UNITS AND PHYSICAL QUANTITIES

1.1 THE NATURE OF PHYSICS
1.2 solving Physics Problems
1.3 STANDARDS AND UNITS
1.4 USING AND CONVERTING UNITS
1.5 UNCERTAINTY AND SIGNIFICANT FIGURES

Prepared by: Naurah M. Malawi

Physics

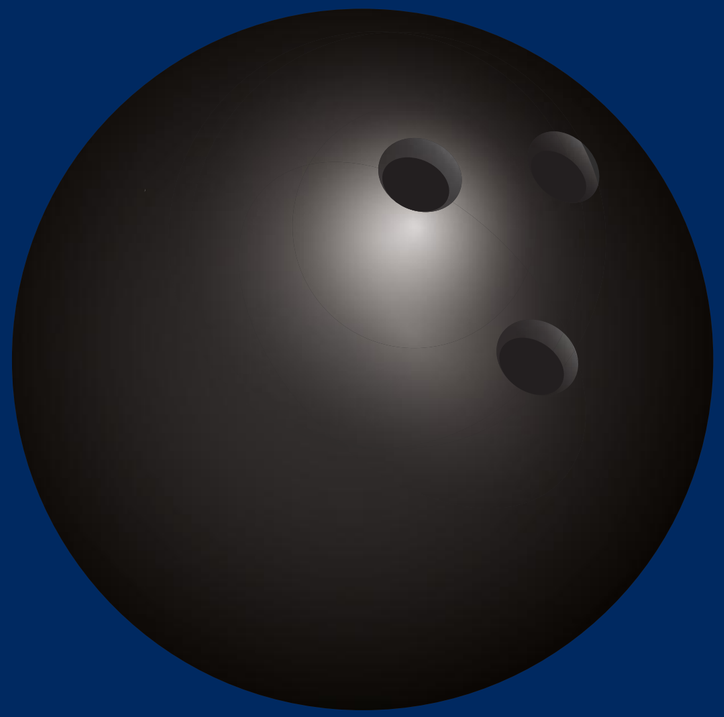
- derived from the Greek word, φυσισ (*phusis*) meaning nature
- an *experimental science*
- *study of nature and deals with the interaction of matter, force and energy.*

Physicists

- a scientist who specializes in the field of physics
- observe phenomena of nature and try to find physical theories, laws, or principles.

If you drop a light object and a heavy object from a tower, which one reaches the ground first?

