FPST 2343
INDUSTRIAL HYGIENE

VIDEO LECTURE
WEEK 1 LAB 1B
TRACKING AND
CONVERTING UNITS

Learning Objectives

- Recall the methods for tracking and converting units in mathematical operations

Why are units important?

Nov. 10, 1999: Metric Math Mistake Muffed Mars Meteorology Mission

A disaster investigation board reports that NASA's Mars Climate Orbiter burned up in the Martian atmosphere because engineers failed to convert units from English to metric.

The software calculated the force the thrusters needed to exert in pounds of force. A separate piece of software took in the data assuming it was in the metric unit: newtons.

$125M mistake

What's an order of magnitude among friends?

£2 billion Spanish navy submarine will sink to bottom of sea

A former Spanish official told the Associated Press at the time that someone had put a decimal point in the wrong place, and "nobody paid attention to review the calculations"

The original design from state-owned defense company Navantia was for a 71m, 2,200-ton displacement vessel.

Now, the S-80 Plus is an 81m, 3,000-ton boat.

You can fix almost anything with money, right?

Too long to fit: launch of new Spanish sub runs aground

First it was too heavy, then it was too long.

The Spanish navy has now been forced to dredge and expand its main submarine base to accommodate the latest version of its S-80 Plus flagship vessel.

The Spanish government will approve funds in the next few days raising the total additional cost of the new submarine by €17m and taking the total cost to roughly €1bn for each of the four submersibles, practically twice what was initially forecast.

Journalist need to check their decimal places as well

● This article was amended on 19 July 2018 because an earlier version said in the next few days the Spanish government would approve raising the total additional cost of the new submarine by €1.7m. This has been corrected to €17m.

Rules for Units

When multiplying, units multiply

3 meters x 3 meters = 9 meters squared

When dividing, units divide

3 meters / 3 seconds = 1 meters/second

Addition and subtraction must be in the same units

3 meters – 2 meters = 1 meter

Complex Unit Cancelation

5 miles / 5 miles/hr = 1 hr

Units in the denominator "flip" then cancel

$$5\ mi \div \frac{5\ mi}{hr} = 1\ hr$$

$$\frac{5\ \cancel{mi}}{1} \times \frac{1}{5}\frac{hr}{\cancel{mi}} = 1\ hr$$

Example

Convert the speed of sound @ 20˚C, 343 m/s, to miles per hour.

$$343\frac{m}{\cancel{s}} \times 60\frac{\cancel{s}}{min}$$

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$$343\frac{\cancel{m}}{\cancel{s}} \times 60\frac{\cancel{s}}{\cancel{min}} \times 60\frac{\cancel{min}}{hr} \times 3.28\frac{ft}{\cancel{m}}$$

Example

Convert the speed of sound @ 20˚C, 343 m/s, to miles per hour.

$$343\frac{\cancel{m}}{\cancel{s}} \times 60\frac{\cancel{s}}{\cancel{min}} \times 60\frac{\cancel{min}}{hr} \times 3.28\frac{\cancel{ft}}{\cancel{m}} \times \frac{1}{5280}\frac{mi}{\cancel{ft}}$$

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Practice

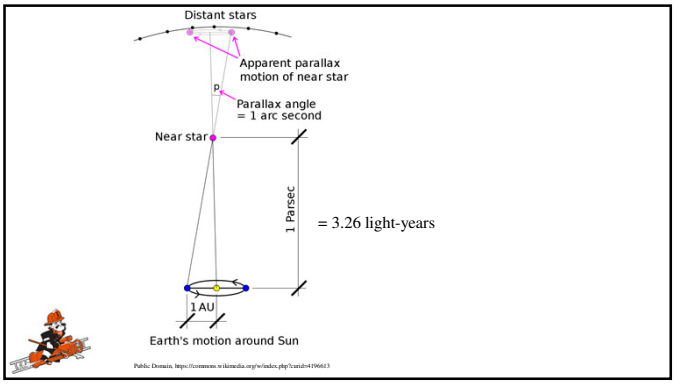
Convert 1 attoparsec per microfortnight to inches per second.

