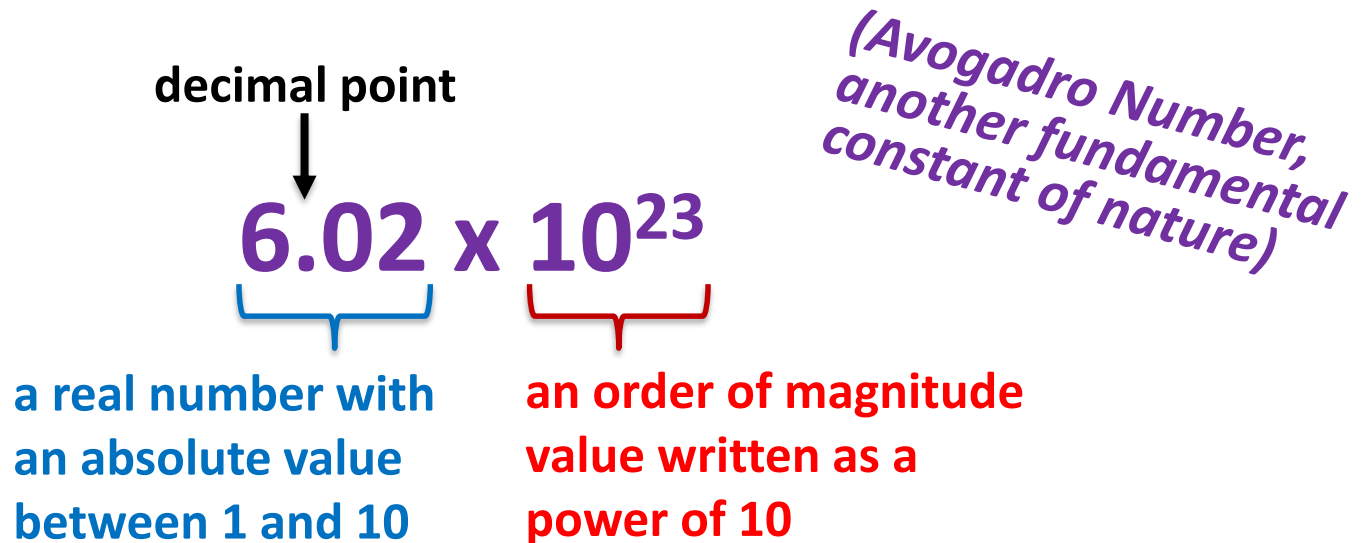


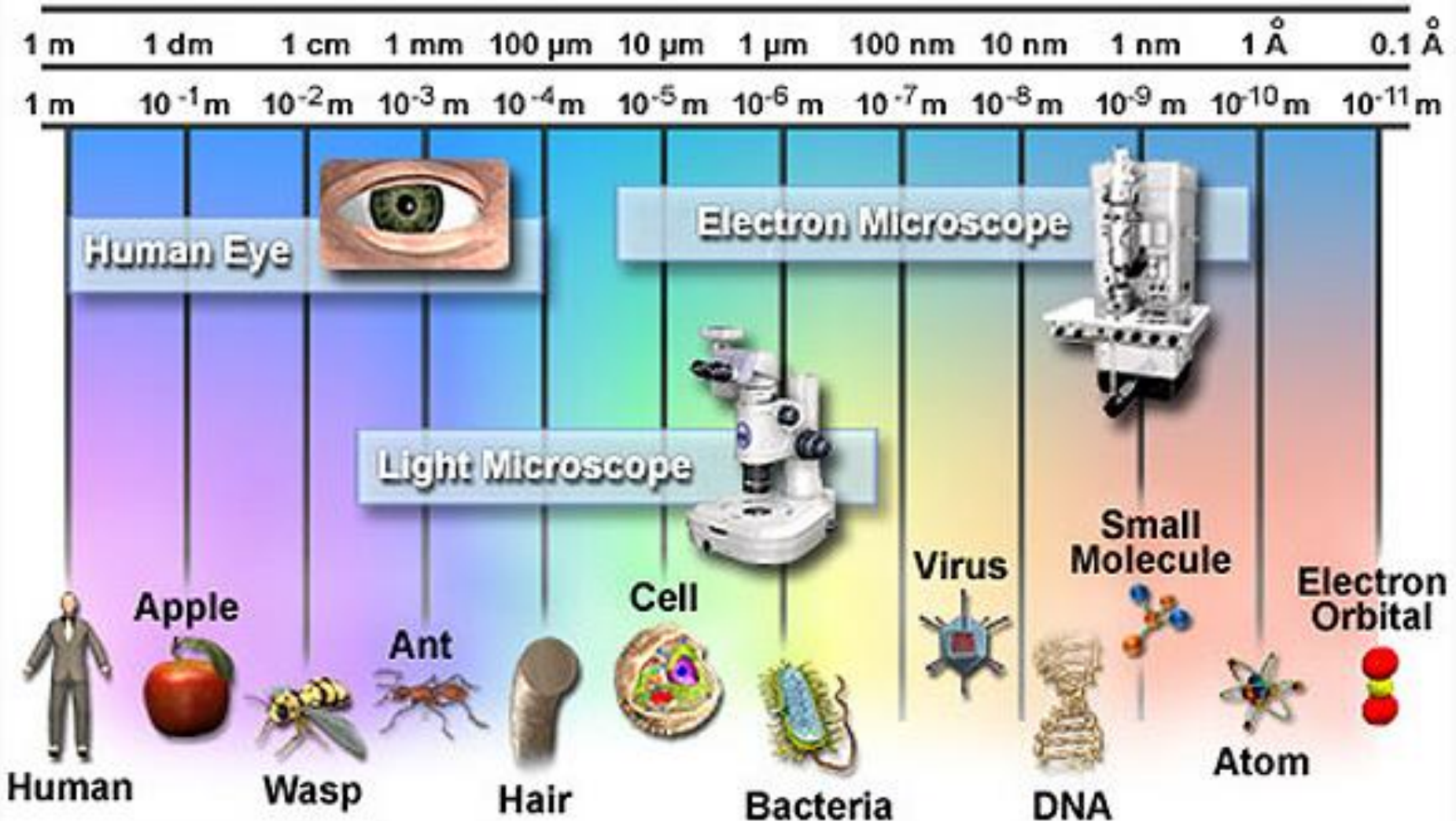
Scientific Notation

Scientific notation (also referred to as "*standard form*" or "*standard index form*") is a **way of writing numbers** that are either too big or too small to be conveniently written in decimal form.

