WARD'S
STAR MAGNITUDES LAB ACTIVITY
Student Investigation

Chapter 30.1

Name: _____ **Date:** _____

BACKGROUND

Stars like our sun produce radiant energy in the form of visible light. By studying this starlight, astronomers can learn much about a star's composition, distance from the earth, brightness, and temperature. Some stars appear to be brighter than others when viewed from the earth. This **apparent magnitude** of a star is often compared to its true brightness, or **absolute magnitude**, which reflects how bright a star appears from a fixed distance of 32.6 light years. Two stars can have the same absolute magnitude but different apparent magnitudes because one star may be farther from the earth. In a similar way, two stars with the same apparent magnitude may actually have two different absolute magnitudes, but appear equally "bright" because the star with the higher absolute magnitude is farther away. Scientists have also discovered that a relationship exists between a star's surface temperature and its absolute magnitude. Generally, this means that the higher the surface temperature of a star, the higher the absolute magnitude.

MATERIALS REQUIRED (per student/group)

- 2 Flashlights
- 1 Copper spacer
- 2 Paraffin blocks (approx. 2.5" x 4.75")
- 1 Sheet of aluminum foil
- 1 Rubber band
- 1 Set of student copymasters
- 3 D-cell flashlight batteries (see instructor)
- Meter stick (see instructor)
- Desk lamp with incandescent bulb (see instructor)
- Masking tape (optional)

PROCEDURE (Part I)

In this activity, you will be constructing a simple "photometer" to determine the effect of distance on the brightness of two artificial light sources, and explore the relationship between brightness and color in the study of starlight.

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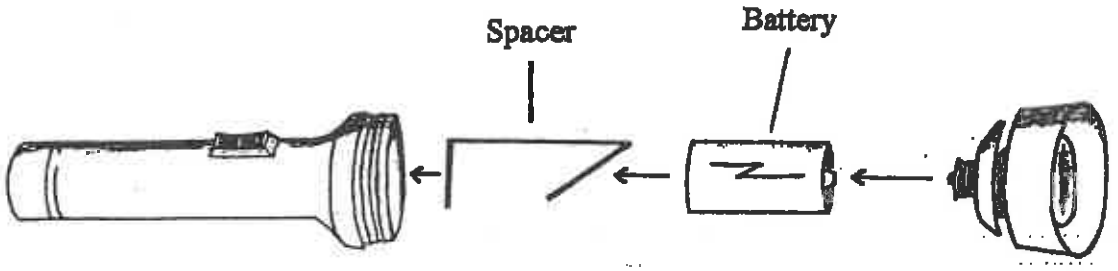
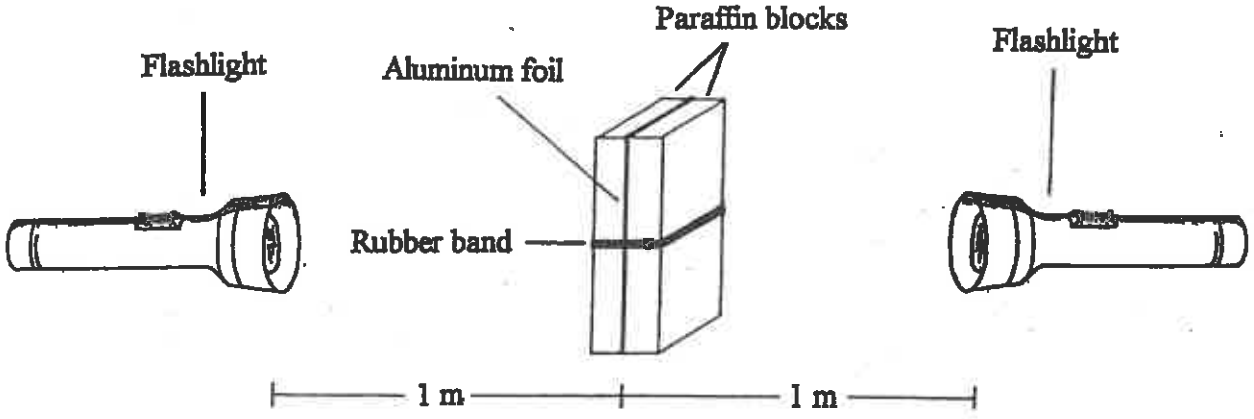
A. Locate the two flashlights and obtain three D-cell flashlight batteries from your instructor. Insert two of the batteries in one flashlight. In the second flashlight, place the copper spacer into the battery compartment as shown. Place one D-cell battery in this flashlight so that it rests on top of the spacer and screw on the lens. Test both flashlights to make sure they light when the switch is turned on.



