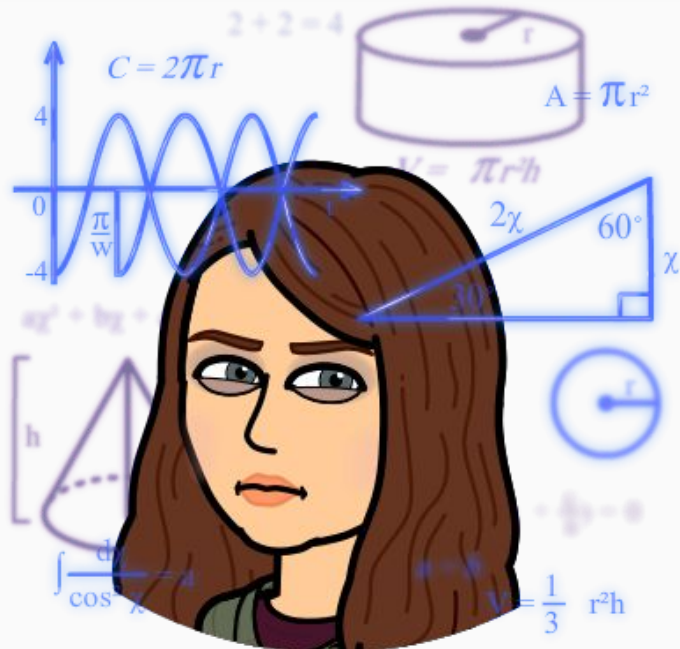


# PLTW Engineering and Math Connections

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# Introductions



# Common Math Themes

- Practical Math (We have the answer to WHY we learn this in math class)
- Scientific notation
- Dimensional analysis.
- Unit Conversion
- Multi-Step Problems

# IED Primary Math Topics

- Basic Measurement US and Metric
- Basic Statistics and Statistical Analysis
- Tolerances
- Cartesian coordinate system/ Polar Graphs
- Shape Geometry/ Geometric and Dimensional constraints.
- Converting fractions to decimals
- Unit Conversion / Dimensional analysis.
- Decimal addition/ subtraction.
- Mass/ Density/ Volume

# POE Primary Math Topics

- How to use a Scientific Calculator
- Solving Equations
- Solving Equations for a Variable
- Proportions and Ratios
- Dimensional Analysis
- Direct and Indirect Relationships
- Reading Graphs
- Area of Composite Shapes
- Coordinate Plane
- Special Right Triangles and Pythagorean Theorem
- Trigonometry
- Probability/Statistics

# CEA Primary Math Topics

- Solving Multi-Equations
- Area and Volume
- Dimensional Analysis
- Reading Graphs
- Angles and Basic Trigonometry
- Scientific Notation

# EDD Primary Math Topics

- Statistics and Analysis
- Disaggregating Data
- Area and Volume
- Reading Graphs

# What does an effective math environment look like?

1. Demonstrate acceptance of students' divergent ideas ✓
2. Influence learning by posing challenging and interesting questions ✓
3. Project a positive attitude about mathematics and about students' ability to "do" mathematics
4. Students are actively engaged in doing mathematics
5. Students are solving challenging problems ✓
6. Interdisciplinary connections and examples are used to teach math ✓
7. Students are sharing their ideas while working collaboratively
8. Students are provided with a variety of opportunities to communicate
9. Students are using manipulatives and other tools

