Guatemala

Flag

- The flag of Guatemala was officially adopted on August 17th, 1871. The blue and white are the original colors used by the United Provinces of Central America.
- The **coat of arms** (centered on white) was adopted in 1968 and features the quetzal bird, a symbol of liberty, perched on the Declaration of Independence.

Flag

- The coat of arms shows two Bay Laurel branches symbolizing victory. The bird displayed in the crest is the Quetzal, in our country this bird is a symbol of **liberty**.
- The **scroll** contains the date that all of Central America was declared independent from Spain. The **crossed rifles** are a warning that Guatemala will defend itself with force if necessary. Finally, the **swords** represent the honor of the people of Guatemala.

Vocabulary

- Comprise
- Compulsory
- Council
- Dictatorship
- Fabled
- Insurgency
- Peasantry
- Perch
- Plunge
- Remnant
- Ruthlessly
- Seize
- Suffrage

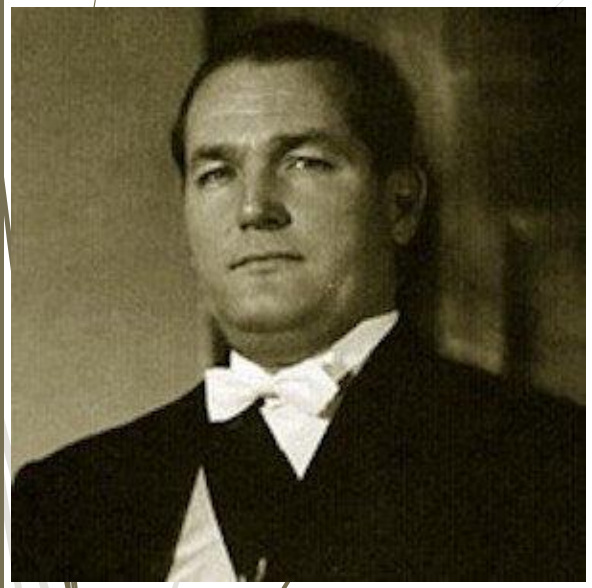
Guatemala Brief History

- The **fabled** Maya people flourished throughout the Yucatan Peninsula and Guatemala for centuries. This very advanced civilization constructed great cities, grand palaces, pyramids and observatories, as well as advanced works of art, astronomy, literature and mathematics.
- **Remnants** of this extraordinary people and a quite sizeable population of descendants still exist in Guatemala and all across the Yucatan today. In fact, even though they remain the largest population majority in the country and their languages and religions survived, they sadly live in poverty, and if you will, form an almost forgotten and repressed minority-majority.

Guatemala Brief History

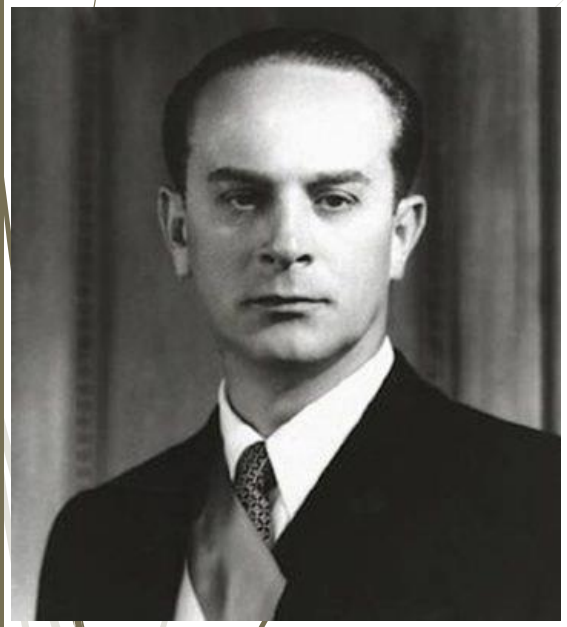
- When the Spanish conquistadors and their leader, Pedro de Alvarado, arrived in 1523, they quickly defeated the weaker Maya forces and aggressively began the colonization of the land.
- For the almost 300 hundred years that followed, the Spanish colonial powers ruthlessly exploited and persecuted the remaining Maya, all but erasing their culture from the map of world history.
- After the independence from Spain in 1821, Guatemala, Costa Rica, El Salvador, Honduras and Nicaragua formed the United Provinces of Central America, but that federation quickly dissolved, and Guatemala became an independent republic in 1838.

Guatemala Brief History



- This new country experienced a lengthy series of **coups**, **dictatorships**, **insurgencies**, **human atrocities**, and long stretches of brutal military rule.
- In the 1940s, two reformist presidents were elected; presidents that permitted free expression, legalized unions, encouraged social reform, and the formation of political parties. It's referred to as the **"Ten Years of Spring"**, but it was short-lived.

Guatemala Brief History



- Jacobo Arbenz was forced out of office and the repressive military regained control, and eventually Guatemala slipped into a 36-year civil war; over 200,000 civilians were murdered, and of course, the country's economy was ruined.
- Finally, in 1996, the government signed a peace agreement with the leftist rebels, formally ending the conflict which had left countless people dead and over one million homeless refugees.

Guatemala's Legislation

Guatemala's Legislation

- Guatemala is a constitutional democratic republic that is divided into 22 departments and governed by a 3-branch system, consisting of the executive, legislative, and judicial.
- The Executive branch is integrated by the President, the Vice President and the Cabinet (Council of Ministers appointed by the president). The president and vice president are directly elected through universal suffrage and limited to one term. A vice president can run for president after 4 years out of office.

Guatemala's Legislation

- The legislative branch consists of the National Congress. It is the unicameral legislature of the Republic of Guatemala. It comprises 158 deputies (members), who are elected by direct universal suffrage to serve four-year terms (the number was increased from 113 for the 2003 election).
- It is not uncommon that Congress Members change parties during the legislature term, as well as Congress Members seceding from a party to create a new party or congressional block.

