Physics #1

You will need a calculator for this unit.

Physics

Physics is the study of matter and energy and their relationships.

Physical Quantities

A physical quantity is a physical property that can be measured. Examples are distance, time, and mass.

Measurements always require units.

SI System of Units

International System of Units
Systeme International d'Unités

Base Units

Seven fundamental units form the basis of the SI System of units. Three of the seven base units are:

Unit Name	Unit Symbol	Physical Quantity
meter	m	distance
second	s	time
mass	kg	mass

Derived Units

Units formed by the combination of two or more base units.

Combination of Base Units	Physical Quantity
m^2	area
m/s	speed and velocity
m/s^2	acceleration

Scientific Notation

scientific notation - expresses numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10

$\square.\square\square \times 10^{\square}$

assume decimal point is here

0.1234 m

decimal to **right**

negative exponent

1.234×10^{-1} m

decimal point was moved 1 place to the right

5678. m

decimal to **left**

positive exponent

5.678×10^{3} m

decimal point was moved 3 place to the left

RUBY NEWTON LOVES PHYSICS

* Scientific calculators can change numbers in standard notation to scientific notation for you.

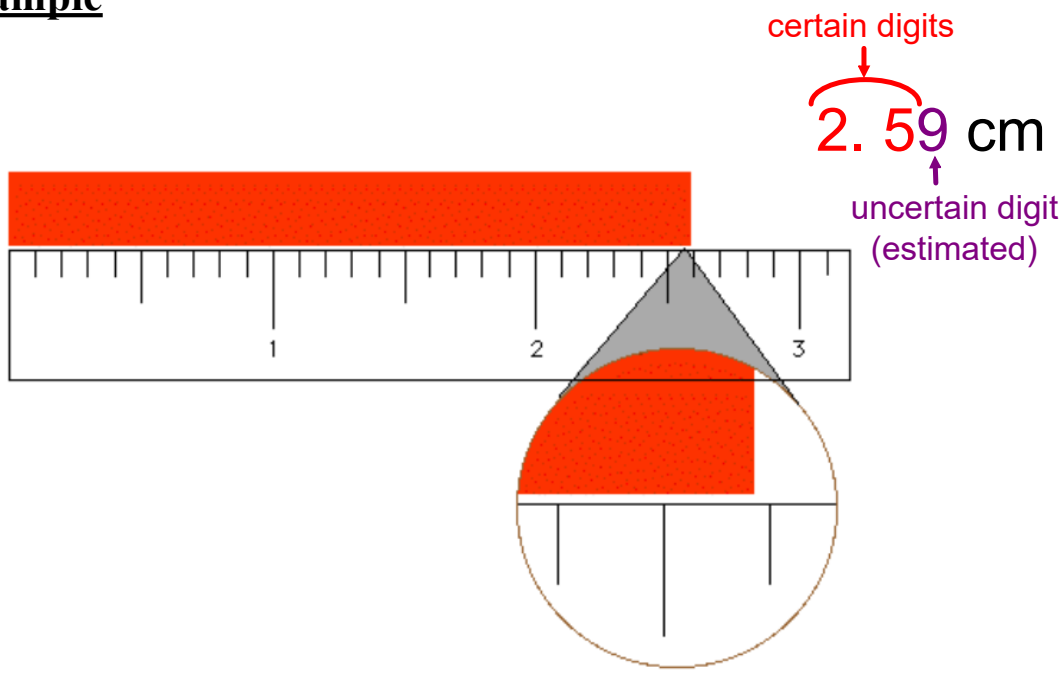
Certainty and Significant Digits

Every measurement has uncertainty.

The international agreement about the correct way to record measurements is to record all digits that are certain plus one uncertain/estimated digit.

The "certain-plus-one" digits are called significant digits (SDs).

Example



The certainty of a measurement is determined by its number of significant digits. The greater the number of significant digits, the greater the certainty of the measurement.

Our Rule for Counting SDs

Start at the far left of a measurement. The first digit that is not zero is significant as are all the digits that follow.

✓ certain digit

? uncertain digit

✓✓✓? 307.0 cm #SD - 4

✓? 6.8 m/s #SD - 2

✓ ? 0.00506 m #SD - 3

✓✓? 4.10×10^2 km #SD - 3

In chemistry, there is a difference between:

200 kg and 200. kg

1 SD 3 SD

zeros aren't counted

It would be best to write the measurement in scientific notation to clearly indicate the number of significant digits.

2×10^2 kg 2.00×10^2 kg

1 SD 3 SD

For our purposes, we will assume that zeros at the end of a measurement like 200 kg are significant.

