Notes for parents (1).

The purpose of the activity is to help your student to:

- Express numbers in scientific notation.
- Interpret number expressed in scientific notation.

Here is what to do:

Read through the problem together. Clarify that the distances can be expressed using either standard whole numbers of kilometres or in scientific notation. Use 150 000 000 km as an example.

The scientific notation is 1.5×10^8.

What is 10^8? (100 million)

Enter 1.5 into a calculator then repeatedly multiply by ten until 150 000 000.

Some calculators allow you to enter 1.5 x 10 and continue pressing = to multiply by ten. It takes eight multiplications by ten to change 1.5 into 150 000 000.
$10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^8 = 100\,000\,000$. Note that 10^8 has eight zeros.

Encourage your student to use this same principle to complete the table.

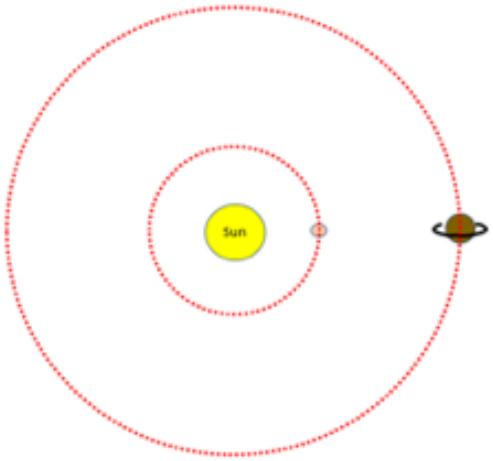
For example:

Mars is 228 000 000 km from the Sun. Beginning with 2.28 multiply by ten until 228 000 000 is visible on the calculator. Eight multiplications by ten are needed so the scientific notation is 2.28 x 108.

In reverse find the distance for Uranus. 2.88×10^9 means that 2.88 is multiplied by ten nine times giving 2 880 000 000.

The final problems require geometric thinking. Assume that the planets orbit in the same plane (roughly true except for Pluto) and that the orbits are circles (the orbits are ellipses).

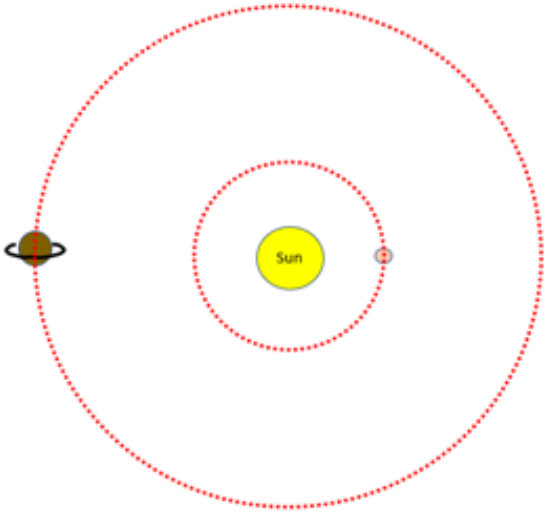
Create a drawing to represent the problem.



The shortest possible distance is when Venus and Saturn are colinear (on the same line) with the Sun.

Notes for parents (2).

Since Saturn is 1 430 000 000 km away from the Sun and Venus is 108 000 000 km away, the difference of 1 322 000 000 km is the shortest distance between the planets. If either planet is colinear with the Sun and the other planet but on the opposite side, the longest distance is achieved.



The furthest distance between the planets is the sum of their distances from the Sun.
1 430 000 000 + 108 000 000 = 1 538 000 000.

Points to note

Understanding scientific notation requires the connection of several important aspects of place value knowledge. These aspects are listed below:

1. **Decimal fractions.** Students need to know the meaning of places in the decimal system and the relative size of those places. For example, 1.43 is composed of one unit of one, four tenths, and three hundredths.
2. **Use of periods** Whole numbers are written in periods of three separated by a space. For example, the number 1 538 000 000 represents 1 billion, and 538 millions. The other periods in the number are the thousands and ones.
3. **Effect of multiplying and dividing by ten** Multiplying by ten scales each unit up by a factor of ten. Dividing by ten has the inverse effect. For example, 2.43 x 10 = 24.3. The effect of multiplying by ten is to shift the digits to the left one place. 2.43 ÷10 = 0.243, the effect of dividing by ten is to shift the digits one place to the right.
4. **Indices (exponents)** Powers are created by multiplying the same number by itself a given number of times. For example, 10^3 = 10 x 10 x 10. Three tens are multipied together. Negative powers are used in scientific notation to effectively divide a decimal by tens. Here is a table of powers of ten.

