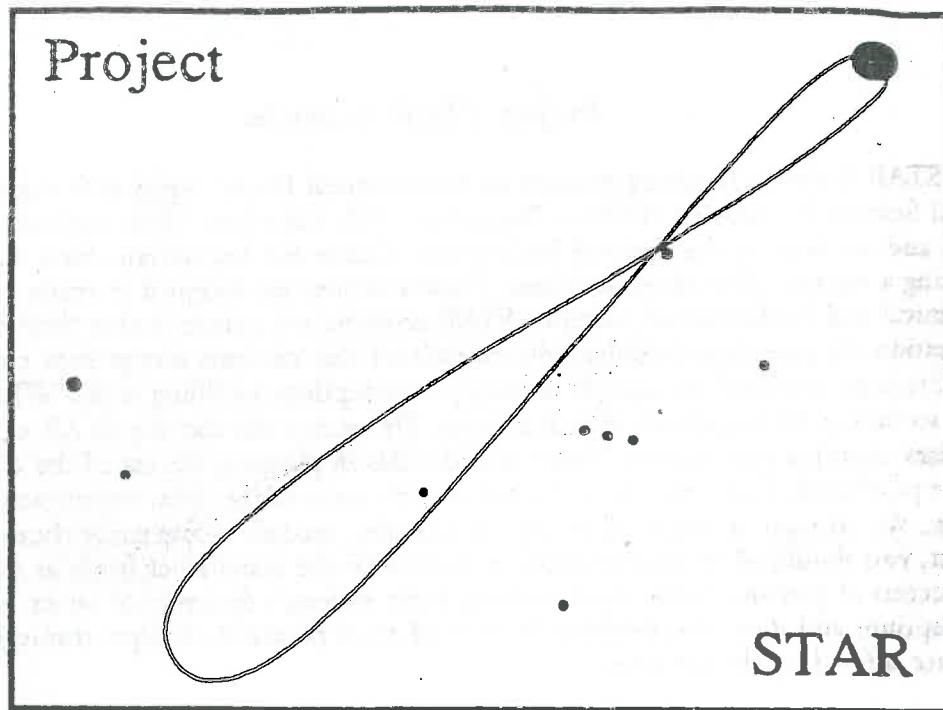




Science Teaching through its Astronomical Roots

## **#PS-06 3-D Constellation Kit Teacher's Notes and Activities**

Abstracted from the Project STAR activity book, Where We are in Space and Time.

## Project STAR Activities

Project STAR (Science Teaching through its Astronomical Roots) began with a grant from the National Science Foundation (NSF) in December 1985. Since July 1986, high school astronomy teachers and scientists at the Harvard Smithsonian Center for Astrophysics have been developing and testing a variety of hands-on activities. These activities are designed to teach basic astronomical and mathematical concepts. STAR activities are unique in that they take into consideration the preconceptions (or misconceptions) that students may possess on entering your course. Students are asked to commit to their preconceptions by filling in the What Do You Think? section at the beginning of each activity. We must stress that the STAR curriculum emphasizes concepts over content; please consider this in planning the use of the star activities you have purchased. The activities in this kit, as with most science labs, require some teacher guidance. We strongly recommend doing the activities yourself before using them in class. However, you should allow your students to work with the materials as freely as possible. The key to the success of preconception-based learning is the student's discovery of his or her preconceptions and their abandonment in favor of more powerful concepts through the personal experience offered by the activities.

The activities in this kit are taken from the STAR Activity Manual "Where We Are in Space and Time." The original activity numbering sequence has been retained for the benefit of those teachers who purchase more than one kit or have bought the complete manual. The activities should be done in numerical order to obtain the most effective results. You may have found some "extra" activities in your kit; these were included because we felt that they would provide important experiences in support of the principal activity you ordered. Please read the Teacher's Notes for the kit for special instructions, answers to questions, tips and other information. You have permission to make as many photocopies of the activities in the kit as you need for your classes.

