steady starlight that has been distorted, or bent, by the Earth's atmosphere. It's like looking at an object through a glass of water. The atmosphere has a similar effect on telescopes on Earth that look into space.

That's why astronomers dreamed of having a telescope in space. From above Earth's atmosphere, a telescope would be able to catch light from objects in space before that light is absorbed or distorted.

Stop and Jot #3: *Why do scientists launch telescopes into Space?*

What Is A Space Telescope?

In 1990, the Hubble Space Telescope was launched into space. Hubble is the length of a large school bus and weighs as much as two adult elephants. The telescope travels about 5 miles per second. That is like traveling from the eastern coast of the United States to the western coast in 10 minutes. Hubble is solar-powered.

Hubble takes sharp pictures of objects in space. It has made more than one million observations, including detailed pictures of the birth and death of stars and galaxies billions of light years away.

What Instruments Are On Hubble?

As Hubble orbits Earth, sensors lock onto stars and aim Hubble in the right direction. Then Hubble's primary mirror collects light. From there, the light shines to Hubble's scientific instruments. Each instrument has a different way of interpreting the light.

Hubble has five scientific instruments.

The Wide Field Camera 3 is Hubble's main camera. It studies everything from the planets in the solar system to the formation of distant galaxies. The camera can see three different kinds of light, one at a time. It can see visible light, which human eyes can see. It can also see near-ultraviolet and near-infrared light, which are just beyond what our eyes can see.

Another camera, called the Advanced Camera for Surveys, captures images of large areas of space. These images have helped scientists study some of the earliest activity in the universe.

Hubble also has spectrographs, which are instruments that split and measure wavelengths of light. The Cosmic Origins Spectrograph reads ultraviolet light. This spectrograph studies how galaxies, stars, and planets formed and changed.

The Space Telescope Imaging Spectrograph helps scientists determine the temperature, composition and other characteristics of objects in space. It also has been used to find black holes.

Hubble also has a near-infrared camera, an instrument that sees objects deep in space by sensing the heat they emit. The Hubble near-infrared camera captures images of stars and planets, which help scientists study how these objects were formed.

Stop and Jot #4a: *Describe two of the tools found on the Hubble space telescope.*

Stop and Jot #4b: *Do you think that Hubble only senses the visible light waves from the Electromagnetic Spectrum, or do you think it senses other wavelengths as well? Cite text details to support your answer.*

Where Do The Colors In Hubble's Images Come From?

Hubble sends a huge amount of science data back to Earth every week. The Space Telescope Science Institute translates the data into images and information we can understand.

Hubble pictures start out in black and white. The Space Telescope Science Institute adds colors to show how an object might look to the human eye. Other times colors are used to highlight an important detail. They can also be used to show details that would otherwise be invisible to the human eye.

What Are Hubble's Most Important Discoveries?

Pictures taken by Hubble have revealed much about the universe and how it was formed. Hubble helped scientists determine the age of the universe, which is almost 14 billion years old. It led to the discovery of dark energy, a mysterious force that causes the universe to expand faster and faster. It has also revealed details of the giant explosions that happen when the universe's biggest stars die.

Stop and Jot #5 – Making Hypotheses: *If the Hubble Telescope is in space, how do you think we are able to access the photographs it takes here on Earth? Construct a hypothesis.*

Part 2: Pixilation and Digital Imaging

In order to understand astrophotography, first need to understand how digital images are constructed. Below are two samples of pixelated images – one was done correctly, and one was not. Use these images respond to the questions that follow.
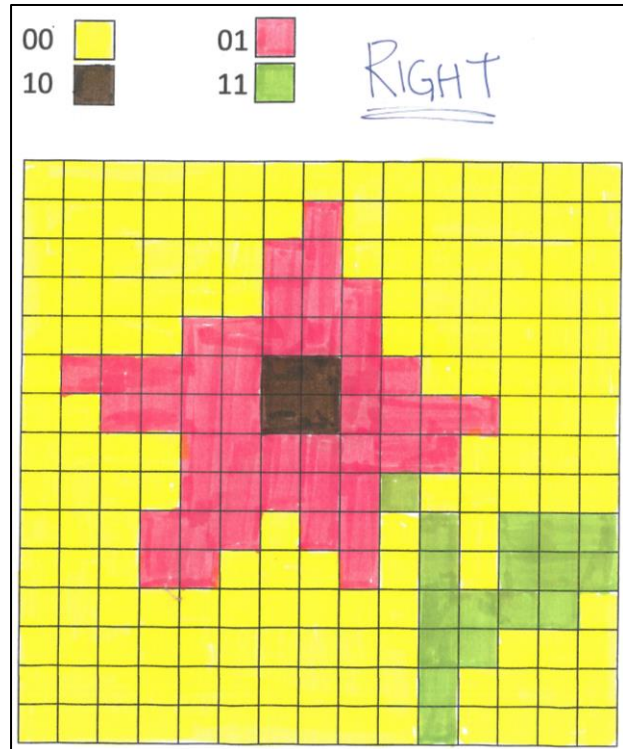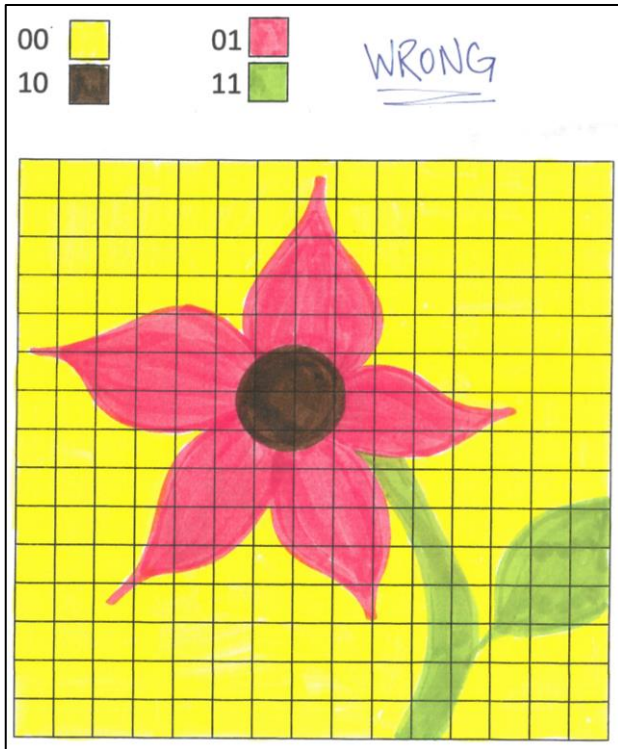

