LESSON MAKER PRO

Orbit Forecast

Predict trips around the Sun with Kepler's third law.

HIGH SCHOOL · ESS.2

ESS.2 "Obtain, evaluate, and communicate information about the structure and motion of components of the universe and solar system. a. Use mathematics and computational thinking to predict the motion of natural and man-made objects in the solar..."

NAME _____ DATE _____

THE ORBIT RULE

For an object orbiting the Sun, Kepler's third law is $P^2 = a^3$, where P is the orbital period in years and a is the orbit's semimajor axis in astronomical units (AU). Square the period or cube the semimajor axis, then find the positive value that makes both sides equal.

WORKED EXAMPLE

A model solar orbit has a semimajor axis of 1/4 AU. What is its orbital period?

1. Use $P^2 = a^3$.
2. Substitute $a = 1/4$: $P^2 = (1/4)^3 = 1/64$.
3. The positive number whose square is 1/64 is 1/8.

Answer: P = 1/8 year

PRACTICE 6 problems

1 An asteroid's solar orbit has a semimajor axis of 4 AU. Find its orbital period.

ANSWER _____

2 A comet's solar orbit has a semimajor axis of 9 AU. Find its orbital period.

ANSWER _____

3 A spacecraft takes 64 years to orbit the Sun. Find its orbit's semimajor axis.

ANSWER _____

4 A model solar orbit has a semimajor axis of 1/9 AU. Find its orbital period.

ANSWER _____

5 A comet takes 125 years to orbit the Sun. Find its orbit's semimajor axis.

ANSWER _____

6 A team checks two proposed solar orbits. Which row follows Kepler's third law? Show the equality that proves it.

PROPOSED SOLAR ORBITS

Orbit	a (AU)	P (years)
A	4	8
B	9	9

ANSWER _____

APPLY IT Show your work

1 A spacecraft collecting asteroid dust follows a solar orbit with a semimajor axis of 4 AU. Its mission lasts 24 years. How many complete solar orbits can it make?

WORK SPACE

ANSWER _____

2 A student is building a scale display for a newly discovered comet that takes 125 years to orbit the Sun. What is its orbit's semimajor axis? How many AU larger is that than a model orbit with a semimajor axis of 16 AU?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A space probe's solar orbit has a semimajor axis of 4 AU and a period of 8 years. A redesigned mission changes the semimajor axis to 16 AU. Find the new period and explain how many times longer it is than the original period.

WORK SPACE AND ANSWER

Orbit Forecast

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	An asteroid's solar orbit has a semimajor axis of 4 AU. Find its orbital period.	**8 years**
2	A comet's solar orbit has a semimajor axis of 9 AU. Find its orbital period.	**27 years**
3	A spacecraft takes 64 years to orbit the Sun. Find its orbit's semimajor axis.	**16 AU**
4	A model solar orbit has a semimajor axis of 1/9 AU. Find its orbital period.	**1/27 year**
5	A comet takes 125 years to orbit the Sun. Find its orbit's semimajor axis.	**25 AU**
6	A team checks two proposed solar orbits. Which row follows Kepler's third law? Show the equality that proves it.	**Orbit A; $8^2 = 4^3 = 64$.**

PART 2 · APPLY IT

1. **3 complete orbits** Kepler's law gives $P^2 = 4^3 = 64$, so P = 8 years. Divide 24 years by 8 years per orbit.
2. **25 AU; 9 AU larger** Since $125^2 = 25^3$, the comet's semimajor axis is 25 AU. Subtract 16 AU to find the difference.

CHALLENGE

The new period is 64 years, which is 8 times as long. Kepler's law gives $P^2 = 16^3 = 4{,}096$, so P = 64; 64/8 = 8.

Accept equivalent equalities that verify Orbit A. Periods must be positive, and semimajor axes must be reported in AU.