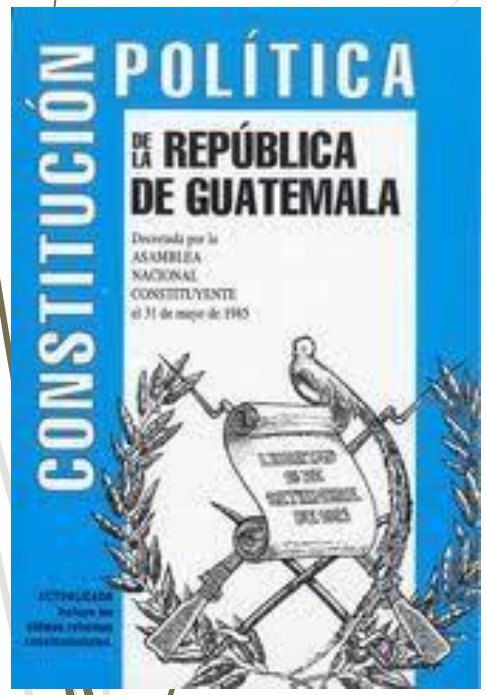
Guatemala's Legislation

- The Judicial branch includes the Constitutional Court and it is Guatemala's highest court (five judges are elected by Congress for concurrent five-year terms).
- This branch also includes the Supreme Court of Justice, its members are elected by Congress to serve concurrent five-year terms, the president of the Supreme Court of Justice supervises trial judges around the country; this court consists of 13 justices who are elected by the Congress.

Guatemala's Legislation

- These 13 justices are elected by the Congress from a list of 26 qualifying candidates submitted by the **bar association**, law school **deans**, a university rector, and appellate judges. The Supreme Court and local courts handle civil and criminal cases.

Constitution of Guatemala



- The Constitution of Guatemala is THE SUPREME LAW of the Republic of Guatemala. It sets the bases for the organization of Guatemalan government and it **outlines** the three main branches of Guatemalan government: executive branch, legislative branch, and judicial branch.

- Guatemala's 1985 constitution provides for a separation of powers among the executive, legislative, and judicial branches of government

Constitution of Guatemala

- In 1993 the Constitution was reformed. Constitutional reforms included an increase in the number of Supreme Court justices from 9 to 13.
- The reforms also reduced the terms of office for president, vice president, and congressional representatives from 5 years to 4 years, and for Supreme Court justices from 6 years to 5 years; they increased the terms of mayors and city councils from 2-1/2 years to 4 years.

Guatemala's Tax System

- The tax system is currently undergoing reform as the Guatemalan government attempts to make taxation a more lucrative tool. In 1996, Guatemala's tax **revenue** accounted for just 8 percent of its GDP, putting it at the second lowest rate in the Western hemisphere.
- The peace accords signed in 1996 called for an increase that would bring tax revenues up to 12 percent of the GDP by 2000, providing greater **funding for social programs**.

Guatemala's Tax System

- Unfortunately, the parties who signed on to this fiscal pact (government, social organizations, and business leaders) have not all given it their **steadfast** support, and tax revenues for 2000 only amounted to slightly more than 10 percent of the GDP.
- Among the taxes on which Guatemala relies for revenue are customs duties, sales taxes, and **excises** on liquor and tobacco. Additional taxes under discussion for reform or implementation in Guatemala currently include the **value-added tax** and new taxes to be applied to a variety of industries.

Manufacturing in Guatemala

Manufacture

- The **manufacture** and **assembly** sector in Guatemala used to be integrated by industries involved in **apparel** and textiles. Currently, the objective is to **position** Guatemala as an investment destination that may be attractive to strategic sub-sectors such as electronics, auto parts and medical supplies.
- The main commercial **partners** for Guatemala are: Central America, the United States, the Caribbean, South America and the European Union.

Manufacture

- The **manufacture** sector represented 30% of the total exports of Guatemala during 2007. This shows the dynamic performance and growth of this sector in Guatemala.
- Elements such as **adding value** to the products, the opening of new markets, the on going negotiations of free trade agreements, as well as the improvement of productivity and market intelligence represent investment and trade opportunities for new investors who want to utilize the advantages offered by Guatemala as an export platform and a logistics center for the world.

Advantages from investing in manufacture

- Guatemala offers high **profitability** in the manufacturing/assembly sector thanks to its mixture of favorable conditions, such as: human resources with high learning and skills; the **cost-efficiency of human resources**; strategic location, and **low operation costs**. Guatemalan human resources show a **high level of commitment** to training and performing their job with knowledge and efficiency.
- The sub-sector of assembly of electronics, automotive parts and medical supplies has chosen our country to invest after evaluating the opportunities that the country offers.

Tourism

- The touristic sector provides a huge potential for investment, becoming the main entry of the commercial balance, surpassing coffee, sugar, cardamom and other exports.
- The main objective of investing in Guatemala and entities supporting the sector, are to strongly encourage the structuring, marketing and information on tourist products and destinations by promoting the country.

Tourism

- Unlike the other Central American countries, Guatemala provides a comprehensive supply and has a large variety of high quality tourism segments, such as:

- *Archeology*
- *Colonial History and Legacy*
- *Indigenous culture and communities*
- *Volcanoes*
- *Fishing*
- *Ecotourism and adventure*
- *Beaches on the Atlantic and Pacific coast*

Main Areas for Tourism Development

Antigua Guatemala

- Antigua Guatemala is the country's Main tourism destination. Antigua, were declared "World Heritage" by UNESCO (1979); is the most outstanding and best preserved Colonial City in all Spanish America.
- Antigua's favorable weather not only allow outdoor activities and sports as Golf, horseback riding, and others, but also makes it attractive for the retirement communities market.