Atto = 1E-18

Micro = 1E-6

Fortnight = 14 days

Parsec (see next slide)



Pause the video and try to work the problem yourself. (or get a hint on the next slide)

Hint

Break the problem into parts:

First, find the length of a light-year in inches, convert parsecs to inches, then apply the prefix atto

Second, convert a fortnight to seconds, then apply the prefix micro

Third, divide the first result by the second

Pause video and finish working the problem (solution on next slide)

Solution

$$186{,}000\frac{mi}{s} \times 60\ \frac{s}{min} \times 60\frac{min}{hr} \times 24\frac{hr}{day} \times 365\frac{day}{yr} \times 5{,}280\frac{ft}{mi} \times 12\frac{in}{ft} =$$

mi = miles	yr = year
s = second	ft = feet
min = minutes	in = inch
hr = hours	ft = foot

Solution

$$186{,}000\frac{\cancel{mi}}{s} \times 60\ \frac{s}{min} \times 60\frac{min}{hr} \times 24\frac{hr}{day} \times 365\frac{day}{yr} \times 5{,}280\frac{ft}{\cancel{mi}} \times 12\frac{in}{ft} =$$

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mi = miles
s = second
min = minutes
hr = hours
yr = year

ft = feet
in = inch
ft = foot
ly = light year
par = parsec

Solution

$$186{,}000\frac{\cancel{mi}}{\cancel{s}} \times 60\frac{\cancel{s}}{\cancel{min}} \times 60\frac{\cancel{min}}{\cancel{hr}} \times 24\frac{\cancel{hr}}{\cancel{day}} \times 365\frac{\cancel{day}}{yr} \times 5{,}280\frac{\cancel{ft}}{\cancel{mi}} \times 12\frac{in}{\cancel{ft}} = 3.7165E17\frac{in}{ly}$$

mi = miles
s = second
min = minutes
hr = hours
yr = year

ft = feet
in = inch
ft = foot
ly = light year
par = parsec

$$3.26\frac{\cancel{ly}}{par} \times 3.7165E17\frac{in}{\cancel{ly}} \times 10^{-18} = 1.2116\frac{in}{attoparsec}$$

Solution

$$14\frac{day}{fn} \times 24\frac{hr}{day} \times 60\frac{min}{hr} \times 60\frac{sec}{min} =$$

fn = fortnight
hr = hour

min = minute
sec = second

Solution

$$14\frac{\cancel{day}}{fn} \times 24\frac{\cancel{hr}}{\cancel{day}} \times 60\frac{\cancel{min}}{\cancel{hr}} \times 60\frac{sec}{\cancel{min}} =$$

fn = fortnight min = minute
hr = hour sec = second

Solution

$$14\frac{\cancel{day}}{fn} \times 24\frac{\cancel{hr}}{\cancel{day}} \times 60\frac{\cancel{min}}{\cancel{hr}} \times 60\frac{sec}{\cancel{min}} = 1{,}209{,}600\frac{sec}{fn}$$

fn = fortnight min = minute
hr = hour sec = second

Solution

$$14\frac{\cancel{day}}{fn} \times 24\frac{\cancel{hr}}{\cancel{day}} \times 60\frac{\cancel{min}}{\cancel{hr}} \times 60\frac{sec}{\cancel{min}} = 1{,}209{,}600\frac{sec}{fn}$$

$$1{,}209{,}600\frac{sec}{fn} \times 10^{-6} = 1.2096\frac{sec}{microfortnight}$$

fn = fortnight min = minute
hr = hour sec = second

Solution

$$\frac{1.2116\frac{in}{attoparsec}}{1.2096\frac{sec}{microfortnight}} \therefore 1\frac{attoparsec}{microfortnight} = 1.00\frac{in}{sec}$$

Have a great day!