

# Physics Workbook

## Introduction to Physics

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STUDENT NAME



Section  
Check for  
Understanding



Teacher  
Demo



Final  
Check for  
Understanding



Note  
Area

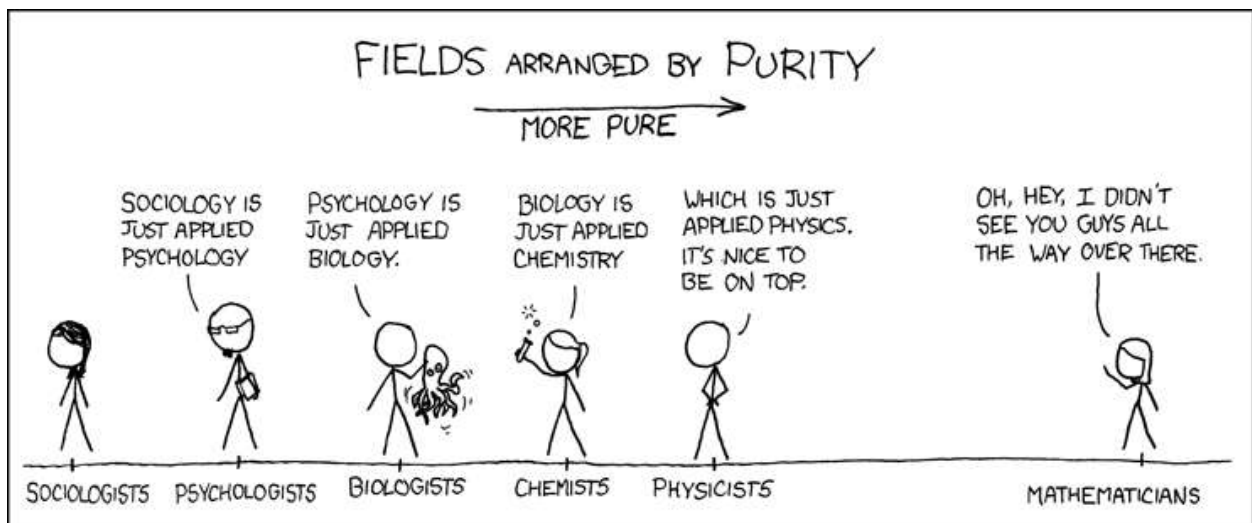
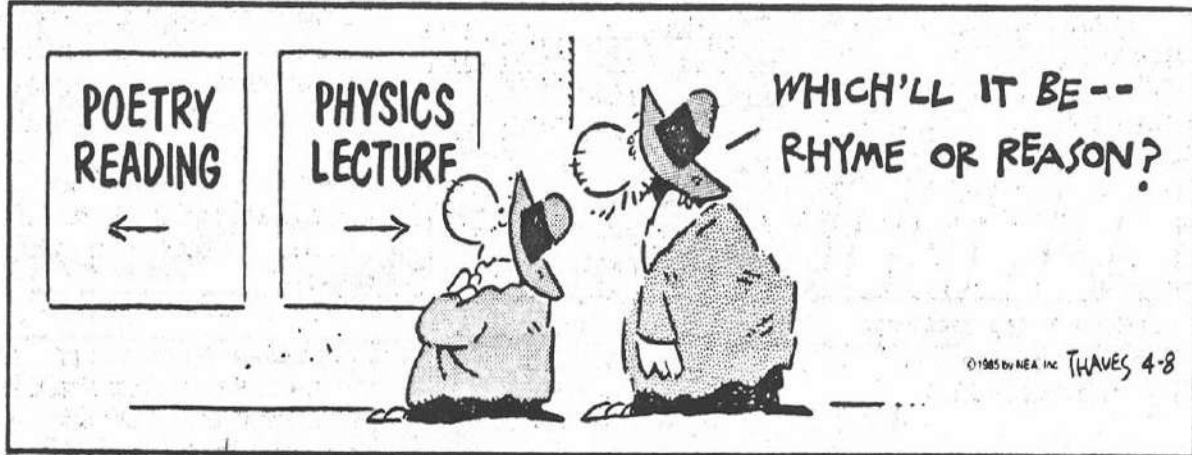
Compiled by Miss Rebekah Taylor  
2018

