EARTH SCIENCE

Parallax

10 Points

Overall Score:	Overall Grade:

Name______________________

Group______________________

Date______________________

PURPOSE AND MATERIALS

The purpose of this experiment is to simulate the parallax observed when trying to determine the distance to a star observed in the Milky Way. Follow the procedure below and answer the questions that follow. Refer to the illustration on page 3 for assistance. You will work in groups of 2 or 3 and will need the following equipment:

metric ruler
penny (or another object)
scientific calculator
protractor

PROCEDURE

1. Record the date that this experiment is being conducted: ______________________

2. List the names of the classmates that are conducting the experiment with you. ______________________ ______________________

3. Stand at one end of your table. Place a penny in the exact center of the table and tape it down so it cannot move. **Measure the distance from the far end of the table to the penny. Record the measurement here**. This measurement is the number you will be trying to approximate using *parallax*. ______________________

4. Take your protractor and line up the 90-degree line with the *left* edge of the table so that the line is parallel with the *left* edge of the table. Line up the 0-degree line with the closest edge of the table (the edge closest to you) so that the 0-degree line is parallel with closest edge of the table. Once you have done this, the circle on the protractor where the 90-degree line and 0-degree line intersect should be directly over the *left* corner of the table.

5. Kneel down and view the penny from a vantage-point behind the protractor. Without moving the penny or protractor, use a pencil to line your eye up with protractor and penny. In other words, point the pencil at the penny while holding the eraser-end of the pencil over the left corner of the table.

6. Using the pencil to aim at the penny, record the angle that the pencil makes with the protractor. The angle should be less than 90 degrees (and with one decimal place). If you do not understand this part of the procedure, ask Mr. Roberts for assistance. ______________________

7. Take your protractor and line up the 90-degree line with the *right* edge of the table so that the line is parallel with the *right* edge of the table. Line up the 0-degree line with the closest edge of the table (the edge closest to you) so that the 0-degree line is parallel with closest edge of the table. Once you have done this, the circle on the protractor where the 90-degree line and 0-degree line intersect should be directly over the *right* corner of the table.

8. Kneel down and view the penny from a vantage-point behind the protractor. Without moving the penny or protractor, use a pencil to line your eye up with protractor and penny. In other words, point the pencil at the penny while

holding the eraser-end of the pencil over the left corner of the table.

9. Using the pencil to aim at the penny, record the angle that the pencil makes with the protractor. The angle should be less than 90 degrees. If you do not understand this part of the procedure, ask Mr. Roberts for assistance. ____________________

10. In centimeters, record the width of the table between the two corners where you had placed the protractor. Your answer should have two decimal places. ____________________

11. Divide the number you recorded for *Step 10* by *two*. Record the result here. ____________________

12. Subtract the angle you recorded in *Step 6* from 90 degrees. Record the result here. (90° - Step 6 = ?) ____________________

13. Subtract the angle you recorded in *Step 9* from 90 degrees. Record the result here. (90° - Step 9 = ?) ____________________

14. Using a scientific calculator, press the *TAN* key and then type in the number you recorded in *Step 12* (some calculators require you to type the number *first,* then *TAN*). If you do not have a scientific calculator or you are unfamiliar with the *TAN* key, ask Mr. Roberts for assistance. Round off to 3 decimal places. ____________________

15. Using a scientific calculator, press the *TAN* key and then type in the number you recorded in *Step 13*. Round off to 3 decimal places. ____________________

16. Divide the number you recorded in *Step 11* by the number you recorded in *Step 14*. Round off to 2 decimals and record the result here. (Step 11/Step 14 = ?) ____________________

17. Divide the number you recorded in *Step 11* by the number you recorded in *Step 15*. Round off to 2 decimals and record the result here. (Step 11/Step 15 = ?) ____________________

18. Add *Step 16* and *Step 17* together and then divide the result by *two*. This new number is the *average* distance to the penny that you have measured. ____________________

QUESTIONS

Answer the following questions on a ***separate piece of paper*** and then attach it to this lab.

