

A Reminder of Scientific Notation and the Metric System

(You'll be expected to know this cold)

Exponents and Significant Figures

$$5000 = 5 \times 10^3 \qquad 5134 = 5.134 \times 10^3$$


Significant Figures signal Accuracy

$$5 \times 10^3 \quad \text{and} \quad 5.00 \times 10^3$$

may *numerically* be the same, but they don't *mean* the same.

- 5 could be 4.7 or 5.1
- 5.00 could be 4.997 or 5.001, but NOT 4.7 or 5.1

The last digit listed is the only one that could be rounded.

Multiplication and Division

$$(5 \times 10^3)(6 \times 10^4) = (5 \times 6)(10^3 \times 10^4) = (30)(10^7) = 3 \times 10^8$$

$(10 \times 10 \times 10)(10 \times 10 \times 10 \times 10)$

When numbers multiply, exponents add.

$$\frac{(6 \times 10^4)}{(5 \times 10^3)} = \frac{6}{5} \times \frac{10^4}{10^3} = 1.2 \times 10^1 \quad \frac{10 \times 10 \times 10 \times 10}{10 \times 10 \times 10} = 10^{4-3}$$

When numbers divide, exponents subtract.

You should always group powers of 10 for quick simplification *before* you reach for the calculator.

Negative Exponents

$$\frac{(6 \times 10^3)}{(5 \times 10^6)} = \frac{6}{5} \times \frac{10^3}{10^6} = 1.2 \times \frac{1}{10^3} = 1.2 \times 10^{3-6} = 1.2 \times 10^{-3}$$

A negative exponent means the power of 10 is in the denominator

$$\text{so } 0.0012 = \frac{1.2}{1000} = 1.2 \times 10^{-3}$$

$$\frac{10^7}{10^7} = 1 = 10^{7-7} = 10^0$$

$$10^0 = 1$$

A Little Practice

Convert into standard form: n.ddd x 10^p

4313.1 0.00056 54x10³ 0.63x10⁻²

Convert each number into standard form, then do the math:

$$(0.0003)(400) = 1.2 \times 10^{-1} \frac{0.0006}{3000000} = 2 \times 10^{-10}$$

$$\frac{(6400)(0.02)}{(0.0008 \times 10^1)} = 1.6 \times 10^4$$

Powers and Roots

$$(10^2)^3 = (10^2)(10^2)(10^2) = 10^{2*3} = 10^6$$

One power raised to another power will multiply

$$\sqrt{100} = (10^2)^{1/2} = 10^{2/2} = 10$$

Roots are fractional powers that multiply

$$\sqrt[3]{8 \times 10^6} = (8 \times 10^6)^{1/3} = (8)^{1/3} (10^6)^{1/3} = 2 \times 10^{6/3} = 2 \times 10^2$$

Separate the numbers and powers and work out arithmetic

Practice:
$$\frac{\sqrt{(20000)(0.08)}}{40} =$$

Addition and Subtraction

$$5 \times 10^6 + 2 \times 10^4 = 5 \times 10^6 + 0.02 \times 10^6 = (5 + 0.02) \times 10^6 = 5.02 \times 10^6$$

When adding or subtracting numbers with different powers of 10, adjust the smaller exponent to match the larger one, then group the numbers and simplify.

$$7.2 \times 10^{-6} - 5 \times 10^{-5} =$$

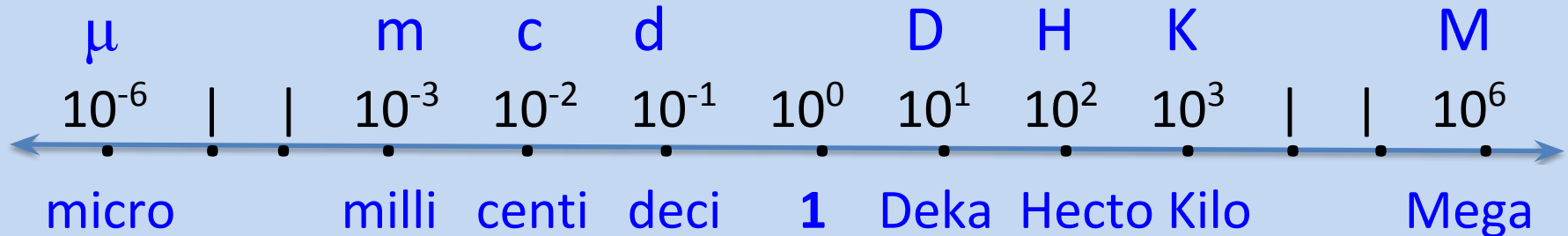
$$0.72 \times 10^{-5} - 5 \times 10^{-5} = (0.72 - 5) \times 10^{-5} = -4.28 \times 10^{-5}$$

Quick Arithmetic

$$\frac{(585762)(0.00487)}{0.00002917} = \frac{(6 \times 10^5)(5 \times 10^{-3})}{3 \times 10^{-5}}$$
$$= \frac{30 \times 10^2}{3 \times 10^{-5}} = \frac{10 \times 10^3}{10^{-5}} = \frac{10^4}{10^{-5}} = 10^9$$

Estimate to 1 significant figure. Should only take about 15 seconds.

