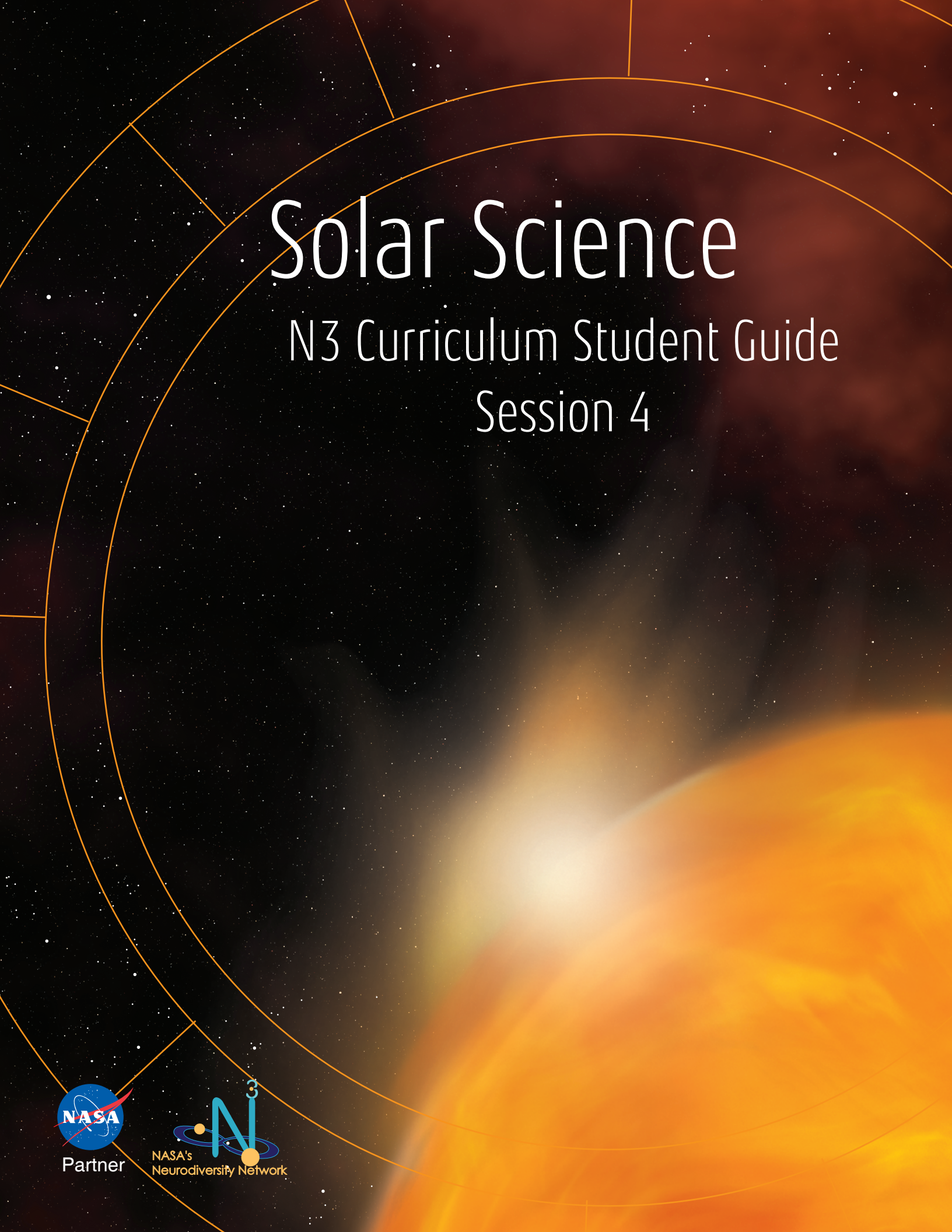
Solar Science

N3 Curriculum Student Guide

Session 4



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Content

4. A Stormy Sun

Session 4: Observing the Sun

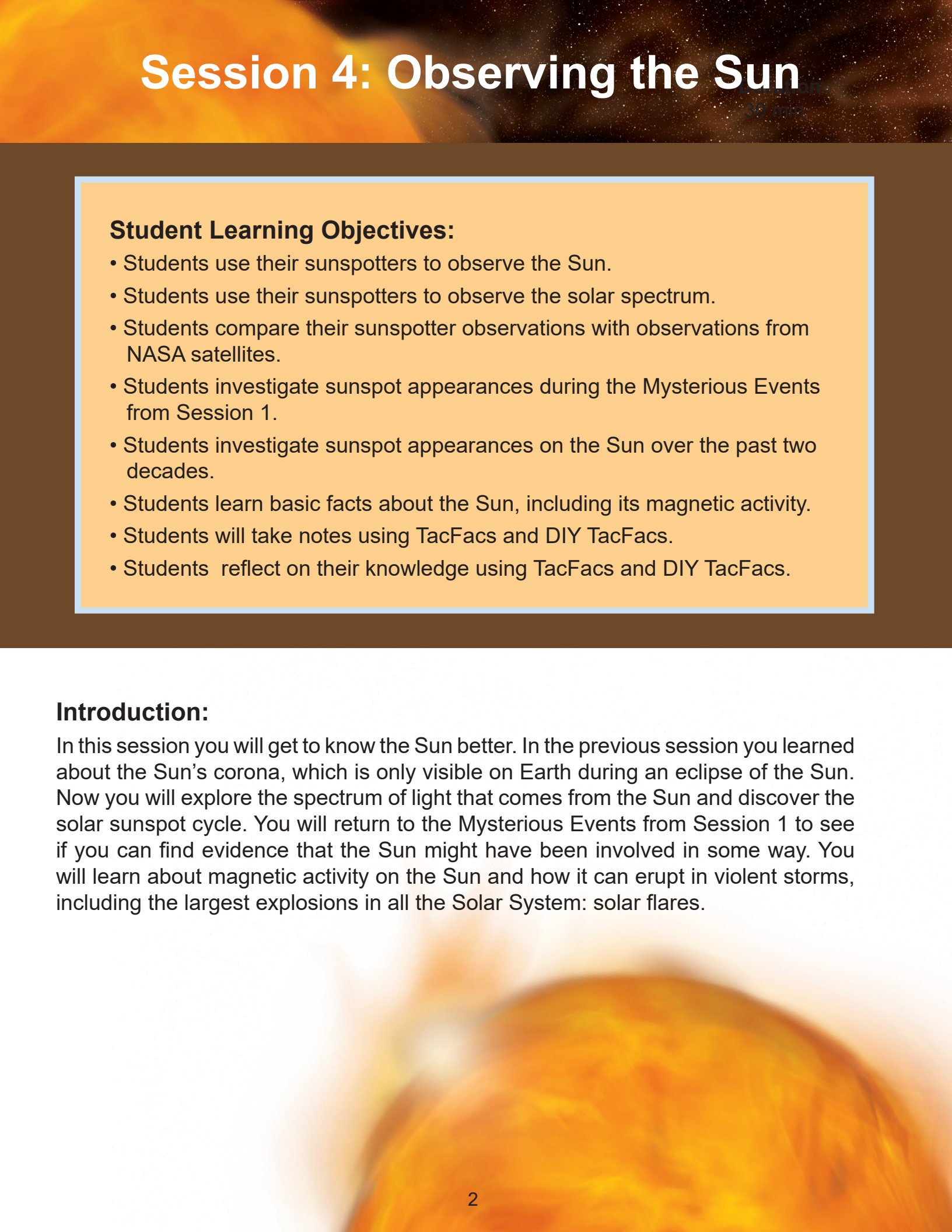
Duration:
30 min

Student Learning Objectives:

- Students use their sunspotters to observe the Sun.
- Students use their sunspotters to observe the solar spectrum.
- Students compare their sunspotter observations with observations from NASA satellites.
- Students investigate sunspot appearances during the Mysterious Events from Session 1.
- Students investigate sunspot appearances on the Sun over the past two decades.
- Students learn basic facts about the Sun, including its magnetic activity.
- Students will take notes using TacFacs and DIY TacFacs.
- Students reflect on their knowledge using TacFacs and DIY TacFacs.

Introduction:

In this session you will get to know the Sun better. In the previous session you learned about the Sun's corona, which is only visible on Earth during an eclipse of the Sun. Now you will explore the spectrum of light that comes from the Sun and discover the solar sunspot cycle. You will return to the Mysterious Events from Session 1 to see if you can find evidence that the Sun might have been involved in some way. You will learn about magnetic activity on the Sun and how it can erupt in violent storms, including the largest explosions in all the Solar System: solar flares.



4.1 Sunspot Observing continued:

Materials:

- Assembled Sunspotter (built in Session 2)
- Sunspot Detector

Assembled Sunspot Detector

The complete setup photo is showing the white side of the panda board on the front.

Instructions:

1. Set up your assembled sunspotter and sunspot detector again, being sure to align them properly like you did in Session 2.

2. Record your observations onto the clipboard of your sunspot detector like you did previously by making a drawing of how the Sun appears with your sunspot detector. Refer back to Session 2's instructions for a refresher if needed.

3. Save this drawing for the future and keep it with your drawing from Session 2 and Session 3. If you have a hardcopy, make sure they are together. If it is a photo, make sure it is saved in a folder online or on your computer.