1. *Study the images above and notice how they are different. Knowing that the image on the right is the one that was done correctly, what do you think the "rules" are for creating a pixelated image?*

2. *Each of the images above contains 225 pixels. Based on this information, how would you define the term "pixel" in a digital image?*

STEP 1 → ILLUSTRATION

*Use the space below to create a pixelated image, using the "right" image from the previous page as a guide. Remember that each **pixel** can only have one color in it. Your image must contain a total of four colors.*

2 Bit Binary Code, 225 Pixels, Illustrtation Sheet
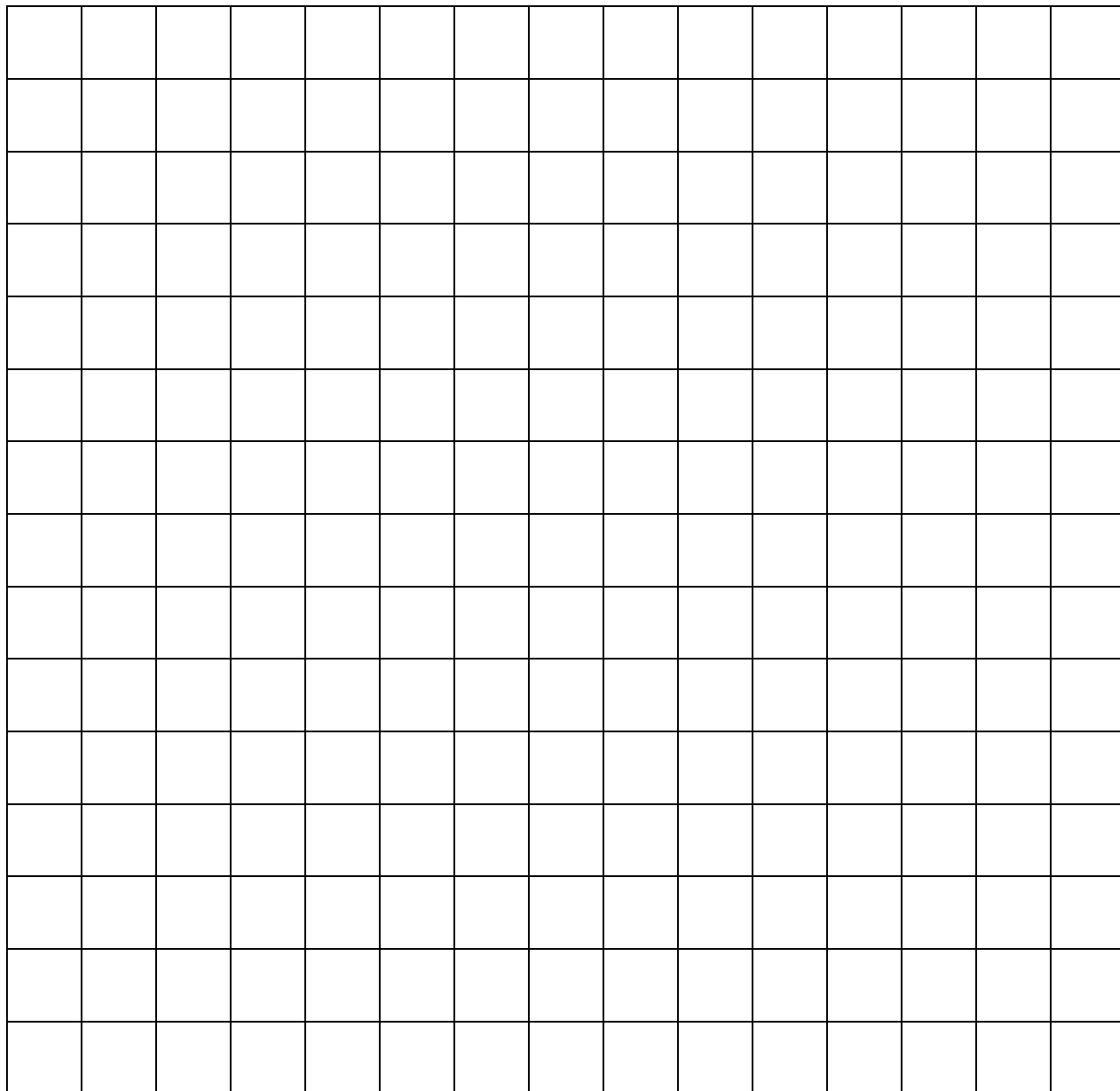
00 ☐   01 ☐
10 ☐   11 ☐

STEP 2 → ENCODING

*Use the space below to **encode** your image. In each pixel, write the 2 digit binary code that corresponds to the color of that pixel.*

2 Bit Binary Code, 225 Pixels, Code Transmission Sheet

00 □
10 □
01 □
11 □

STEP 3 → DECODING

*Your teacher will collect, copy, and redistribute your class' image transmission sheets. Use the space below to **decode** the binary code image transmission sheet of one of your peers, and see if you can accurately recreate their original image!*

2 Bit Binary Code, 225 Pixels, Image Decoding Sheet

00 ☐   01 ☐
10 ☐   11 ☐

STEP 4 → ANALYSIS

In this task, we carried out a simulation. Describe, as best you can, *what* you think we were modeling in our simulation and how it connects to the theme of astrophotography. (*Minimum 4 sentences*)

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_____

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_____

How could you adapt this activity to create a more detailed picture?

_____

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_____

Scientists can use land-based telescopes to look at objects in the sky. Space telescopes, such as Hubble, create challenges since we aren't up in space to look through the telescopes directly. Space telescopes need to send digital images back to computers on Earth. Thinking about the activity you just did, how do space telescopes use **binary code** (strings of "1s" and "0s") to send images to computers on Earth?

_____

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_____

In this activity you used **two-bit** code, which means that each pixel was coded by two digits. This gave us four possible combinations: 00, 01, 10, 11, etc.

How many difference colors could you possibly code for using **three-bit** code? Show your work and explain your reasoning!

_____

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MATH / PROBLEM SOLVING SPACE:

CHALLENGE QUESTION:

NASA is developing a new space telescope, and it wants the camera to be able to record 256 different colors. What bit number would its code need to be in order to record and code for 256 different colors? Show your work and explain your reasoning!

_____

_____

_____

_____

_____

MATH / PROBLEM SOLVING SPACE:

Part 3: An Introduction to the MicroObservatory

Follow along and take notes as your teacher uses the diagram below to explain how we will be using the Harvard MicroObservatory in this project to become astrophotographers, collecting and processing images from space! As your teacher explains the flow of information from space objects right to your computer, add notes and annotations to the diagram below.

