LESSON MAKER PRO

Signals Across Space

Use light-travel time to estimate distance and delay.

HIGH SCHOOL · ESS.2.b

ESS.2.b "Use mathematics and computational thinking to explain the relationships between the properties of light and distances in the solar system and universe, including the Doppler effect, red shift, light years, and astronomical units."

NAME _____ DATE _____

THE BIG IDEA

An astronomical unit (AU) is the average distance from Earth to the Sun. Light takes about 8 minutes to travel 1 AU, so multiply AU by 8 to estimate travel time in minutes, or divide minutes by 8 to estimate distance in AU. A light-year is the distance light travels in one year, so light from an object x light-years away takes x years to reach us.

WORKED EXAMPLE

A spacecraft is 9 AU from Earth. About how long does its signal take to reach Earth?

1. Use 8 minutes of travel time for each AU.
2. 9 × 8 = 72 minutes.

Answer: About 72 minutes.

PRACTICE 6 problems

1 A spacecraft is 3 AU from Earth. About how many minutes does its signal take to reach Earth?

ANSWER _____

2 A signal takes about 40 minutes to reach Earth. About how many AU away is its source?

ANSWER _____

3 A probe is 1/2 AU from Earth. About how many minutes does its signal take to reach Earth?

ANSWER _____

4 A spacecraft is 2.5 AU from Earth. About how many minutes does its signal take to reach Earth?

ANSWER _____

5 A star is 7 light-years from Earth. How many years does its light take to reach Earth?

ANSWER _____

6 Light from a star has traveled for 12 years to reach Earth. How far away is the star in light-years?

ANSWER _____

APPLY IT Show your work

1 You send a command to a rover 2 AU away. The rover sends back a photo as soon as it receives your command. About how many minutes pass from sending the command to receiving the photo?

WORK SPACE

ANSWER _____

2 A space-photo app posts an image in 2026 of a star 25 light-years away. In what year did the light in that image leave the star?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Two spacecraft send signals to Earth at the same moment. One is 2 AU away, and the other is 5 AU away. When the farther spacecraft's signal arrives, how many minutes has Earth already had the nearer spacecraft's signal? Explain your reasoning.

WORK SPACE AND ANSWER

ANSWER KEY # Signals Across Space

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A spacecraft is 3 AU from Earth. About how many minutes does its signal take to reach Earth?	**About 24 minutes.**
2	A signal takes about 40 minutes to reach Earth. About how many AU away is its source?	**About 5 AU.**
3	A probe is 1/2 AU from Earth. About how many minutes does its signal take to reach Earth?	**About 4 minutes.**
4	A spacecraft is 2.5 AU from Earth. About how many minutes does its signal take to reach Earth?	**About 20 minutes.**
5	A star is 7 light-years from Earth. How many years does its light take to reach Earth?	**7 years.**
6	Light from a star has traveled for 12 years to reach Earth. How far away is the star in light-years?	**12 light-years.**

PART 2 · APPLY IT

1. **About 32 minutes.** The command takes about 2 × 8 = 16 minutes to reach the rover. The photo takes another 16 minutes to return, for about 32 minutes total.
2. **2001.** The light traveled for 25 years. Subtract 25 from 2026 to get 2001.

CHALLENGE

Earth has had the nearer signal for about 24 minutes. The signals take about 16 minutes and 40 minutes to arrive, so the difference is about 40 − 16 = 24 minutes.

AU-based times and distances are estimates because light takes about 8 minutes, not exactly 8 minutes, to travel 1 AU. Accept answers with or without the word "about".