Main Areas for Tourism Development

Peten, Mayan World

- Tikal National Park is declared "World Heritage" by UNESCO in 1979 and these is the second tourist site most visited in Guatemala, along with Lake Atitlan.
- The Mayan culture and it's rainforests responds to the demand of 58% of the tourists, which visit the country in search of culture, nature, adventure and sports. The Peten rainforest's Mirador basin is the last tract of virgin rainforest remaining in Central America.

Main Areas for Tourism Development

Caribbean Coast: Izabal

- Izabal is the third tourism destination most visited of the country. Amatique Bay, Río Dulce, and Izabal Lake, due to their geographic location, are protected from hurricanes. There is a short distance from Quirigua, declared "World Heritage" by UNESCO (1981)

Atitlan Lake

- The Lake of Atitlan is the second tourism site most visited in the country. The Natural landscapes of the Lake combined with local ethnicity, attract the incoming tourists seeking for culture and adventure.

Main Areas for Tourism Development

Guatemala City

- Guatemala City attracts a high number of business travelers, which represent 21% of its total visitors and whose visit purposes are business & conferences. Guatemala City is the most cosmopolitan and contemporary of all Central America.
- For this reason, many multinational firms establish their headquarters for the Latin and/or Central American region in Guatemala.

Engineering

Engineering

- Engineering is the application of science to the **optimum** conversion of the resources of nature to the uses of humankind.
- The field has been defined by the **Engineers Council for Professional Development**, in the United States, as the creative application of "scientific principles to design or develop **structures, machines, apparatus, or manufacturing processes**, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to **forecast** their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property."

Engineering

- The words engine and ingenious are derived from the same Latin root, ***ingenerare***, which means "to create." The early English verb engine meant "to contrive." The function of the **scientist** is to know, while that of the **engineer** is to do. Engineering is based principally on physics, chemistry, and mathematics and their extensions into materials science, solid and fluid mechanics, thermodynamics, transfer and rate processes, and systems analysis.
- Unlike the scientist, the engineer is not free to select the problem that interests him; he must solve problems **as they arise**; his solution must satisfy conflicting requirements.

History of Engineering

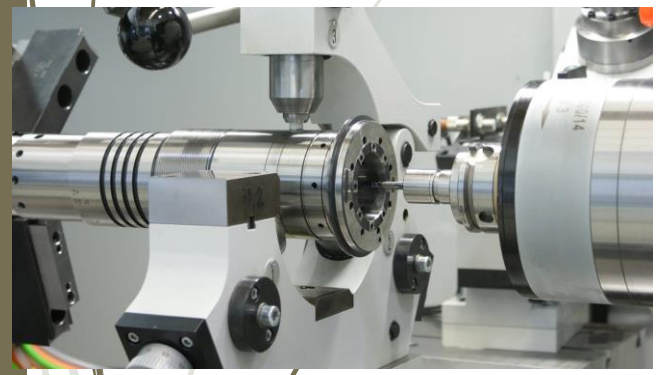
History of Engineering

- The first engineer known by name and achievement is **Imhotep**, builder of the Step Pyramid at Ṣaqqārah, Egypt, probably in about 2550 B.C.
- Engineering remarkable works include: The **Pharos (lighthouse)** of Alexandria, Solomon's Temple in Jerusalem, the Colosseum in Rome, the Persian and Roman road systems, the **Pont du Gard** aqueduct in France, and many other large structures, some of which endure to this day.

History of Engineering

- In construction medieval European engineers carried technique, in the form of the Gothic arch and **flying buttress**, to a height unknown to the Romans.
- **Civil engineering** emerged as a separate discipline in the 18th century, when the first professional societies and schools of engineering were founded.
- Civil engineers built structures of all kinds, designed water-supply and sanitation systems, laid out railroad and highway networks, and planned cities.

History of Engineering



- England and Scotland were the birthplace of **mechanical engineering**, as a derivation of the inventions of the Scottish engineer **James Watt** and the textile machinists of the Industrial Revolution.

- The development of the British **machine-tool** industry gave tremendous impetus to the study of mechanical engineering both in Britain and abroad.

History of Engineering

- The growth of knowledge of electricity from **Alessandro Volta**'s original electric cell of 1800 through the experiments of **Michael Faraday** and others, culminating in 1872 in the Gramme dynamo and electric motor led to the development of **electrical and electronics engineering**.
- The electronics aspect became prominent through the work of such scientists as **James Clerk Maxwell** of Britain and **Heinrich Hertz** of Germany in the late 19th century.

History of Engineering

- **Chemical engineering** grew out of the 19th- century proliferation of industrial processes involving chemical reactions in metallurgy, food, textiles, and many other areas.
- By 1880 the use of chemicals in manufacturing had created an industry whose function was the mass production of chemicals. The design and operation of the plants of this industry became a function of the chemical engineer.

Functions of Engineering

Engineering Functions

- Problem solving is common to all engineering work. The problem may involve quantitative or qualitative factors; it may be physical or economic; it may require abstract mathematics or common sense. Of great importance is the process of creative synthesis or design, putting ideas together to create a new and optimum solution.
- Although engineering problems vary in scope and complexity, the same general approach is applicable. First comes an analysis of the situation and a preliminary decision on a plan of attack. In line with this plan, the problem is reduced to a more categorical question that can be clearly stated. The stated question is then answered by deductive reasoning from known principles or by creative synthesis, as in a new design.