4. Open your Google Sheet titled "Sunspot Data" or turn to your Sunspots Worksheet (either the adjusted table p. 24 of Session 2: Student Guide, or the 3.2 Worksheet, p. 7 of Session3: Student Guide).

5. Enter in your sunspot data in the row immediately below where you left off previously..

4.1 Worksheet:

Sunspot Observations continued

Name: _____

Do you notice any changes in the Sun's appearance since your last observations?

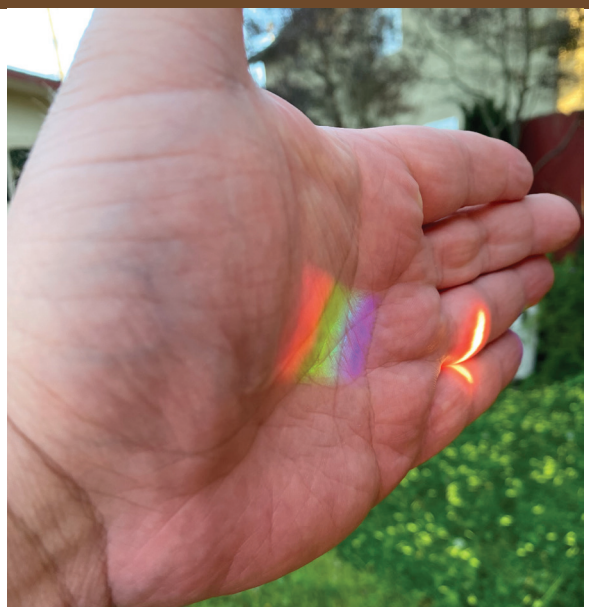
Have the sunspots you previously observed moved?

Are there any new sunspots?

Have previous sunspots disappeared or changed shape or size?

You can also use the 4.3 Worksheet on p. 8 if you need a new sheet..

4.2 Observe the Colors of the Sun:



Materials:

- Large sheet of opaque material (cardstock or cardboard)
- Scissors
- Diffraction Grating
- Tape
- Sunspot Detector with new sheet of paper

Introduction:

The Sun shines in many colors. These colors of the electromagnetic spectrum combine together to make a white Sun. If we send the white light from the Sun through a thin slit of material, it will separate into its individual colors sorted by wavelength. This should produce a rainbow effect. You will get a chance to do this for yourself and learn about electromagnetic waves outside of the range that we can see with our eyes. Bees can actually see in the range of ultraviolet light and mosquitos can see infrared light.

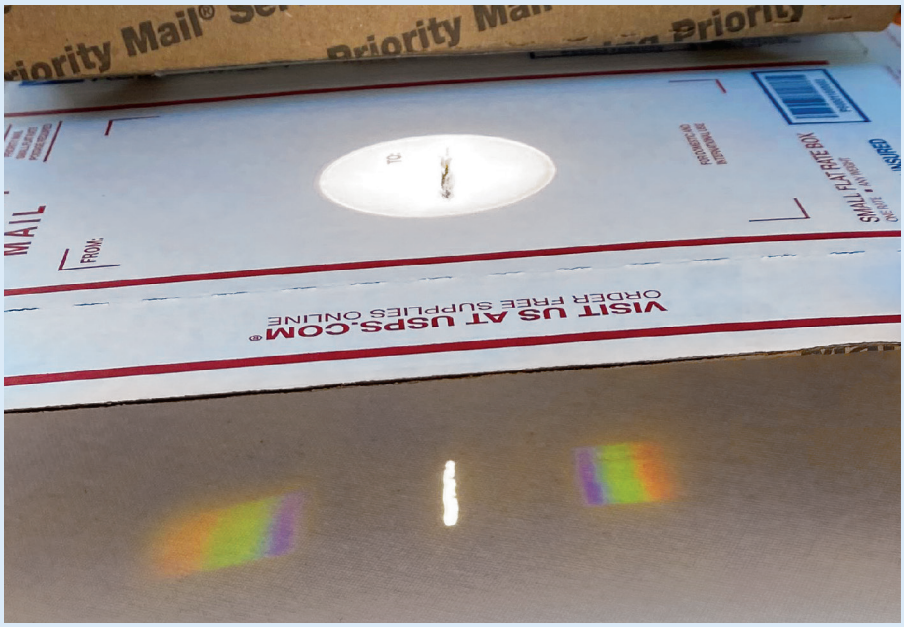
Instructions:

1. Use your scissors to cut a one-two inch long slit, thin enough to let a narrow beam of light pass through, into the cardboard. Try your best to clear it of cardboard shavings that might obscure the path of light.

2. Place the diffraction grating over the slit and tape it in place. Make sure that the letters on the grating are upright when the slit is held in the vertical position.

