Human HR Diagram Activity – Teacher Guide:*

Background – Students need to be familiar with stars and that they have different intrinsic properties, such as surface temperature and luminosity. We can plot these properties together and look for trends in the data. For stars, this is the Hertzsprung – Russell Diagram. In addition, students need to be comfortable with linear and logarithmic scales.

In this activity, we are going to be making a human HR Diagram. We will need a large clear space, but with walls, or boards where we can post axes labels. A large classroom with desks pushed to the side or out of the way works best.

Teacher set-up:

1.) Before the activity begins, and typically before students are present, print out and post the axes labels around the room. The axes labels are in the file called, "axis_labels". Each axes label value can be printed on one 8.5x11 inch paper for Surface Temperature. For Luminosity, two values are printed on each paper, cut those in half after printing.
2.) Two walls in the classroom will serve as the x and y axes of your plot.
3.) For the x-axis, you will post the surface temperature values along one wall. To allow students to understand that the HR Diagram is plotted in log-scale, we will first start with putting are x & y values in a linear scale.
4.) Tip: you can post / tape up both the linear and log scale values at the same time. Tape up the logarithmic scale values first and then cover them up with the linear scale values. After students realize that a linear scale won't work and you ask them what scale would be better, after some guessing they will hopefully identify a logarithmic scale. At that point you can take down the linear values and reveal the logarithmic values.
5.) For surface temperature – remember that the scale runs backwards, with the largest values starting close to the origin and the lower values (cooler temperatures) going out.
6.) Post in the following order, starting at the origin, then equally spaced out along your wall:

    Surface Temp = 50,000 K;
    Surface Temp = 24,000 K (log value), covered up by Surface Temp = 40,000 K (linear value)
    Surface Temp = 11,000 K (log value), covered up by Surface Temp = 30,000 K (linear value)
    Surface Temp = 5500 K (log value), covered up by Surface Temp = 20,000 K (linear value)
    Surface Temp = 2500 K (log value), covered up by Surface Temp = 10,000 K (linear value)

7.) Post on the other wall in the following order, starting at the origin, then equally spaced out, your luminosity values which will be the y-axis:

    Luminosity = 0.0001 Lsun (log value), covered up by L = 0 Lsun (linear value)
    Luminosity = 0.01 Lsun (log value), covered up by L = 70,000 Lsun (linear value)
    Luminosity = 1 Lsun (log value), covered up by L = 140,000 Lsun (linear value)

Luminosity = 100 Lsun (log value), covered up by L = 210,000 Lsun (linear value)
Luminosity = 10,000 Lsun (log value), covered up by L = 280,000 Lsun (linear value)
Luminosity = 1,000,000 Lsun (log value), covered up by L = 350,000 Lsun (linear value)
NOTE: for the logarithmic Luminosity values there is also a set that is given in exponential notation if you prefer to use those values.

8.) Print out and cut out the individual stellar strips of paper – these will be given one to each student individually at the start of the activity. These are found in the file labeled "stellar_info_slips".
9.) Each stellar info slip gives the real properties of a star, including: stellar mass, luminosity, surface temperature, and Main-Sequence lifetime, and in some cases a common name if the star is a well known nearby star. Pages 1 & 2 list the properties in non-scientific notation, Pages 3 & 4 contain the same stars / information just in scientific notation.
10.) There are 33 unique stars given on the pages. If you have less than 33 participants, you can select only as many as you need, however try to get a range of masses to pass out so that at least a few students will be high-mass stars, and more will be medium and low-mass stars.
11.) Print out copies of the Student Sheet, but do not pass out at beginning of the activity. Students can get these after completing the kinesthetic activity, and can answer the questions as a group during the activity and/or complete it individually or in small groups after doing the active HR Diagram.

Teacher Directions During Activity:

1.) At the start of the activity, make sure the axes labels are posted and only the linear value labels can be seen at first.
2.) Pass out a stellar info slip, one to each student / participant.
3.) Start the narration by reading the introduction on the Student Sheet.
4.) Read the steps / narration in the student sheet, one at a time, and have students begin by making the HR Diagram, and placing themselves around the room where they should be based on their own unique stellar info.
5.) NOTE: At the beginning for the linear scale students should be bunching up in the corner with low surface temperature and low luminosities. Most students will be all packed together, with only a few students (1-3) separated from the bunch.
6.) Ask: "Do we have a problem with our HR Diagram?" or "Is this what you expect your HR Diagram to look like? Remember these are all real values for stars in our Milky Way Galaxy." "How do we fix this?"
    a. Anticipate a range of answers. Look for answers related to changing the scale / values of our plot.
7.) Once you get a number of answers, you can remove the linear values of each axes label and reveal the logarithmic scale values.

8.) Then say, “Now let’s try this again!” – Once again everyone arranges themselves based on their star’s surface temperature and luminosity. A correlation / trend line should start to appear, and not just a random scatter plot.
9.) Continue reading the script on the “Student Sheet”. You will fast forward time at a few different intervals, and have some students / stars start to evolve off the Main Sequence.
10.) Have students answer the questions in the script as a group as you are going through it.
11.) At the end, you can pass out the student sheets to the students or have them work in small groups to write down the answers to the questions they just acted out and discussed in the larger group.

Texas Essential Knowledge and Skills:

Science – Grade 8, 112.20:

(8) Earth and space. The student knows characteristics of the universe. The student is expected to:

(A) describe components of the universe, including stars, nebulae, and galaxies, and use models such as the Herztsprung-Russell diagram for classification.

Astronomy, 112.33:

(10) Science concepts. The student knows the role of the Sun as the star in our solar system. The student is expected to:

(A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun;

(11) Science concepts. The student knows the characteristics and life cycle of stars. The student is expected to:

(A) identify the characteristics of main sequence stars, including surface temperature, age, relative size, and composition;

(D) differentiate among the end states of stars, including white dwarfs, neutron stars, and black holes;

(G) use the Hertzsprung-Russell diagram to plot and examine the life cycle of stars from birth to death.

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Activity documentation can be found at:
http://www.as.utexas.edu/~keelyf/Additional_Teacher_Resources.html