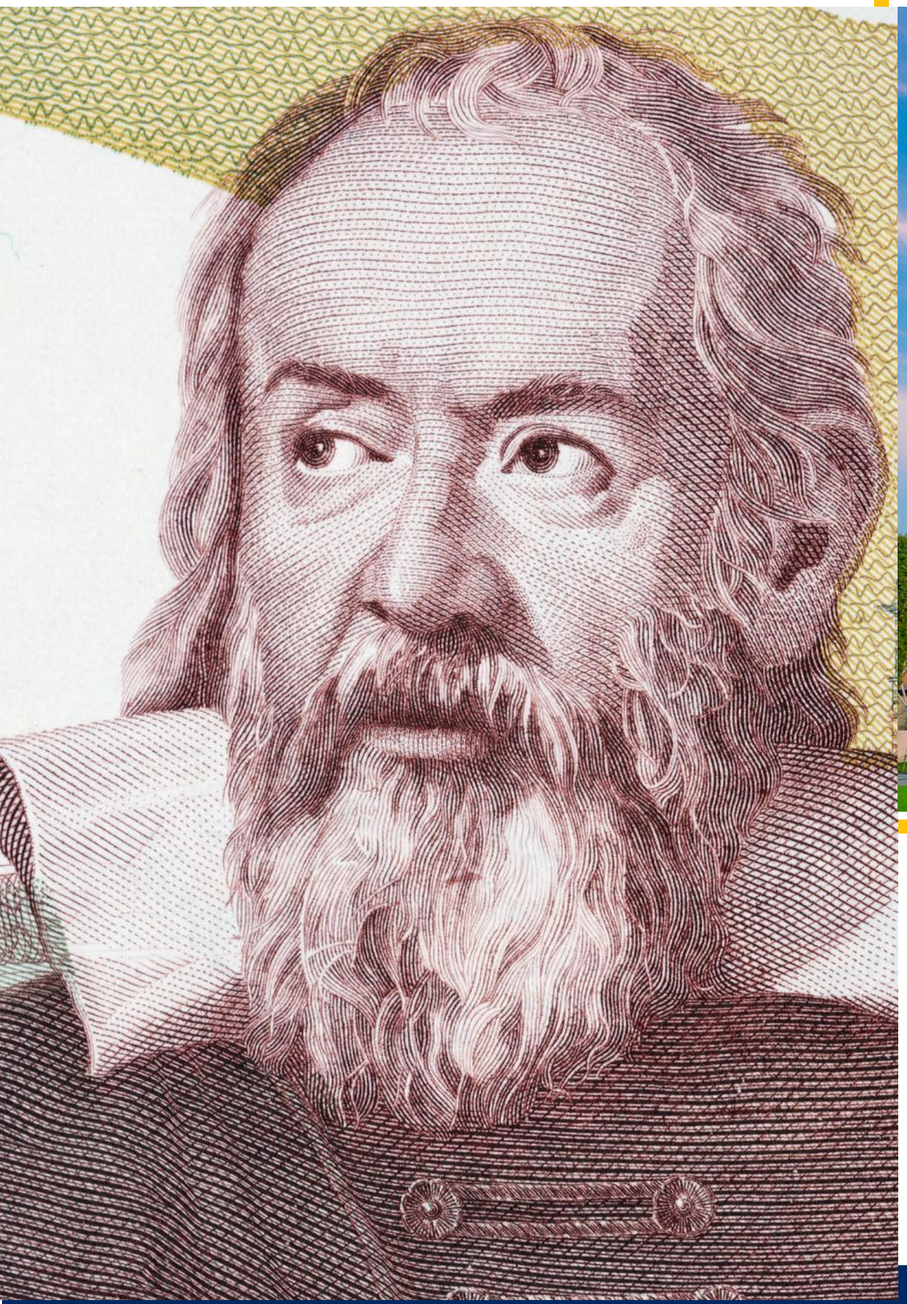
Which one reaches the ground first?