ENCODING/DECODING

LIGHT

DATA
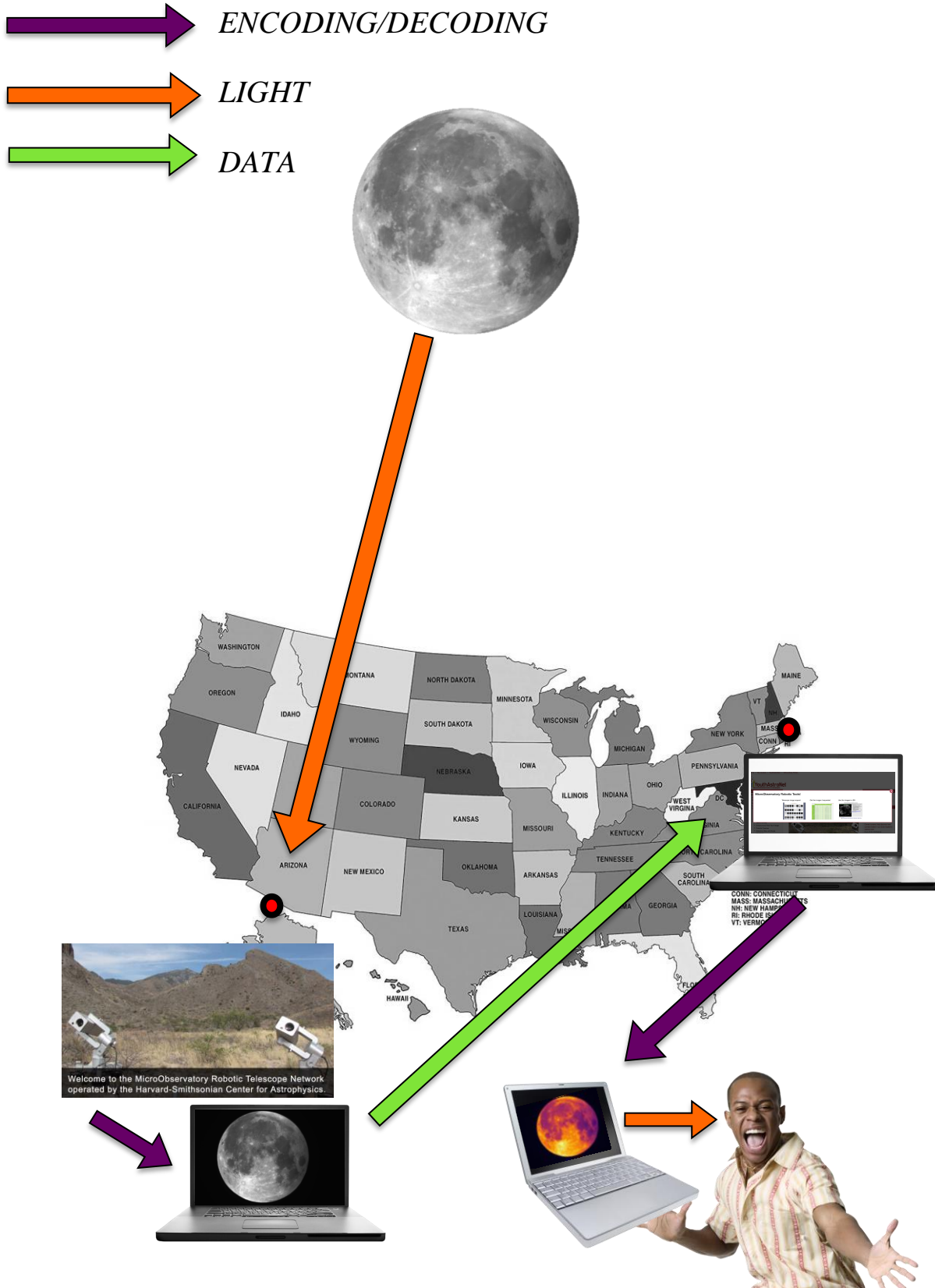
Part 4: YAN MicroObservatory – Capturing Images

It's time to learn how to use Harvard's MicroObservatory to photograph space! Below are the five different images you will capture. For today, we will just photograph the moon. Each day you will go into MicroObservatory and request a new image as you work through the list below.

Image Capture Sequence:

☐ Moon
☐ Solar system object beyond Earth-Sun-Moon system
☐ Star & Nebula
☐ Galaxy: No Filter
☐ Galaxy: Multiple Filters

The screenshots below will help you follow along as your teacher shows you how to use the MicroObservatory to photograph space.

Home ▶ Log in to the site

Harvard-Smithsonian Center for Astrophysics Science Education Portal

Log in

⚠ Your session has timed out. Please login again.

Username [＿＿＿＿]

Password [＿＿＿＿]

☐ Remember username

[Log in]

Forgotten your username or password?
Dear educators, if you have issues with resetting your password please contact **Erika Wright**

Cookies must be enabled in your browser ⑦

Some courses may allow guest access

[Log in as a guest]

MicroObservatory Robotic Tools

Take a Survey!