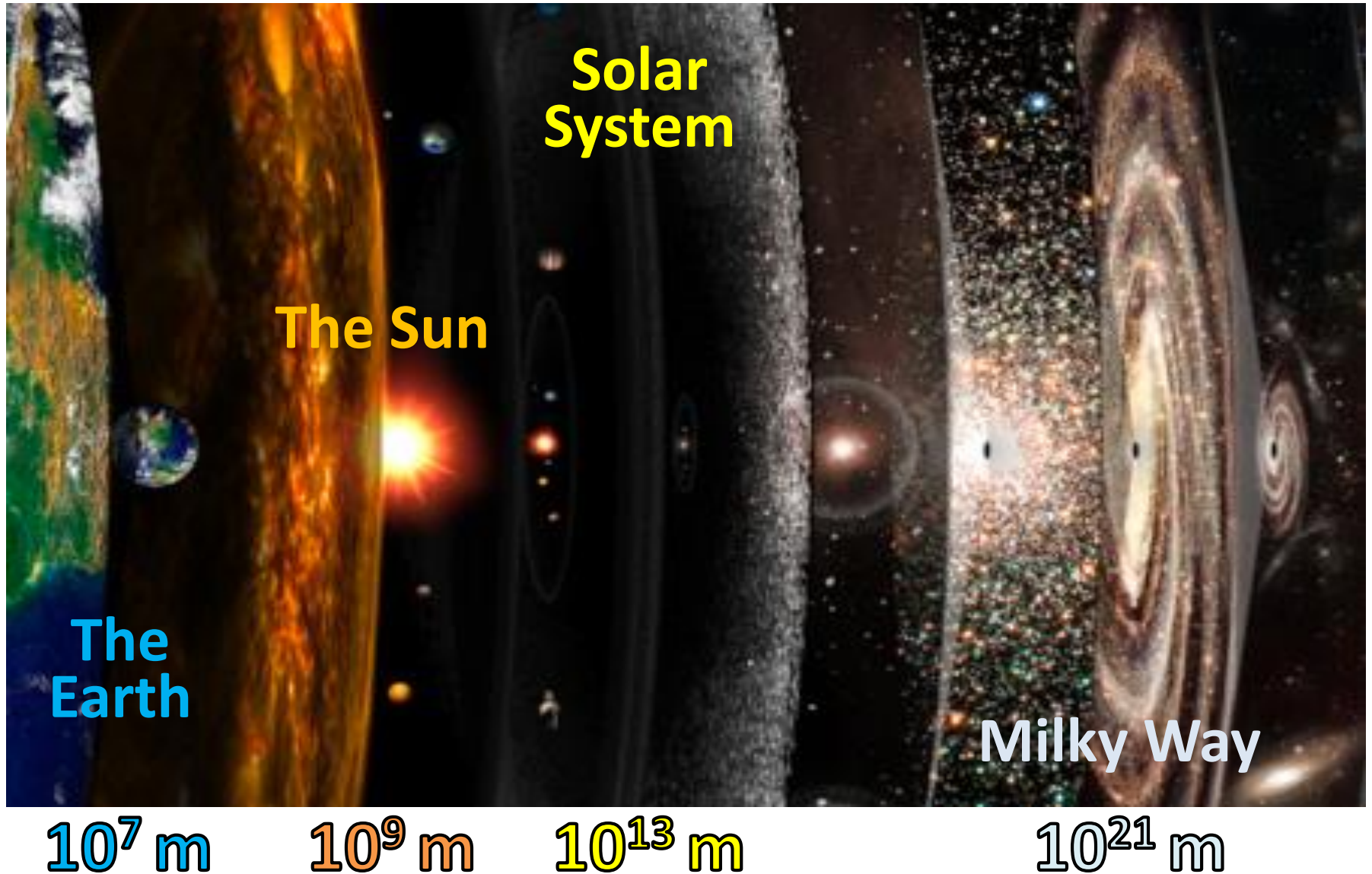


- **One light year** is equal to about **5.88 x 10¹² miles**
- **Natural spider silk** is about **3 x 10⁻⁶ meters thick**
- **Lake Superior volume** is about **1.21 x 10¹⁶ liters**