Bowling Ball

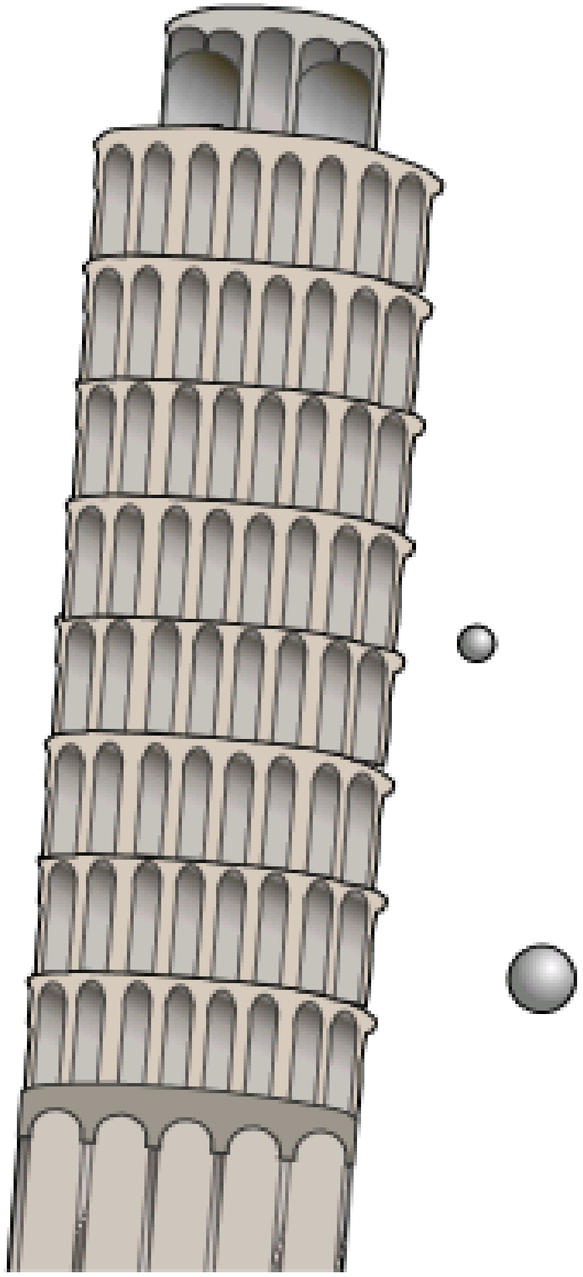
VS

Feather

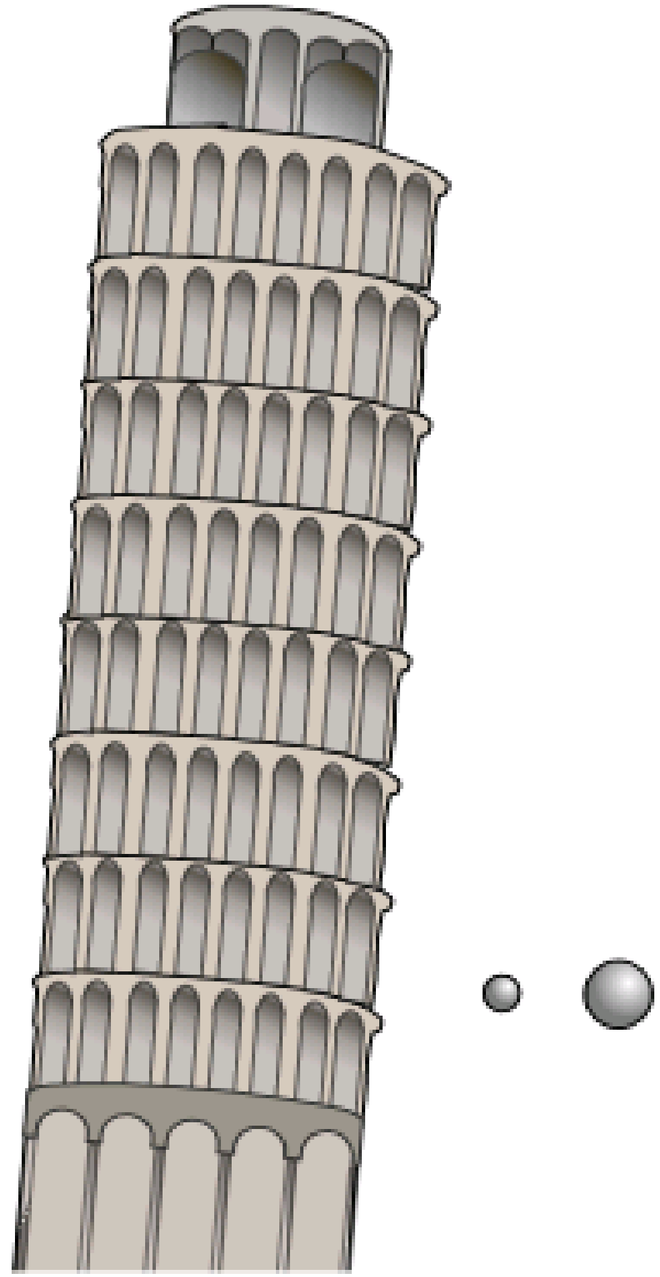


GALILEO GALILEI (1564–1642)

- In the late 1500s C.E. in Italy, he dropped light and heavy objects from the top of the Leaning Tower of Pisa to find out whether their rates of fall were different
- the acceleration of a falling object is independent of its weight.