Enhance and Post Your Image

Colorful Cosmos

ome ▶ My courses ▶ YouthAstroNet ▶ YAN Activity Portal

YouthAstroNet
Harvard-Smithsonian Center for Astrophysics

MicroObservatory Robotic Tools!

Telescope image request   Get the images I requested   Use the images in JS9

Take a Survey!
Enhance and Post Your Image
Colorful Cosmos
Distance, Size, and Scale

Comet hunters: Help discover new comets hidden in our Solar System's asteroid belt
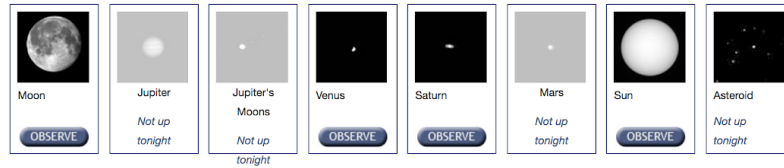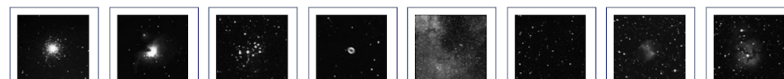
8 Jun, 07:54 Erik Mylenek

Request an Image

Today Thu, 19 Oct 2017 14:33:53 +0000 The telescope will take an image of your selected target.

Prior to selecting your target, you can click on the thumbnail to see a detailed view.

Go Back to Main page

Solar System

Moon	Jupiter	Jupiter's Moons	Venus	Saturn	Mars	Sun	Asteroid
OBSERVE	*Not up tonight*	*Not up tonight*	OBSERVE	OBSERVE	*Not up tonight*	OBSERVE	*Not up tonight*

Stars & Nebulae

Field of View ?

Normal View - 1°
Good setting for most objects

Zoom View - 0.5°
Best for objects that have a small angular size

Wide View - 10°
Best for objects that cover a wide area of the sky

Exposure Time ?