Video

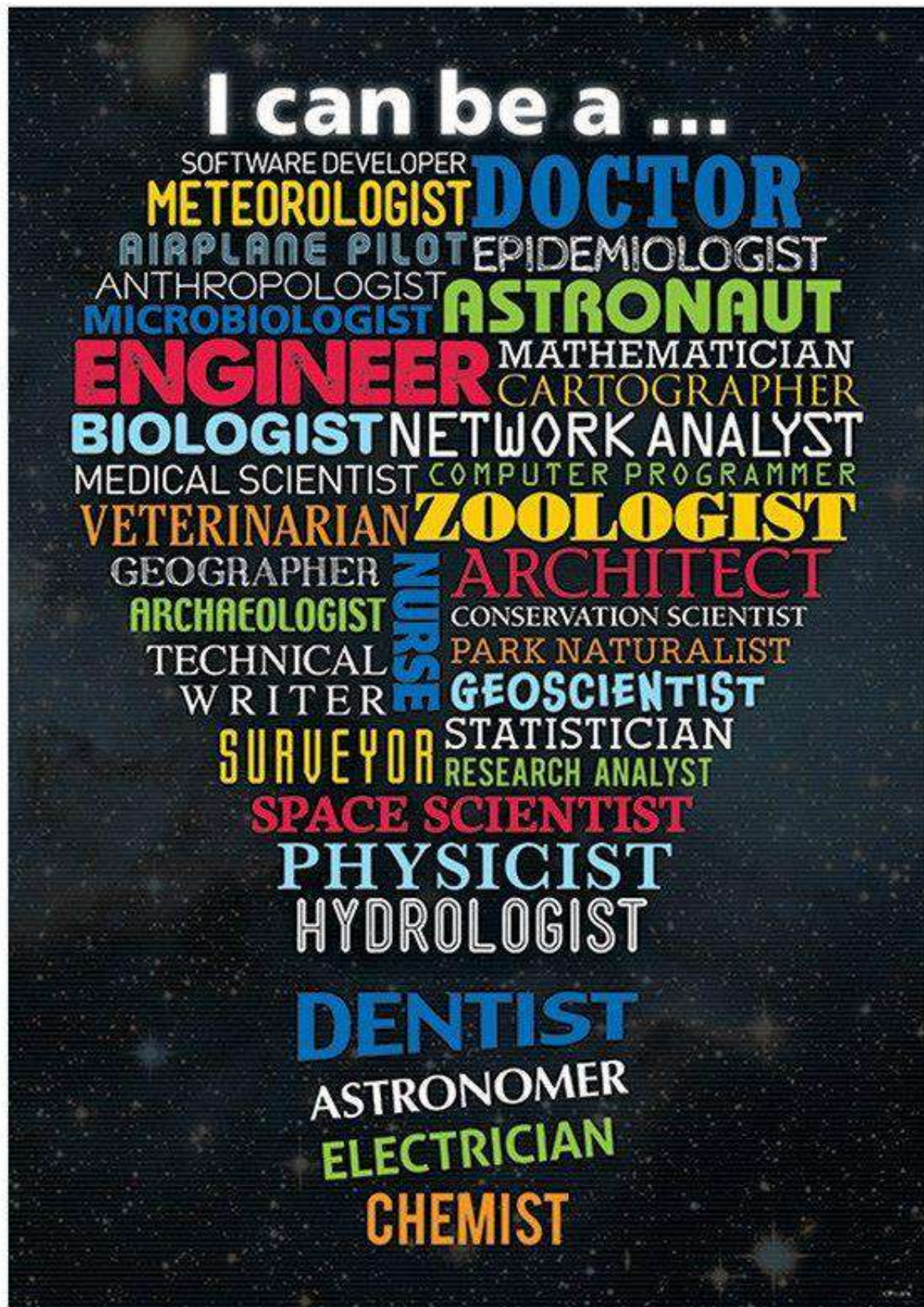




FRANK & ERNEST BOB THAVES







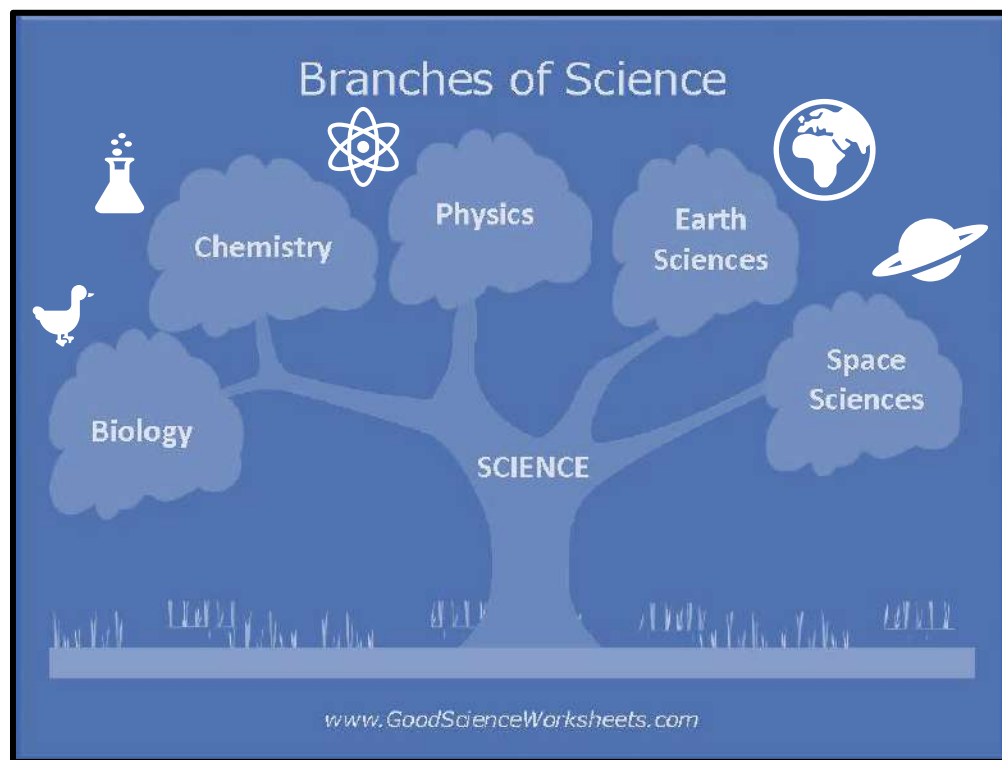
# Physics



2: [Crash Course Physics Preview Video](#)

## Definition of Physics (noun):

The branch of science concerned with the nature and properties of matter and energy.



## MATCHING

**Biology**

**Chemistry**

**Physics**

**Earth Sciences**

**Space Sciences**

Study of matter, energy, space and time.

Study of Earth.

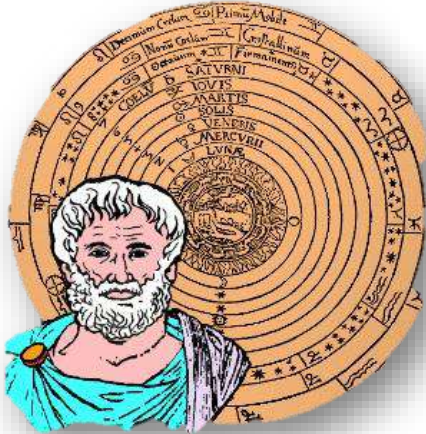
Study of the interactions between elements and compounds

Study of the universe.

Study of living organisms



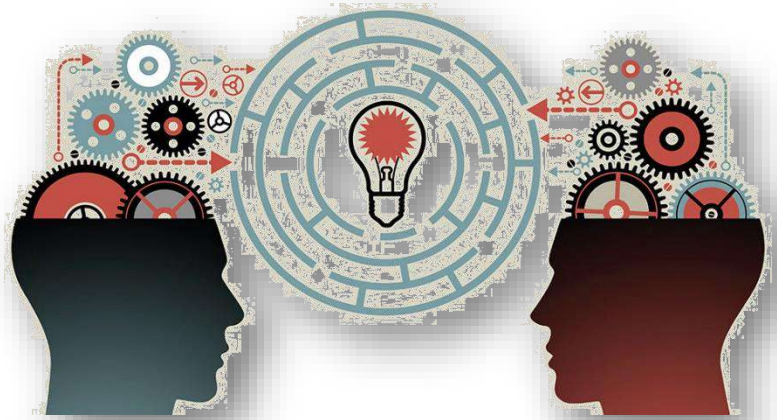
# WHERE DID PHYSICS COME FROM?



Physics can trace its roots all the way back to ancient Greece. Some physicists trace it back to Aristotle (384-322 BC). Aristotle observed the world around him and used reasoning to explain how the world worked in terms of matter, energy, space and time. He did all this by using **critical thinking skills**.

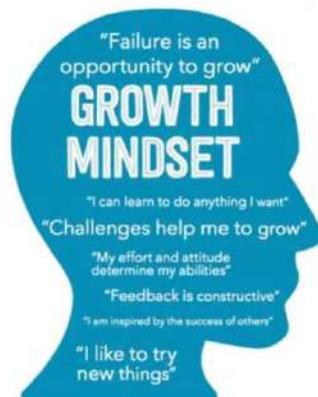
## WHY SHOULD WE CARE ABOUT PHYSICS?

Physics is where we develop **critical thinking skills**. Critical thinking skills help us to think clearly and rationally about what to do. These skills help us be independent thinkers and have a **growth mindset**.



**Example of a critical thinking skill used in your everyday life:**





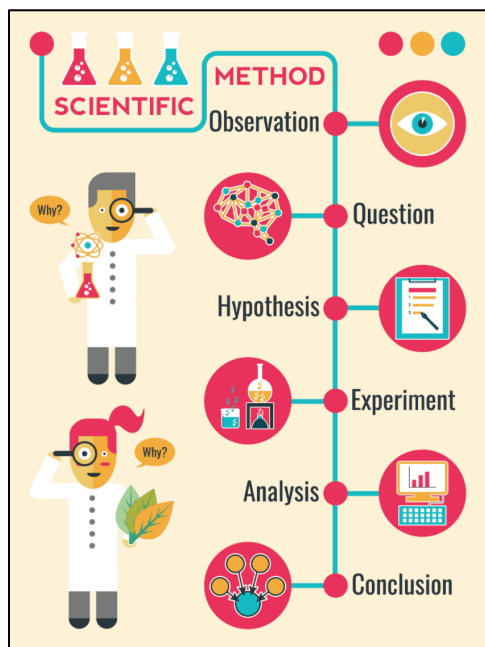
3: [Mindsets: Fixed Versus Growth Video](#)

# CRITICAL THINKING SKILLS

<b>1</b> <b>Knowledge</b>  <b>Identification and recall of information</b>	define fill in the blank list identify	label locate match memorize	name recall spell	state tell underline
	Who _____?		How _____?	
	What _____?		Describe _____?	
	Where _____?		What is _____?	
	When _____?			
<b>2</b> <b>Comprehension</b>  <b>Organization and selection of facts and ideas</b>	convert describe explain  Re-tell _____ in your own words. What is the main idea of _____?	interpret paraphrase put in order	restate retell in your own words rewrite  What differences exist between _____? Can you write a brief outline?	summarize trace translate
<b>3</b> <b>Application</b>  <b>Use of facts, rules, and principles</b>	apply compute conclude construct  How is _____ an example of _____? How is _____ related to _____? Why is _____ significant?	demonstrate determine draw find out	give an example illustrate make operate  Do you know of another instance where _____? Could this have happened in _____?	show solve state a rule or principle use
<b>4</b> <b>Analysis</b>  <b>Separating a whole into component parts</b>	analyze categorize classify compare  What are the parts or features of _____? Classify _____ according to _____. Outline/diagram/web/map _____.	contrast debate deduct determine the factors	diagram differentiate dissect distinguish	examine infer specify  How does _____ compare/contrast with _____? What evidence can you present for _____?
<b>5</b> <b>Synthesis</b>  <b>Combining ideas to form a new whole</b>	change combine compose construct create design  What would you predict/infer from _____? What ideas can you add to _____? How would you create/design a new _____?	find an unusual way formulate generate invent originate plan	predict pretend produce rearrange reconstruct reorganize  What solutions would you suggest for _____? What might happen if you combined _____ with _____?	revise suggest suppose visualize write
<b>6</b> <b>Evaluation</b>  <b>Developing opinions, judgements, or decisions</b>	appraise choose compare conclude  Do you agree that _____? Explain. What do you think about _____? What is most important?	decide defend evaluate give your opinion	judge justify prioritize rank  Prioritize _____ according to _____? How would you decide about _____? What criteria would you use to assess _____?	rate select support value