Inquiries about orders can be sent to:

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## TEACHER'S NOTES

### PROJECT STAR CONSTELLATION MODELS KIT

#### Activity 18: Building 3-Dimensional Models Of Constellations

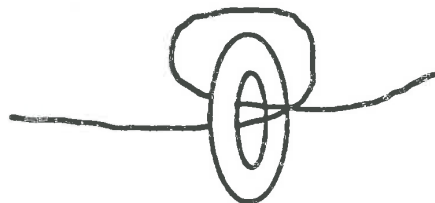
##### 1. Preconceptions

Questions 18.1 and 18.2 make up the What Do You Think? section for this activity. Question 18.1 ask the student to consider that if stars appear equally bright, are they equally distant from the Earth. Some students believe that all stars are the same distance away; they appear to have different brightnesses because they're re different sizes or temperatures. Students who think that all stars have the same brightness are likely to assume that the brightness of a star is related only to its distance and therefore stars of equal brightness must be equally distant. Many students simply have no grasp of the distance to the stars compared to the planets; students often believe there are stars nearer to the Earth than Pluto. Question 18.2 tests the student's ability to visualize a pattern of objects, in this case the stars in the Big Dipper, from the different perspective. If the student thinks the stars are equidistant, the "side view" would show the stars in a line, but not evenly spaced. If the student believe the stars could be a different distances, then the side view would show some stars with displacements from a straight line, indicating a sense of three dimensions. The student is not given sufficient information in Question 18.2 to draw or describe an accurate side view of the Big Dipper.

##### 2. Activity Tips

For each constellation there is a photograph and a chart. The student mounts the photograph on the cardboard sheet and the chart provides information on the distances to key stars in the constellation.

Step 2 describes how to string a bead so that its position can be adjusted, yet remain in place when it has been properly positioned. If the written description is not clear, the diagram below illustrates how the thread should pass through the bead.



Note that the string is only looped through the bead; it is not tied. Although the beads will stay in place, you may wish to have your students place a drop of glue on each bead when the model is complete to fix the beads in place, especially if the models will be handled a lot.

Step 7 suggests looking at the constellation photo through the hole in the washer. This is to insure that the students view the photo from the proper distance. However, if a students model has many stars, the threads tied to the washer may make it difficult to see through the washer's hole. The student can then hold the washer next to her or his eye. This still keeps the photo at the right distance and does not offset the viewing point enough to create problems with perspective.

The uniqueness of these three-dimensional models suggests that they be made accessible to other students. You may wish to mount several of the models on a bulletin board so that students can go up to a model and take a look. This also makes a good display for a parent's night or other open house events.

### **3. Answers to Questions**

The answer to Questions 18.4-18.11 will depend upon the constellation being modeled.

**ACTIVITY 18 BUILDING 3 - DIMENSIONAL MODELS OF CONSTELLATIONS****PURPOSE**

To build three-dimensional models of constellations.

**WHAT DO YOU THINK?**

Write the answers to the questions and/or problems in the spaces provided.

Show your math and box your answers, labeling answers with proper units.

*18.1 All the stars in the Big Dipper appear almost equally bright to us. Do you think all the stars that you see in the Big Dipper are almost the same distance from the Earth? Discuss your answer.*