3. Place the diffraction grating in the light path of your sunspotter to split the sunlight into a spectrum. Make sure the slit in the cardboard is between the sunspotter and the diffraction grating - you need a slit of white light to pass through the diffraction grating.

4. You should see multiple spectra projected through the slit in the cardboard. Place your sunspot detector with a fresh sheet of paper under one of them.



5. Record the spectrum's appearance by drawing pictures (label the colors you see), taking photos, and describing your observations in your notes.

4.3 Compare with NASA's Observations

Materials:

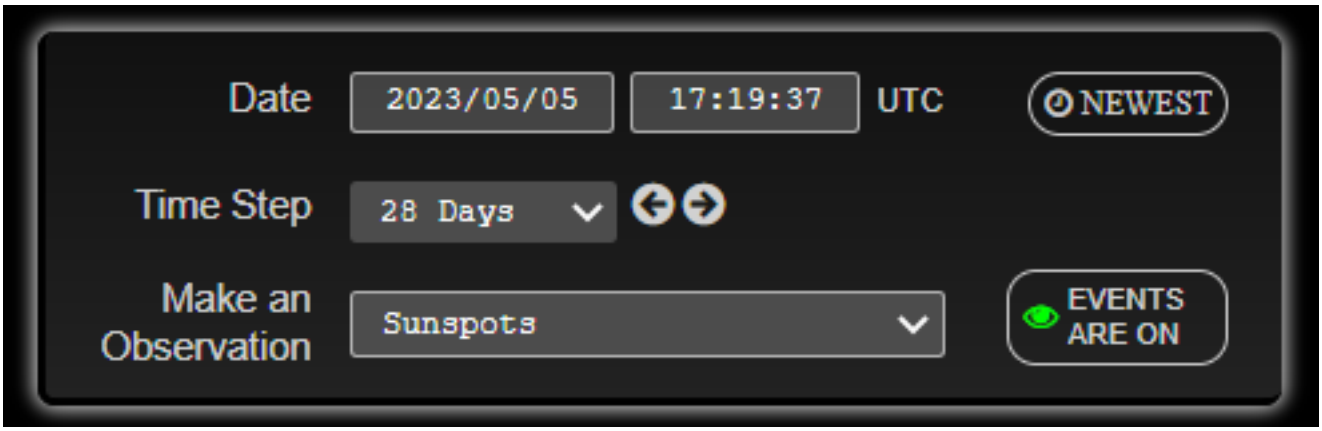
- Helioviewer guide: ***buac18-doc-helioviewerguide-handout.pdf***

Instructions: How to Use Helioviewer continued:

1. Open the Helioviewer Guide (here) or read the handout your teacher provided for you.

2. Go to *NASA's Student Helioviewer* or type this url into a web browser:
► *https://student.helioviewer.org.*

3. Notice the controls in the upper left corner of the window. Select the corresponding date for your sunspot observations from the calendar. In the "Make an Observation" drop down menu, select "Sunspots"..



4. Compare the data you've recorded on your sunspot detector and Google Sheet.
a. Are there more sunspots than you observed using the sunspotter?

b. Do you notice any differences in the sunspot's details (shapes and/or sizes) in the Helioviewer's SDO images?

5. You may need to do Time Zone conversions to find Coordinated Universal Time (UTC). Your teacher may give you an additional exercise for this, or you can use the conversion chart in the Helioviewer Guide, or use Google to convert time to UTC.

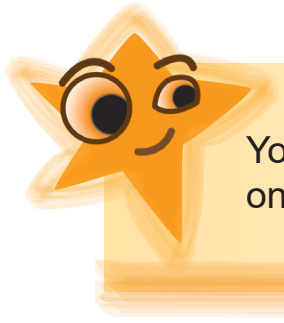
4.3 Worksheet

Compare with NASA's Observations

Name: _____

Date	Time	# of Sunspots	Notes	Helioviewer Data (# of sunspots & notes)					

4.4 Mysterious Events Revisited



You are going to investigate the mysterious events once again, using everything you know so far!

You will use Helioviewer and the sunspots viewing option (directions p.8) to observe the appearance of sunspots on the dates of the different events from Session 1.

For each event date you will record: the number of sunspots, their relative sizes, and their locations on the face of the Sun.

You will record these observations direction into the worksheets on p.12-13 or into a new data table in Google Sheets (instructions sample below).

See p.14 for how to record your observations.

