

Name \_\_\_\_\_ Period \_\_\_\_\_ Date \_\_\_\_\_

Partners \_\_\_\_\_

### What's Going on with these Stars?

**Goal-** Be able to use graphing and analytical thinking to infer the relationships between different groups of stars.

**Background-** Have you ever gazed up at the night sky and looked at the stars? Are they all the same brightness, or are some brighter than others? What about their color? Are all stars “white,” or are there other color stars you’ve noticed? What determines a star’s brightness and color? Are they created that way? Do stars change in color or brightness as they age? What are stars made of anyway? Are they all made of the same things, or are there differences between what they are made of?

None of these questions are easy to answer. However, we can observe, infer, and question our way closer to meaningful answers if we use the right strategies.

In this graphing lab, you and your partners will work to determine how you can organize and graph data so that it yields patterns to help you understand the behavior of stars.

**Instructions-** First look at the data on the next page. Your instructor may support a short discussion about what data you are seeing.

Discuss the data with your partners and answer the questions below.

1. What are the two characteristics being used to compare the stars in this data table? Are the stars arranged in any order? \_\_\_\_\_
2. Consider the column that indicates Color. Can you come up with any ideas about what the numbers in this column mean? How can a qualitative characteristic such as color be described with a number?

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3. For the Color column, find these values, including the unit:
  - a. The **lowest** value: \_\_\_\_\_
  - b. The **highest** value: \_\_\_\_\_
4. Consider the column that indicates Luminosity. What could this term refer to? What makes you think this?

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5. Consider Luminosity again. Do you have any ideas why we would compare stars’ luminosity to that of the sun? Why might this be useful or convenient? \_\_\_\_\_

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6. For the Luminosity column, find these values, including the unit:
  - a. The **lowest** value: \_\_\_\_\_
  - b. The **highest** value: \_\_\_\_\_

7. What might be difficult about trying to graph the luminosity values? How would you format this axis?

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#	Star Name	Color (Peak wavelength in nm)	Luminosity (Relative to Sun)	Spectral Class (Completed after Graphing and Discussion)
1	110 Herculis	610	18	
2	16 Cygni	590	0.5	
3	40 Eridani B	500	0.005	
4	54 Piscium	750	0.0001	
5	61 Ursae Majoris	565	1.05	
6	70 Virignis	540	1.8	
7	9 Sagittarii	455	260	
8	Alcyone	560	100	
9	Aldebaran	610	170	
10	$\alpha$ Aurigae Aa	670	105	
11	$\alpha$ Carinae	610	250	
12	Antares	650	10500	
13	AR Scorpii A	490	0.001	
14	Arcturus	630	65	
15	Barnard's Star	670	0.03	
16	$\beta$ CVn	575	1.5	
17	Betelgeuse	700	11000	
18	BP Crucis	480	45000	
19	ChaHa8	750	0.0005	
20	Cygnus OB2-12	460	50000	
21	$\delta$ Cephei	510	3000	
22	$\delta$ Orionis	600	110	
23	Deneb	575	9400	
24	Epsilon Indi	730	0.0002	
25	Epsilon Ophiuchi	650	115	
26	Eta Bootis	580	80	
27	GJ 440	575	0.0005	
28	Gliese 570	720	0.0006	
29	Gliese 581	690	0.002	
30	Groombridge 1830	620	0.05	
31	HD 13189	740	0.0002	
32	HD 33579	725	50000	
33	HT Sagittae	450	75000	
34	$\iota$ Orionis	500	12	
35	Kappa 1 Ceti	570	1.1	
36	Kapteyn's Star	600	0.2	
37	Lalande 21185	660	0.09	
38	LDS 275	465	0.009	
39	Mira	630	110	
40	Mu Cassiopeiae	600	0.1	
41	NGC 4349-127	760	0.0001	
42	NML Cygni	625	70000	
43	O Herculis	535	9	

