

Chapter 14: H-R Diagram Plotting

Student Worksheet

Objective:

Learn how the H-R diagram illustrates stellar properties and how to plot stars according to their properties.

Engage:

Nutritional value and good flavor are two properties of food. On a spare sheet of paper, or on the back of this activity, make a chart ranking the good flavor of foods on the x-axis and the nutritional value of food on the y-axis. Choose some sample foods to plot on this chart. See if any trends are found. Of course, this is an inherently biased undertaking.

Introduction:

The H-R diagram is one of the very most important diagrams in astronomy. It tells us how a star can be understood based on its properties. By observing these properties and plotting them on a chart (that eventually evolved into the H-R diagram), astronomers were able to decode the life stages of a star. While stars are not alive, the way they form, fuse, and ultimately cease to fuse is analogous to a life cycle.

NOTE: For more background information on this H-R diagram, please see **Section 13.5** on **pages 350-354** of your textbook, *Explorations: Introduction to Astronomy, 7/E* (Arny).

Your Task:

You will be given the properties of some stars which you will plot on the blank H-R diagram provided by your teacher.

1. Label the spectral classes OBAFGKM, spaced appropriately in the horizontal box at the top of your diagram. Use **Table A.10** in the appendix of your book to match the spectral types with their ranges of temperatures. The spectral classes are not evenly spaced. You will need to plot them based on the ranges of temperatures. Mark where one class ends and another begins.
2. Use **tables A.8 and A.9** in the appendix at the end of your book to plot each star listed in these two tables. Use the columns *Spectral Type* and *Luminosity* to plot the stars.

3. You might see some grouping tendencies on the diagram you have plotted. One natural cluster is for stars that have come near the end of their lives. The heat generated by the fusion of heavier elements in their cores has outweighed the inward pull of gravity, resulting in an expanding star. Heat causes objects to expand but as they expand they also cool. So, this group of stars is bigger in size and cooler in temperature than they were during the main part of their lives. Label the *red giants*.
4. One region of the H-R diagram includes stars in the main part of their lives, defined by the burning of hydrogen into helium and sometimes more. Label the *main sequence*.
5. Label the *white dwarfs*.
6. The Sun is a G star with a luminosity of $1 L_{\odot}$. Label the *Sun*.
7. When the Sun leaves the main sequence it will go through a *red giant* phase, and ultimately become a *white dwarf*. The universe is not old enough to observe what happens to white dwarfs as they cool, but hypothetically they should become cooler as time goes on, eventually becoming a *black dwarf*. Use a dotted path to show this evolution on your chart.

Conclusion:

8. What difference do you notice about the direction of x-axis? Would reversing this traditional plotting change anything significant about your diagram?
9. Before the Sun was a star it was a *protostar*. It was cooler, and more luminous than it is now. Protostars are not included on the H-R diagram. If they were, where might they be located?

10. What do you notice about O stars on your plot? Why is this?
11. Do you notice any trends about our nearby stars? What could this tell you about our stellar neighborhood?
12. As luminosity increases, what other stellar property increases?
13. A common misconception students hold after being introduced to the H-R diagram is that stars move through space as they would move along the chart through a main sequence, giant, and dwarf phase. Explain why this is not so.

Extend:

- Who were Hertzsprung and Russell? Find out more about their lives and astronomical contributions.
- Label the spectral subclasses and the luminosity classes on your diagram.
- Do the Project listed **at the end of chapter 14** in your textbook, *Explorations: Introduction to Astronomy, 7/E* (Arny); by doing so you will get an understanding of the time spent in each region of the H-R diagram.

