

Powers of ten: from a cell to a mountain

Ages 11–14 · Number: standard form, powers of ten, logarithmic scales, ratio

Name _____ Class _____ Date _____

These nine things range from a white blood cell to a mountain. The biggest is more than 500 million times the size of the smallest.

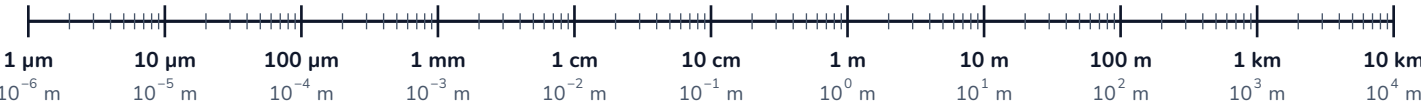
1. Write each size in metres, in standard form

Example: 35 µm = 3.5 × 10^{−5} m

Thing	Size	In metres, standard form
A Human T Lymphocyte	7 µm across	_____
B Dandelion Pollen Grain	35 µm across	_____
C Onion Epidermal Cell	100 µm across	_____
D Chaos carolinense	1 mm long, stretched out	_____
E Blueberry	1.5 cm across	_____
F Giant panda	70 cm tall at the shoulder	_____
G Coast redwood tree	70 m tall	_____
H Uluru	348 m high above the plain	_____
I Mount Fuji	3,776 m high above sea level	_____

2. Put them on the scale

On this scale every step to the right is 10 times bigger. Write each letter above the place where it belongs.



3. How many times bigger?

- a) Dandelion Pollen Grain (35 μm) compared with Human T Lymphocyte (7 μm)

Times bigger: _____

- b) Chaos carolinense (1 mm) compared with Onion Epidermal Cell (100 μm)

Times bigger: _____

- c) Coast redwood tree (70 m) compared with Giant panda (70 cm)

Times bigger: _____

- d) Mount Fuji (3,776 m) compared with Uluru (348 m)

Times bigger: _____

- e) Mount Fuji compared with Human T Lymphocyte. Write your answer in standard form and in words.

4. Count the steps

Each step on the scale multiplies by 10. About how many steps is it from Human T Lymphocyte to Mount Fuji? Why can't a single picture show both at their real sizes?

What students practise

Converting units to metres; writing numbers in standard form; reading a logarithmic scale; ratio as division of powers of ten; why sizes that differ by many powers of ten cannot share one picture.

Answers

1. In standard form:

- A Human T Lymphocyte: $7\text{ }\mu\text{m} = 7 \times 10^{-6}\text{ m}$
- B Dandelion Pollen Grain: $35\text{ }\mu\text{m} = 3.5 \times 10^{-5}\text{ m}$
- C Onion Epidermal Cell: $100\text{ }\mu\text{m} = 1 \times 10^{-4}\text{ m}$
- D Chaos carolinense: $1\text{ mm} = 1 \times 10^{-3}\text{ m}$
- E Blueberry: $1.5\text{ cm} = 1.5 \times 10^{-2}\text{ m}$
- F Giant panda: $70\text{ cm} = 7 \times 10^{-1}\text{ m}$
- G Coast redwood tree: $70\text{ m} = 7 \times 10^1\text{ m}$
- H Uluru: $348\text{ m} = 3.48 \times 10^2\text{ m}$
- I Mount Fuji: $3,776\text{ m} = 3.776 \times 10^3\text{ m}$

2. Each letter sits between the two labels that bracket its size, e.g. E (1.5 cm) between 1 cm and 10 cm, a little to the right of 1 cm.

3. a) 5; b) 10; c) 100; d) about 11.

e) $3,776\text{ m} \div 7\text{ }\mu\text{m} \approx 5.4 \times 10^8$: about 540 million times bigger.

4. The ratio is between a hundred million and a billion: about 8.7 powers of ten, so about 9 steps. Drawn so that the cell was 1 mm wide, Mount Fuji would be about 540 km tall.

Good to know

A logarithmic scale gives every power of ten the same space, which is how scientists compare sizes this different. The Magnitude game scores size guesses the same way: a guess twice too big and a guess half the true size count as equally far off. Sizes are typical values from the Magnitude catalogue, rounded (how we measure: magnitude.fit/methodology).