Major Functions of Engineering

- **Research:** Using mathematical and scientific concepts, experimental techniques, and inductive reasoning, the research engineer seeks new principles and processes.
- **Development:** Development engineers apply the results of research to useful purposes. Creative application of new knowledge may result in a working model of a new electrical circuit, a chemical process, or an industrial machine.
- **Design:** In designing a structure or a product, the engineer selects methods, specifies materials, and determines shapes to satisfy technical requirements and to meet performance specifications.
- **Construction:** The construction engineer is responsible for preparing the site, determining procedures that will economically and safely yield the desired quality, directing the placement of materials, and organizing the personnel and equipment.

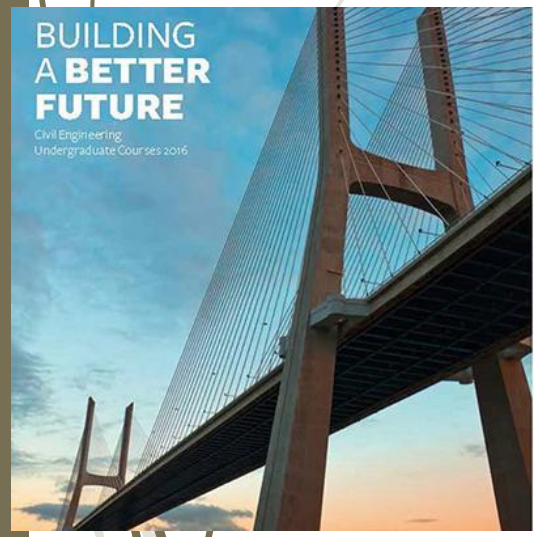
Major Functions of Engineering

- **Production**: Plant layout and equipment selection are the responsibility of the production engineer, who chooses processes and tools, integrates the flow of materials and components, and provides for testing and inspection.
- **Operation:** The operating engineer controls machines, plants, and organizations providing power, transportation, and communication; determines procedures; and supervises personnel to obtain reliable and economic operation of complex equipment.
- **Management and other functions:** In some countries and industries, engineers analyze customers' requirements, recommend units to satisfy needs economically, and resolve related problems.

Fields of Engineering

- **Chemical Engineering**: It consists on the development of processes and the design and operation of plants in which materials undergo changes in their physical or chemical state. Applied throughout the process industries, it is founded on the principles of chemistry, physics, and mathematics.
- Mathematics is a basic tool in optimization and modeling. *Optimization* means arranging materials, facilities, and energy to yield as productive and economical an operation as possible. *Modeling* is the construction of theoretical mathematical prototypes of complex process systems, commonly with the aid of computers. Chemical engineers are employed in the design and development of both processes and plant items. Plant operation and control is increasingly the sphere of the chemical engineer rather than the chemist.

Fields of Engineering



- **Civil Engineering**: It is the profession of designing and executing structural works that serve the general public. The term was first used in the 18th century to distinguish the newly recognized profession from military engineering, until then preeminent.
- The functions of the civil engineer can be divided into three categories: those performed ***before construction*** (feasibility studies, site investigations, and design), those performed ***during construction*** (dealing with clients, consulting engineers, and contractors), and those performed ***after construction*** (maintenance and research).

Fields of Engineering

- **Science and Systems Engineering**: Computer engineering involves many aspects of computer design, the creation of individual components for computer equipment, networking design, and integrating software options with the hardware that will drive the applications. Computer engineers can find work in such fields as telecommunications, transportation, manufacturing, and product development.
- Some of the common tasks associated with the computer engineer include software design that is customized for a particular industry type. A computer engineer is not only part of the design process of a new application, but also continues to provide service and support as new versions of software are released.

Fields of Engineering

- **Electric And Electronics Engineering:** *Electric engineering* is the branch of engineering concerned with the practical applications of electricity in all its forms, including those of the field of electronics.
- *Electronics engineering* is that branch of electrical engineering concerned with the uses of the electromagnetic spectrum and with the application of such electronic devices as integrated circuits, transistors, and vacuum tubes.
- Electrical engineering is the branch dealing with "heavy current" (electric light and power systems and apparatuses) whereas electronics engineering deals with such "light current" applications as wire and radio communication, the stored-program electronic computer, radar, and automatic control systems.

Fields of Engineering

- **Environmental Engineering**: Environmental engineering consists on the development of processes and infrastructure for the supply of water, the disposal of waste, and the control of pollution of all kinds. These endeavors protect public health by preventing disease transmission, and they preserve the quality of the environment by averting the contamination and degradation of air, water, and land resources.
- Projects in environmental engineering involve the treatment and distribution of drinking water; the collection, treatment, and disposal of wastewater; the control of air pollution and noise pollution; municipal solid-waste management and hazardous-waste management; the cleanup of hazardous-waste sites; and the preparation of environmental assessments, audits, and impact studies.

Fields of Engineering

- **Industrial Engineering:** It is the application of engineering principles and techniques of scientific management to the maintenance of a high level of productivity at optimum cost in industrial enterprises. The managers responsible for industrial production require an enormous amount of assistance and support because of the complexity of most production systems, and the additional burden of planning, scheduling, and coordination. Historically, this support was provided by industrial engineers whose major concern was with methods, standards, and the organization of process technology.
- Industrial engineering originated with the studies of Taylor, the Gilbreths, and other pioneers of mass production methods. Their work expanded into responsibilities that now include the development of work methods to increase efficiency and eliminate worker fatigue.