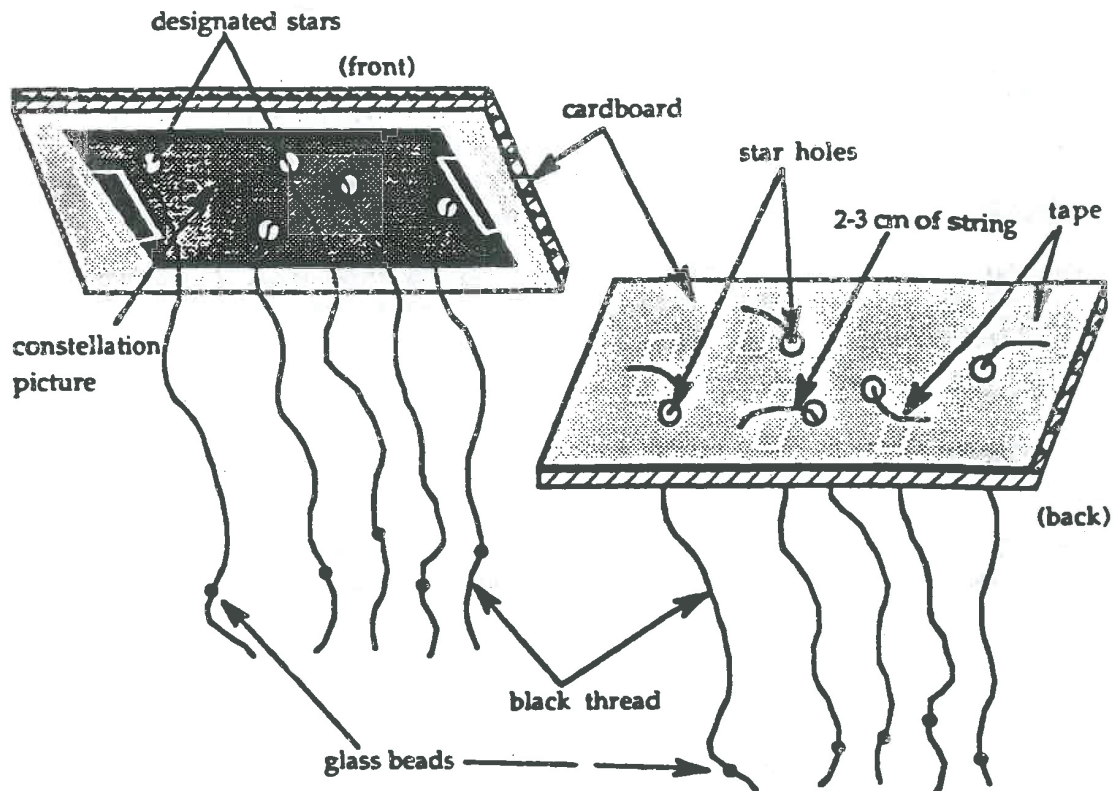
*18.2 What do you think the Big Dipper would look like if you could observe it from a planet orbiting the star at the end of the Dipper's handle? (Describe or draw your answer.)*

**MATERIALS**

- Constellation charts
- Constellation photographs
- Transparent tape
- 1 piece of box cardboard about 30 cm x 30 cm (1 ft. x 1 ft.)
- Glass beads ( number equal to number of stars in constellation)
- 1 ball point pen (with long, exposed writing point)
- 1 meter stick
- 1-meter long pieces of black thread (number of pieces equal to number of beads)
- 1 steel washer

**PROCEDURE**

1. Choose one of the constellation photographs. Tape it to a piece of cardboard. Cut pieces of thread about 1 meter (40 inches) long. You will need one piece of thread for each star marked with an arrow on the constellation chart.
2. Place a bead on each string by first passing the thread through it, then around and through it again. By stringing the bead this way, you will be able to slide the bead along the length of the string but it will stay in place when you let go.
3. Refer to Figure 18.1. Using a ball point pen, punch holes through the photo and cardboard at each star which has a distance written next to it on the corresponding chart. Slide a piece of thread through each hole, leaving about 2.5 cm (1 inch) at the back and the rest on the front. (The front side is the side with the constellation photo.) Tape the 2.5 cm (one-inch) length of thread to the back of the cardboard to hold it in place.

**Figure 18.1**

4. Bring the ends of all the threads on the star side of the cardboard together and tie them into a tight knot around a steel washer about 56 cm (22 inches) from the sheet of cardboard. Cut off the excess string.

A thread length of 56 cm is used because the camera that took the pictures of these constellations had a focal length of 56 cm. Thus, if you hold the picture at a distance of 56 cm from your eyes, the constellation will appear the same size as it does in the sky.

5. The distance to the stars on your photo is indicated on the charts. A star labeled "75 LY" is 75 Light Years from the Earth. (A Light Year, abbreviated LY, is the distance that light travels in one year, about 9.5 million million km.)

18.3 The name of your constellation is \_\_\_\_\_

18.4 What is the distance to the farthest star in your constellation? \_\_\_\_\_

18.5 What is the distance to the closest star in your constellation? \_\_\_\_\_

6. To make a three-dimensional model of your constellation, you must slide the beads along the string until they are the correct scale distance from the Earth. You will use a scale of 2.5 cm = 100 LY. For example, if a star is 100 LY away, slide the bead representing the star 2.5 cm (1 inch) from the washer. If you have a star that is 830 LY away, slide that bead out 21 cm (8.3 inches). Use a meter stick or ruler to position the beads at their approximate scaled distances. REMEMBER TO MEASURE STAR DISTANCES FROM THE WASHER TOWARDS THE PHOTOGRAPH!!!