44	Pollux	640	95	
45	Procyon B	550	0.0006	
46	Proxima Centauri	650	0.06	
47	Rho Cassiopeiae	525	7000	
48	Rigel	480	8500	
49	S Persei	580	80000	
50	SDSS J0003+0718	480	0.003	
51	$\Sigma$ Octantis	665	90	
52	$\Sigma$ Orionis	475	150	
53	Sirius B	470	0.005	
54	SSSPM J1549-3544	630	0.03	
55	Stein 2015 B	460	0.01	
56	<b>Sun</b>	<b>590</b>	<b>1</b>	
57	$\tau$ Geminorum	760	0.0007	
58	Teegarden's Star	650	0.1	
59	Thuban	640	55	
60	$\mu$ Cancri	590	25	
61	$\mu$ Combae	480	70	
62	UY Scuti	680	5000	
63	V509 Cassiopeiae	650	60000	
64	van Maanen's Star	620	0.0002	
65	VB 10	670	0.005	
66	VY Canis Majoris	550	80000	
67	WD B1620-26	520	0.0008	
68	Wolf 359	645	0.5	
69	$\Upsilon$ Cephei	575	30	
70	$\Upsilon$ Orionis	525	10	
71	Zeta Ophiuchi	460	380	
72	Zeta Ophiuchi	485	88	
73	Zeta Scorpii	700	95000	

After you have discussed and data and answered the questions on the first page, discuss with your group how you will graph the star data.

8. What **type** of graph is best to use? Why?

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9. How will you **format the luminosity axis** with such widely different values?

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10. Do you think it matters which value is on the x-axis and which is on the y-axis? Where do you think your group should place these values? Explain why.

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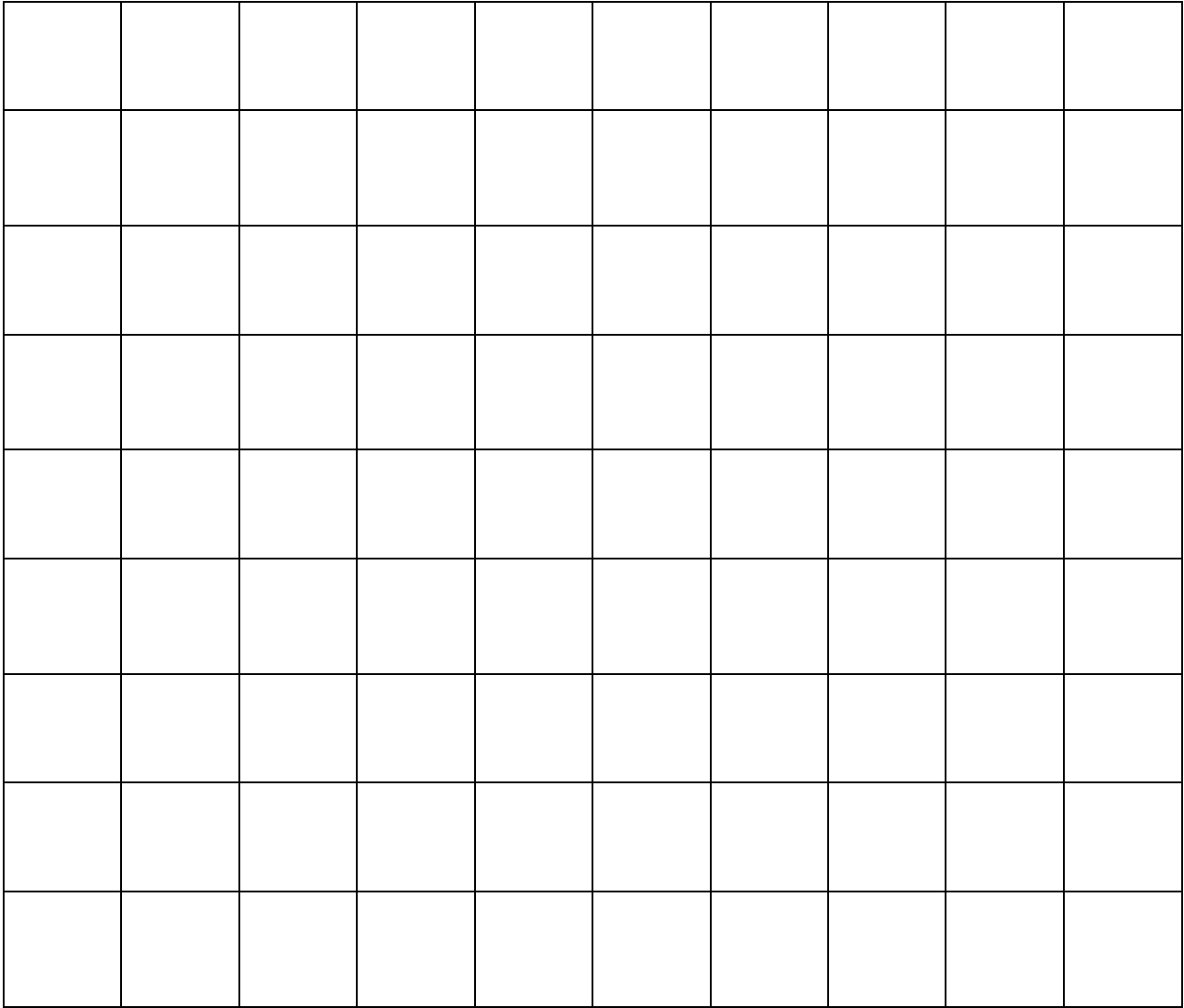
Have your instructor talk with your group before you proceed with your graphing.