200 kg

3 SD

☆

Exact and Defined Values

If a value is exact or defined, it DOES NOT affect the accuracy or the precision of a calculation as shown in upcoming pages.

Exact Values
4 dogs
10 pencils
2 mittens

Defined Values
1 m = 100 cm
1 h = 3600 s
1 kg = 1000 g

Rounding Values

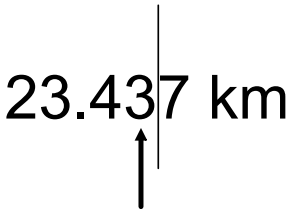
Rounding is important to preserve significant digits in calculations.

Determine what your rounding digit is and look at the digit to its right.
(i) If the digit is 0, 1, 2, 3, or 4 do not change the rounding digit.
(ii) If the digit is 5, 6, 7, 8, or 9, your rounding digit rounds up by one number.

Round to 3 SDs.

23.4 km

Round to 4 SDs.



23.44 km

Certainty Rule for Multiplying and Dividing Measurements

When multiplying or dividing measurements, the answer has the same number of significant digits as the measurement with the fewest number of significant digits. Your final answer must include an appropriate unit.

#1. $2.36\ \text{m} \times 1.4\ \text{m} = 3.304\ \text{m}^2$

(3 SD; 2 SD; Round to 2 SD.)

$= 3.3\ \text{m}^2$

#2. $\dfrac{34.92\ \text{km}}{1.56\ \text{h}} = 22.38461538$

(4 SD; 3 SD; Round to 3 SD.)

$= 22.4\ \dfrac{\text{km}}{\text{h}}$

OR

$34.92\ \text{km} \div 1.56\ \text{h} = 22.4\ \dfrac{\text{km}}{\text{h}}$

#3. $18.3\ \text{cm} \times \dfrac{1\ \text{m}}{100\ \text{cm}} = 0.183\ \text{cm}$

(3 SD; defined value; We already have 3 SD.)

Precision Rule for Adding and Subtracting Measurements

Precision is measured by the number of decimal places in a measured or calculated value.

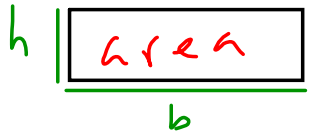
When adding or subtracting measured values of known precision, the answer has the same number of digits after the decimal point (dd) as the measured value with the fewest digits after the decimal point. Your final answer must include an appropriate unit.

457.49 m	2 dd
- 19.1 m	1 dd
438.39 m	
438.4 m	

12. 51 g	2 dd
+ 2. g ←	no digits after decimal point
14.51 g	
15 g ←	no digits after decimal point

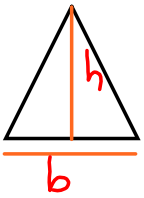
Defining Equations

A defining equation is an equation that defines new quantities in terms of other quantities. Quantities are represented by variables, the single letters or symbols in an equation.



$A = bh$

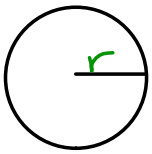
area, base, height



$A = \frac{1}{2}bh$

area, base, height

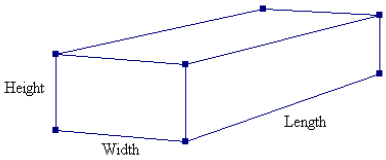
$A = \frac{bh}{2}$



$A = \pi r^2$

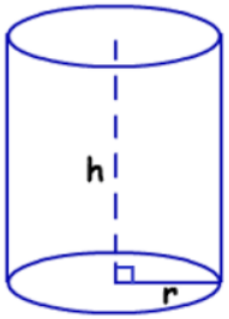
pi, area, radius

π = 3.14...



$V = lwh$

volume, length, width, height



$V = \pi r^2 h$

pi, volume, radius, height

Operations

+	–
x	÷
$( )^2$	$\sqrt{\ }$

Terms

A term can be a signed number, a variable, or a constant multiplied by a variable or variables. Each term in an algebraic expression is separated by + or – sign.

term term term

$$\boxed{y} = \boxed{mx} + \boxed{b}$$

Rearranging Equations

defining equation - a mathematical relationship expressed in symbols

Rearrange for the variable in the brackets.