Some Smaller Things



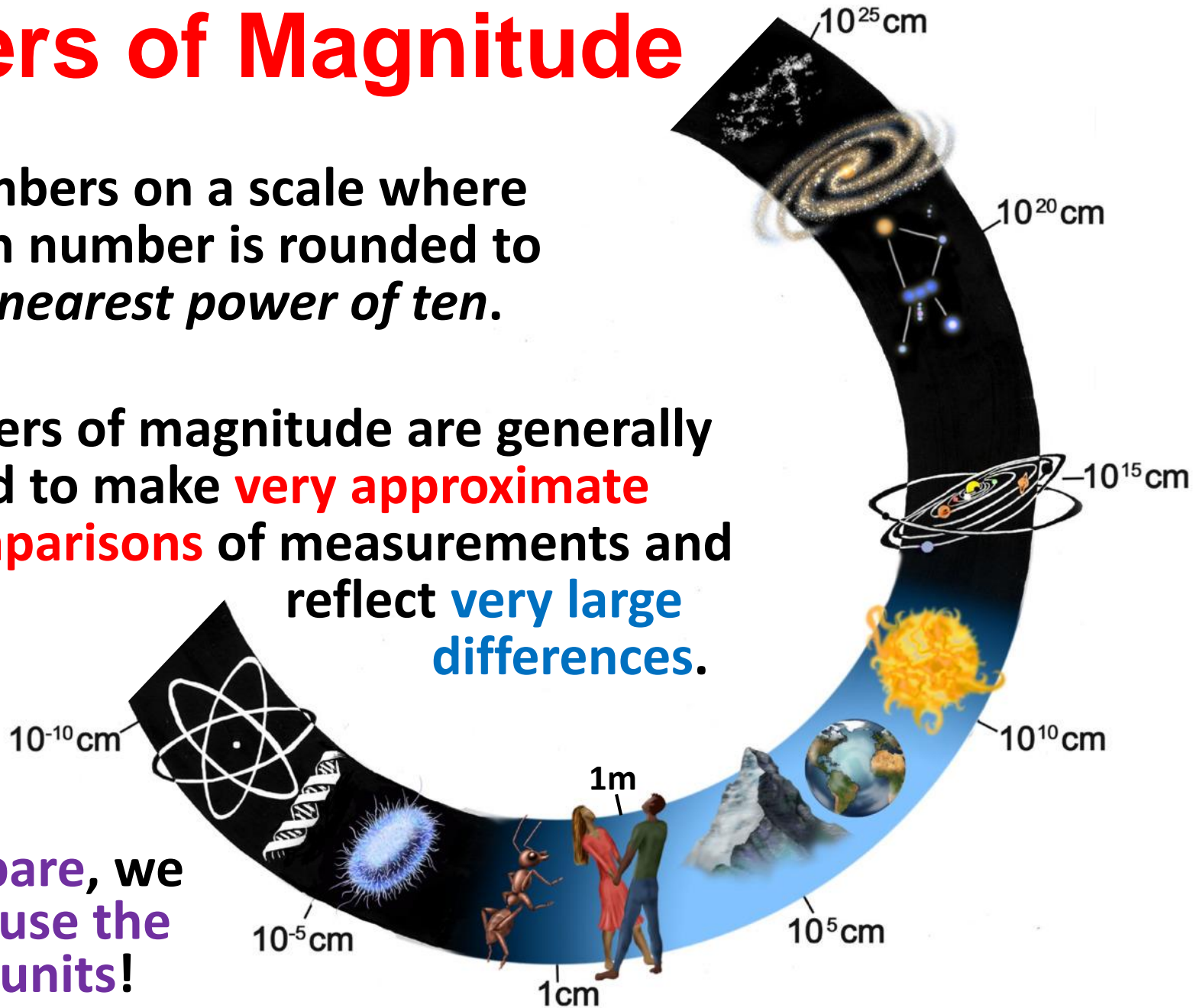
Some Bigger Things



Orders of Magnitude

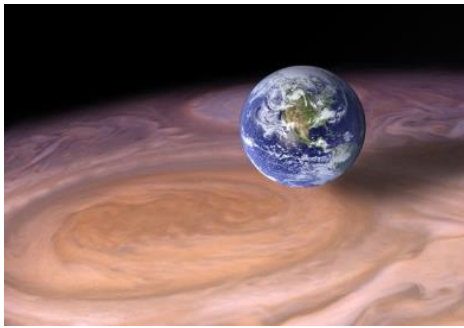
- Numbers on a scale where each number is rounded to the *nearest power of ten*.
- Orders of magnitude are generally used to make **very approximate comparisons** of measurements and reflect **very large differences**.

To compare, we always use the same units!