## WHO IS CONSIDERED THE FIRST PHYSICIST?



Galileo Galilei (1564-1642) was an Italian scientist that is considered the “Father of Modern Science”. He all but disproved the Aristotelian physics and cosmology that had previously dominated the sciences in Europe. He set up many of the techniques we consider necessary in science, including experimentation and recording results. It wouldn’t be until



around 1650 that this became a standard amongst scientists. This standard is called the **Scientific Method**. It is not the only method that scientists use. Scientists approach problems with imagination, creativity, prior knowledge, and perseverance. What distinguishes science from other endeavors is scientists’ focus on testing ideas against observations of real-world phenomenon.

## WHAT ARE “REAL-WORLD PHENOMENON”?

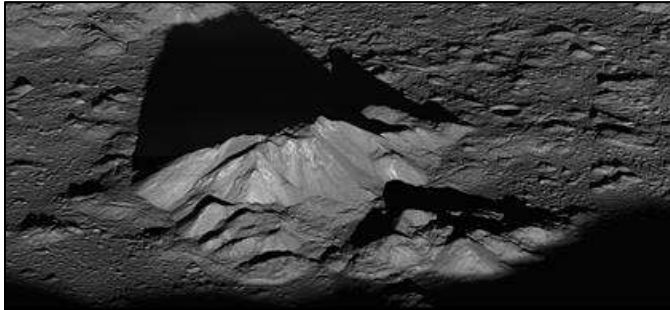
A **real-world phenomenon** is a fact, occurrence, or circumstance that is observed or can be observed. *Example: Why do we see lightning before we hear the thunder?*



Teacher Demo 3  
Spoon in water / Levitating Ping Pong Ball



# Studying Real-World Phenomenon

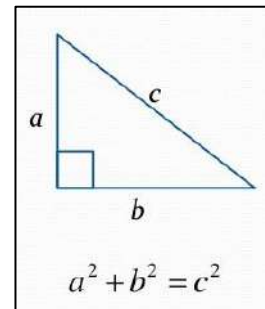
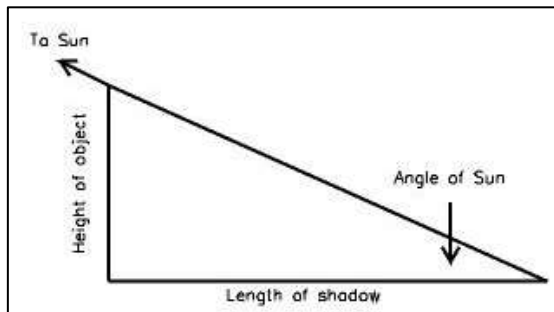


Galileo, with the aid of his telescope, estimated the heights of mountains on the Moon by estimating the lengths of the shadows. He may have used the Pythagorean theorem and/or right triangle trig.

## Pythagorean Theorem

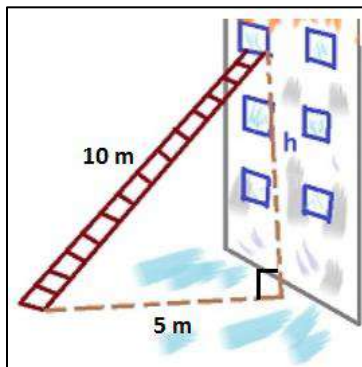


Teacher Demo 4  
Casting Shadows  
Knowing Length and  
hypotenuse /  
Activity

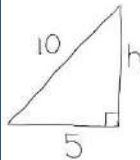


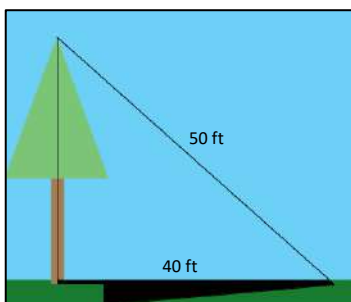
\*This should  
bring back  
memories of  
Algebra class.

## Applying the Pythagorean Theorem



EXAMPLE:



$$\begin{aligned}
 h^2 + 5^2 &= 10^2 \\
 -5^2 &\quad -5^2 \\
 \hline
 h^2 &= 10^2 - 5^2 \\
 h &= \sqrt{10^2 - 5^2} = \sqrt{100 - 25} = \sqrt{75} = \boxed{8.66\text{m}}
 \end{aligned}$$


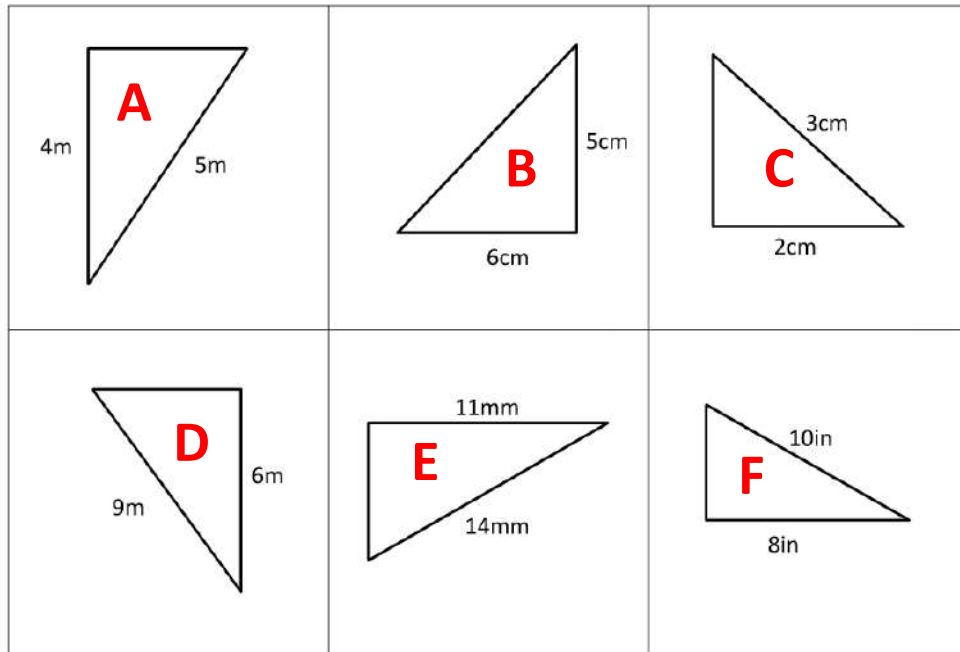
Using the picture on the left, find the height of the tree.





# Pythagorean Theorem Practice

Solve for the missing side. Triangles not to scale.



<b>A:</b>	<b>B:</b>	<b>C:</b>
<b>D:</b>	<b>E:</b>	<b>F:</b>

# Right Triangle Trig.



Teacher Demo 5  
Casting Shadows  
Knowing Length and  
Angle / Activity

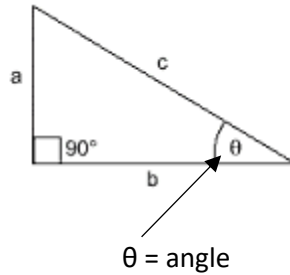
## Right Triangle

$$c^2 = a^2 + b^2$$

$$\sin \theta = \frac{a}{c}$$

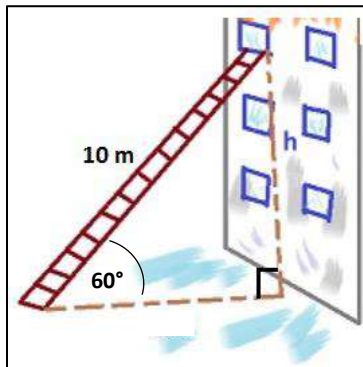
$$\cos \theta = \frac{b}{c}$$

$$\tan \theta = \frac{a}{b}$$



\*This should  
bring back  
memories of  
Algebra class.