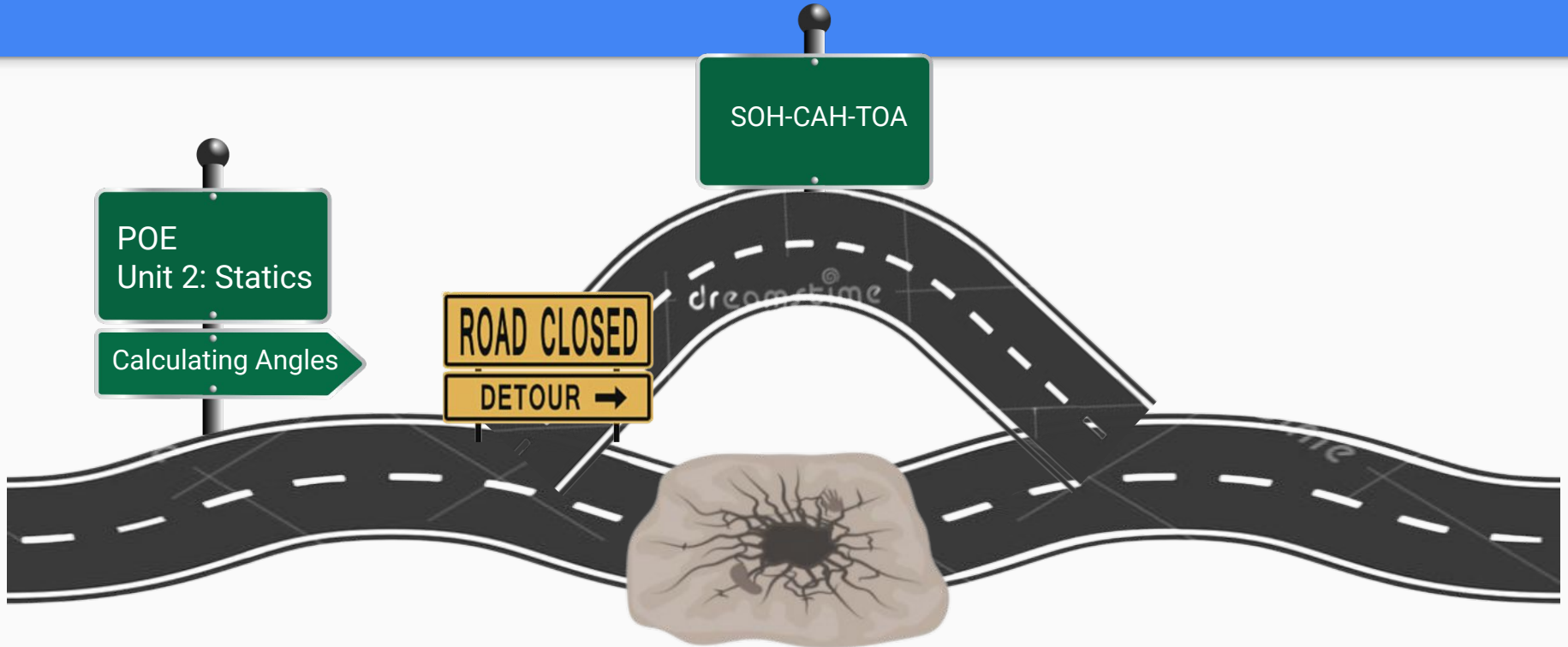




# Common Misunderstandings

- Students understand the process when they have just memorized the operations
- Students know how to use a scientific calculator
- Students have an innate grit to persevere through a challenging problem
- Students solve math problems in sequential order
- All math teachers teach the same way
- Assume that all students learned what they were “supposed to learn”

# Math Lesson Embedded in Content



# Strategies for Dimensional Analysis

- Unit Set-up, conversion ratio, simplify
- FOO (form of one)

$$90 \text{ mph} = \underline{\hspace{2cm}} \text{ ft/sec}$$

$$\frac{90 \text{ mi}}{\text{hr}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}}$$

$$= \frac{475,200}{3600} = 132 \text{ ft/sec}$$

# Strategies for Dimensional Analysis

- Talk to the chemistry teacher
- Try some silly problems

Go to the front and grab a Tootsie Roll. Measure the mass of the Tootsie Roll with wrapper. Measure the time it takes you to chew and swallow a single Tootsie Roll. How many hours would it take you to eat 10 pounds of Tootsie Rolls? (One piece at a time).

mass of Tootsie Roll w/ wrapper	
mass of Tootsie Roll wrapper alone	
mass of Tootsie Roll	
time to chew and swallow	

203 wockets are equal to 213 zoodles. 16 zoodles equals 150 noodles. 15 noodles equal 21 zillows. How many zillows are 100 wockets?