7. When you have finished positioning the beads, hold the washer with one hand and the photo upright with the other hand. Stretch the strings and hold the washer up to your eye. Look through the hole in the washer toward the photo. (If you have many threads tied to the washer, the knot may block your view through the washer. If this occurs, hold the washer next to your eye and view the photo from that position.) You should be able to see the beads outlining the shape of the constellation. As we mentioned above, the scale of the photo is such that if you hold the cardboard at 56 cm, your view of the constellation is the same as you would have at night looking at the constellation with your naked eye. (You may wish to have a partner hold up your cardboard so that it is easier to view the constellation. In turn, you can hold up your partner's cardboard.)

8. Hold the model so that you are looking at the constellation from the side. This is how the constellation would appear if someone traveled hundreds of Light Years out into space and looked at it from the "side."

*18.6 Draw the constellation the way it would appear in a "side-view." Indicate the direction towards the Earth with an arrow. Write the name of your constellation: \_\_\_\_\_*

9. Exchange your model for that of a model of a different constellation. Examine your new model by looking at it first through the washer and then from the side.

*18.7 In what ways does the side view of this model look different from the side view of your original model?*

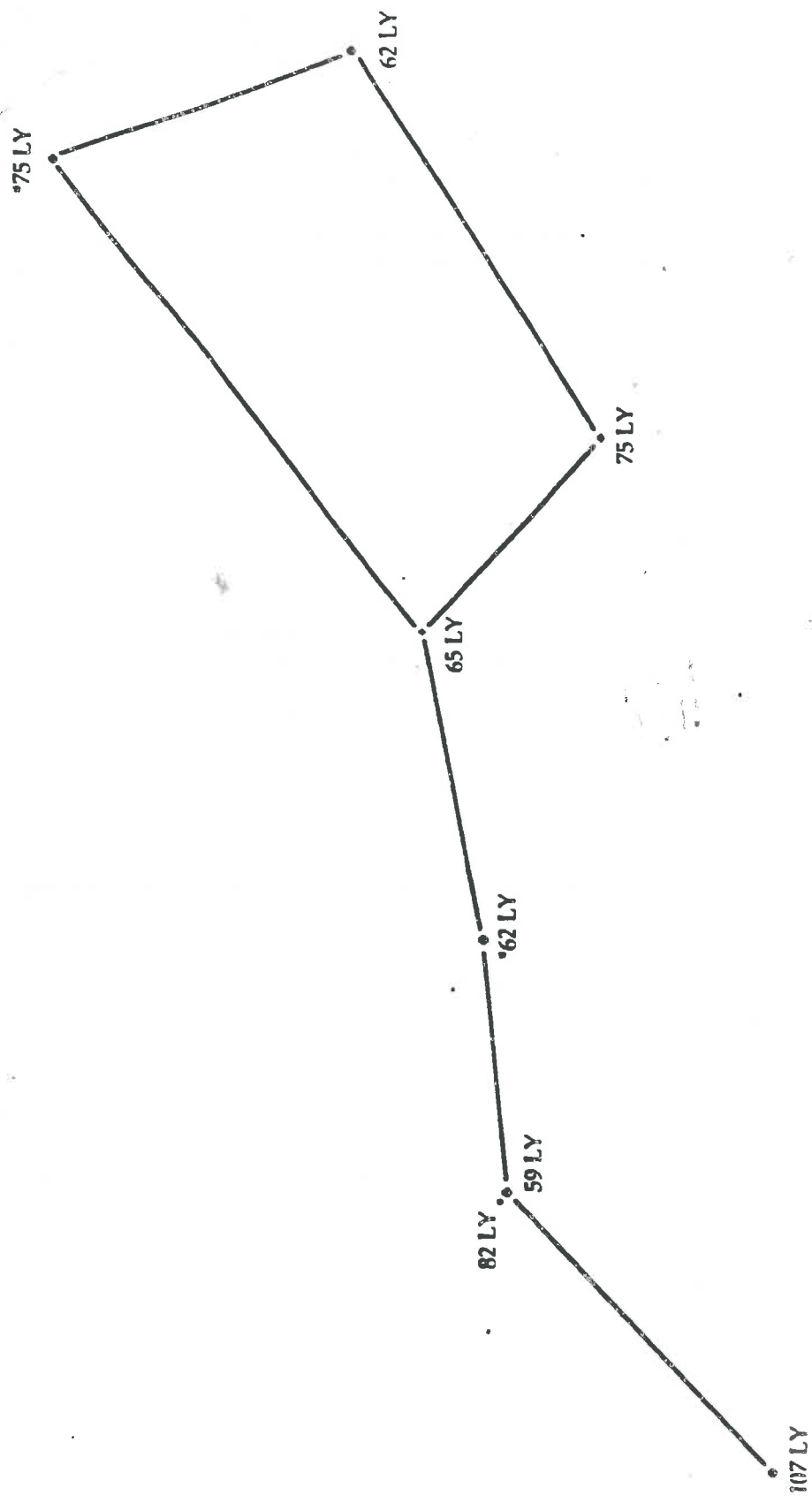
10. The brightest star of stars (as seen from the Earth) are marked with an asterisk (\*) on your constellation chart.