**Initials:** \_\_\_\_\_

**Graphing-** Now you are ready to graph! In your graph, be sure to include the following:

- A scaled and labeled x-axis
- A scaled and labeled y-axis
- Data in the graph space
- Color bands using markers or colored pencils
- A title

(Note that your graph may look a little different from other groups. This is alright. After we graph, we will discuss these differences.)



**Wavelength-Color Reference:**

Peak Wavelength	Star Appearance
>740 nm	Brownish
625-740 nm	Red
590-625 nm	Orange
565-590 nm	Yellow
500-565 nm	White
450-500	Blue

**Analysis-** After you finish graphing with your group, have your instructor look over your graphs. Your instructor may have input or follow-up questions for you.

Once you have discussed your graph with your instructor, answer the analysis questions below. You will need to use your graph to help answer them.

11. What jumps out at you after completing the graph? Describe any groupings or patterns you notice. If at first you don't spot any, discuss this question with your group.

12. Hopefully you and your partners were able to identify several groups of stars (at least four). Be prepared to share with the class what groups you found. Your instructor may lead a discussion to help you identify these groups. In your graph, outline each group.

Each group that is identified needs a general name so we know how to refer to them. Your instructor may lead a discussion to help come up with common names. Add those names to your graph in the appropriate areas.

13. Now that the class has agreed upon names to call these different clusters, name and describe each group in the spaces below. There are 5 rows in case you came up with as many groups. Also describe the characteristics that define each group.

Name of Star Group	Description

## Thought Questions

14. Think about the colors of the stars. Why might stars come in different colors?

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15. Look at the luminosities of the stars. Why might stars come in different degrees of brightness?

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16. Is there a relationship between color and luminosity? Describe any relationship you see. (Does such a relationship depend upon the group you are looking at?)

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17. Consider the BLANK areas of the graph, or the areas where no stars are present. What could these empty areas indicate about stars?

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18. Do you suppose that all stars in the universe are the same age, or different ages?

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19. Do you think that there is any relationship between a star's age and where it is in the diagram? If so, explain.

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20. Do you think that there is any relationship between a star's mass and where it is in the diagram? If so, explain.

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**Further Questions-** In the spaces that follow, develop 2 questions that you still have about stars after doing this data analysis lab. What questions or wonderings have not been answered yet? What are you curious about?

If you wish, you may begin these with "I wonder..."

(Hint: You are NOT allowed to copy or rephrase a question from above! Be creative!)

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22. \_\_\_\_\_

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