## Applying Right Triangle Trig.

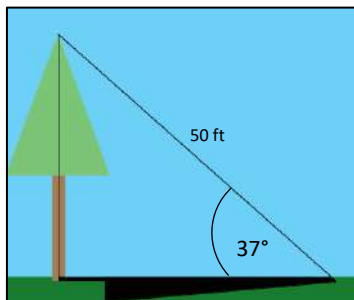


EXAMPLE:

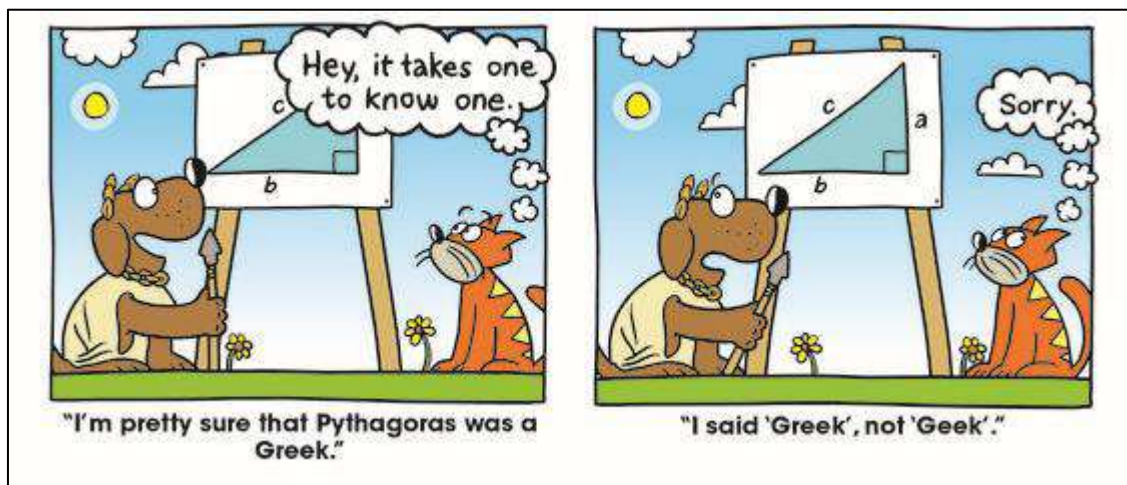
$$\cos \theta = \frac{b}{c}$$

$$10 \cdot \cos 60 = \frac{b}{10} \cdot 10$$

$$10 \cdot \cos 60 = b$$

$$\boxed{5\text{m}} = b$$


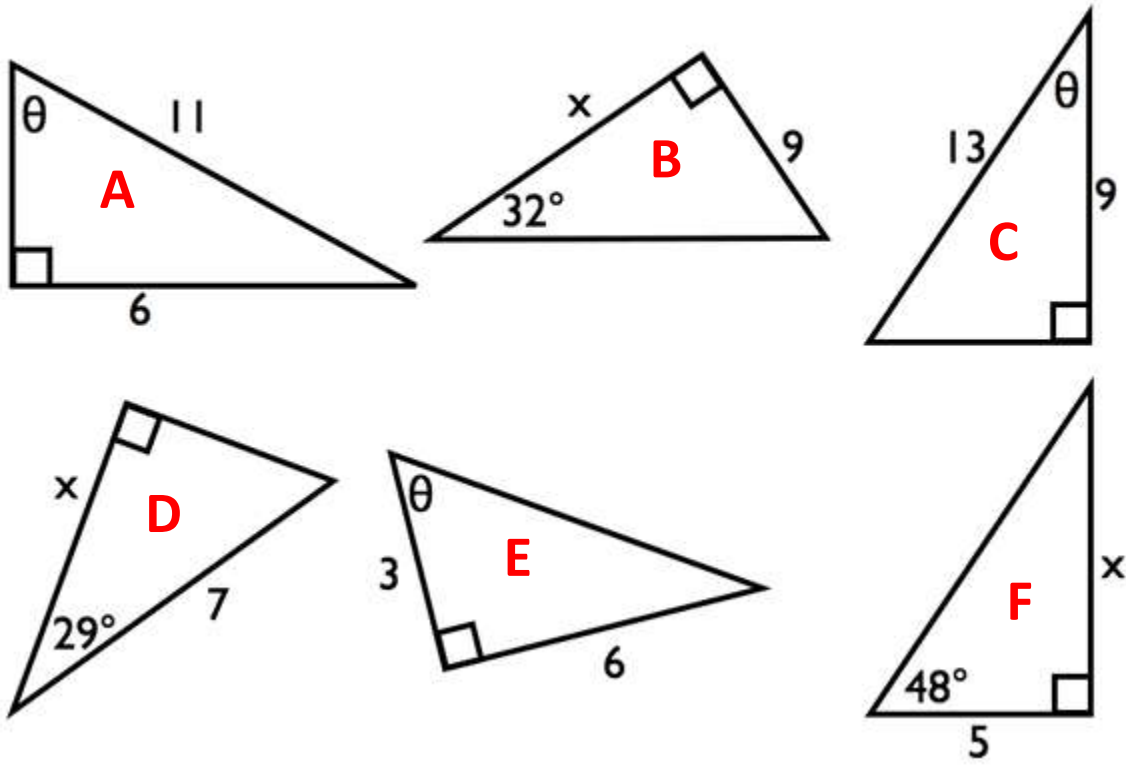
Using the picture on the left, find the height of the tree.





## Right Triangle Trig. Practice

Solve for either "x" or " $\theta$ ." Triangles are not to scale.



<b>A:</b>	<b>B:</b>	<b>C:</b>
<b>D:</b>	<b>E:</b>	<b>F:</b>



# HOW DO PHYSICISTS COMMUNICATE?

## Mathematics

Physics uses mathematics to represent nature because nature can be described in logical and quantitative terms. In physics we use units to describe a quantity. If I'm giving you directions to party I might say, "Go six blocks and then...". Six is the quantity and blocks are the unit. I could replace blocks with feet. Now feet is the unit. A unit gives you a context for the quantity. In other words, it makes the quantity make sense. We will use a table to organize The International System of Units (SI). Why do scientists use the metric system, instead of using English units or some other system? In the metric system, with its base of ten, it is easy to convert from one scale of measurements to another. For instance, it's much easier to convert from centimeters to meters than from inches to yards.

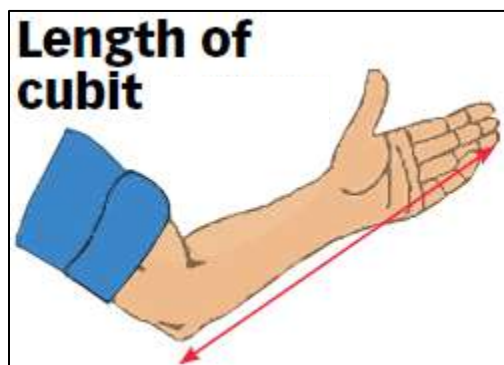


5: [Measurement](#)  
[Mystery: Crash](#)  
[Course Kids #9.2](#)  
[Video](#)

### The International System of Units (SI) Examples

Quantity	Variable	Unit	Symbol
Distance	x or y	meter	m
Mass	m	kilogram	kg
Time	t	second	s
Velocity	v	meter / second	m/s
Acceleration	a	meter / second <sup>2</sup>	m/s <sup>2</sup>

### Ancient Standards Example



All civilizations have had to develop standards for measuring. For example, in Mesopotamia (3500-1800 B.C.), workers built the first cities using cubits, measuring roughly the length of one's forearms from elbow to wrist bone.