*18.8 What is the distance to your brightest star(s)?*

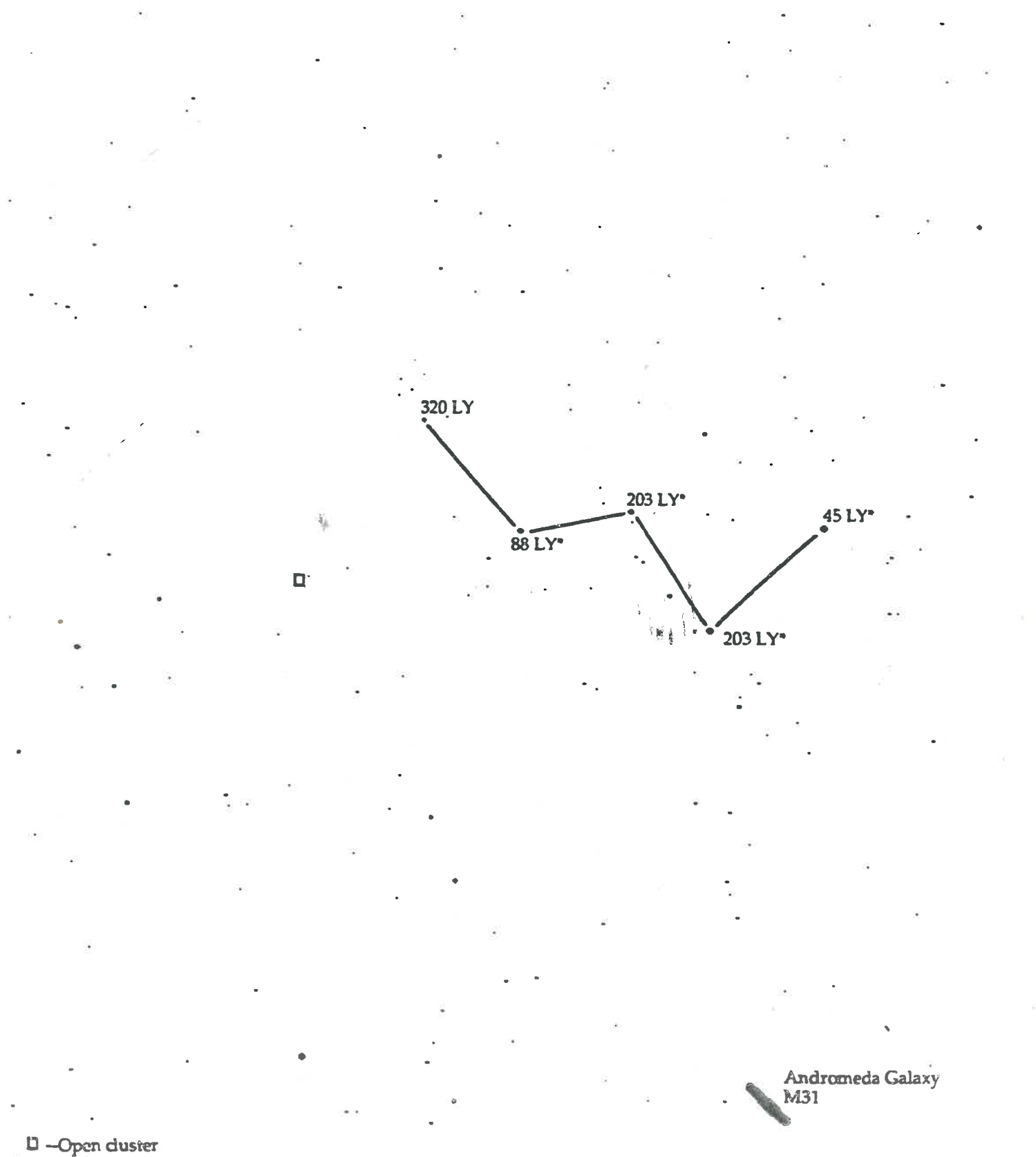
*18.9 What is the distance to your closest star(s)?*