#1. $v = f\lambda$ [f]

Find the term that contains the variable of interest.

$$v = \boxed{f\lambda}$$

Keep f where it is. Divide both sides by λ to isolate f.

$$\frac{v}{\lambda} = \frac{\boxed{f\cancel{\lambda}}}{\cancel{\lambda}}$$

$$\frac{v}{\lambda} = f$$

Rewrite the equation with f on the left of the equal sign.

$$f = \frac{v}{\lambda}$$

#2. $y = mx + b$ [m]

Find the term that contains the variable of interest.

$$y = \boxed{mx} + b$$

Subtract b from both sides to isolate mx. On the left hand side of the equal sign, write y first then subtract b.

$$y - b = \boxed{mx} + \cancel{b - b}$$

$$y - b = \boxed{mx}$$

Divide both sides by x to isolate m.

$$\frac{y - b}{x} = \frac{\boxed{m\cancel{x}}}{\cancel{x}}$$

$$\frac{y - b}{x} = m$$

Rewrite the equation with m on the left of the equal sign.

$$m = \frac{y - b}{x}$$

#3. $\mathbf{v_f^2 = v_i^2 + 2ad}$ **[vi]**

Find the term that contains the variable of interest.

$$v_f^2 = \boxed{v_i^2} + 2ad$$

Subtract 2ad from both sides to isolate v_i^2.

$$v_f^2 - 2ad = \boxed{v_i^2} + \cancel{2ad} - \cancel{2ad}$$

$$v_f^2 - 2ad = \boxed{v_i^2}$$

Take the square root of both sides to get v_i.

$$\sqrt{v_f^2 - 2ad} = \sqrt{\boxed{v_i^2}}$$

$$\sqrt{v_f^2 - 2ad} = v_i$$

Rewrite the equation with v_i on the left of the equal sign.

$$v_i = \sqrt{v_f^2 - 2ad}$$

#4. $\mathbf{d = \frac{1}{2}(v_i + v_f)t}$ **[t]**

Find the term that contains the variable of interest.

$$d = \boxed{\frac{1}{2}(v_i + v_f)t}$$

Multiply both sides by 2 to get rid of the denominator.

$$2d = \left(\boxed{\frac{1}{\cancel{2}}(v_i + v_f)t}\right)\cancel{2}$$

$$2d = \boxed{(v_i + v_f)t}$$

Divide both sides by $v_i + v_f$ to isolate t.

$$\frac{2d}{v_i + v_f} = \frac{\boxed{(v_i + v_f)t}}{\cancel{v_i + v_f}}$$

$$\frac{2d}{v_i + v_f} = t$$

Rewrite the equation with t on the left of the equal sign.

$$t = \frac{2d}{v_i + v_f}$$

Metric Conversions

Some Defined Values/Conversion Factors	
1 h = 3600 s	1 km = 1000 m
1 min = 60 s	1 m = 100 cm
1 h = 60 min	1 cm = 10 mm

Metric Conversions - Examples

1 Step Conversion

Convert 57.4 m to cm.

$1\ cm = 10^{-2}\ m$

$$57.4\ m \times \frac{1\ cm}{10^{-2}\ m} = 5.74 \times 10^{3}\ cm$$

3SD 3SD

2 Step Conversion

Convert 1049 μg to kg.

$1\ \mu g = 10^{-6}\ g$ $1\ kg = 10^{3}\ g$

$$1049\ \mu g \times \frac{10^{-6}\ g}{1\ \mu g} \times \frac{1\ kg}{10^{3}\ g} = 1.049 \times 10^{-6}\ kg$$

4SD 4SD

Convert 24 m/s to km/h. (86 km/h)

$1\ km = 10^{3}\ m$ $1\ h = 3600\ s$

$$24\ \frac{m}{s} \times \frac{1\ km}{10^{3}\ m} \times \frac{3600\ s}{1\ h} = 86\ \frac{km}{h}$$

2SD 2SD

$$\frac{3600}{10^{3}}$$

$$3.6$$

Shortcut:

$$\frac{m}{s} \xrightleftharpoons{\times 3.6} \frac{km}{h}$$

Topics - Physics #1

1. definitions: physics, physical quantity, significant digits, certainty, exact value, defined value, rounding digit, precision, defining equation, variable, term

2. SI System - International System of Units
   - know the SI base units for length, time and mass
   - be able to identify a derived unit

3. certainty - identify certain and uncertain digits in a measurement
   - determine the certainty of a measurement by stating its number of significant digits

4. SDs and operation rules - Certainty Rule
   -> multiplication and division
   -> count total # of significant digits
   -> round to the same number of significant digits as the original measurement with the <u>fewest</u> SDs
   - Precision Rule
   -> addition and subtraction
   -> count # of digits after the decimal
   -> round to the same number of digits after the decimal as the original measurement with the fewest # of digits after the decimal

scientific notation

5. rearrange an equation for a specified variable

6. perform metric conversions using conversion factors