Metric Prefixes and Conversions



Conversion within the metric system is done by counting the number of steps between prefixes, and changing the power of 10 accordingly, making it larger or smaller as needed.

$$6.3 \times 10^5 \text{ cm} = ? \text{ Km?}$$

$$6.3 \times 10^{5-5} = 6.3 \times 10^0 \text{ Km}$$

$$3.1 \times 10^{-2} \text{ DL} = ? \text{ dL?}$$

$$3.1 \times 10^{-2+4} = 3.1 \times 10^2 \text{ dL}$$

Two Units used for Remote Sensing

$$1 \text{ micron} = 10^{-6} \text{ m}$$

$$1 \text{ Angstrom} = 10^{-10} \text{ m}$$

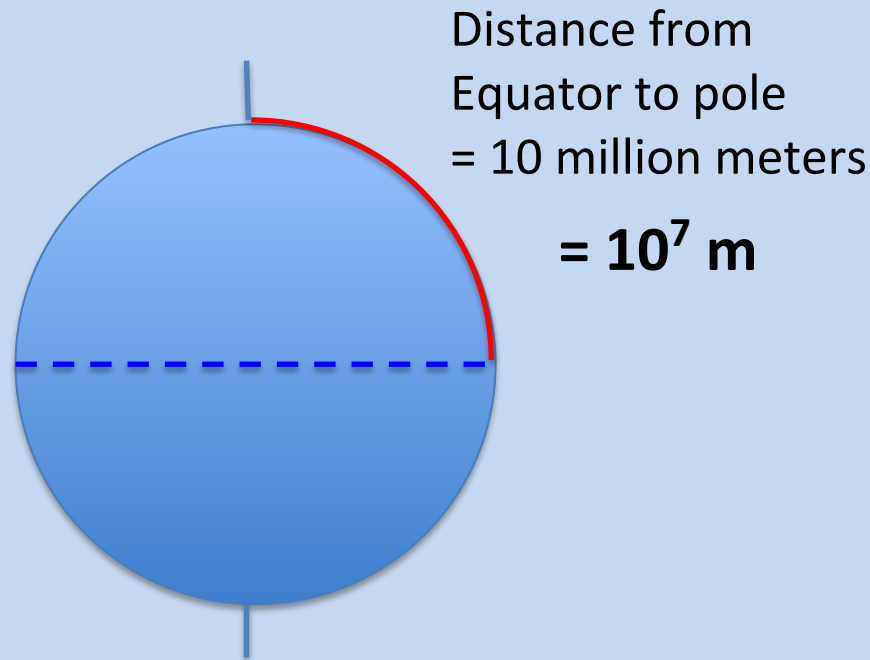
Visible light wavelength ~ 0.5 microns

Also the size of fine dust, bacteria

Atomic diameter ~ 1 Angstrom

How many atoms stretch across a bacterium?

Original Definition of the Meter



What is the distance around the earth in km?

The typical person walks 5 km/hr, how long would it take to walk around the earth?

Volumes and Masses

$$\text{Liter} = (1 \text{ dm})^3 = (10 \text{ cm})^3 = 1000 \text{ "cc"}$$

$$\text{So } 1 \text{ cc} = 1 \text{ mL}$$

$$1 \text{ m}^3 = (10 \text{ dm})^3 = 1000 \text{ dm}^3 = 1000 \text{ Liters}$$

$$1 \text{ Liter water} = 1 \text{ kilogram}$$

$$\text{So } 1 \text{ cc} = 1 \text{ gram}$$

$$1 \text{ m}^3 \text{ water} = 1000 \text{ kg} = 1 \text{ metric ton}$$

So we can estimate: *what is the mass of water in your tub?*
(do it in kg and metric tons)

Conversions to “American” Units

1 inch = 2.54 cm ~ 2.5 cm

1 yard = 91.4 cm ~ 1 m ~ 39 inches

1 mile = 1.61 km ~ 8/5 km

1 liter = 1.06 quarts ~ 1 quart

1 kg = 2.21 lbs ~ 2 lbs

1 ton = 2000 lbs = 0.905 metric tons ~ 1 metric ton

How many gallons of water would fill your bathtub?

What is your approximate volume in liters?

Other Fun Questions

- If air has a density of 1.2 g/liter, estimate the mass of air in ... your room...the empire state building.
- If lightning strikes a mile away, you hear thunder 5 seconds after you see the flash. From this calculate the speed of sound in m/s.