Fields of Engineering

- **Mechanical Engineering:** It is the branch of engineering concerned with the design, manufacture, installation, and operation of engines and machines and with manufacturing processes. It is particularly concerned with forces and motion.
- Four functions of the mechanical engineer can be cited. ***The first*** is the understanding of and dealing with the bases of mechanical science. It include dynamics, concerning the relation between forces and motion. ***Second*** is the sequence of research, design, and development. This function attempts to bring about the changes necessary to meet present and future needs. ***Third*** is production of products and power, which embraces planning, operation, and maintenance. ***Fourth*** is the coordinating function of the mechanical engineer, including management, consulting, and, in some cases, marketing

Measurement Systems

Introduction

- Weights and measures were among the earliest tools invented by man. Primitive societies needed rudimentary measures for many tasks: constructing dwellings of an appropriate size and shape, fashioning clothing and bartering food or raw materials.
- As societies evolved, measurements became more complex. The invention of numbering systems and the science of mathematics made it possible to create whole systems of measurement units suited to trade and commerce, land division, taxation, and scientific research.
- Although the concept of weights and measures today includes such factors as temperature, luminosity, pressure, and electric current, it once consisted of only four basic measurements: mass (weight), distance or length, area, and volume (liquid or grain measure).

The English System

- The measurement system commonly used in the United States today is nearly the same as that brought by the colonists from England.
- The "yard" as a measure of length can be traced back to early Saxon kings. They wore a sash or girdle around the waist that could be removed and used as a convenient measuring device. The word "yard" comes from the Saxon word "gird" meaning the circumference of a person's waist.
- Standardizing various units and combining them into loosely related systems of measurement units sometimes occurred in fascinating ways.

The English System

- Tradition holds that King Henry I decreed that a yard should be the distance from the tip of his nose to the end of his outstretched thumb.
- After 1959, the U.S. and the British inch were defined identically for scientific work and were identical in commercial usage.
- The U.S. customary bushel and the U.S. gallon, and their subdivisions differ from the corresponding British Imperial units. Also, the British ton is 2240 pounds, whereas the ton generally used in the United States is the short ton of 2000 pounds. The American colonists adopted the English wine gallon of 231 cubic inches.

Metric System

- The metric system is a relatively modern system (just over 200 years old) which has been developed based on scientific principles to meet the requirements of science and trade.
- The metric system offers a number of substantial advantages:
  - **Simplicity**: The Metric system has only 7 basic measures, plus a substantial number of measures using various combinations of these base measures. The imperial system (prior to the UK converting to metric) and the USA system have over 300 different measures of which many are ambiguous.

Metric System

- **Ease of calculation:** All the units in the metric system are multiplied by 10 (to make larger units) or divided by 10 (to make smaller units). For example a kilometer is 1000 meters (10 *10 * 10).
- **International Standard:** With the exception of the USA, all major countries have converted to the metric system (although in some countries, such as the UK, the conversion to metric is not yet complete).

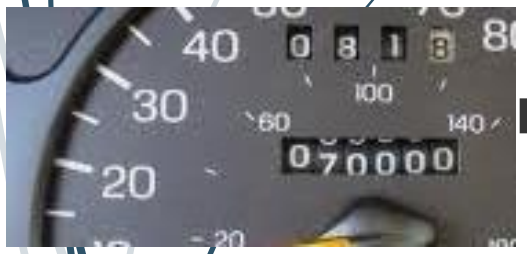
Measurement Instrumentation

FOR TIME

- **Clock:** a clock is an instrument used to indicate, measure, keep, and co-ordinate time. The modern clock has been used since the 14th Century.
- **Chronometer:** A chronometer is a very accurate time-keeping device that is used for determining precise duration of events.
- **Calendar:** A calendar is a system of organizing days for social, religious, commercial, or administrative purposes. This is done by giving names to periods of time, typically days, weeks, months, and years. The name given to each day is known as a date.
- **Atomic Clock:** A timepiece that derives its time scale from the vibration of atoms or molecules.

FOR LENGTH

- **Tape Measure:** It is a measuring instrument consisting of a narrow strip (cloth or metal) marked in inches or centimeters and used for measuring lengths.



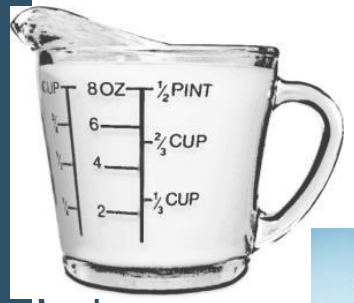
- **Odometer:** Instrument used to record journeys or total mileage of a car.

- **Altimeter:** an instrument that measures the height above ground; used in navigation.

FOR LENGTH

- **Vernier Scale:** A small movable scale that slides along a main scale; the small scale is calibrated to indicate fractional divisions of the main scale
- **Caliper:** An instrument for measuring the distance between two points (often used in the plural).
- **Opisometer:** An opisometer, also called a meilograph or map measurer, is an instrument for measuring the lengths of arbitrary curved lines.

FOR VOLUME

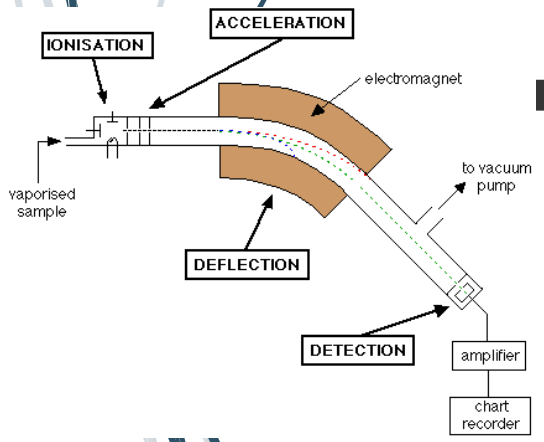


- **Measuring cup:** Graduated cup used to measure liquid or granular ingredients.
- **Pipet:** Measuring instrument consisting of a graduated glass tube used to measure or transfer precise volumes of a liquid by drawing the liquid up.
- **Beaker:** A beaker is a simple container for stirring, mixing and heating liquids commonly used in many laboratories. Beakers are generally cylindrical in shape, with a flat bottom and a lip for pouring.
- **Eudiometer:** It is a laboratory device that measures the change in volume of a gas mixture following a physical or chemical change.