Example template

Data Table 4.4 - Sunspots and Mysteries

File Edit View Insert Format Data Tools Extensions Help

Share

A1 | Event

	A	B	C	D	E	F	G	H
1	**Event**	**Event Date**	**# of Sunspots**	**Average Sunspot Sizes**	**AverageSunspot Latitudes**	**Solar Flares**	**CMEs**	**Geomagnetic Storms**
2	SpaceX Satellites					A class, 2/3/2021, 12:32 UT	Earth directed, 2/3/2012, 12:35 UT	Yes/No
3	Halloween 2003 Satellite Malfunction							
4	Power outages in midwestern states							
5	Mysterious GPS failures							
6	Power outages in northern cities							
7	Electrical blackout in Sweden							
8	Strange red sky over the Mojave Desert							
9	Strange red sky over Texas							
10	Air traffic control blackout							
11	Radiation doses on flights							

Sheet1

Instructions: Create a Document for Your Sunspot Data

1. Open up a new Google Sheets document and call it “Data Table 4.4 - Sunspots and Mysteries”.

2. Create a title row with eight cells with these eight words:
a. Event
b. Event Date
c. # of Sunspots
d. Average Sunspot Sizes
e. AverageSunspot Latitudes
f. Solar Flares
g. CMEs
h. Geomagnetic Storms

3. Return to your Mysterious Events deck. In the first column “A”, list the Mysterious Event names.

4. Highlight cells D2 through D12 and E2 through E12 by clicking on D2 and dragging your cursor down and to the right until all of the cells up to E12 are selected.

5. In the top menu, click “Insert” and from the drop down menu select “Dropdown”.

6. A new menu should appear on the right side of the screen.

7. Select cells D2 through D12, and under “Criteria” on the right hand menu, click “Add another item”.

8. Triple click “Option 1” and type “Small” to replace it.

9. Do this same thing for “Option 2” and “Option 3”, replacing them with “Medium” and “Large” respectively.

10. Next, highlight cells E2 through E12.

11. Repeat this process, except for Option 1, 2, and 3, replace them with “Low (near equator)”, “Middle”, and “High (near poles)” respectively.

4.4 Worksheet:

Mysterious Events Data

Name: _____

Event	Event Data	# of Sunspots	Average Sunspot Sizes (small, medium, or large)	Average Sunspot Latitudes (low (near equator), middle, or high (near poles))
SpaceX Satellites				
Halloween 2003 Satellite Malfunction				
Power outages in midwestern states				
Mysterious GPS failures				
Power outages in northern cities				

4.4 Worksheet continued:

Mysterious Events Data

Name: _____

Event	Event Data	# of Sunspots	Average Sunspot Sizes (small, medium, or large)	Average Sunspot Latitudes (low (near equator), middle, or high (near poles))
Strange red sky over the Mojave Desert				
Strange red sky over Texas				
Air traffic control blackout				
Radiation doses on flights				
Southeastern states experience power loss				

Record Your Observations

1. Use Helioviewer to look up the solar activity that occurred on each date that a Mysterious Event took place.
2. Record your observations in your new Google Sheet in the appropriate rows. You can also record this information in the Mysterious Events Data Worksheet above if you'd prefer to.
   a. For the column labeled "Average Sunspot Sizes", you'll want to record their relative size compared to the ones you've seen.
   b. For the column "AverageSunspot Latitudes", record their locations on the face of the sun for each date.
3. Next, answer the following three questions in the worksheet on p.15 about your observations to the best of your ability given the information you've gathered.

4.4 Worksheet:

Mysterious Events Observations

Name: _____

1. Do you have enough data to come to the conclusion that the Sun might have something to do with these events? Explain your reasoning.