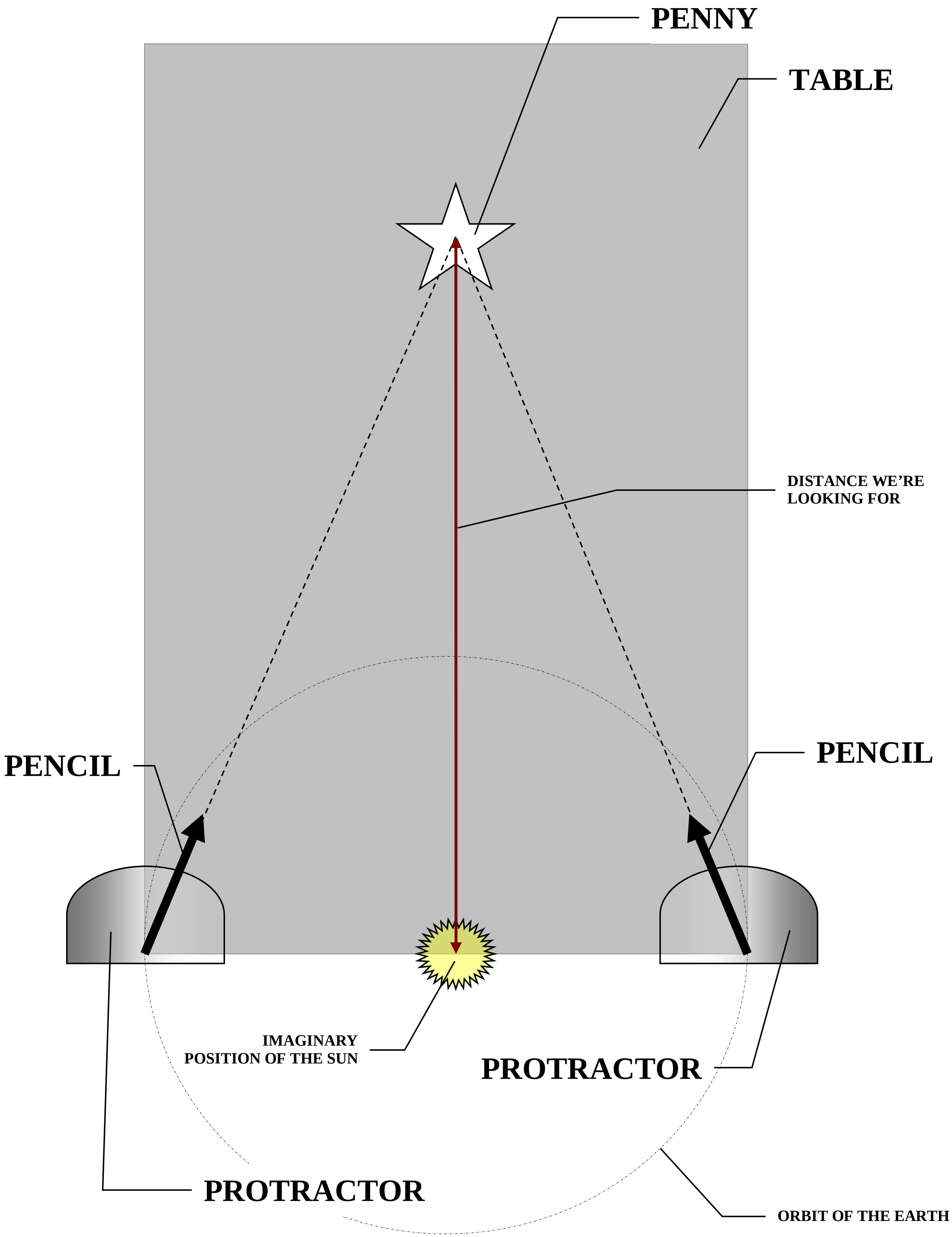
1. Congratulations! You've just used trigonometry (junior/senior math) and parallax to calculate the "unknown" distance to a penny. The numbers that you calculated for *Step 16* and *Step 17* are approximate distances between the penny and the edge of the table closest to you and both numbers should be the same if you made perfect measurements and your table is perfectly square. Are your numbers the same for *Step 16* and *Step 17*? If not, why do you think they are different?

