

Order-of-Magnitude Estimation

Bird Speed (Level 1)

The Question

On average, how fast is a migratory bird moving?

Background

Many birds migrate south in the winter (in the northern hemisphere) and north in the summer. This requires a lot of flying! These birds of course aren't always moving, so what is the average speed of a bird over the course of a year, including moving and stopped time?

Guiding Questions

Here are some things you may need to consider:

- How far does a bird have to travel?
- How long does it take to make these trips?

The Solution

To simplify things, let's assume that the migration is from the equator to the north pole. This distance is one-fourth of the circumference of earth:

$$d = 0.25 \times 2 \times \pi \times R_{\text{Earth}} = 0.25 \times 2 \times \pi \times 6400 = 1 \times 10^4 \text{ km} \quad (1)$$

Over the course of a year, the birds must make this trip two times. We'll ignore any local movement while they are in a given place, both because we likely over-estimated the migration distance, and because this is a small amount relative to the migration. Therefore, the average speed is:

$$v = \frac{2d}{t} = \frac{2 \times 1 \times 10^4}{1} = 2 \times 10^4 \text{ km/yr} \quad (2)$$

Finally let's convert this to km/hr:

$$v = 2 \times 10^4 \frac{\text{km}}{\text{yr}} \times \frac{\text{yr}}{365 \text{ day}} \times \frac{\text{day}}{24 \text{ hr}} = 2 \text{ km/hr} \quad (3)$$

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