15 seconds

30 seconds

45 seconds

60 seconds
✓ optimal exposure time

Filter Selection ?

No Filter
all light let through

Red Filter
only red light let through

Blue Filter
only blue light let through

Green Filter
only green light let through

Multiple Filters
multiple images to make color picture

Part 5: Rendering Images in JS9

*Now that you have collected your first image using the MicroObservatory (you should have an image of the moon), it is time to learn how to **render** (or adjust) your image.*

Navigating JS9 Software

*On Google Classroom there is a link to a film called "MicroObservatory – How to **Open** a FITS Image." Watch the film and use the space below to record notes that will help you remember how to open your images in the JS9 program.*
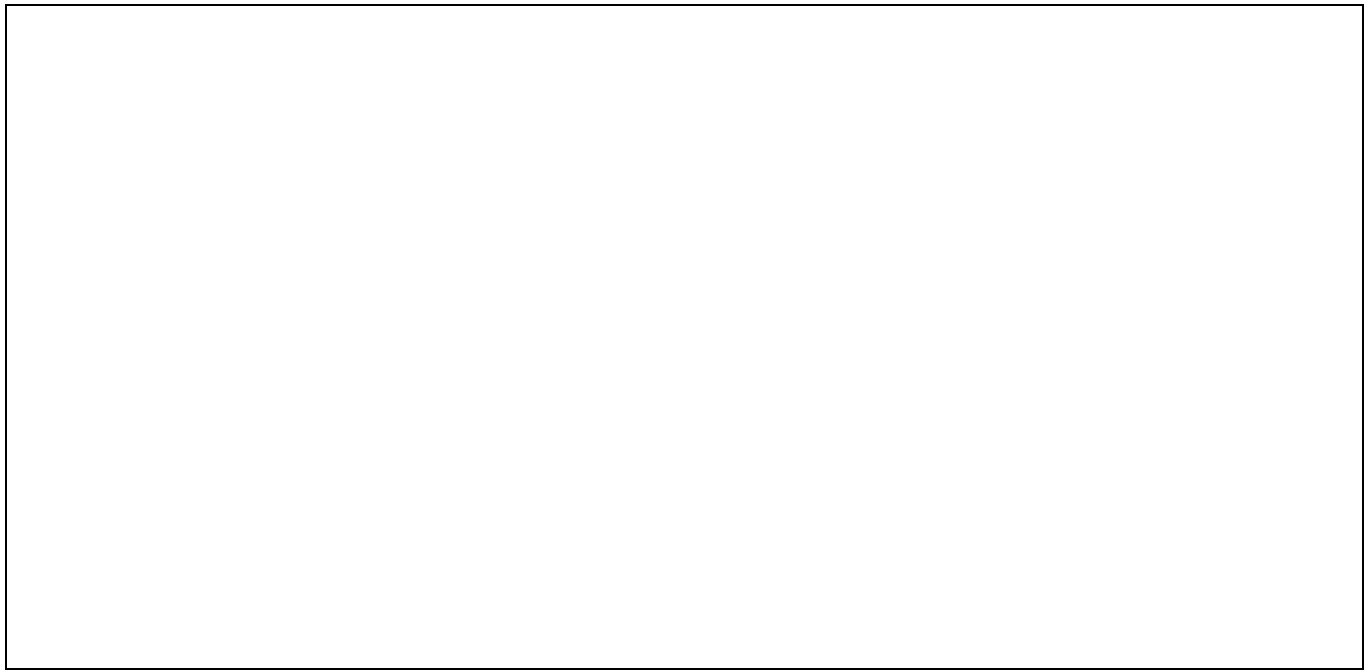
Black & White and False Color Images

*On Google Classroom there is a link to a film called "MicroObservatory – How to **Process** a FITS Image." Watch the film and use the space below to record notes that will help you remember how to create high quality black and white and false color images in JS9.*

True Color Images Part 1: Color Theory Lesson

Phet Simulator: Color Vision!