Old idea



Galileo

Let’s watch this video.


BBC TWO
CAP
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- Getting back to Galileo, suppose we drop a feather and a cannonball. They certainly do not fall at the same rate.

- This does not mean that Galileo was wrong; it means that his theory was incomplete.

- If we drop the feather and the cannon ball in a vacuum to eliminate the effects of the air, then they do fall at the same rate

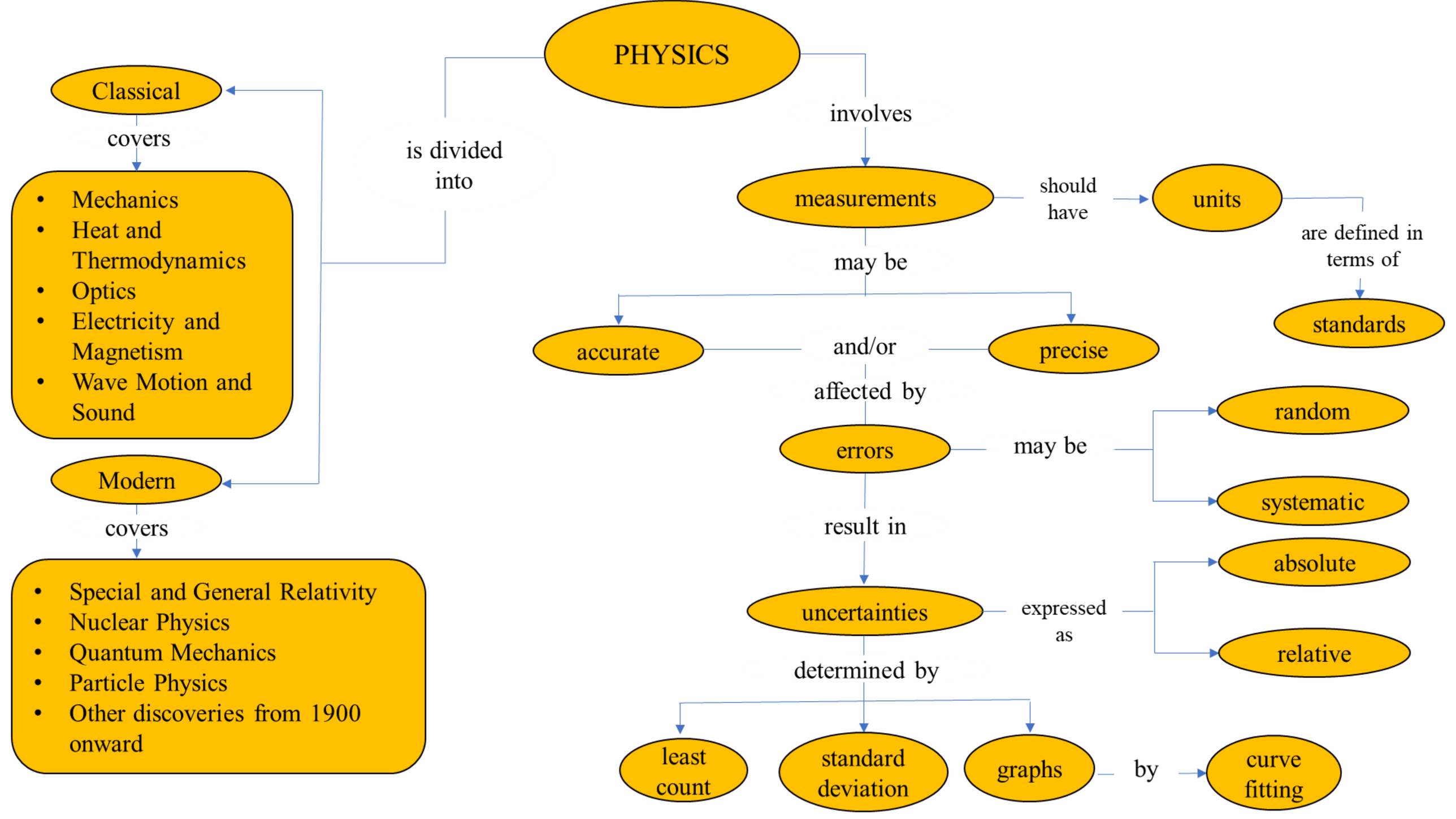
- The development of physical theories such as Galileo’s often takes an indirect path, with blind alleys, wrong guesses, and the discarding of unsuccessful theories in favor of more promising ones.