FOR SPEED

- **Radar gun:** A radar speed gun (also radar gun and speed gun) is a device used to measure the speed of moving objects. It is used in law-enforcement to measure the speed of moving vehicles and is often used in professional spectator sport, for such things as the measurement of the speed of pitched baseballs, runners and tennis serves.
- **Speedometer:** An instrument that records the speed of a vehicle in motion for the driver of the vehicle.
- **Tachometer:** Used to measure the speed of rotation of a gear or shaft or other rotating part of the engine.

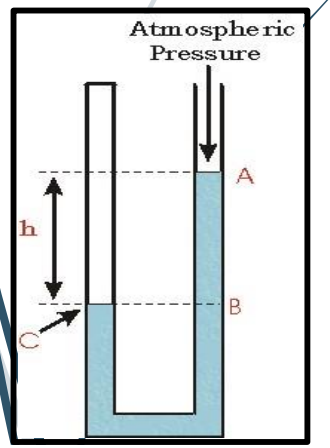
FOR MASS



- **Balance:** A device based on gravity and equilibrium among two sides, one side used for the measuring sample and the other for the comparing standard.
- **Weighing Scales:** Is a measuring instrument for determining the weight or mass of an object.
- **Mass Spectrometer:** Is an instrument that can measure the masses and relative concentrations of atoms and molecules. It makes use of the basic magnetic force on a moving charged particle.

FOR PRESSURE

- **Anemometer:** A gauge for recording the speed and direction of wind.
- **Barometer:** An instrument that measures atmospheric pressure.
- **Manometer:** Device to measure pressures. A common simple manometer consists of a U shaped tube of glass filled with some liquid. Typically the liquid is mercury because of its high density.
- **Tire Pressure Gauge:** A tire-pressure gauge is a pressure gauge used to measure the pressure of tires on a vehicle.

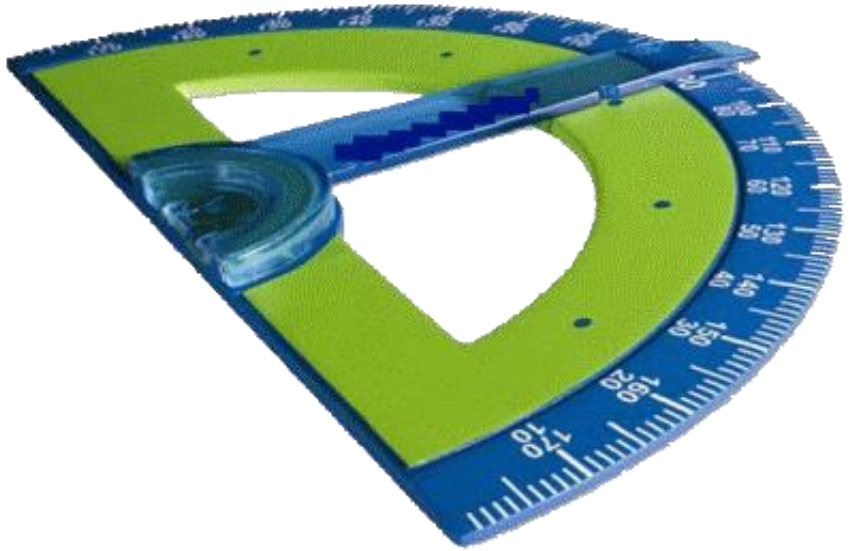


FOR ELECTRICITY

- **Ohmmeter:** A meter for measuring electrical resistance in ohms.
- **Ammeter:** A meter that measures the flow of electrical current in amperes.
- **Voltimeter:** Meter that measures the potential difference between two points in volts.
- **Multimeter:** A multimeter or a multitester, also known as a volt/ohm meter or VOM, is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter may include features such as the ability to measure voltage, current and resistance.

FOR ANGLES

- **Protractor:** A semi-circle device used for measuring angles. The edge is subdivided into degrees.



Science and Technology

Definitions

- **Science:** is a system of acquiring knowledge based on the scientific method, as well as the organized body of knowledge gained through such research, in order to reliably predict the type of outcome. It can be broadly defined as the study of things with branches like biology, chemistry, physics and psychology.

- **Technology:** is more of an applied science. It's a broad concept that deals with a species' usage and knowledge of tools and crafts to control and adapt them to its environment, and also to be used for the study of a particular science.

Differences

- For example, the science of energy can have technology as its application. In the case of energy as a subject in science, solar panels can be used for a variety of technologies, an example of which are solar-powered lights.
- If the goal of science is the pursuit of knowledge for science's sake, technology aims to create systems to meet the needs of people. Science has a quest of explaining something, while technology is leaning more towards developing a use for something.

Differences

- According to Kingsley Davis (1908 – 1997), one of the most outstanding social scientists of the twentieth century, science is the part of the cultural heritage which represents a systematic **knowledge of nature**, while technology contains the **application of this knowledge.**
- Another difference, pointed out by Kingsley Davis, is that technology encounters less conflict with morality in one sense because it is always aimed in achieving a utilitarian goal. Without the goal, the technology would be **meaningless**.

Mathematics

Introduction

- Mathematics is the abstract study of topics encompassing quantity, structure, space, change, and other properties. Mathematicians seek out patterns and formulate new conjectures. Mathematicians resolve the truth or falsity of conjectures by mathematical proof.
- It has become customary to view mathematical research as establishing truth by rigorous deduction from appropriately chosen axioms and definitions.
- There is not even consensus on whether mathematics is an art or a science. A great many professional mathematicians take no interest in a definition of mathematics, or consider it undefinable.

