Plan Your Own Investigation 8-A

Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

The Brightness of Stars

Is a star bright because it is close? Or is a star bright because it is luminous? Are both distance and luminosity important? In this investigation, you will plan and conduct a simulation to determine the relationship between star brightness and star distance from Earth. You will set up your simulation as though you are a designer at a science centre and are preparing a display for the general public. Your display cannot be longer than 4 m.

Safety Precautions

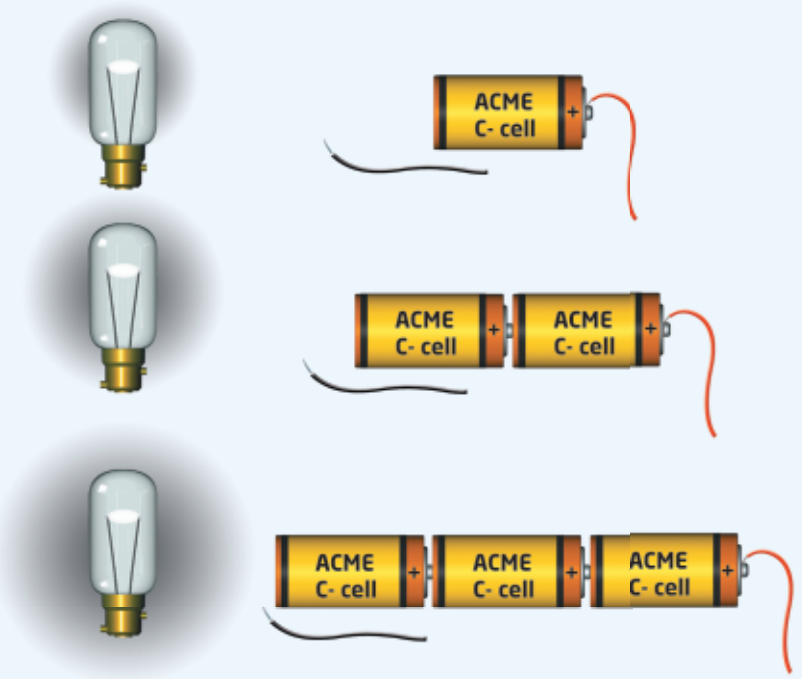
- Do not short circuit the batteries. The batteries will become very hot, and their usable lifetime will be shortened.
- Use only incandescent bulbs.
- Do not exceed 4.5 V when hooking up the bulbs.
- Work carefully if you perform this investigation in a darkened room.

Materials

- six 1.5 V C or D battery cells, set up with one, then two, and then three in series (that is, 1.5 V, 3.0 V, and 4.5 V); see the illustration
- 6 hook-up wires with clips
- three 5 V (4.8 V) incandescent flashlight bulbs
- 3 base sockets for bulbs
- 3 battery holders
- sufficient connecting wires with connecting clips for 3 lamps
- metric tape measure

Question

What is the relationship between star brightness and star distance from Earth?



Prediction

Predict the relationship between distance and brightness, and predict how the flashlight bulbs must be arranged in order to have the same apparent brightness.

Plan and Conduct

1. Brainstorm about how you might perform this investigation. Write an outline of how the display will be built.
2. Make a prediction. Give a reason why you believe your prediction is correct.
3. Create a data table for collecting your data. Give your table a title.
4. Have your teacher approve your investigation method, outline, data table, and safety precautions.
5. Carry out your investigation. Remember to record your observations in your data table.
6. Repeat your investigation several times to collect more data.

Analyze and Interpret

1. Describe the relative positions of the lamps when they all have the same apparent brightness as seen by an observer.

Conclude and Communicate

2. Explain how the properties that you discovered can be used to help astronomers find the distances from Earth to the stars.
3. Evaluate the tools, techniques, and processes that you used to gather evidence. What improvements could you make?
4. From your observations, write a general statement about the relationship between distance and brightness.
5. Write the display plaque that explains to visitors the purpose of the display.

Extend Your Inquiry and Research Skills

6. **Inquiry** What are the benefits and limitations of the model in this experiment? If you were to design a new model, what modification would you make?
7. **Research** Simulations are important in the study of space. Research the advantages and disadvantages of using simulations.

Inquiry Investigation 8-B

Skill Check

Initiating and Planning

✓ **Performing and Recording**

✓ **Analyzing and Interpreting**

✓ **Communicating**

Materials

- ruler

Using Spectral Analysis to Identify Star Composition

Recall from your previous chemistry studies that a spectroscope separates white light into its rainbow colours, like a prism. A star's spectrum shows dark lines across the colours, as shown in the diagram below. These lines reveal that some wavelengths of light have "disappeared." The wavelengths have been absorbed by gases in the star's atmosphere. Each element absorbs certain wavelengths, producing a unique pattern of dark lines—like a bar code—on a spectrum. For example, the diagram below shows the spectrum for the element carbon.