# Multi-Step Problems

PLTW does a pretty good job of listing out steps students can take to solve multi step problems.

Formula	Substitute / Solve	Final Answer

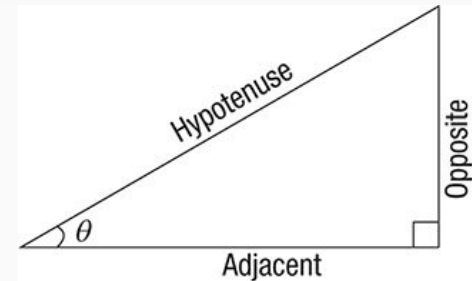
We use lots of Graphic organizers.

Cheat Sheets [Projectile Motion Cheat Sheet](#)

List all Known Values	List all Unknown Values	Select the formula	Substitute and solve	Answer

# Strategies for Trigonometry

- Find out which math class your students are in
- Talk to the math teacher
  - Pythagorean Theorem is an 8th grade standard
  - Special Right Triangles are in Geometry (9th or 10th grade)
  - SOH-CAH-TOA is in Geometry (if time allows) or PreCalculus
- Spend time on the basics
- Explain that it is just a ratio
- [Peardeck Example](#)



$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\csc \theta = \frac{\text{hypotenuse}}{\text{opposite}}$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

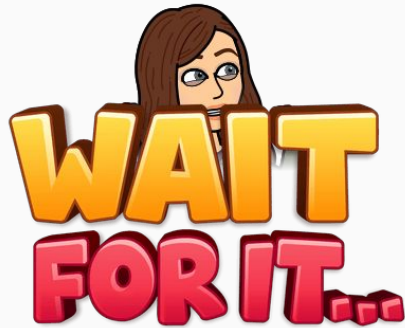
$$\sec \theta = \frac{\text{hypotenuse}}{\text{adjacent}}$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\cot \theta = \frac{\text{adjacent}}{\text{opposite}}$$

# Static Equilibrium Formulas

*Why does it take so long?!*



$$\textcircled{+} \Sigma \mathbf{M}_A = \mathbf{0}$$

$$\text{+} \rightarrow \Sigma F_x = \mathbf{0}$$

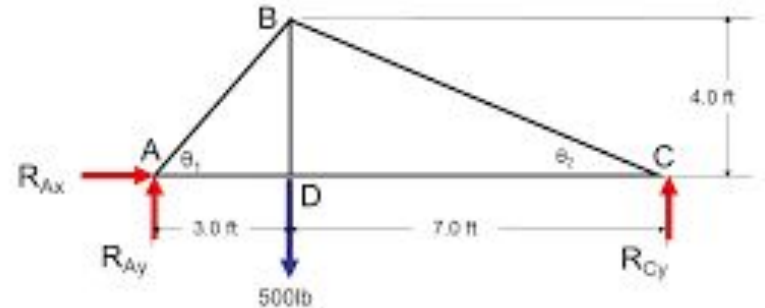
$$\text{+} \uparrow \Sigma F_y = \mathbf{0}$$

# Truss Example

- Pre-teach or review Trigonometry
  - Pythagorean Theorem
  - Special Triangles (helpful, not necessary)
  - SOH-CAH-TOA
- Set the truss on a coordinate plane
- Keep the work organized