*18.10 Is your closest star the brightest star?*

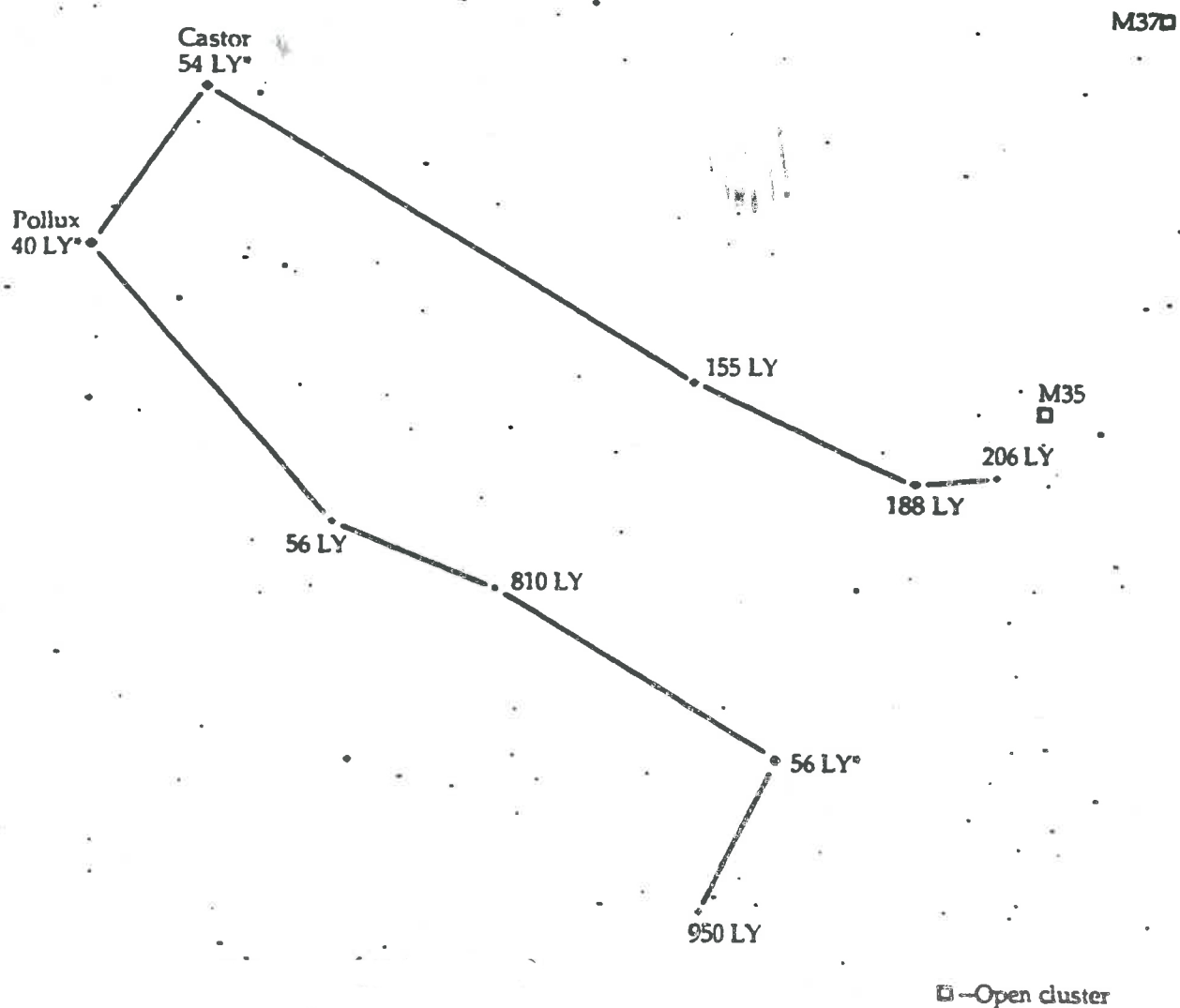
*18.11 Compare your answer to Question 18.10 with that of someone with a different constellation. In general, are the brightest stars the closest stars?*