1) Go to the color simulation lab posted on Google Classroom. We will be working with the single bulb simulator. When the simulator opens, begin by turning on the flashlight.
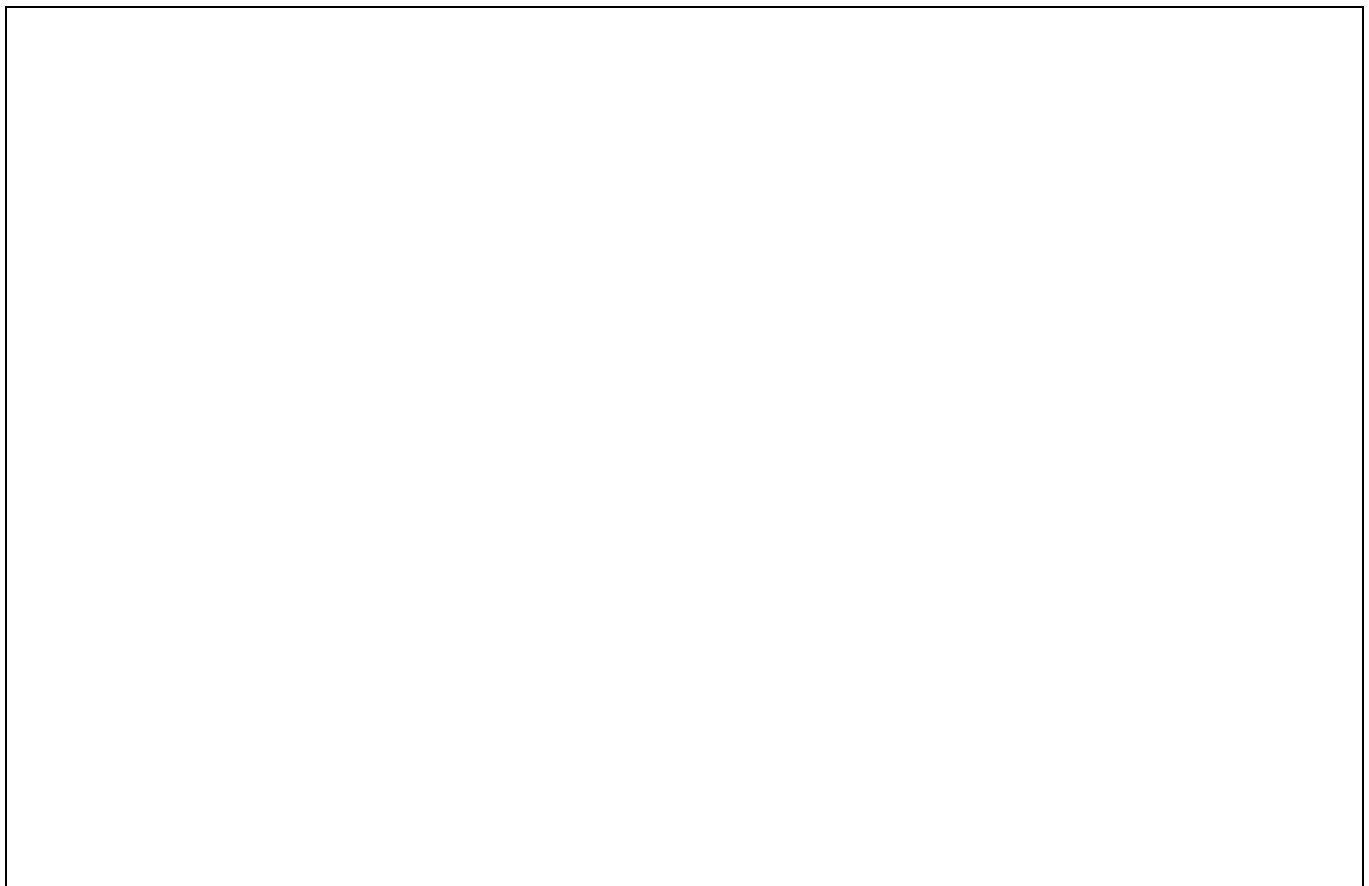
2) Change the bulb color from yellow to white.

3) Study the simulation. Change the settings of the flashlight from light beam to light particles. When our brains perceive white light, what colors are actually being emitted from the light source?

4) Click on the RGB Bulbs tab at the bottom of your screen. Try adjusting the sliders to mix different quantities of red, green, and blue light. Note the color of light created when you mix the following combinations of colored light:

COLOR COMBINATIONS	RESULTING COLOR
Red: *100%* **Green:** *100%* **Blue:** *100%*	
Red: *0%* **Green:** *100%* **Blue:** *100%*	
Red: *100%* **Green:** *0%* **Blue:** *100%*	
Red: *100%* **Green:** *100%* **Blue:** *0%*	
Red: *100%* **Green:** *100%* **Blue:** *100%*	
Red: *0%* **Green:** *50%* **Blue:** *100%*	
Red: *50%* **Green:** *50%* **Blue:** *100%*	
Red: *50%* **Green:** *100%* **Blue:** *0%*	
Red: *100%* **Green:** *0%* **Blue:** *50%*	