In this investigation, you will examine the simplified spectra of five known chemical elements and use that information to interpret the composition of the Sun and three "mystery" stars.

The spectral lines for carbon are illustrated here.

Question

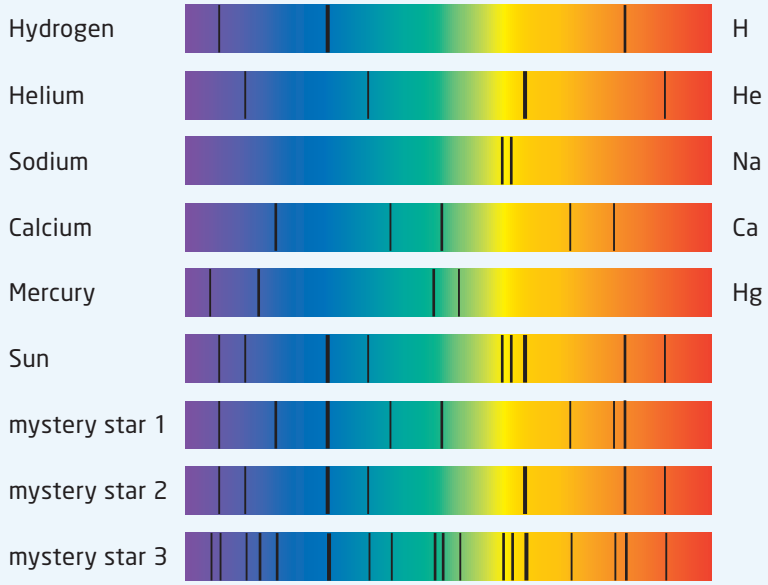
What are the Sun and the three mystery stars made of?

Prediction

The composition of the stars can be predicted by analyzing their spectra.

Procedure

1. The diagram illustrates the spectral patterns for five elements. Study these spectra to familiarize yourself with their patterns.



2. Examine the spectra for the Sun and the three mystery stars in the diagram. Using a ruler to help you line up the spectral lines, compare the spectral patterns of the known elements to those of the Sun and the three unknown stars. Then answer the following questions.

Analyze and Interpret

1. Which elements are present in the Sun's spectrum?
2. In which two mystery stars is calcium (Ca) present?
3. Which mystery star contains sodium (Na)?
4. Only one mystery star contains mercury (Hg). Which one is it?
5. Which mystery star's composition is least like that of the Sun?

Conclude and Communicate

6. In a paragraph, briefly describe how a star's composition can be inferred by analyzing its spectral pattern.

Extend Your Inquiry and Research Skills

7. **Inquiry** Suppose you were to analyze the light from the full Moon with a spectroscope. Predict the spectra that you would see. Explain your answer.
8. **Research** Research how astronomers use spectroscopy in their work.

Data Analysis Investigation 8-C

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Data for H-R Diagram

Spectral Type	Absolute Magnitude
O5	−5.7
O9	−4.5
B0	−4.0
B2	−2.45
B5	−1.2
A0	+0.65
A2	+1.3
F0	+2.7
F2	+3.6
F8	+0.44
G2	+4.7
G8	+5.5
K0	+5.9
K2	+6.4
K5	+7.35
M0	+8.8
M2	+9.9
M5	+12.3

Building an H-R Diagram

Some H-R diagrams plot absolute magnitude on the *y*-axis instead of luminosity. In this investigation, you will build an H-R diagram from the data in the table. You will use your H-R diagram to predict the absolute magnitudes of main-sequence stars.

Question

How can you predict the absolute magnitudes of stars in the main sequence if you know whether the star is hot or dim?

Hypothesis

Hotter stars have higher absolute magnitudes.

Organize the Data

Your teacher will give you a blank H-R diagram. To make it easier to refer to the different types of main-sequence stars, astronomers developed a series of star types based on their spectra. These are called spectral types and are named O, B, A, F, G, K, and M. They are further broken into subcategories, using numbers, such as O5 and B2. Using the table of data at the left, graph each spectral type against its absolute magnitude on the blank H-R diagram.

Analyze and Interpret

1. What pattern do you see on your graph?

2. The Sun's spectral type is about G2. Use your chart to predict the Sun's absolute magnitude.

3. The star Vega's spectral type is A0. Use your chart to predict Vega's absolute magnitude.

4. A star's spectral type is B5. Use your chart to predict its absolute magnitude.

Conclude and Communicate

5. Summarize how you can use this pattern to predict a main-sequence star's absolute magnitude if you know the star's spectral type.

6. Was the hypothesis supported by the data? Why or why not?

Extend Your Inquiry and Research Skills

7. Research Research why astronomers use absolute magnitude instead of apparent magnitude on H-R diagrams.