- Physics is not simply a collection of facts and principles; it is also the process by which we arrive at general principles that describe how the physical universe behaves

- No theory is ever regarded as the final or ultimate truth.

- The possibility always exists that new observations will require that a theory berevised or discarded.

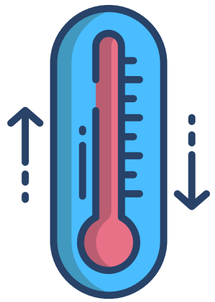
- It is in the nature of physical theory that we can disprove a theory by finding behavior that is inconsistent with it, but we can never prove that a theory is always correct


PHYSICS
is divided into
Classical
covers
Mechanics
Heat and Thermodynamics
Optics
Electricity and Magnetism
Wave Motion and Sound
Modern
covers
Special and General Relativity
Nuclear Physics
Quantum Mechanics
Particle Physics
Other discoveries from 1900 onward
involves
measurements
should have
units
are defined in terms of
standards
may be
accurate
and/or
precise
affected by
errors
may be
random
systematic
result in
uncertainties
expressed as
absolute
relative
determined by
least count
standard deviation
graphs
by
curve fitting

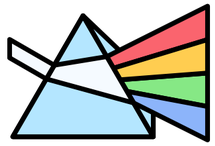
Classical Physics

– all discoveries, principles, and inventions prior to 1900.

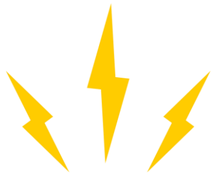
Mechanics – deals with motion, force, work, energy and fluids.



Heat and Thermodynamics – deals with the effects of heat when added or removed from a system, the methods of heat transfer and the transformation of heat energy to mechanical energy or work and vice versa.



Optics – deals with the study of light and its properties.



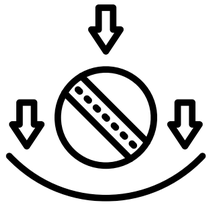
Electricity and Magnetism – deals with phenomena associated with electric charges (whether at rest or moving), magnetism and the relationship between electricity and magnetism.

Wave motion and sound – deals with properties, transmission, and perception of different types of waves.

Modern Physics

– discoveries beyond 1900.

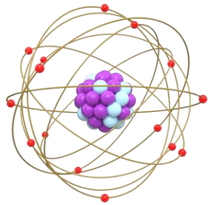
Nuclear Physics – deals with the properties and the reactions within the atomic nucleus.



General Relativity – tells how matter curves space-time and how the curvature of space-time dictates the trajectory of matter and light.

Special Relativity – deals with phenomena associated when an object moves with speeds approaching the speed of light in vacuum.

Particle Physics – deals with the building blocks of matter called elementary particles.



Quantum Mechanics – deals with the nature and behavior of matter and energy on the atomic and subatomic levels.

Measurements

- **is the process of comparing something with a standard.**

Two System of Units

1.The Metric System

-*mks* (meter, kilogram, and second) system

-*cgs* (centimeter, gram, and second) system

2. The English System

-or *fps* system (foot, pound, and second) system

- Each system is represented by abbreviation of its three basic units.

SI unit (*International System*)

– is internationally accepted system of units measurements in all of the sciences including Physics.

- abbreviated from the French word “Le Système International d’ Unités”.