SYNTHESIS TASK

The term "pixel" is short for "**pic**ture **el**ement." A computer screen is an array of pixels. Each pixel on a screen is made of 3 tiny units called phosphors. Each phosphor in a pixel can only emit <u>one</u> color of light: green, red, or blue.   Using the diagram below as well as your results from the PhET investigation for support, explain why the pixels on a computer screen can produce many different colors when they only have three different color phosphors.
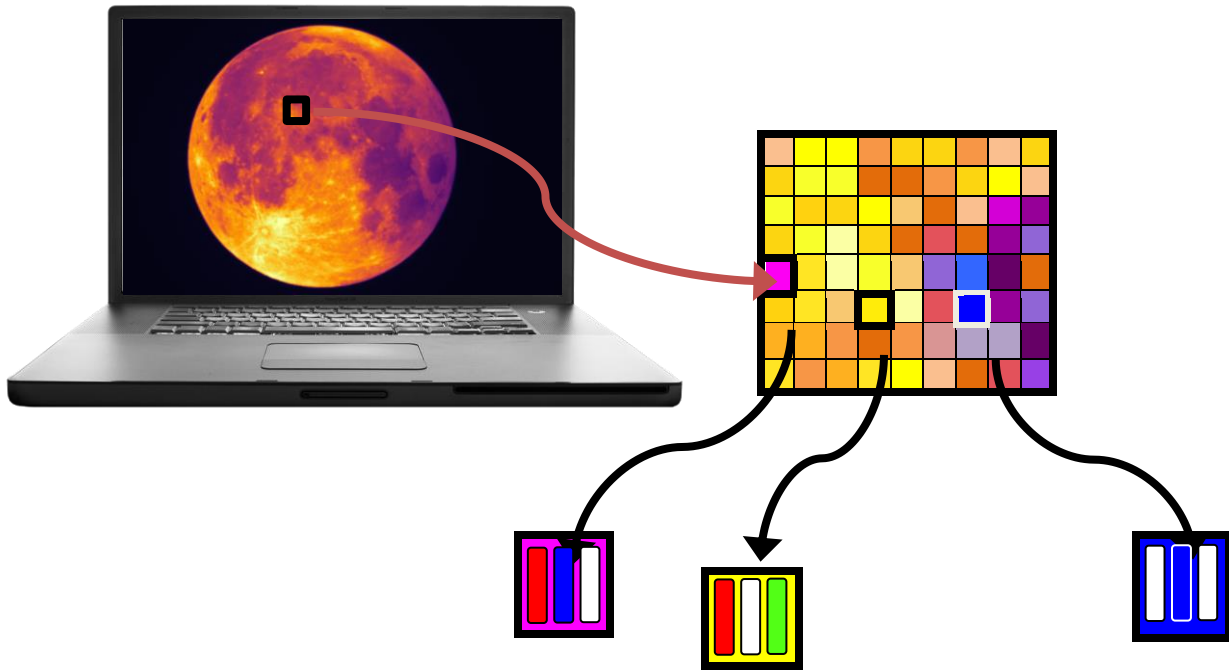
True Color Images Part 2: Creating RGB Composite Images

*On Google Classroom there is a link to a film called "MicroObservatory – How to **Create** a Simple RGB Image." Watch the film and use the space below to record notes that will help you remember how to create high quality black and white and false color images in JS9.*

Part 6: Project Write-Up

BACKGROUND INFORMATION

Organization of the Universe

☐ *Model:*

When we introduced the project, you learned about how objects in the universe are classified and organized. Your project poster should include a model (diagram) that communicates the organization of the universe from the Earth-Sun-Moon System, all the way out to large fields of galaxies. You may use the same model we used in class, or create your own model to communicate the organization of the universe.

☐ *Model Summary:*

Include a short summary that explains your model, with a brief description of what is found at each organizational level of the universe.

SUMMARY OUTLINE:

Digital Imaging & Astrophotography

☐ *Pixelated Image & Binary Code:*

Each member of your group created a pixelated map at the beginning of this project. Choose one of the images to include on your poster. Include the binary code for the pixelated image you chose to include.

☐ *Digital Imaging Write-up:*
   Your group will need to write a paragraph explaining binary code, and how you used binary code to "digitize" your pixelated image. <u>You should draw connections between your pixelated drawing and astrophotography</u>. Explain how telescopes use pixels and code to create digital images.

DIGITAL IMAGING SUMMARY OUTLINE:

☐ *Communication Systems & Astrophotography:*
   In this project you learned some of the vocabulary that scientists and engineers use to describe communication systems and the transfer of different types of information (encode, decode, transmit, source, receiver, etc.). Using this content vocabulary, write a paragraph to explain how information is transferred from a space object all the way to your computer. Describe the different ways that information is stored or transmitted at various points in the communication process (example: light, color, binary code, radio waves).

COMMUNICATION SYSTEMS & ASTROPHOTOGRAPHY OUTLINE

☐ *JS9:*

Include a brief overview of how you used the JS9 software to process space images to create both false color and true color images. Your written explanation should demonstrate a strong understanding of light waves and color theory as you explain how to create a true color image.

OUTLINE

EARTH-SUN-MOON SYSTEM

Telescope Images
Your group will need to **capture** and **process** images of <u>either</u> the sun *or* the moon. You will include **two** processed images:

☐ *Black and White Image*

Include your best black and white image of your chosen space object.

☐ *Color Image*

Include your best color image of your chosen space object, using a color map of your choice.

SOLAR SYSTEM

Telescope Images
Your group will need to **capture** and **process** images of one solar system object other than the sun or the moon. You will include **two** processed images:

☐ *Black and White Image*

Include your best black and white image of your chosen space object.

☐ *Color Image*

Include your best color image of your chosen space object, using a color map of your choice.

MILKY WAY GALAXY

Telescope Images
Your group will need to **capture** and **process** images of one object or area in our Milky Way Galaxy. You will include **three** processed images:

☐ *Black and White Image*
  Include your best black and white image of your chosen space object.

☐ *False Color Image*
  Include your best false color image of your chosen space object.