10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}	10^{3}	10^{4}
0.001	0.01	0.1	1	10	100	1 000	10 000

Notes for parents (3). Activity next page.

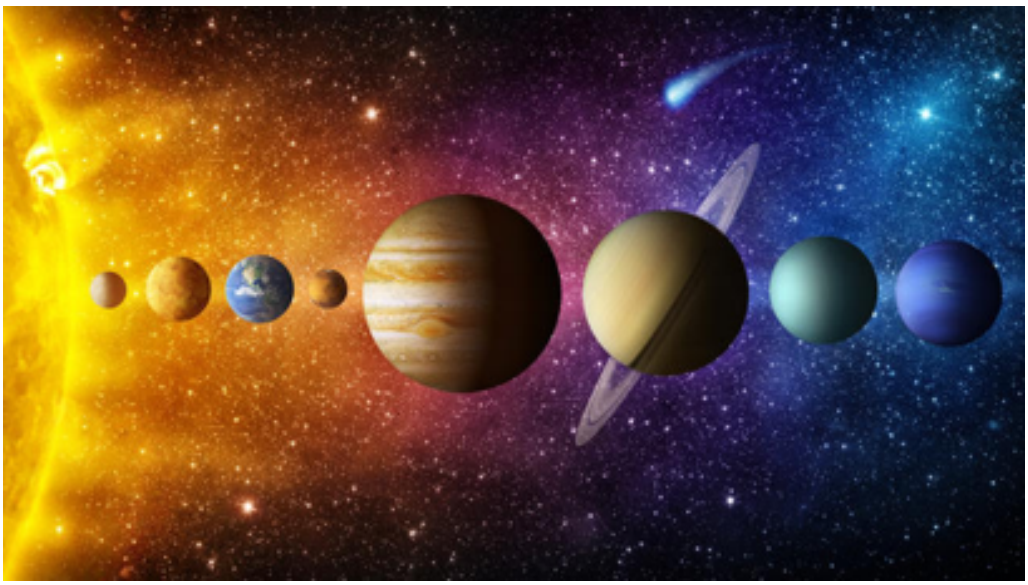
For example, $2.3 \times 10^{-3} = 2.3 \times 0.001 = 0.0023$. Note that 0.001 is the decimal for 1/1000.

Sources that give the distance between planets usually give the average distance between the planets, not the minimum and maximum. Distances might also be given in astronomical units. One astronomical unit is 150 000 000 km, the distance from Earth to the Sun. Although the figures are rounded for simplicity in this task, and assumptions are made about the planetary orbits the figures are reasonable accurate.

Planet A	Planet B	Astronomical units	Kilometres
Venus	Jupiter	4.48	670 130 000
Venus	Saturn	8.80	1 316 400 000
Venus	Uranus	18.49	2 765 350 000

The distances from the Sun to each planet are huge. For example, the distance from The Earth to the Sun is 150 000 000 kilometres.

if you could drive there at 100 kilometres per hour, the trip would take you 1, 500 000 hours or 62 500 days or about 171 years or 1.71 centuries!



To write very large numbers, or very small numbers, scientists use special notation. 150 000 000 can be written as 1.5×10^8.

Complete this table of distances.

Planet	Distance (in kms)	Scientific notation
Mercury	57 000 000	5.7×10^7
Venus	108 000 000	
Earth		1.5×10^8
Mars	228 000 000	
Jupiter		7.79×10^8
Saturn	1 430 000 000	1.43×10^9
Uranus		2.88×10^9
Pluto	4 500 000 000	

What is the furthest distance that Saturn can be from Venus?
What is the shortest distance that the planets can be from one another?