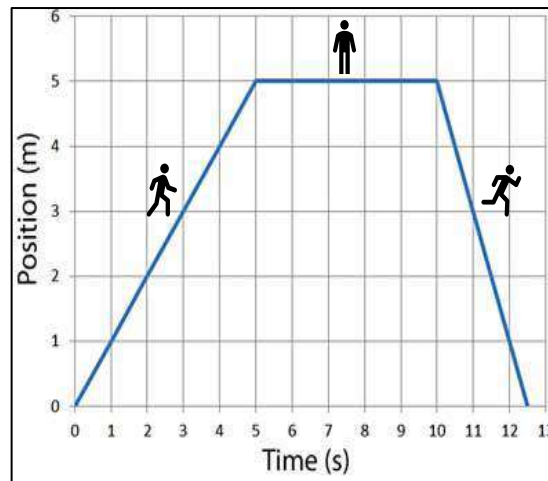


Teacher Demo 6  
Measuring Forearms

## Graph Example



Teacher Demo 7  
Position v. Time



**Use the Position v. Time Graph to Create a Data Table:**

Time (s)	Position (m)
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

From your starting position to 5s what is the distance that you traveled? \_\_\_\_\_

When were you not moving? \_\_\_\_\_

What is the total distance that you traveled? \_\_\_\_\_

Compare between your movement from 0 – 5s and 10 – 12.5s using evidence from the graph or table.

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# THE LANGUAGE OF PHYSICS

## SCIENTIFIC NOTATION

Scientists are lazy and developed a method to express very large numbers. This method is called scientific notation. In common English *significant* means “important”, while in science it means “measured”.

The smallest distance between Earth and Mars is about 58 million kilometers.

Decimal Notation → 58,000,000 km

OR

Scientific Notation →  $5.8 \times 10^7$  km



Teacher Demo 8  
Lazy Scientists

The number 123,000,000,000 in scientific notation is written as:

$$1.23 \times 10^{11}$$

The first number 1.23 is called the **coefficient**. It must be between 1 and 9.

The second number is called the **base**. It must always be 10 in scientific notation. The number above the base is called the **power** (or exponent, index or order).

base number					
<p>base <math>4 \leftarrow</math> power, exponent, index, order</p> <p><math>b = b \times b \times b \times b</math></p>					
in the decimal system the base number is 10					
$10^5$	$10^4$	$10^3$	$10^2$	$10^1$	$10^0$
100000's	10000's	1000's	100's	10's	1's
hundred thousands	ten thousands	thousands	hundreds	tens	ones

$10^3$	$10^2$	$10^1$	$10^0$	$10^{-1}$	$10^{-2}$	$10^{-3}$
1000	100	10	1	0.1	0.01	0.001



### Writing numbers in scientific notation.

1. Put a decimal point after the first digit.
2. To find what power of 10 to use, count the number of places from the decimal point to the end of the number.
3. Drop the zeros and write the number  $\times 10$  to the power.

$$3.4560000000000^{12}$$
$$= 3.456 \times 10^{12}$$

For very small numbers, count back to the original decimal point and write the power of 10 as a negative.

$$0.0000000725^{-8}$$
$$= 7.25 \times 10^{-8}$$

#### examples

decimal notation	scientific notation
84 500	$8.45 \times 10^4$
678 345.96	$6.7834596 \times 10^5$
50 000 000 000	$5 \times 10^{10}$
0.0246	$2.46 \times 10^{-2}$
0.000 024 6	$2.46 \times 10^{-5}$
0.000 000 000 1	$1 \times 10^{-10}$



Teacher Demo 9  
Accuracy and  
Precision

**Accuracy** refers to the closeness of a measured value to a standard or known value. For example, you obtain a mass of 3.2 kg for a given substance, but the actual or known mass is 10 kg, then your measurement is not accurate.

**Precision** refers to the closeness of two or more measurements to each other. Using the example above, if you measured the mass of a given substance five times, and get 3.2 kg each time, then your measurement is very precise. Precision is independent of accuracy.



**Compile a list of real-world examples where it is important that measurements be done accurately and precisely.**



# Scientific Notation Practice

1. The speed of light in a vacuum (no air) is 300,000,000 m/s. How can we write this value of speed of light in scientific notation?
2. The mass of the Earth is 5,970,000,000,000,000,000,000 kg. Write this value in scientific notation.
3. The constant of universal gravitation is found to be  $0.00000000006673 \frac{N \cdot m^2}{kg^2}$ . Write this value in scientific notation.

# Scientific Notation Addition

## Addition Example 1:

$$\begin{array}{r} (9 \times 10^5) + (1 \times 10^6) \\ 9 \times 10^5 = 900,000 \\ 1 \times 10^6 = 1,000,000 \\ \hline 1,900,000 = 1.9 \times 10^6 \end{array}$$

## Addition Example 2:

$$\begin{array}{r} (9 \times 10^{-5}) + (1 \times 10^{-4}) \\ 9 \times 10^{-5} = 0.00009 \\ 1 \times 10^{-4} = 0.00010 \\ \hline 0.00019 = 1.9 \times 10^{-4} \end{array}$$



*You may use your calculator.*

### Addition Practice:

1.  $(9.81 \times 10^3) + (10 \times 10^{-5})$

2.  $(9.81 \times 10^3) + (10 \times 10^5)$



# Scientific Notation Subtraction

## Subtraction Example 1:

$$(1 \times 10^6) - (9 \times 10^5)$$

$$\begin{array}{r} 1 \times 10^6 = 1,000,000 \\ 9 \times 10^5 = 900,000 \\ \hline 1,000,000 \\ - 900,000 \\ \hline 100,000 = 1.0 \times 10^5 \end{array}$$

## Subtraction Example 2:

$$(1 \times 10^{-4}) - (9 \times 10^{-5})$$

$$\begin{array}{r} 1 \times 10^{-4} = 0.00010 \\ 9 \times 10^{-5} = 0.00009 \\ \hline 0.00010 \\ - 0.00009 \\ \hline 0.00001 = 1.0 \times 10^{-5} \end{array}$$



***You may use your calculator.***

### **Subtraction Practice:**

1.  $(9.81 \times 10^{-3}) - (10 \times 10^{-5})$

2.  $(10 \times 10^5) - (9.81)$

# Scientific Notation Multiplication

## Multiplication Example 1:

$$(1 \times 10^6) \cdot (9 \times 10^5)$$

1st  $1 \cdot 9 = 9$

2nd  $(10^6) \cdot (10^5) = \text{add powers} = 10^{6+5} = 10^{11}$

$$9 \times 10^{11}$$

## Multiplication Example 2:

$$(2 \times 10^{-4}) \cdot (9 \times 10^{-5})$$

1st  $2 \cdot 9 = 18$

2nd  $(10^{-4}) \cdot (10^{-5}) = \text{add powers} = 10^{-4+-5} = 10^{-9}$

$$18 \times 10^{-9}$$

has to be  
between  
1 and 9

therefore

$$18 \times 10^{-9} = 1.8 \times 10^{-8}$$



***You may use your calculator.***

**Multiplication Practice:**

1.  $(9.81 \times 10^5) \cdot (10 \times 10^{-5})$

2.  $(10 \times 10^5) \cdot (9.81 \times 10^{23})$

# Scientific Notation Division

## Division Example 1:

$$\frac{(9 \times 10^6)}{(3 \times 10^5)}$$

$$\text{1st } \frac{9}{3} = 3$$

$$\text{2nd } \frac{10^6}{10^5} = \text{subtract powers} = 10^{6-5} = 10^1$$

$$3 \times 10^1 = \boxed{30}$$

## Division Example 2:

$$\frac{(3 \times 10^{-4})}{(1 \times 10^{-5})}$$

$$\text{1st } \frac{3}{1} = 3$$

$$\text{2nd } \frac{10^{-4}}{10^{-5}} = \text{subtract powers} = 10^{-4-(-5)} = 10^1$$

$$3 \times 10^1 = \boxed{30}$$



**You may use your calculator.**

**Division Practice:**

1.  $(9.81 \times 10^5)/(10 \times 10^{-6})$

2.  $(10 \times 10^5)/(9.81 \times 10^{23})$



# Putting It ALL Together

## Combination Example:

$$\frac{(6 \times 10^6)(2 \times 10^3)(2 \times 10^3)}{(4 \times 10^4)} =$$

Top: <sup>1st</sup>  $6 \cdot 2 \cdot 2 = 24$

<sup>2nd</sup>  $10^6 \cdot 10^3 \cdot 10^3 = 10^{6+3+3} = 10^{12}$

TOP:  $24 \times 10^{12}$

Put together

$$\frac{24 \times 10^{12}}{4 \times 10^4}$$

1st:  $\frac{24}{4} = 6$

2nd:  $\frac{10^{12}}{10^4} = 10^{12-4} = 10^8$

$$\boxed{6 \times 10^8}$$



***You may use your calculator.***

**Practice:**

1.  $\frac{(4 \times 10^6)(5 \times 10^{-3})}{(8 \times 10^{-4})(5 \times 10^3)} =$

2.  $\frac{(4 \times 10^6)(2 \times 10^3)}{(8 \times 10^{-4})(2 \times 10^4)} =$

# Scientific Notation and Prefixes

**News Flash:** Scientists are VERY lazy and developed another method to make their lives easier, when it comes to numbers. Scientists use prefixes in front of units to abbreviate numbers.