OUTER SPACE

Telescope Images
Your group will need to **capture** and **process** images of a galaxy beyond the Milky Way. You will include **three** processed images:

☐ *Black and White Image*
  Include your best black and white image of your chosen space object.

☐ *False Color Image*
  Include your best color image of your chosen space object, using a color map of your choice.

☐ *True Color Image*
  Include your best true color image of your chosen space object.

CONCLUSION
For the conclusion to your project, you must write a reflective paragraph responding to <u>either</u> the Essential Question for our unit, or to the Guiding Quote for 8th grade science.
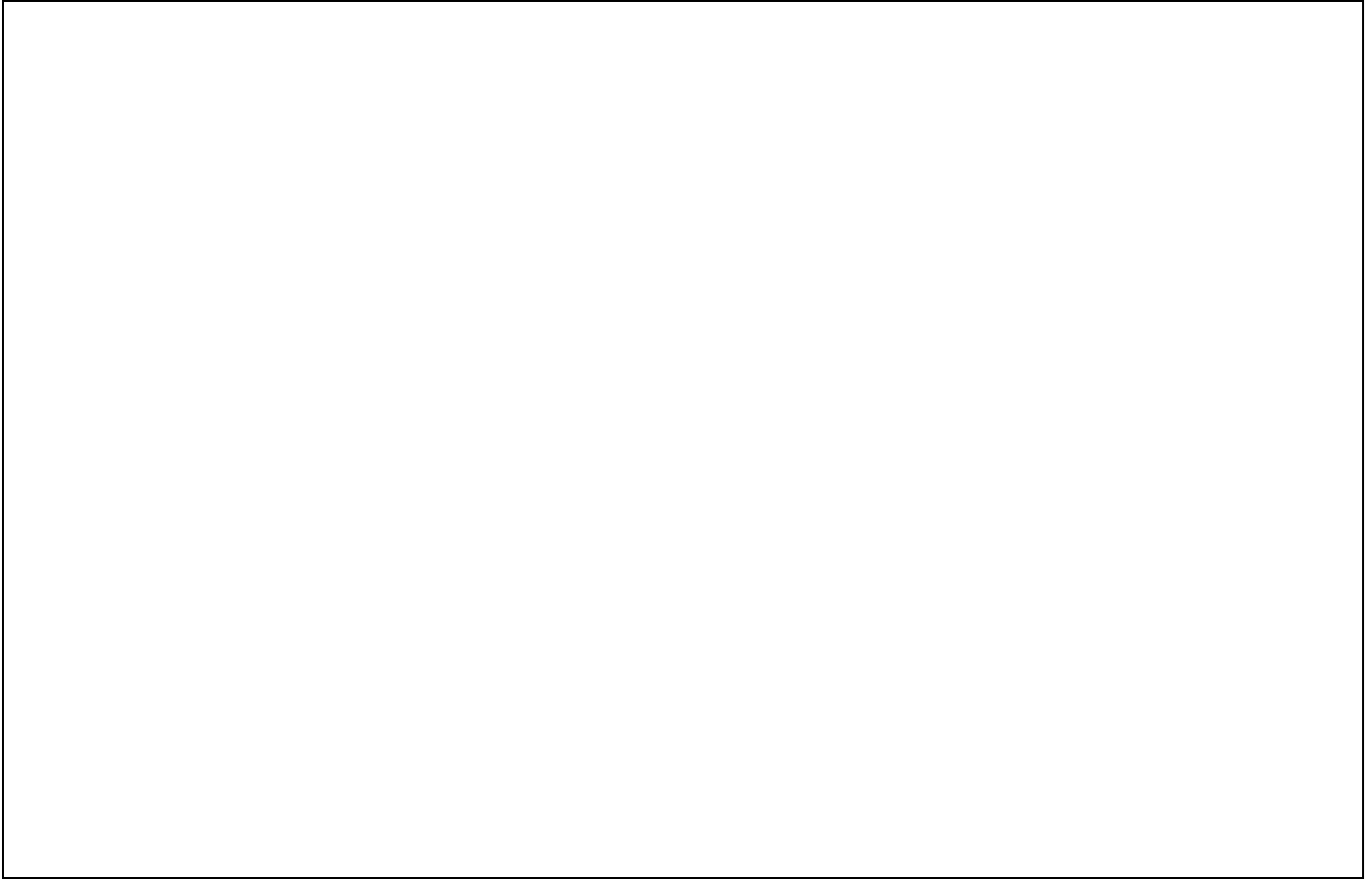
Guiding Quote
At the beginning of the year we read a quote that will guide our year in 8th grade science: "Numbers have an important story to tell. They rely on you to give them a clear and convincing voice." Reflecting on this assignment <u>and</u> the other work you've done in 8th grade science, discuss how we have **used numbers** and **data** to communicate important concepts about space

Essential Question
The Essential Question for our unit asks: *"How have humans **imaged** and **imagined** space throughout history?"* Reflecting on this assignment, the models and illustrations you've done in class, and what you know about modern telescopes, discuss how scientists **use images** and **models** to communicate important concepts about space.

BRAINSTORM: