OXFORD SCIENCE 10
WESTERN AUSTRALIAN CURRICULUM

Name: Class:

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STEM Project

Chapter 6 – The universe

Pages 139–154

Sit back and parallax

Hold up your thumb up in front of an object on the wall and cover one eye. Notice where your thumb is in relation to the object, then swap eyes. Did you see it jump?

This difference in the apparent position of the nearer object (your thumb) when viewed from two different locations (each eye) is called the **parallax effect**.

Astronomers have used this idea for centuries to estimate distances in space by observing space phenomena from different locations on Earth.

One of the most famous early applications of the parallax effect was carried out by Captain Cook during the voyage that first brought him to Australia. One of his missions on that voyage was to measure the movement of Venus between Earth and the Sun (the 'Transit of Venus') from a southern latitude.

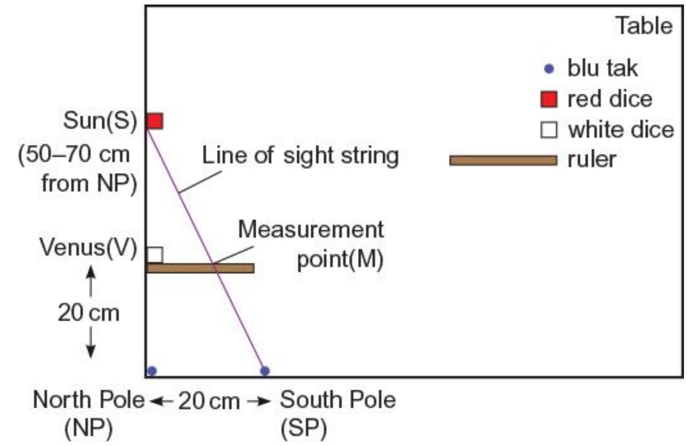
In this task, you and a partner will use the parallax effect to measure distances.

Experiment

Aim: To use the parallax effect to measure the distances of objects that simulate the transit of Venus between the Earth and the Sun.

Equipment:

- A table with right-angled corners
- A red dice (this will represent the Sun)
- A white dice (this will represent Venus)
- A ruler
- Two small balls of Blu-Tack (these will represent the North and South Poles – the two observation locations)
- A length of string
- Measuring tape
- A calculator



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Method:

1 Place one ball of Blu-Tak at one corner of the table and the other 20 cm from the corner, as shown in the diagram. These balls of Blu-Tak represent the North and South Poles on Earth – the two observation points in the parallax situation you are exploring.

2 Along the other edge of the table, place the front edge of the white dice 20 cm from the North Pole (the corner). This dice represents Venus in transit between Earth and the Sun.

3 Place a ruler at right angles to the table at the location of Venus, as shown in the diagram. Make sure the 0 cm mark on the ruler is in line with the edge of the table.

4 Place the front edge of the red dice anywhere from 50 cm to 70 cm from the North Pole along the table edge. This dice represents the Sun.

5 Crouch down and check that when you view Venus and the Sun from behind the North Pole, they line up exactly with each other along the edge of the table.

6 Now move across to behind the South Pole and look towards the Sun again. With each partner holding one end of the string, use it to trace your line of sight from the South Pole to the front corner of the Sun touching the table edge. Note down how many centimetres away from the table edge (and Venus) this line of sight crosses the ruler. This is the measurement point ‘M’ in the diagram.

7 Move Venus and the ruler closer to the Sun by 10 cm, so it is now 30 cm from the North Pole. Repeat step 6 and note down again where your line of sight crosses the ruler at the new measurement point.

8 Finally, move Venus and the ruler closer to the Sun by a further 10 cm, so it is now 40 cm from the North Pole. Repeat step 6 once more and again note down where your line of sight crosses the ruler at the measurement point.

Data and results

You should now have made three measurements of the distance between Venus and your line of sight string at point *M* for the three different locations of Venus. Enter your results in the table below.