Physical Quantity

– is any number that is used to describe a physical phenomenon quantitatively.

For example:

The mass of mangoes is 2kg.

The distance from your house to school is 1km.

Every measurement is expressed in value and unit.

2 kilograms

Value **Unit**

Two types of Physical Quantities:

a. Fundamental Quantities/ Base Quantities

b. Derived Quantities

Fundamental Quantities

– deals with basic measurements and cannot be expressed in any other quantities.
(independent of one another)

SI Fundamental Units		
Quantity	**Unit Name**	**Unit Symbol**
Length	meter	m
Time	second	s
Mass	kilogram	kg
Amount of substance	mole	mol
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd

Derived Quantities

– are based from fundamental quantities. They are obtained by multiplying, dividing and combining fundamental quantities.

Examples: $\text{Speed} = \frac{distance\ (meter)}{time\ \ (second)}$ **, meter and second are both fundamental quantities.**

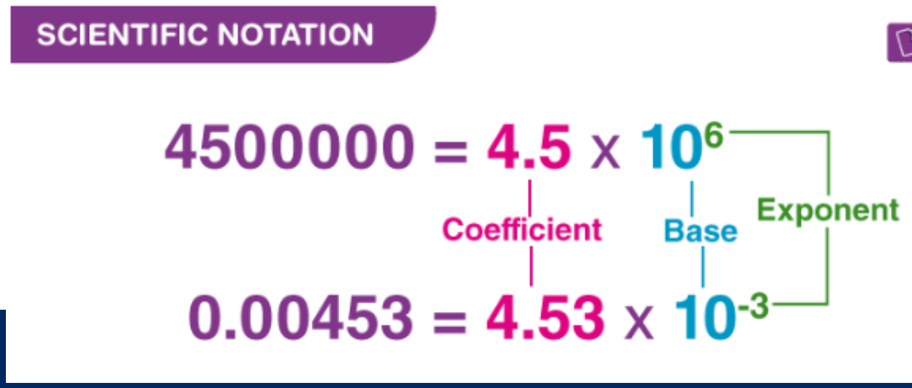
Derived Units			
Physical Quantity	Formula	Unit	Involved fundamental units
1. Area	$A = l \times b$	m^2	m^2
2. Volume	$V = l \times b \times h$	m^3	m^3
3. Velocity	$V = s/t$	m/s	$m\ s^{-1}$
4. Acceleration	$a = \frac{v-u}{t}$	m/s^2	$m\ s^{-2}$
5. Force	$F = m \times a$	N	$kg\ m\ s^{-2}$
6. Density	$D = \frac{m}{V}$	$kg\ /\ m^3$	$kg\ m^{-3}$
7. Pressure	$P = \frac{F}{A}$	Pa	$\frac{kg\ m/s^2}{m^2}$

Scientific Notation

– is a compact, simplest and easiest way of writing down very small and very large numbers using powers of ten or in exponential notation.

- Any quantity may be expressed in the form of N x 10^n where N is any number between 1 and 10 and n is the appropriate power of 10.

Example: 1.42 x 10 ²



Name	Symbol	Multiplying factor
quetta	Q	10^{30}
ronna	R	10^{27}
yotta	Y	10^{24}
zetta	Z	10^{21}
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}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}
zepto	z	10^{-21}
yocto	y	10^{-24}
ronto	r	10^{-27}
quecto	q	10^{-30}

Sample Problem 1.1

1.The speed of light is approximately 300 000 000 m/s.

Solution:

$$300\,000\,000\ \text{m/s} = 3\text{x}10^{8}\ \text{m/s}$$

2. The mass of a strand of hair is approximately 0.000 000 62 kg.

Solution:

$$0.000\,000\,62\ \text{kg} = 6.2\ \text{x}10^{-7}\ \text{kg}$$

Practice Exercise 1.1

Express the ff. in scientific notation:

a. 0.000646

b. 5 430 000

c. 301 000 000

d In 1990 the budget deficit reduction plan was to trim $500 billion from the deficit. Write this figure in scientific notation.

