

# Order-of-Magnitude Estimation

## Earth's Orbital Speed (Level 1)

### The Question

How fast is the Earth moving around the Sun (in m/s)?

### Background

The Earth orbits around the Sun in a nearly circular orbit, with an average distance that defines the *Astronomical Unit*. How fast is the Earth traveling relative to the Sun?

### Guiding Questions

Here are some things you may need to consider:

- Does the Earth move at a constant speed?
- What kind of timescale is reasonable to consider?
- How far does the Earth have to travel in that time?

### The Solution

An astronomical unit is  $1.5 \times 10^8$  km, or  $1.5 \times 10^{10}$  m. That means the Earth travels a circle with this circumference:

$$d = 2\pi R = 2 \times \pi \times 1.5 \times 10^{10} = 10^{11} \text{ m} \quad (1)$$

The Earth completes one orbit every year, or 365 days. This corresponds to:

$$365 \text{ days} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{3600 \text{ s}}{1 \text{ hr}} = 3 \times 10^7 \text{ s} \quad (2)$$

Finally, the Earth is moving at a speed of:

$$v = \frac{d}{t} = \frac{10^{11}}{3 \times 10^7} = 3 \times 10^3 \text{ m/s} \quad (3)$$

## Education Standards

This OoM Estimation problems meets the following standards in **bold**:  
*Next Generation Science Standards (NGSS)*:

- Physical Sciences
  - Matter & Its Interactions
  - **Motion and Stability: Forces and Interactions**
  - Energy
  - Waves and Their Applications in Technologies for Information Transfer
- Life Sciences
  - From Molecules to Organisms: Structures and Processes
  - Ecosystems: Interactions, Energy, and Dynamics
  - Heredity: Inheritance and Variation of Traits
  - Biological Evolution: Unity and Diversity
- Earth and Space Sciences
  - Earth’s Place in the Universe
  - Earth’s Systems
  - Earth and Human Activity
- Engineering, Technology, and Applications of Science
  - Engineering Design

*Common Core Standards (CSS)*:

- **Counting & Cardinality**
- **Operations & Algebraic Thinking**
- **Numbers & Operations in Base Ten**
- **Number & Operations — Fractions**
- Measurement & Data
- Geometry
- Ratios & Proportional Relationships
- The Number System
- **Expressions & Equations**
- Functions
- Statistics & Probability