Teacher Demo 10  
Even Lazier  
Scientists

Prefix	Symbol	Multiplier
exa	E	$10^{18}$
peta	P	$10^{15}$
tera	T	$10^{12}$
giga	G	$10^9$
mega	M	$10^6$
kilo	k	$10^3$
hecto	h	$10^2$
deka	da	$10^1$
deci	d	$10^{-1}$
centi	c	$10^{-2}$
milli	m	$10^{-3}$
micro	$\mu$	$10^{-6}$
nano	n	$10^{-9}$
pico	p	$10^{-12}$
fermto	f	$10^{-15}$
atto	a	$10^{-18}$

## Example 1: Converting from scientific notation to prefix

$1.8 \times 10^6$  *meters* becomes  
1.8 Mm (Megameter)

Explanation:

Mega stands for  $1 \times 10^6$

$$\frac{1.8 \times 10^6}{1 \times 10^6} \rightarrow 1.8 \times 10^{6-6} = 1.8 \text{ Mm}$$

Note:  $10^0 = 1$

## Example 2: Converting from prefix to scientific notation

**65 kg** becomes  $65 \times 10^3 \text{g}$   
or  $6.5 \times 10^4 \text{g}$  or 65,000 g

Explanation:

Kilo stands for 1000

$$65 \cdot 1000 = 65,000 \text{ g}$$

OR

$$6.5 \times 10^4 \text{g}$$



## Prefixes Practice

Write the following in scientific notation:

$10 \mu\text{g}$

Write the following using a prefix:

1,200 m



# Mathematics Prefixes Practice

a.  $10^{-2}$  m

b.  $10^9$  yrs

c.  $10^3$  g

d.  $10^{-3}$  s

e.  $10^{-9}$  m/s

f.  $10^6$  m/s<sup>2</sup>

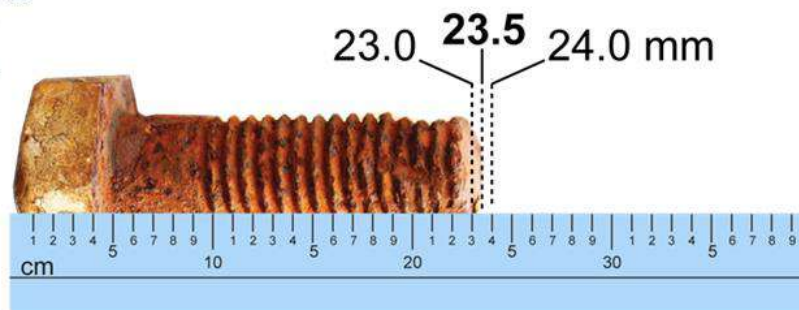


# THE LANGUAGE OF PHYSICS

## SIGNIFICANT FIGURES

When making a measurement, you may estimate to one more subdivision than the smallest marking on the measuring instrument. The estimated digit is a significant figure.

This measurement of 23.5 mm has *three* significant figures.



## Significant Figures Rules

Significant Figures can be done using a set of around 5 rules, With a lot of complications for how to deal with zeroes.

Not significant:

zero for  
“cosmetic”  
purpose

0

Not significant:

zeros used only  
to locate the  
decimal point

0

0

4

0

0

4

5

0

0

Significant:

all nonzero  
integers

Significant:

all zeros between  
nonzero numbers

Significant:

zeros at the end of  
a number to the right  
of decimal point

## Determining Significant Figures

15 000

The Number is **Greater than 10**,  
so the **Exponent will be Positive**.

= 1 5 0 0 0  
4 places

Move the Decimal point to the **LEFT**  
to create a number between 1 and 10.

= 1.5 ~~0 0 0~~

Remove Zeroes that are not needed.

= 1.5 × 10<sup>4</sup>

Count how many digits are present.

15 000 has **TWO Significant Figures**



## Determining Significant Figures

0.0270

The Number is a decimal **less than 1**,  
so the **Exponent will be Negative**.

= 0 .0 2 7 0  
2 places

Move the Decimal point to the **RIGHT**  
to create a number between 1 and 10.

= ~~0 0 0~~ 2.70

Remove Zeroes that are not  
needed, **but not ones from after a  
Decimal Pt.**

= 2.70 × 10<sup>-2</sup>

Count how many digits are there.

0.0270 has **THREE Significant Figures**





## Significant Figures in Multiplication, and Division

$$\begin{array}{ccccccc} 5.02 & \times & 89,665 & \times & 0.10 & = & 45.0118 = 45 \\ \text{3 sig. figs.} & & \text{5 sig. figs.} & & \text{2 sig. figs.} & & \text{2 sig. figs.} \\ 5.892 & \div & 6.10 & = & 0.96590 & = & 0.966 \\ \text{4 sig. figs.} & & \text{3 sig. figs.} & & & & \text{3 sig. figs.} \end{array}$$

In a calculation involving multiplication and division the number of significant digits in an answer should equal the least number of significant digits in any one of the numbers being multiplied or divided.

## Significant Figures in Addition and Subtraction

$$\begin{array}{rcl} 89.453 & & \\ + 2.5 & \leftarrow & \text{one significant figure after decimal point} \\ \hline 91.953 & \leftarrow & \text{round off to } 92.0 \end{array}$$
  
$$\begin{array}{rcl} 3.72 & \leftarrow & \text{two significant figures after decimal point} \\ - 2.9173 & & \\ \hline 0.8027 & \leftarrow & \text{round off to } 0.80 \end{array}$$

When quantities are being added or subtracted, the number of *decimal places* (not significant digits) in the answer should be the same as the least number of decimal places in any of the numbers being added or subtracted.



# Significant Figures Practice

**1. Determine the number of significant figures in each of the following:**

a) 3427

d) 172

b) 0.00456

e) 0.000984

c) 123,453

f) 0.502

**2. Calculate the following. Give the answer in correct scientific notation.**

a)  $\frac{3.95 \times 10^2}{1.5 \times 10^6}$

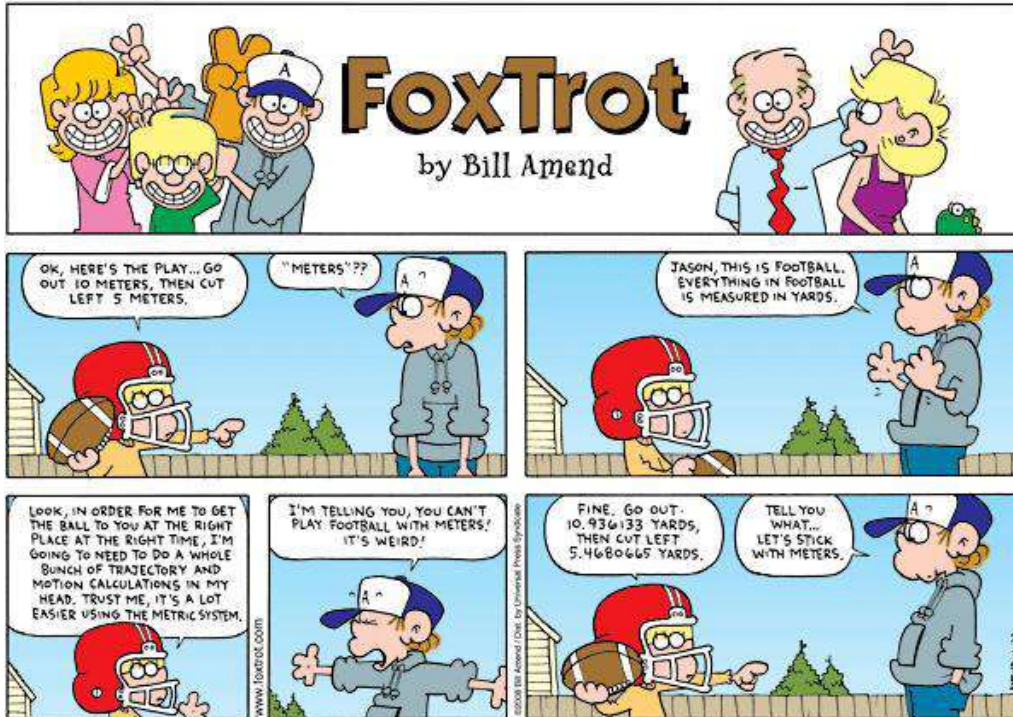
b)  $\frac{1.05 \times 10^{-26}}{4.2 \times 10^{56}}$