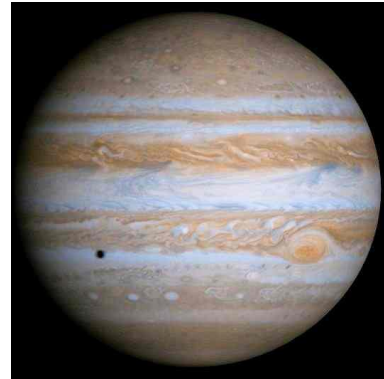


Examples of Difference

- If two numbers differ by **one order of magnitude**, one is about **ten** times larger than the other.



$\times 10 \approx$



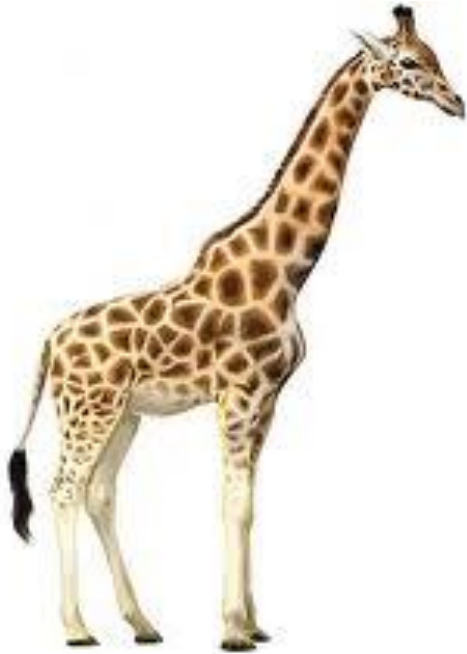
- If they differ by **two orders of magnitude**, they are related by a factor of about **100**.



$\times 100 \approx$



By how many orders of magnitude is a giraffe taller than an ant?



Let's round each measurement to the nearest power of ten!

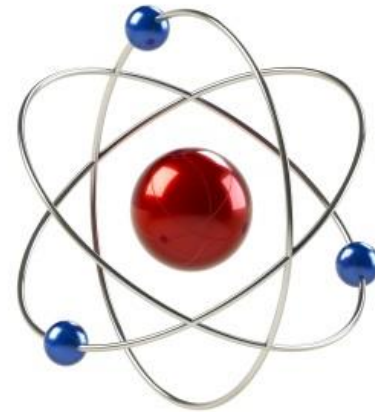


*A giraffe is about 6 m tall:
nearest power of ten is
 $10\text{ m} = 1 \times 10^1\text{ m} = 10^1\text{ m}$*

*An ant is about 0.7 mm tall:
nearest power of ten is
 $1\text{ mm} = 1 \times 10^{-3}\text{ m} = 10^{-3}\text{ m}$*

The giraffe is taller by $1 - (-3) = 4$ **four orders of magnitude.**

By how many orders of magnitude is human bigger than an atom?



***A human is about 175 cm tall:
nearest power of ten is
100 cm = 1 m = 10^0 m***

***An atom is about 0.1 nm:
nearest power of ten is
0.1 nm = 0.1×10^{-9} m = 10^{-10} m***

The human is bigger by $0 - (-10) = 10$ ten orders of magnitude.

Blue Whale heart and Human heart

A Blue Whale heart is about 2000 lb:

converting lb to kg $2000 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 909 \text{ kg}$

nearest power of ten is $1000 \text{ kg} = 10^3 \text{ kg}$



A human heart is about 250 g:

converting g to kg $250 \text{ g} = 0.25 \text{ kg}$

nearest power of ten is

$0.1 \text{ kg} = 10^{-1} \text{ kg}$

Difference: $3 - (-1) = 4$

**four orders of magnitude
more massive!**



Let us compare Sun and Earth in terms of orders of magnitude

	Sun	vs	Earth
• Mass	10^{33} g		10^{27} g
• Radius	10^9 m		10^7 m

Sun is heavier than Earth by **6 orders of magnitude** and bigger by **2 orders of magnitude**.

Can you imagine that difference?



Powers of Ten video

<https://www.youtube.com/watch?v=bhofN1xX6u0>

<https://www.youtube.com/watch?v=EMLPJqeW78Q>