Alternative H-R Diagram

Understanding Hertzsprung-Russell Graphs

with Everyday Objects

Classroom Activity

Overview

Age Range:

16-18

Prep. Time:

10 minutes

Lesson Time:

1 hour 15 minutes

Cost per activity:

Low (printing costs)

Includes the use of:

Graph paper, Excel, internet

Outline

Students will practise plotting Hertzsprung-Russell diagrams using a range of different, yet familiar, items. Once they have plotted their graph they will compare this with other groups.

Next they will see how a real Hertzsprung-Russell diagram is created by using the stars table to plot a true H-R diagram.

Finally, they will compare the range of items by creating a 'master diagram', using all the items and stars plotted. Creating an expanded H-R diagram to see how objects really compare.

Pupils will Learn:

- How to create graphs and plot data
- Logarithmic scales
- Using the Hertzsprung-Russell diagram

Lesson Plan:

Overview of the time required to complete lesson.

Description	Time	Notes
Introduction to the subject	10 min	

The online observatory collaboration consists of the following partners:
Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory

Activity 1	30 min	Create a H-R diagram for a set of everyday objects.
Activity 2	20 min	Create a H-R diagram
Assessment	15 min	Combine the information from all of your H-R diagrams to create an expanded version and compare the items.

Introduction to the subject:

The Hertzsprung-Russell diagram (HR diagram) is one of the most important tools in the study of stellar evolution. Developed independently in the early 1900s by Ejnar Hertzsprung and Henry Norris Russell, it plots the temperature of stars against their luminosity (the theoretical HR diagram), or the colour of stars (or spectral type) against their absolute magnitude (the observational HR diagram, also known as a colour-magnitude diagram).

There are two main reasons to use logarithmic scales in charts and graphs. The first is to respond to skewness towards large values; i.e., cases in which one or a few points are much larger than the bulk of the data. The second is to show percent change or multiplicative factors.

Activity 1:

- Divide students into five groups and provide each with a different table from the background resources section

Introduce the activity, telling students they will learn about H-R diagrams using familiar, everyday objects, first.

1. Give students some time to try and come up with a scale for their everyday objects (temperature-luminosity) graph.
2. Introduce the concept of logarithmic scale to the students and have them create a new graph, in the H-R diagram style, for their everyday objects.
3. If students have time available, they should do some research and add two new items to their diagram, these could be similar objects or very different ones.

Activity 2:

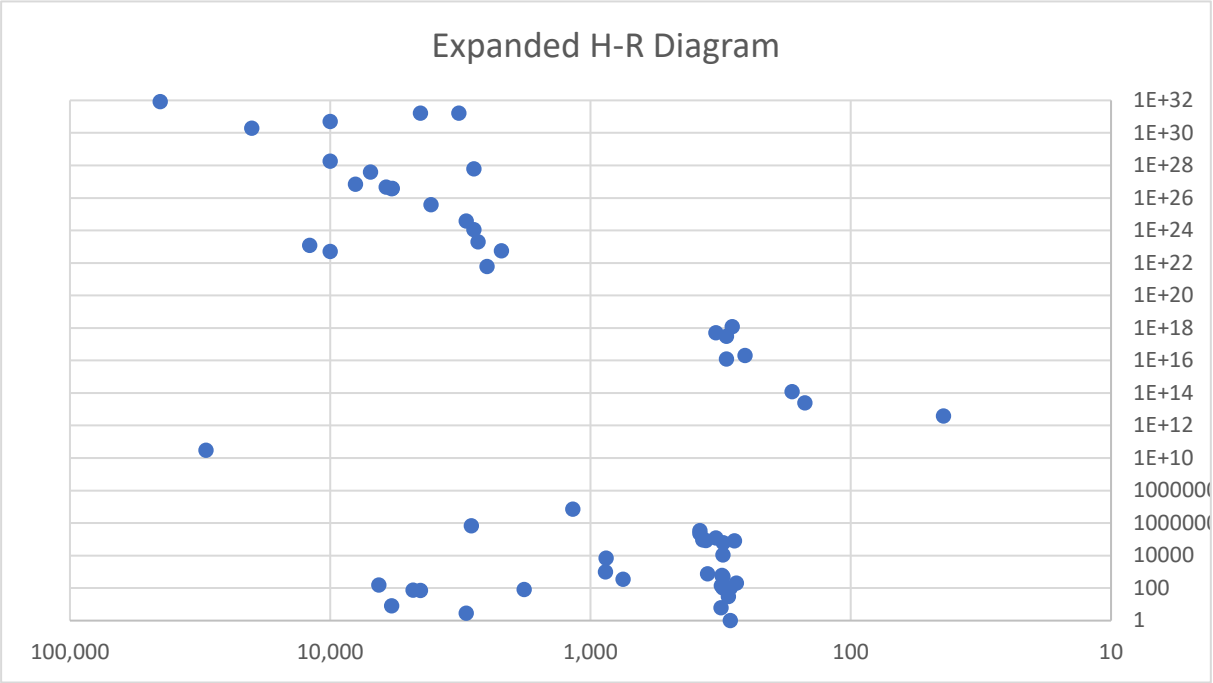
Introduce the activity, telling students that they will now use star data to plot an actual Hertzsprung-Russell diagram.

1. Have the students consider what axis and scale they should be using (if they do not come to a sensible conclusion suggest logarithmic scales going from 100,000 to 1,000 for the temperature and $1x10^{20}$ to $1x10^{32}$).

2. Advice students to use colours to mark the stars on their diagram, matching the suggestions made in the star table.
3. Use the Sun's lifespan table to track how it has and will evolve on the Hertzsprung-Russell diagram.

Assessment:

- Either have students create an expanded H-R diagram or show them the completed one below:



- Ask students to identify areas of the expanded H-R diagram (e.g. electronic objects, animals, solar objects and stars/the main sequence)

Background Resources:

Item	Temperature (K)	Luminosity/Power (W)
Lightbulb	4,800	75
LED bulb	5,800	8
Plasma Television	750	350
Fridge	275	200
Washing Machine	310	500
Toaster	875	1,000
Smart Phone	315	6
Laptop	295	30

Object	Temperature (K)	Luminosity/Power (W)
Moon	300	1.2E+16
Earth	300	3.0E+17
Jupiter	285	1.2E+18
Venus	330	5.0E+17
Mars	255	2.0E+16
Ceres (dwarf planet)	168	1.2E+14
Vesta (asteroid)	150	2.4E+13
Pluto	44	3.8E+12

Object	Temperature (K)	Luminosity/Power (W)
Human	310	100
Blue Whale	280	78,000
Elephant	309	61,000
Horse	310	11,000
Cow	312	600
Dog	314	140
Snake	290	100
Fly	290	1

Object	Temperature (K)	Luminosity/Power (W)
Campfire	870	7,000
Lightbulb	4,800	75
LED Bulb	5,800	8
Candle Flame	1,800	80
Lightning Bolt	30,000	3E+10
Hand-held Torch	3,000	2.8
Car Headlight	4,500	70
Arc Lamp	6,500	150

Object	Temperature (K)	Luminosity/Power (W)
Average Car	370	90,000
F1 Car	2,870	670,000
Plane	1,170	7.2E+6
Tractor	355	740
Bus	380	224,000
Lorry	380	343,000
Motorbike	360	84,000
Speed Boat	330	119,000