_____

_____

_____

_____

_____

2. What things do these observations have in common?

_____

_____

_____

_____

_____

3. How can we determine if the Sun's appearance on these dates is normal or unusual?

_____

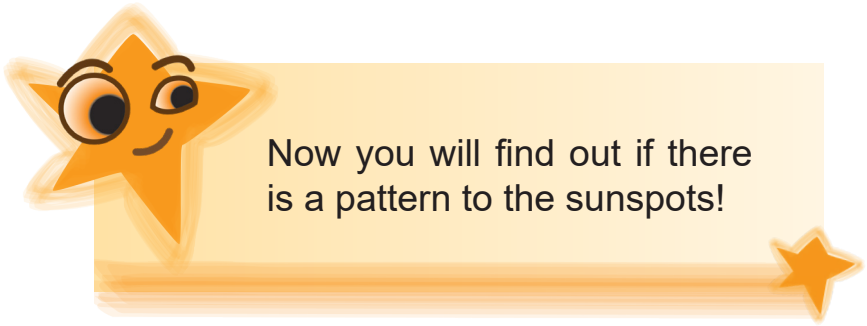
_____

_____

_____

_____

4.5 Discover the Solar Cycle

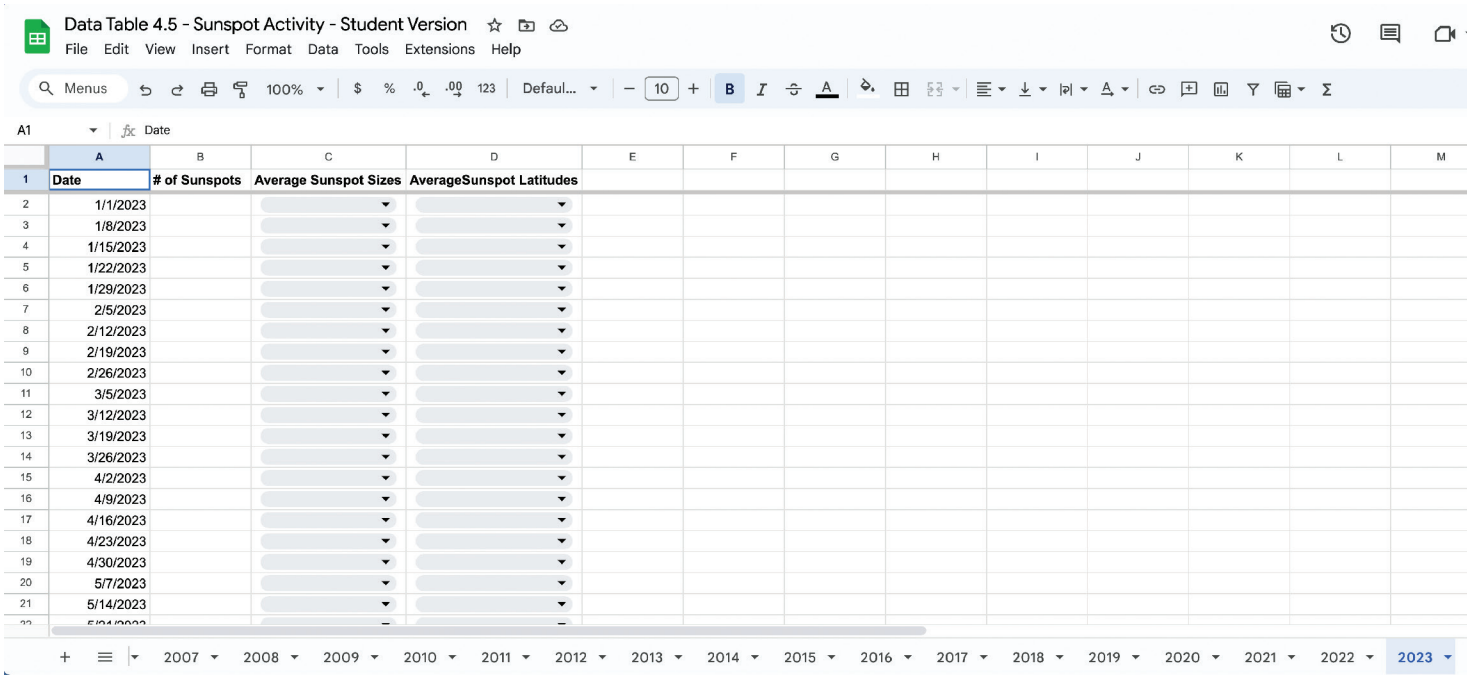


You are going to observe the appearance of susnpots across many years, using Helioviewer.

You will be assigned a range of dates to observe and you will use the same steps from 4.4 to make your observations.

Your teacher will collect the observations from the entire class so your part is important!