Equations

- An equation, in a mathematical context, is generally understood to mean a mathematical statement that asserts the equality of two expressions. For example:

$$x + 3 = 5$$

- Asserts that x+3 is equal to 5. The = symbol was invented by Robert Recorde (1510-1558), who considered that nothing could be more equal than parallel straight lines with the same length.
- Equations often express relationships between given quantities, the knowns, and quantities yet to be determined, the unknowns. By convention, unknowns are denoted by letters at the end of the alphabet, x, y, z, w, …, while knowns are denoted by letters at the beginning, a, b, c, d, … .

Equations

TYPES OF EQUATIONS

- An **algebraic equation or polynomial equation** is an equation in which a polynomial is set equal to another polynomial. These equations are further classified by their degree:
  - A linear equation has degree one
  - Quadratic equation has degree two
  - Cubic equation has degree three
  - Quartic equation has degree four
- A **Diophantine equation** is an equation where the unknowns are required to be integers.

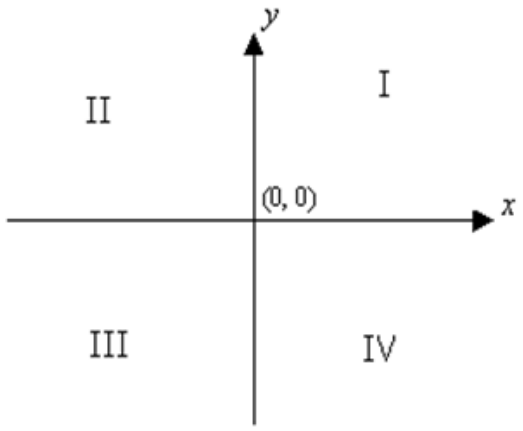
Equations

- An **indeterminate equation** has an infinite set of solutions, which only give one variable in terms of the others.
- A **transcendental equation** is an equation involving a transcendental function of one of its variables.
- A **functional equation** is an equation in which the unknowns are functions rather than simple quantities.
- A **differential equation** is an equation involving derivatives.
- An **integral equation** is an equation involving integrals.
- A **parametric equation** includes variables which are all functions of one or more common variables (called parameters).

Functions and Graphs

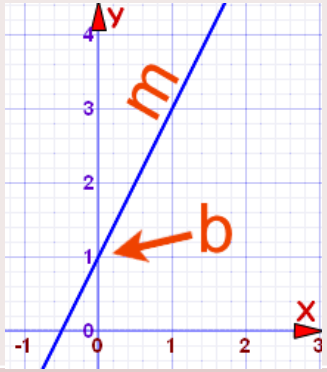
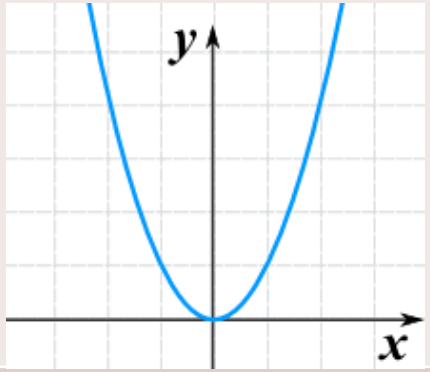
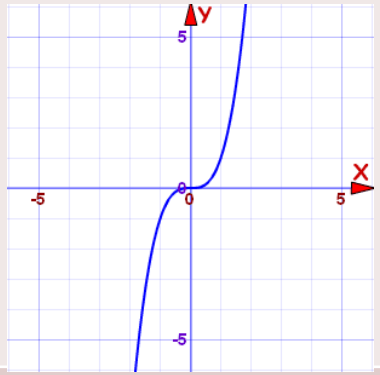
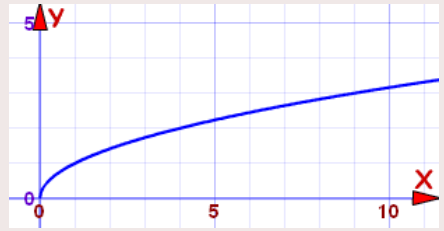
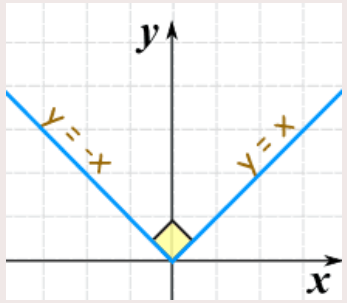
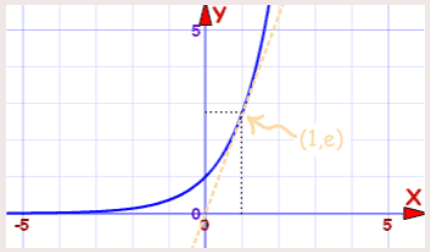
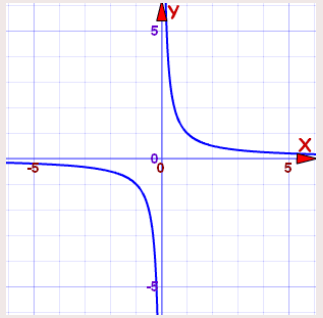
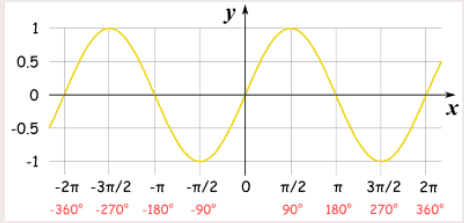
- The graph of a function f is the set of all points in the plane of the form (x, f(x)). We could also define the graph of f to be the graph of the equation y = f(x). So, the graph of a function is a special case of the graph of an equation.
- A good way of presenting a function is by graphical representation. Graphs give us a visual picture of the function. The most common way to graph a function is to use the **rectangular coordinate system**. This consists of:
  - The x-axis;
  - The y-axis;
  - The origin (0,0); and
  - The four quadrants, normally labelled I, II, III and IV.