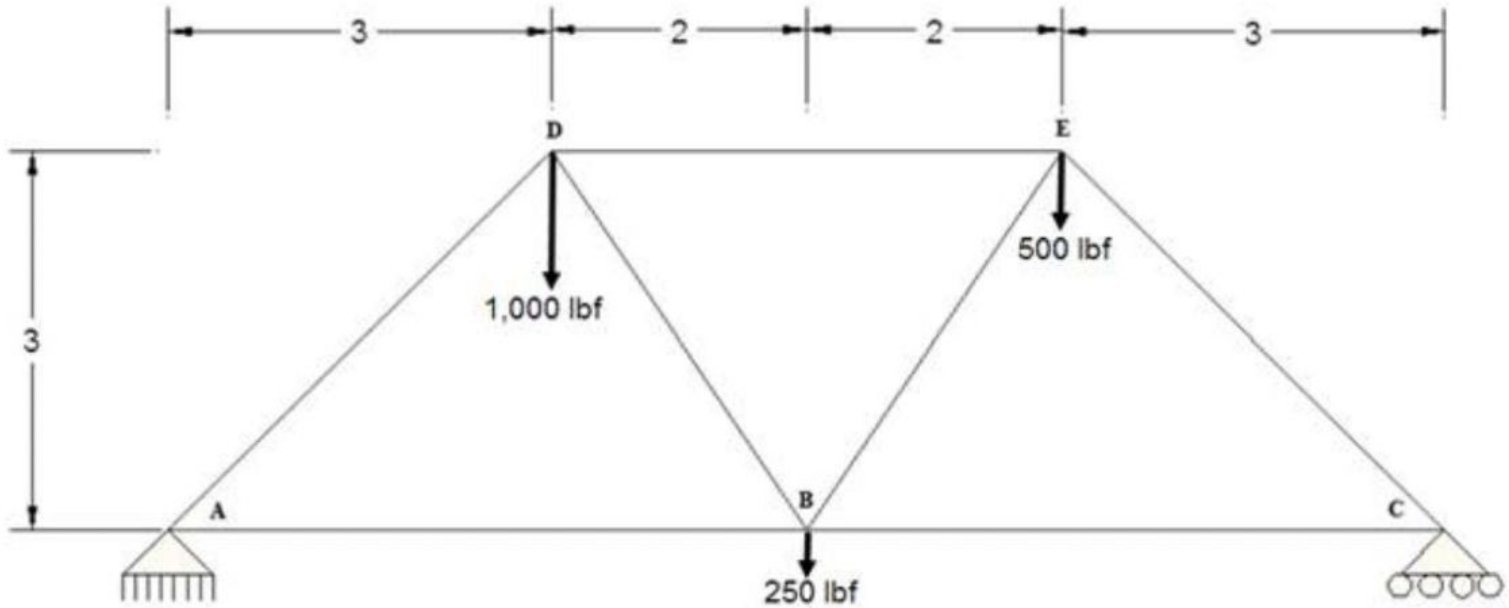
## Method of Joints

### Truss Dimensions





# Truss Example



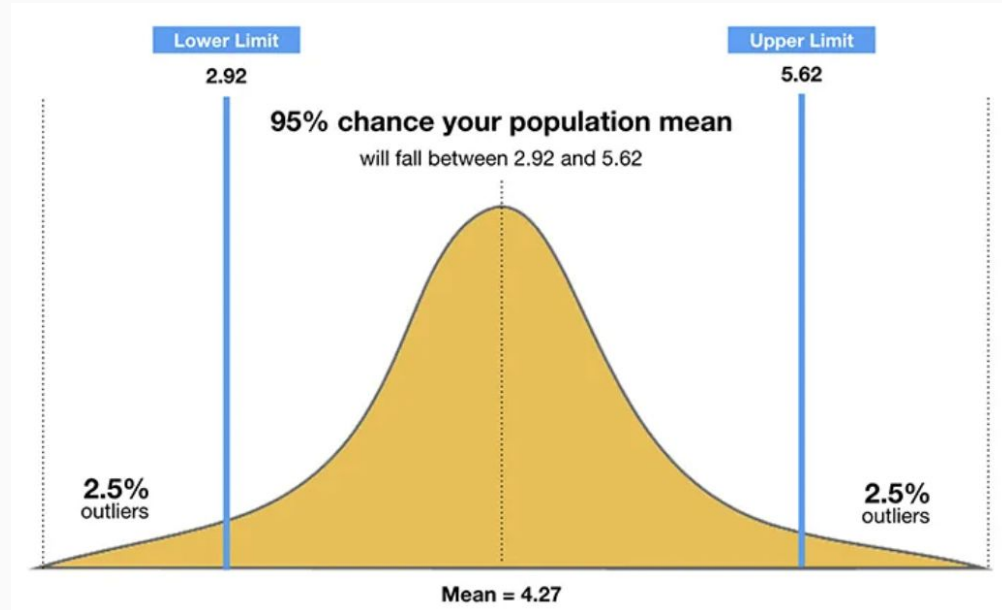
# Strategies for Statistics

- Statistics and Probability standards are at the end of Algebra, Geometry, Algebra 2, and Pre-Calculus textbooks → Math teachers need help!
- Spreadsheets/ formulas
- Cheat sheet of common formulas/ spreadsheet hacks.
  - = SUM
  - =AVERAGE
  - =SORT
  - =SQRT
  - =STDEV
  - =MODE
  - =MEDIAN
- Spreadsheets can do complex calculations if the user inserts parentheses correctly for order of operations. PEMDAS

# Example of Confidence Intervals

The confidence interval (CI) is a range of values that's likely to include a population value with a certain degree of confidence. It is often expressed as a % whereby a population mean lies between an upper and lower interval.

The 95% confidence interval is a range of values that you can be 95% confident contains the true mean of the population.



# Example of Confidence Intervals

The confidence interval is based on the mean, SD and sample size.

[Confidence Interval Calculator](#)

The diagram illustrates the formula for a confidence interval for the population mean  $\mu$ . The formula is  $CI \text{ for } \mu = \bar{x} \pm z^* \cdot \sigma / \sqrt{n}$ . Annotations include: a blue arrow pointing from the word "Mean" to  $\bar{x}$ ; a red arrow pointing