Example template



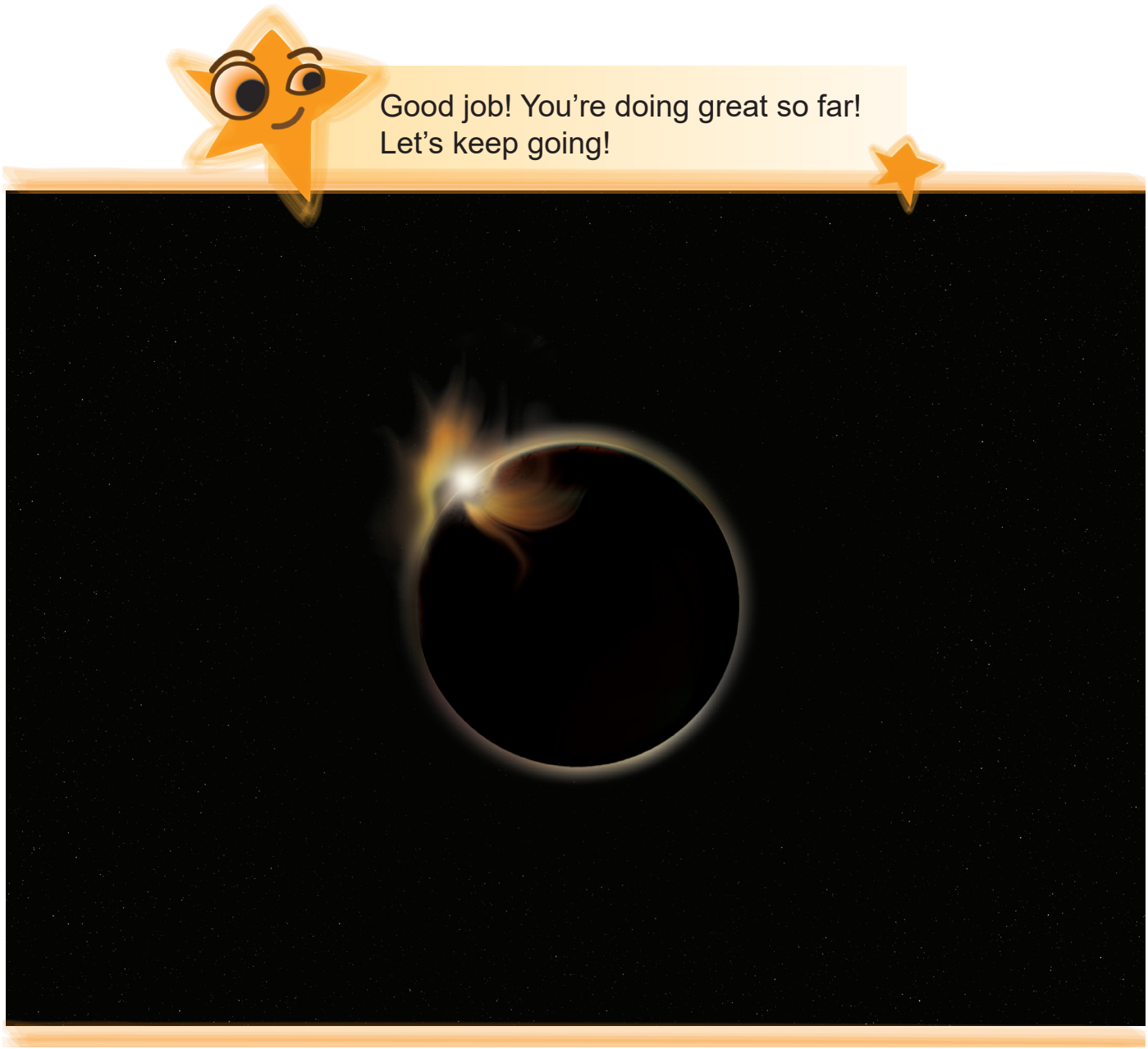
Instructions:

1. Open the Google online spreadsheet provided to you by your teacher.

2. You will be assigned a range of dates to observe. Click on the tab on the bottom of the sheet that represents your assigned date range.

3. Using Helioviewer search for each date listed in the “Date” column of your tab. Record the number of sunspots that appeared on the Sun that day, the average sunspot sizes, and average sunspot latitudes in their respective rows and columns.

4. Once everyone has finished with their data collection, the instructor will guide your class through analyzing a graph of the class’s shared data collections.