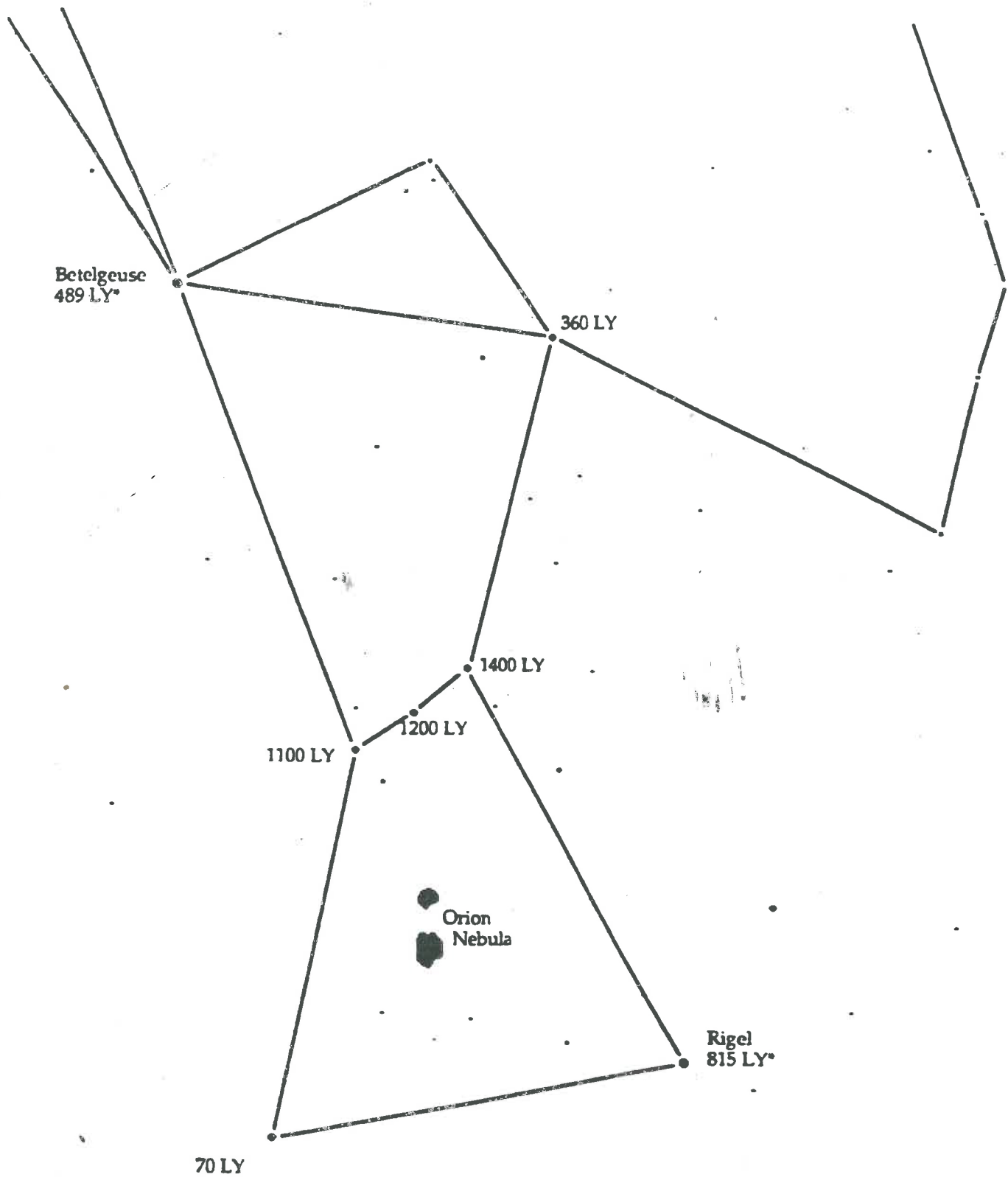
Bigger Dipper Portion of Ursa Major Schematic for Activity 18



Cassiopeia Constellation Schematic for Activity 18



Gemini Constellation Schematic for Activity 18



Orion Constellation Schematic for Activity 18