Critical Math Tools for Physics:

- Dimensional analysis (for conversions and checking work)
- Radians (for measuring angles)
- Trigonometric ratios (for calculations)
- Significant figures (in case you become an engineer)
- Scientific notation (for really big or really small numbers)

Dimensional Analysis:

Convert 15 miles/hr^2 into m/s^2 ...

$\frac{\text{hours}}{\text{hours}} = 1$

$\frac{1 \text{ min.}}{1 \text{ min.}} = \frac{60 \text{ sec}}{1 \text{ min.}}$

$\frac{1 \text{ hr}}{1 \text{ hr}^2} = \frac{1}{1 \text{ hr}}$

$\frac{15 \text{ miles}}{1 \text{ hr}^2} = ? \frac{m}{s^2}$

$1 = \frac{60 \text{ sec}}{1 \text{ min.}}$

conversion factor

$1 \text{ m} = 0.000621 \text{ miles}$

$1 \text{ hr} = 3600 \text{ s}$

$\frac{15 \text{ miles}}{\text{hr}^2} \cdot \frac{1 \text{ m}}{0.000621 \text{ miles}} \cdot \frac{1 \text{ hr}}{3600 \text{ s}} \cdot \frac{1 \text{ hr}}{3600 \text{ s}} = \frac{m}{s^2}$

$0.0019 \frac{m}{s^2}$

Radians:

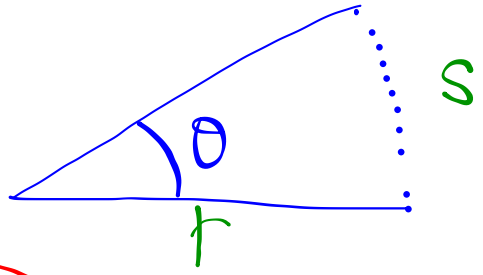
- Relate an angle (theta - θ) to the radius of a circle (r) and the segment length (s)

$$\theta = \frac{s}{r}$$

- One radian is ... (by the way, it's a unitless ratio)

if $s = r$ then

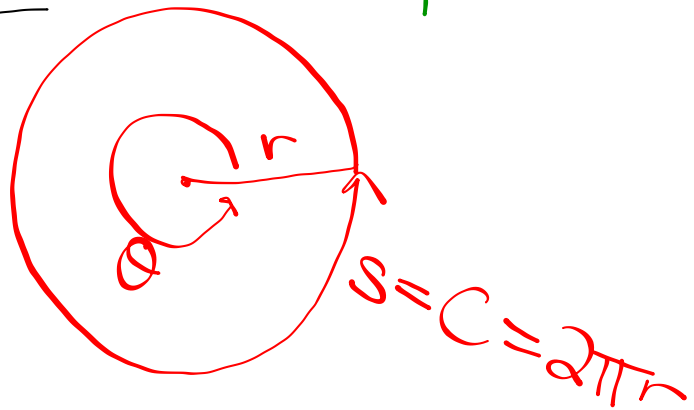
$$\theta = \frac{s}{r} = 1 \text{ rad.}$$



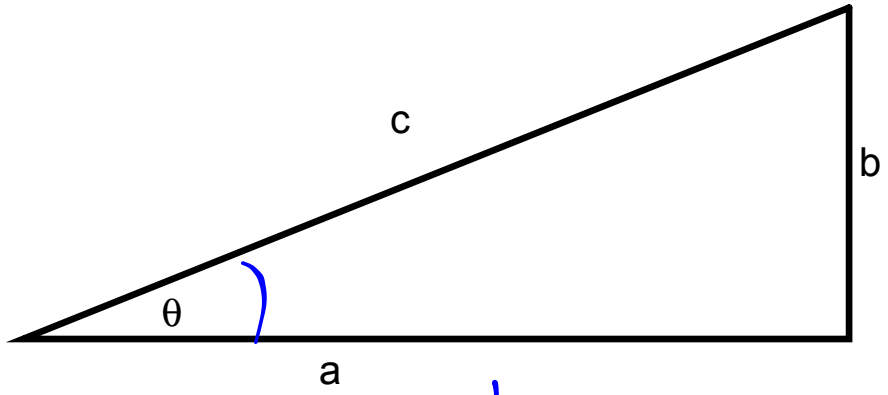
- Radians can be converted to degrees:

$$\theta = \frac{s}{r} = \frac{2\pi r}{r} = 2\pi$$

$$360^\circ = 2\pi \text{ rad.}$$



Trig ratios:



$\sin\theta = \frac{b}{c}$ $\sin^{-1}\frac{b}{c} = \theta$

$\cos\theta = \frac{a}{c}$ $\cos^{-1}\frac{a}{c} = \theta$

$\tan\theta = \frac{b}{a}$ $\tan^{-1}\frac{b}{a} = \theta$

Significant Figures:

- Show how precise a measurement or calculation is
- Don't count leading zeros, or zeros immediately following a decimal point
- Do count zeros that follow the last non-zero digit of a decimal number
- Sometimes count zeros before the decimal point ...
- Always count non-zero numbers

Significant Figures Calculations:

- Addition: Round answers to the same number of decimal digits as the number with the least number of decimal digits ...

- Multiplication: Round answers to the same number of significant figures as the number with the smallest number of significant figures ...

Scientific Notation:

- A decimal number, usually with a single digit to the left of the decimal point, multiplied by a factor of ten

2.24×10^{-2}

- Convert by counting how far you move the decimal point

$0.0142 = 1.42 \times 10^{-2}$

- Useful for very large or very small numbers

1.32×10^{51} 3.71×10^{-107}

- Makes significant figures easier to determine ...

3.70100×10^{7}

Scientific Notation Calculations:

- Addition: Convert each number so that it's the same power of ten, then add, and re-convert to simplify

$3.1 \times 10^3 + 1.2 \times 10^2$

$3.1 \times 10^3 + 0.12 \times 10^3 = 3.22 \times 10^3$

- Multiplication / Division: Multiply or divide the "mantissas" and combine the powers of ten. Then convert to simplify.

$\frac{7.2 \times 10^4}{3.6 \times 10^{-3}}$ 2×10^7

$10^6 \times 10^{-2} = 10^4$

$1.31 \times 10^{105} + \cancel{6.7 \times 10^3}$