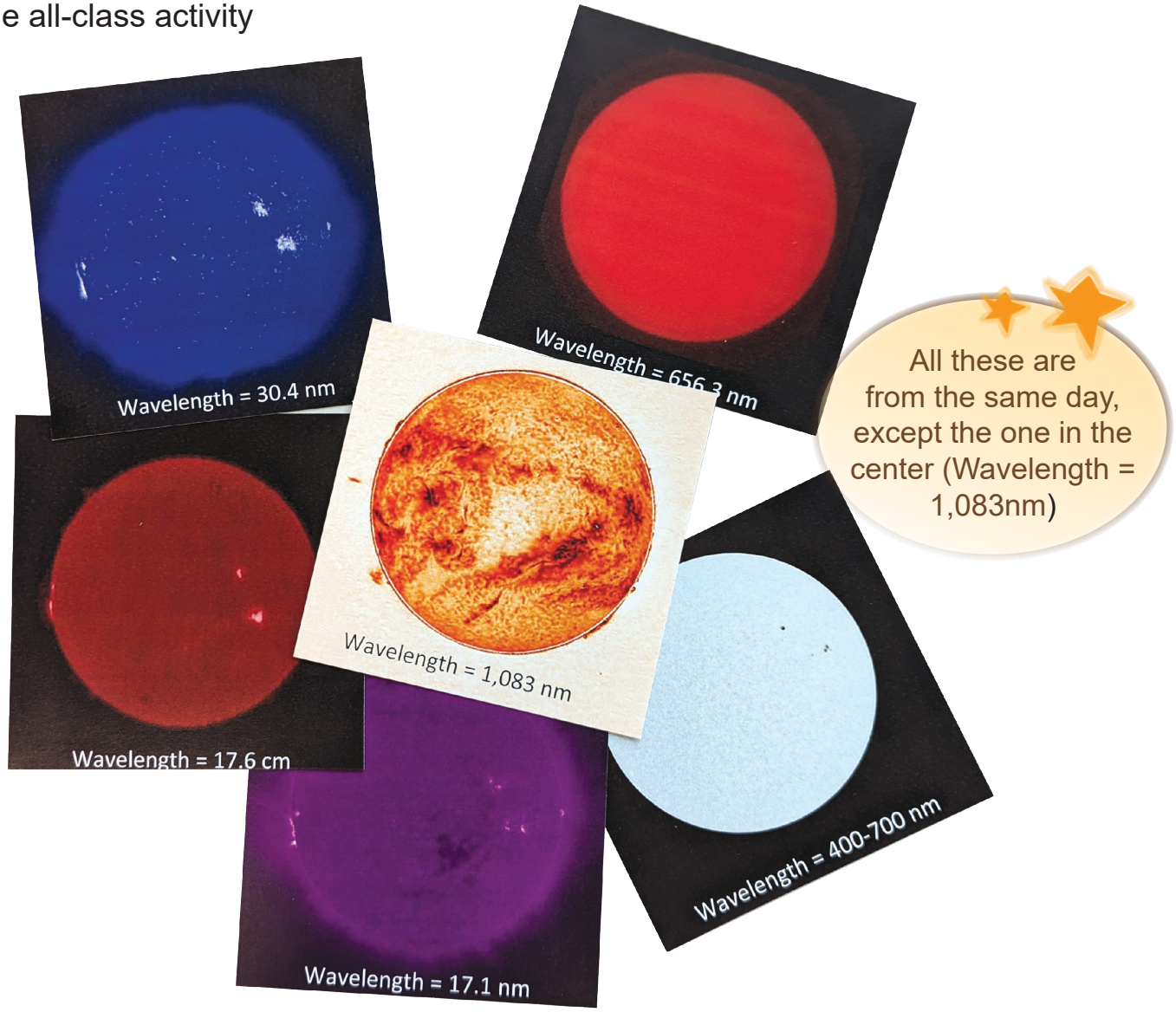
4.6 Sorting Sun Cards

Instructions:

Working with your group, take the Sun Cards and sort them in any way that might help make sense of what you see (e.g. colors, wavelengths, physical features you observe, etc.). Follow your teacher's instructions for the all-class activity

Materials:

- The Sun Cards



What does this reveal about the Sun?

_____

_____

_____

4.7 Science of the Sun Lecture

Materials:

- TacFacs (premade)
- DIY (blank) TacFacs

Introduction:

You will now listen to a lecture by your teacher on the science of the Sun. While you listen, use the materials and instructions below to help you take notes and organize your learning.

Instructions:

1. Flip to the Green TacFacs. These have Sun facts on them. Each card has a different fact on the back.

2. You may pull them off the ring so you can lay them out and look at them as you listen to the lecture.

3. You may also check the other colors of TacFacs to see if any get mentioned. They are organized in colors by topic.

4. If there is a new fact you heard that you like, you may write it on a DIY (blank) TacFac. Follow the same format by writing the theme on one side, and just a single fact on the other side. Try to use the same or similar color theme to the premade TacFacs color theme.

5. Organize your premade TacFacs and DIY TacFacs (if any) on your desk in a way that makes sense to you.

4.8 Reflections

Materials:

- TacFacs (premade)
- DIY (blank) TacFacs

Introduction:

You will now reflect on what you have learned together just like you did at the end of Session 3. You will use the premade TacFacs and the DIY TacFacs (if any) to cement your learning.

Instructions:

You may use the 4.8 Worksheet hardcopy on p.21 or your teacher may give you another option.

1. Choose some of the claims from Session 1 for the different possible causes of the mysterious events in Session 1. Write them on the left side of the “Worksheet: Reflections”.

2. Choose a premade TacFac or a DIY TacFac and place it in the “Evidence” box.

3. Write your reasoning in the “Reasoning” column of the 4.8 Worksheet.

4.8 Worksheet

Name: _____

CLAIM:

EVIDENCE:

Place TacFac Card Here

REASONING:

4.9 Conclusion

What do you think?

Do you feel like you have even more evidence for or against the different possible causes of the mysterious events?

Next Session Preview!

Next time in Solar Science…We're wrapping up! What will we learn in the 5th and final session of this curriculum? How magnetic storms can affect the Earth in "Living With a Star"...