

Orbit Math Mission

Use orbital distance and period to make predictions.

HIGH SCHOOL • HS-ESS1-4

HS-ESS1-4 "Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions..."

NAME _____

DATE _____

THE ORBIT RULE

For an object orbiting the Sun, use $P^2 = a^3$ when P is measured in years and a is the average orbital distance in astronomical units, or AU. To compare two objects orbiting the same central body, use $P_1^2/a_1^3 = P_2^2/a_2^3$. A larger average orbital distance means a longer orbital period.

WORKED EXAMPLE

A planet has an average orbital distance of 36 AU from the Sun. Find its orbital period.

1. Start with $P^2 = a^3$.
2. Substitute $a = 36$: $P^2 = 36^3$.
3. Take the positive square root: $P = 36 \times \sqrt{36} = 216$.

Answer: 216 years

PRACTICE 6 problems

- 1** A planet orbits the Sun at an average distance of 4 AU. Find its orbital period.

ANSWER _____

- 2** A planet's orbital period is 27 years. Find its average orbital distance from the Sun.

ANSWER _____

- 3** A dwarf planet orbits the Sun at an average distance of $1/4$ AU. Find its orbital period.

ANSWER _____

- 4** An object takes 125 years to orbit the Sun. Find its average orbital distance.

ANSWER _____

- 5** A planet orbits the Sun at an average distance of $1/9$ AU. Find its orbital period.

ANSWER _____

- 6** Planet A orbits the Sun at 1 AU. Planet B orbits the Sun at 25 AU. How many times longer is Planet B's orbital period than Planet A's?

ANSWER _____

APPLY IT Show your work

- 1** A weather app receives images from two satellites that orbit Earth. Satellite A has an average orbital distance of 3 scale units and takes 6 hours to orbit Earth. Satellite B has an average orbital distance of 12 scale units. Predict Satellite B's orbital period.

WORK SPACE

ANSWER _____

- 2** While coding a solar-system game, a student sets a planet's average distance from its star to $\frac{1}{16}$ of the Earth-Sun distance. The game uses the same orbital rule as the solar system. How many Earth years does one orbit take?

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

Two probes orbit the same planet. Probe A has an average orbital distance of 5 units and an orbital period of 10 hours. Probe B has an orbital period of 80 hours. Find Probe B's average orbital distance. Explain why its distance is not 10 units.

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	A planet orbits the Sun at an average distance of 4 AU. Find its orbital period.	8 years
2	A planet's orbital period is 27 years. Find its average orbital distance from the Sun.	9 AU
3	A dwarf planet orbits the Sun at an average distance of $1/4$ AU. Find its orbital period.	$1/8$ year
4	An object takes 125 years to orbit the Sun. Find its average orbital distance.	25 AU
5	A planet orbits the Sun at an average distance of $1/9$ AU. Find its orbital period.	$1/27$ year
6	Planet A orbits the Sun at 1 AU. Planet B orbits the Sun at 25 AU. How many times longer is Planet B's orbital period than Planet A's?	125 times longer

PART 2 • APPLY IT

- 48 hours** The distance ratio is $12/3 = 4$, so the period ratio is $4^{3/2} = 8$. Multiply 6 hours by 8 to get 48 hours.
- $1/64$ year** Use $P^2 = (1/16)^3 = 1/4096$. The positive square root is $P = 1/64$ year.

CHALLENGE

20 units. The period ratio is $80/10 = 8$. Since $8^2 = 4^3$, Probe B's distance is 4 times Probe A's distance, or $4 \times 5 = 20$ units. Distance and period do not increase by the same factor.

Accept equivalent fraction forms for fractional periods. For comparison problems, accept correct ratio-based work using $P_1^2/a_1^3 = P_2^2/a_2^3$.