B. Now fold the aluminum foil sheet provided so that it is approximately the same size as one of the paraffin blocks. Fold the foil so that the shiny side is facing out on both sides. Place the folded foil between the two paraffin blocks, and hold the pieces firmly together with a rubber band.

C. Place the two flashlights on a table about 2 meters apart and facing each other. Use a meter stick to measure the distance between them. You may want to use a piece of masking tape to hold the flashlights in position and keep them from rolling once you are done. Next, place the "photometer" (paraffin blocks) in the center of the table between the two flashlights. The blocks should be oriented with the largest flat surface facing each flashlight as shown.



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D. Turn on both flashlights and turn off the room lights. Check to see that each flashlight is properly aimed at the photometer, and that the light is fairly well centered on each block. Adjust the side-to-side position of each flashlight as necessary, but do not change their distance from each other.

E. Observe the brightness of the light projected on each block. Move your paraffin photometer until the light projecting onto the blocks appears equally bright on both sides. With a meter stick, measure the distance, in centimeters, from each flashlight to the center of the photometer. Record your results in the Data Table below. Now square these distances and record the resulting values in the Data Table. Answer the questions which follow.

DATA TABLE

Light Source	Distance to Photometer (cm)	Distance Squared
Two-Battery Flashlight		
One-Battery Flashlight		

QUESTIONS (Part I)

1. In which direction did you move the photometer so that you observed equal brightness on both sides?

2. What values did you calculate in Step E for the squares of your two distances?

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3. What is the ratio of the square of the distance recorded for the two-battery flashlight to that of the one-battery flashlight? What can you conclude from your answer about the relative brightnesses of the two flashlights?

4. Astronomers discover two stars that emit the same spectra and, therefore, should be of equal brightness. However, one star appears four times fainter than the other when observed from the earth. If their true brightness (absolute magnitude) is the same, how much further from earth is the fainter star?

PROCEDURE (Part II)

Stars appear at night in a wide variety of colors. These color differences provide an indication of a star's surface temperature. Like stars, incandescent light bulbs produce visible light. However, the filaments inside light bulbs glow at temperatures which are much cooler than a star's surface. Here we will use our photometer to compare the color of light produced by an incandescent lamp to that of a star (our sun).

F. Using an incandescent desk lamp, place your paraffin photometer between the lamp and an outside window on a bright, sunny day. The sunlight coming through the clear window glass will be the same color as the sunlight outdoors. Turn off any overhead fluorescent room lights, and turn on the lamp. Make sure the lamp is aimed at the photometer.

G. With the photometer in place, compare the color differences you observe between both paraffin blocks—one side facing the lamp, and the other facing the sun.

H. Finally, locate your two flashlights and darken the room once again. Compare the color of the bulb powered by a single battery to that of the bulb powered by two batteries. Answer the questions which follow.

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QUESTIONS (Part II)

5. From your observations in Step G, which light source was more yellow in color? Which light was more white? Which surface temperature do you think is hotter, the sun's or the lamp's? What can you conclude about the color and temperature of each light source?

6. From your knowledge of star colors and temperatures, would you expect a white star to be hotter or cooler than an orange star? What about a blue star and a white star?

7. Based on your observations, which flashlight bulb in Step H would likely be hotter? Why?

8. Red colored stars possess a low surface temperature and are low in absolute magnitude. Despite this, some bright red stars are still visible in the night sky. Why are these stars still visible from earth?