c)  $(3.5 \times 10^2)(6.45 \times 10^{10})$

d)  $(4.50 \times 10^{-12})(3.67 \times 10^{-12})$

# THE LANGUAGE OF PHYSICS

## UNIT CONVERSION

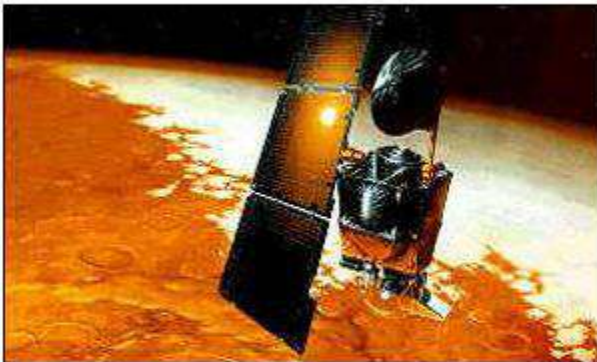


Teacher Demo 12  
Ruler



6: [When NASA Lost a Spacecraft Because It Didn't Use Metric](#)  
[Video](#)

### Confusion leads to Mars failure

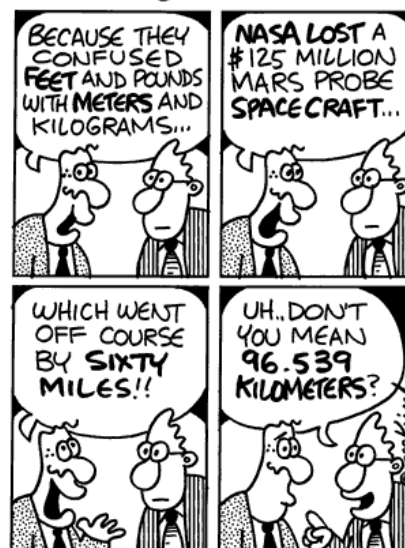


The Mars Climate Orbiter: Now in pieces on the planet's surface

The Mars Climate Orbiter Spacecraft was lost because one Nasa team used imperial units while another used metric units for a key spacecraft operation.

October 4, 1999

### Dry Bones



DryBonesBlog.com







## Unit Conversion Example:



The International Space Station travels around the Earth at 7790 meters per second (7790 m/s).

How fast is it traveling in miles per hour (miles/hr)?

[Note: NASA uses miles/hr and the ESA (European Space Agency) uses m/s to describe speed.]

We want to go from

$\frac{m}{s}$  to  $\frac{miles}{hr}$ . We can do this because we know that  $1 \frac{m}{s} = 2.2 \frac{miles}{hr}$ .

$$7790 \frac{m}{s} \times 2.2 \frac{miles}{hr} = 17,138 \frac{miles}{hr}$$

The units that we want to go away are placed on the bottom of the fraction so that they cancel out. See the next page for conversions used in these examples.

Convert 165 pounds into kilograms.

$$165 \cancel{lbs} \times \left( \frac{0.45kg}{1 \cancel{lbs}} \right) = 74.25 kg$$

Convert 5 grams into kilograms.

$$5\cancel{g} \times \left( \frac{1kg}{1000\cancel{g}} \right) = 0.005kg$$

Convert 5 meters into centimeters.

$$5\cancel{m} \times \left( \frac{100cm}{1\cancel{m}} \right) = 500cm$$





# Unit Conversion Practice

## Conversions

1 hour = 3600 seconds

1 day = 24 hours

1 meter = 100 centimeters

1 quart = 0.946 liters

1 inch = 2.54 cm = 25.4 mm

1 mile = 5280 feet

1 meter = 3.28 feet

1 lbs = 453.6 grams

1 m/s = 2.2 miles/hour

1 km = 1000 meters

1 yard = 3 feet

1 km = 0.62 miles

1 kg = 1000 grams

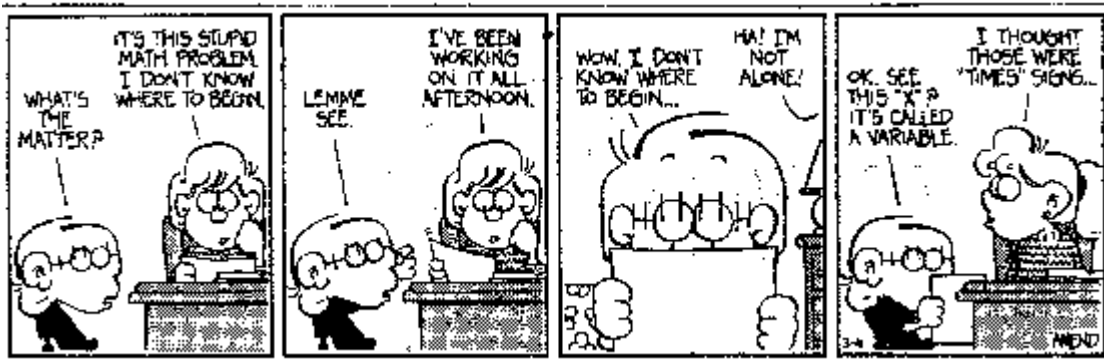
1 foot = 12 inches

1 mile = 1609.34 meters

1. 565,900 seconds is how many hours?
2. 17 years is how many minutes?
3. Convert 130 meters per second into miles per hour
4. Convert 721 lbs per week into kg per second
5. Convert 186,282 miles per second into meters per second

# THE LANGUAGE OF PHYSICS

## SOLVING VARIABLES



**Example: Solve the following equation for the variable,  $\Delta x$ .**

Example:  $v_{avg} = \frac{\Delta x}{\Delta t}$



Teacher Demo 14  
Variables

$v_{avg}$  = average (avg) velocity ( $v$ )

$\Delta x$  = Change in distance

$\Delta t$  = Change in time

$$v_{avg} = \frac{\Delta x}{\Delta t}$$

To solve this equation for  $\Delta x$  we must get  $\Delta x$  by itself. To do this we must remember that the mathematical operation between  $\Delta x$  and  $\Delta t$  is division. The opposite of an operation is another operation that gets you back where you started. This is used primarily to get rid of numbers that are combined with a variable so you can solve for the variable in an equation.