Location of Venus	Distance between Venus and line of sight string *M* (cm)
20 cm from North Pole	
30 cm from North Pole	
40 cm from North Pole	

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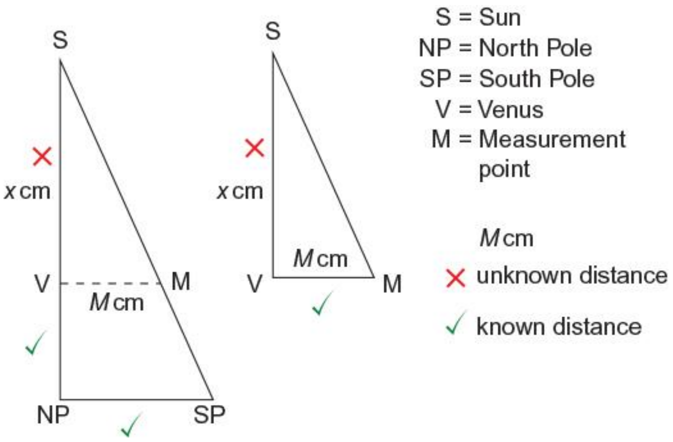
Use the measurements in the previous table and the concept of ‘similar triangles’ to calculate the unknown distance of the Sun from the North Pole by following these steps:

1 Let the distance between the Sun and Venus be x cm.

2 Let the distance between Venus and your measurement point be M cm.

3 Study the similar triangles shown depicting the setup of your experiment.

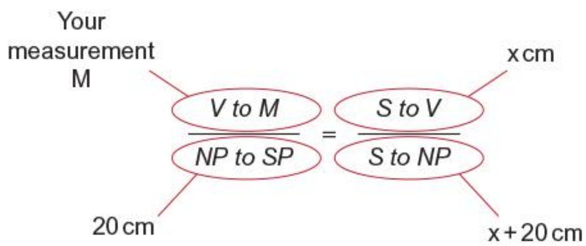


The triangles are similar, so the ratios of the corresponding sides of these triangles are the same.

This means that the ratios of distances below are equal.

$$\frac{V\ to\ M}{NP\ to\ SP} = \frac{S\ to\ V}{S\ to\ NP}$$

1 For the first measurement arrangement, when Venus was placed 20 cm from the North Pole, substitute the distances we know into the similar triangles ratio equation as follows:



So:

$$\frac{M}{20} = \frac{x}{x+20}$$

2 Using algebra to rearrange this equation we get:

$$x = \frac{20M}{(20-M)}$$

This gives us a formula that will calculate the distance from the Sun to Venus x cm.

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3 Now substitute your first measurement *M* into this equation to find *x*:

$x =$

4 If you add 20 cm to your calculated value of *x*, (because Venus is 20 cm from the North Pole) you have found the distance from the North Pole to the Sun!

$x + 20 = \qquad = \text{distance from the North Pole to the sun}$

5 Repeat these steps for the other measurements (when Venus is placed 30 cm and 40 cm from the North Pole). The formulas for *x* for these situations are shown in the table below.

6 Calculate *x* for each measurement and note your results in the table below. Use these results to calculate the distance between the Sun and the North Pole for each of the arrangements. Calculate the average your three results.

Location of Venus	M cm (from previous table)	Distance between Sun and Venus (x cm)	Distance between Sun and North Pole
20 cm from North Pole		$\frac{20M}{(20-M)} =$	x + 20 cm =
30 cm from North Pole		$\frac{30M}{(20-M)} =$	x + 30 cm =
40 cm from North Pole		$\frac{40M}{(20-M)} =$	x + 40 cm =
		Average:	

Just like an astronomer, you have just used the parallax effect to find distances in space!

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Discussion and reflection

Let's check to see how accurate the distances you calculated using the parallax effect are.

Using a measuring tape, physically measure the distance in centimetres between the North Pole and the location of the Sun on your table.

Measured distance between Sun and North Pole: ________________

Compare this measured distance with the average distance between the Sun and North Pole that you calculated using the parallax effect. Are they similar? By how much do they differ?

What could be some reasons for any differences that exist?

What would happen in our experiment if we changed the location of the observation point on Earth (e.g. to the equator) instead of changing the location of Venus? Could we still use the parallax effect to make measurements? Why / Why not?

Think of (or research) some other possible uses of the parallax effect. List them.

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