from the phrase "„Confidence level“" to  $z^*$ ; a green arrow pointing from the phrase "Variance in population" to  $\sigma$ ; a green arrow pointing from the phrase "Sample size" to  $\sqrt{n}$ ; and a green bracket above  $\sigma / \sqrt{n}$  labeled "SEM".

$$CI \text{ for } \mu = \bar{x} \pm z^* \cdot \sigma / \sqrt{n}$$

Mean

„Confidence level“

Variance in population

Sample size

SEM

# Confidence Interval Example

Is the device comfortable?

Sample Size: 50

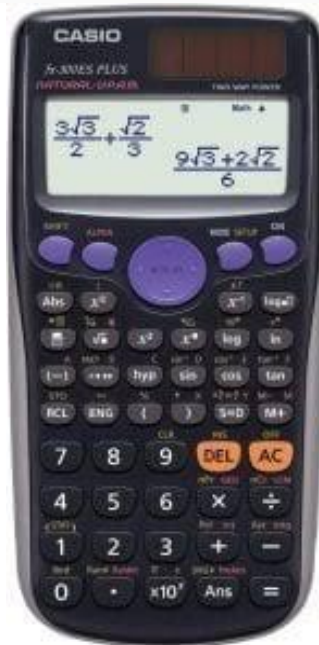
SD: 1.5

Mean: 4.2

**95% Confidence Interval:  $4.2 \pm 0.416$**   
**(3.78 to 4.62)**

"With 95% confidence the population mean is between 3.78 and 4.62, based on 50 samples."

# Scientific Calculator



# Online Resources

- [Kutasoftware](#)
  - Free worksheets to reinforce math skills
- [Math Is Fun](#)
  - Website with explanations and example problems
- [eMATHinstruction](#)
  - Free lesson plans, homework sets, and videos
- [PhET Interactive Simulations](#)
  - Math and science virtual simulations
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# Takeaways

- Don't skip the opportunity to dive into the math
- Talk to your math teachers (Algebra/Geometry/Algebra 2)
- Don't cut out the stats/probability because the math teachers don't always get there
- Don't be scared of math or afraid to ask for help
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