To remove  $\Delta t$  from  $\Delta x$  we must do the opposite operation of division; multiplication. But, keep in mind that what we do to one side of an equation we must also do to the other, otherwise one side will get jealous of the other.

$$\Delta t \cdot v_{avg} = \frac{\Delta x}{\Delta t} \cdot \Delta t$$

By doing this  $\Delta t$  will cancel out on the right-hand side:

$$\Delta t \cdot v_{avg} = \frac{\Delta x}{\cancel{\Delta t}} \cdot \cancel{\Delta t}$$

We have then solved for the variable of  $\Delta x$ :

$$\Delta t \cdot v_{avg} = \Delta x$$



### Practice Solving Variables:

Solve the following equation for  $\Delta v$ .

$$a_{avg} = \frac{\Delta v}{\Delta t}$$

### Example: Solve the following equation for $\Delta t$ .

Example:  $v_{avg} = \frac{\Delta x}{\Delta t}$

$$v_{avg} = \frac{\Delta x}{\Delta t}$$

Steps:

$$\Delta t \cdot v_{avg} = \frac{\Delta x}{\Delta t} \cdot \Delta t$$

Multiplying by  $\Delta t$  to both sides because it is on the bottom of the fraction and we want it on top.

$$\Delta t \cdot v_{avg} = \Delta x$$

Canceling out  $\Delta t$

$$\frac{\Delta t \cdot v_{avg}}{v_{avg}} = \frac{\Delta x}{v_{avg}}$$

Divide  $v_{avg}$  to both sides to get  $\Delta t$  by itself.

$$\Delta t = \frac{\Delta x}{v_{avg}}$$



### Practice Solving Variables:

Solve the following equation for  $\Delta t$ .

$$a_{avg} = \frac{\Delta v}{\Delta t}$$

Example: Solve the following equation for the variable,  $v_i$ .

$$\Delta p = m \cdot v_f - m \cdot v_i$$

$$\Delta p = \boxed{m \cdot v_f} - m \cdot v_i$$

we can  
bring this  
whole  
operation to  
the other  
side

$v_i$  = what we are  
solving for

$$\Delta p - m \cdot v_f = m \cdot v_f - m \cdot v_i$$

minus  $m \cdot v_f$   
from both sides  
because we want  
to isolate  $m \cdot v_i$

$$\Delta p - m \cdot v_f = -m \cdot v_i$$

divide by  $-m$   
to both sides  
to isolate  
 $v_i$

$$\frac{\Delta p - m \cdot v_f}{-m} = \frac{-m \cdot v_i}{-m}$$

$$\frac{\Delta p - m \cdot v_f}{-m} = v_i$$



### Practice Solving Variables:

Solve the following equation for  $t$ .

$$v_f = v_i + a \cdot t$$



# Solving Variables Practice

**Directions:** Solve given equation for stated variable

1) Solve  $d = rt$  for  $r$

2) Solve  $ax + by = c$  for  $y$

3) Solve  $S = R - rR$  for  $R$

4) Solve  $B = \frac{703w}{h^2}$  for  $w$

5) Solve  $K = \frac{1}{2}mv^2$  for  $m$

6) Solve  $F = \frac{Gm_1m_2}{r^2}$  for  $G$





# Occupation Inquiry

**You will be investigating an occupation of your choosing. Identify the occupation and give a description of it. State where someone would work in that occupation (be specific). How is physics used in that job?**

Please Type this up. Include your name at the top.



Teacher Demo 15  
Astronaut

## Example:

Miss Taylor

Occupation: Astronaut



Canadian Astronaut Chris Hadfield

### Description:

The term "astronaut" derives from the Greek words meaning "space sailor," and refers to all who have been launched as crew members aboard NASA spacecraft bound for orbit and beyond. Astronauts are not only selected by NASA but also private space agencies. The US uses the term astronaut while Russia uses the term cosmonaut.

### Astronaut Responsibilities:

Astronauts are involved in all aspects of assembly and on-orbit operations of the ISS. This includes extravehicular activities (EVA), robotics operations using the remote manipulator system, experiment operations, and onboard maintenance tasks. Astronauts are required to have a detailed knowledge of the ISS systems, as well as detailed knowledge of the operational characteristics, mission requirements and objectives, and supporting systems and equipment for each experiment on their assigned missions.

### Basic Qualification Requirements:

Applicants must meet the following minimum requirements before applying.



Bachelor's degree from an accredited institution in engineering, biological science, physical science, computer science or mathematics.

Degree must be followed by at least 3 years of related, progressively responsible, professional experience or at least 1,000 pilot-in-command time in jet aircraft. An advanced degree is desirable and may be substituted for experience as follows: master's degree = 1 year of experience, doctoral degree = 3 years of experience. Teaching experience, including experience at the K - 12 levels, is qualifying experience for the Astronaut Candidate position; provided degree is in a Science, Engineering, or Mathematics field.

Ability to pass the NASA long-duration Astronaut physical, which includes the following specific requirements:

Distant and near visual acuity must be correctable to 20/20, each eye. The use of glasses is acceptable.

The refractive surgical procedures of the eye, PRK and LASIK, are allowed. Note that such surgeries are permitted, but not required for potential applicants.

Since all crewmembers will be expected to fly aboard a specific spacecraft vehicle and perform Extravehicular Activities (space walks), applicants must meet the anthropometric requirements for both the specific vehicle and the extravehicular activity mobility unit (space suit). Applicants brought in for an interview will be evaluated to ensure they meet the anthropometric requirements.

### Physics Use:

Astronauts use physics in both their training and exploration, ranging from the complexity of dynamics of the ship to simple tasks such as exercising.

The image shows two pages of handwritten notes and checklists from the Apollo 13 mission. The top page is titled 'ACT 30' and contains various tasks and calculations. The bottom page is titled 'ACT 31' and contains more tasks and calculations. A blue sticky note is attached to the bottom page, containing handwritten text: 'This page was utilized to transfer CSN guidance data to LM guidance system with a computer. Note of how attached units respond to the calculations. James would not be lost. Not the time these calculations were made. GET ON ON around two hours after the explosion. Jim Jones'.

**ACT 30**

1. Verify CSN In Min DEADBAND ATT HOLD

2. Calculate LM Gimbal Angles

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## Introduction to Physics Check for Understanding

1. In your own words, what is the definition of physics and why is it important?
2. In your own words, what is a real-world phenomenon? Give an example.
3. What type of unit would you give to a measurement of distance?

### 4. Solve the following

Answer boxed and in scientific notation.

a. 
$$\frac{(5 \times 10^6)(2 \times 10^3)(3 \times 10^3)}{(5 \times 10^4)} =$$

b. 
$$\frac{(4 \times 10^6)(2 \times 10^3)}{(8 \times 10^{-4})(2 \times 10^4)} =$$

**Conversions**

1 hour = 3600 seconds

1 meter = 3.28 feet

1 kg = 2.2 lbs

1 m/s = 2.2 miles/hour

1 mile = 5280 feet

1 km = 0.62 miles

1 lb = 0.45 kg

1 foot = 12 inches

1 yard = 3 feet

1 light second = 300,000,000 meters

1 quart = 0.946 liters

1 inch = 2.54 cm = 25.4 mm

**5. Write the following using prefixes. Box your answer.**

a.  $2 \times 10^3$  g

b.  $2 \times 10^{-3}$  m

Prefix	Symbol	Multiplier
exa	E	$10^{18}$
peta	P	$10^{15}$
tera	T	$10^{12}$
giga	G	$10^9$
mega	M	$10^6$
kilo	k	$10^3$
hecto	h	$10^2$
deka	da	$10^1$
deci	d	$10^{-1}$
centi	c	$10^{-2}$
milli	m	$10^{-3}$
micro	$\mu$	$10^{-6}$
nano	n	$10^{-9}$
pico	p	$10^{-12}$
femto	f	$10^{-15}$
atto	a	$10^{-18}$

**6. Convert the following:**

Answer boxed and in scientific notation.

a. 100 yards into meters

b. 22,647 inches into miles

c. 2678 cm into feet

d. 1100 feet per second into miles per hour

e. 53 yards per hour into inches per week

f. 721 lbs per week into kg per second



7. Determine the number of significant figures in each of the following:

a.  $3100.0 \times 10^2$

b.  $0.0114 \times 10^4$

c. 107.2

d. 0.0000455

e. 2205.2

f.  $30.0 \times 10^{-2}$

8. Calculate the following. Give the answer in correct scientific notation.

a.  $\frac{4.44 \times 10^7}{2.25 \times 10^5}$

b.  $\frac{6.022 \times 10^{23}}{3.011 \times 10^{-56}}$

c.  $(2.5 \times 10^9)(6.45 \times 10^4)$

c.  $(6.88 \times 10^2)(3.45 \times 10^{-10})$





9. Solve the following equation for the variable  $v_x$

$$\Delta x = v_x \cdot \Delta t$$

10. Solve the following equation for the variable  $a$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$