ė. In 1980, major airlines flew 5,400,000 flights. Write the number of flights in scientific notation.

f. To measure long distances in space, astronomers use a unit called a light-year. A light-year is approximately 5,880,000,000,000 miles long. Write this in scientific notation.

Unit Conversion Chart

Length :

1cm	10mm
1m	100cm
1km	1000m
1ft	12in
1in	2.54cm
1yd	3ft / 36in
1mi	1760 yd/ 5280 ft / 1.6km

Mass :

1000mg	1g
1000g	1kg
1000kg	1 T (metric ton)
2.2046 lbs. (pound)	1 kg
16 oz	1 lb (pound)
2000 lbs	1 T (metric ton)

Volume :

1 L	1000ml / 1000 cubic meter (cc)
1 KL	1000 L
1 cup	8 fluid oz (fl oz)
1 pint (pt)	2 cups
1 quartz (qt)	2 pints
1 gallon	4 quartz

Temperature :

Kelvin (K) and degree Celsius (°C) conversions:

$K = °C + 273$ $°C = K - 273$

Degree Fahrenheit (°F) and degree Celsius (°C) conversions:

$°F = \frac{9}{5}(°C) + 32$ $°C = \frac{5}{9}(°F - 32)$

Dimensional Analysis

- For example, to convert 8.00 m to inches,
  - convert m to cm
  - convert cm to in.

$$8.00\ \cancel{m} \times \frac{100\ \cancel{cm}}{1\ \cancel{m}} \times \frac{1\ \text{in.}}{2.54\ \cancel{cm}} = 315\ \text{in.}$$

A person's weight is 154 pounds. Convert this to kilograms. (1 lbs. = 454 grams)

$$\frac{154\ \cancel{lbs}}{1} \times \frac{454\ \cancel{g}}{1\ \cancel{lb}} \times \frac{1\ kg}{1000\ \cancel{g}} = \underline{69.9}\ \text{kg}$$

Significant Figure (or Sig fig) refers to the number of digits or figures that best represent the value of a measurement.

Rules for Determining number of Sig figs

1. Non Zero digits are significant
Ex. 316 – 3 sig figs

2. Zeros in between other digits are significant
Ex. 6.003 – 4 sig figs

3. Leading zeros are not significant
Ex. 0.00035 – 2 sig figs

4. Trailing decimal zeros are significant
Ex. 35,000 – 2 sig figs
0.035000 – 5 sig figs

1. Indicate how many significant figures there are in each of the following measured values.

246.32	5	0.00340	3
107.854	6	14.600	5
100.3	4	0.0001	1
0.678	3	700000	1
1.8	2	350.670	6

Rules for Calculation with Significant Figure

1. When adding or subtracting, use the fewest number of decimal places.

10.1 (1 decimal place)
+ 7.43 (2 decimal place)

17.5 (1 decimal place)

2. When multiplying or dividing, use the fewest number of sig figs

4.93 (3 sig figs)
X 6.027 (4 sig figs)

29.7 (3 sig figs)

Note! Whatever the answer, we need to round it up or down.

Ex. Rounding 3 sig fig

9.365 → 9.37

9.364 → 9.36

2. Answer the following items with the appropriate number of significant figures.

a. 32.653 + 252.1 + 98.23 = _____

b. 24.12 + 299.0002 + 712.7 = _____

c. 23.7 x 2.9 = _____

d. 42.145 x 18 = _____

e. 612 / 1.006 = _____

2. Answer the following items with the appropriate number of significant figures.

a. 32.653 + 252.1 + 98.23 = 383.0

b. 24.12 + 299.0002 + 712.7 = 1035.8

c. 23.7 x 2.9 = 69

d. 42.145 x 18 = 760 Or 7.6 x 10^2

e. 612 / 1.006 = 608

THANK YOU!

Prepared by: Naurah M. Malawi