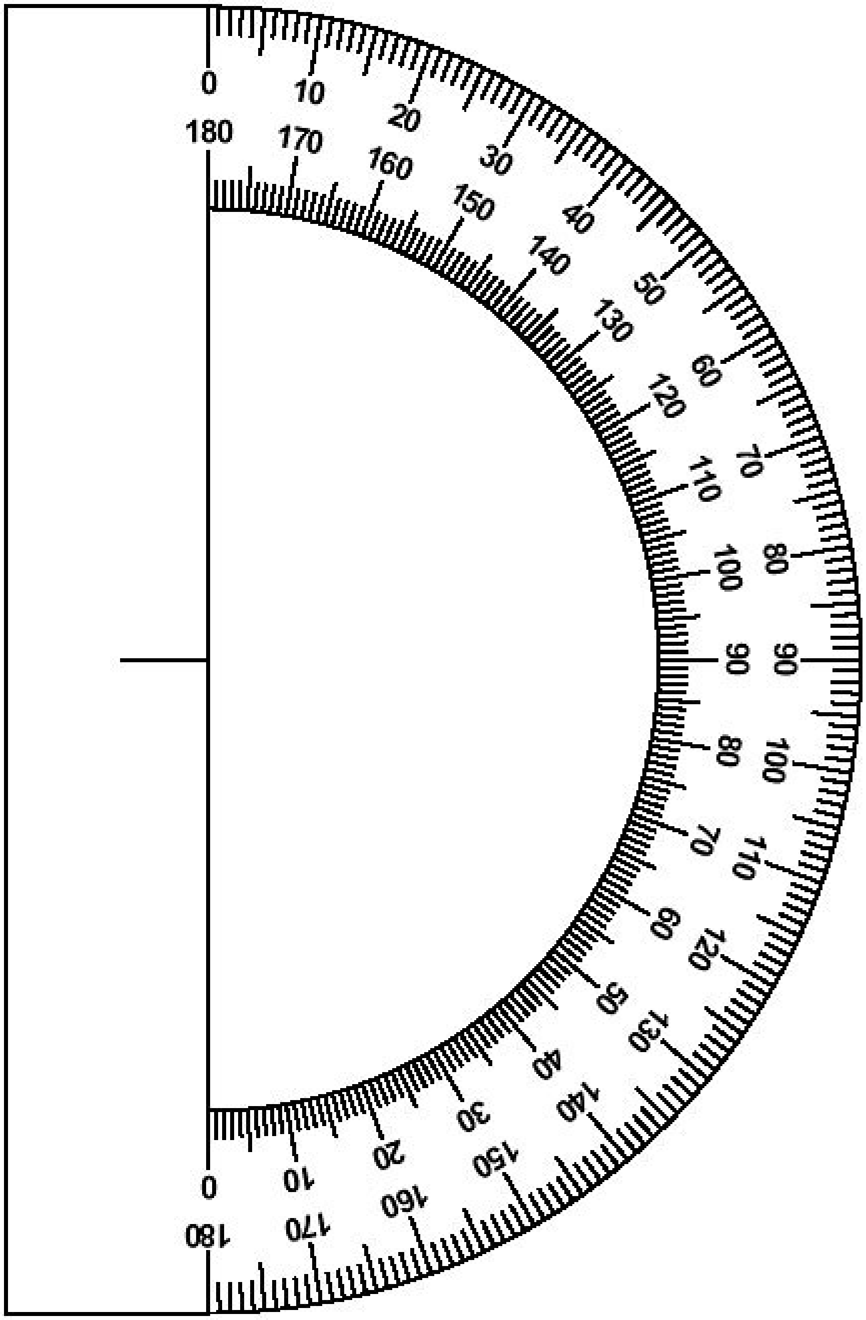
2. Compare the number you recorded for *Step 3* to the number you calculated in *Step 18*. If you performed the experiment perfectly and your table was symmetrical, then the number you recorded for *Step 3* should be exactly the same as the number you calculated in *Step 18*. If the numbers are not the same, why do you think that they are different? What is your *percent error* for this experiment?

3. Describe how this experiment simulates an astronomer on Earth finding the distance to a nearby star. What parts of the table are the Earth, Sun, and distant star? What distances and measurements would a scientist need to know? What kind of tool would a scientist use in place of the protractor?

4. How far away do stars have to be from Earth for astronomers to be able to use parallax to determine their distance? Does parallax work better for very distant stars or for stars that are relatively close to us? Why does parallax have limits?

5. The method you used to calculate the distance to the penny is basically the same method that astronomers use to calculate the distance to stars that are less than 100 light-years away. However, astronomers do not have the luxury of comparing their calculated distances to the actual distance as you did in *Question 2*. Furthermore, the distances that astronomers are calculating are far greater than what you calculated so there is much more room for error. How can astronomers be sure that they have not made a mistake when calculating the distance to stars?


PENNY
TABLE
DISTANCE WE'RE LOOKING FOR
PENCIL
PENCIL
IMAGINARY POSITION OF THE SUN
PROTRACTOR
PROTRACTOR
ORBIT OF THE EARTH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