Functions and Graphs



- Normally, the values of the independent variable (generally the x-values) are placed on the horizontal axis, while the values of the dependent variable (generally the y-values) are placed on the vertical axis.
  - The x-value, called the abscissa, is the perpendicular distance of P from the y-axis.
  - The y-value, called the ordinate, is the perpendicular distance of P from the x-axis.
  - The values of x and y together, written as (x, y) are called the coordinates of the point

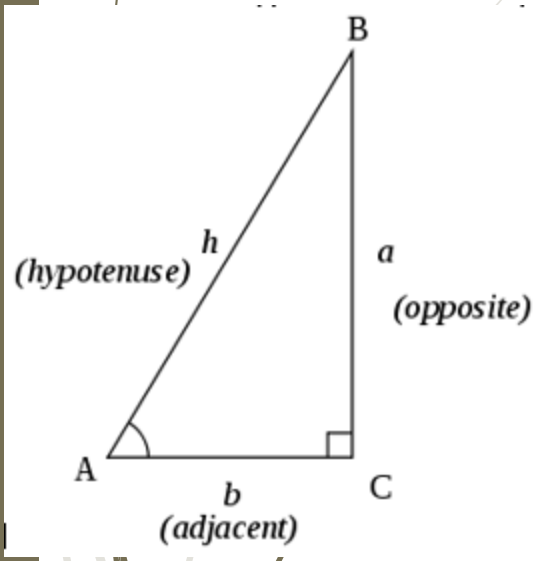
Commonly used functions

FUNCTIONS			
Linear	**Square**	**Cube**	**Square Root**
			
Absolute value function	**Exponential**	**Reciprocal**	**Sine**
			

Trigonometric Functions

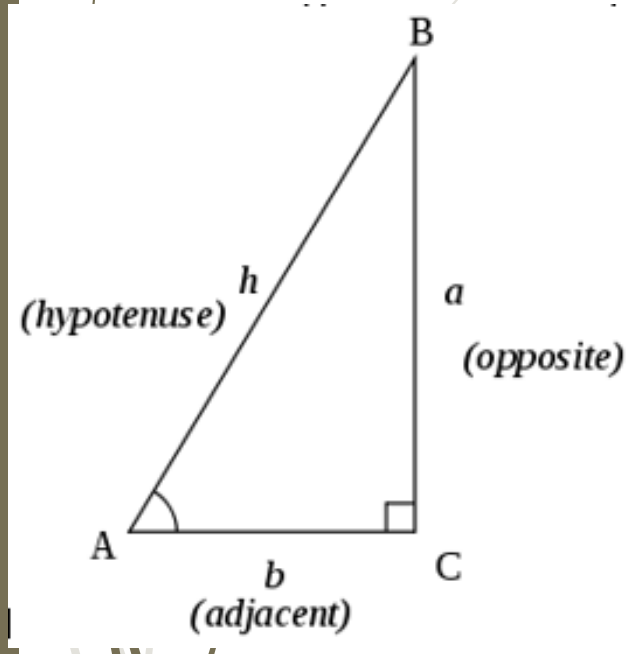
- They are used to relate the angles of a triangle to the lengths of the sides of a triangle. Trigonometric functions are important in the study of triangles and modeling periodic phenomena, among many other applications.
- Trigonometric functions are used, for instance, in navigation, engineering, and physics. A common use in elementary physics is resolving a vector into Cartesian coordinates. The sine and cosine functions are also commonly used to model periodic function phenomena such as sound and **light waves, the position and velocity of harmonic oscillators, sunlight intensity and day length, and average temperature** variations through the year.

Trigonometric Functions



- To define the trigonometric functions for the angle A, start with any right triangle that contains the angle A.
- The hypotenuse is the side opposite the right angle, in this case side h. The hypotenuse is always the longest side of a right-angled triangle.
- The opposite side is the side opposite to the angle we are interested in (angle A), in this case side a.
- The adjacent side is the side having both the angles of interest (angle A and right-angle C), in this case side b.

Trigonometric Functions



Function	Abbreviation	Description
Sine	Sin	opposite / hypotenuse
Cosine	Cos	adjacent / hypotenuse
Tangent	tan (or tg)	opposite / adjacent
Cotangent	cot (or cotan or cotg or ctg or ctn)	adjacent / opposite
Secant	Sec	hypotenuse / adjacent
Cosecant	csc (or cosec)	hypotenuse / opposite

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Reading Mathematical Expressions

(A. Oancea, S. Maillot, C. Mitschi)

Note: Some groups of letters are underlined in order to draw one's attention to their pronunciation.

Basics

$a + b$	a plus b
$a - b$	a minus b
$a \cdot b$	ab, a times b
$\frac{a}{b}$, a/b	a over b, a divided by b
$\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\ldots$, $\frac{1}{10}$	one half, one third, one fourth, ... , one tenth
$\frac{5}{2}$, $\frac{2}{3}$, $\ldots$, $\frac{7}{10}$	five halves, two thirds, ... , seven tenths
$a = b$	a equals b, a is equal to b
$a \neq b$	a different from b, a not equal to b
$a < b$	a (strictly) less than b
$a \leq b$	a less than or equal to b
$a > b$	a (strictly) bigger than b, a greater than b
$a \geq b$	a greater than or equal to b

Powers and roots

a^b	a to the b, a to the b-th (power) [if b is a positive integer]
x^2	x squared
x^3	x cubed
x^{-1}	x inverse
$\sqrt[n]{t}$	n-th root of t
$\sqrt{t}$	square root of t
$\sqrt[3]{t}$	cubic root of t

Sets

$\emptyset$	(the) empty set
$A \cup B$	A union B
$A \cap B$	A intersected with B
A^c	the complement of A
$A \setminus B$	A minus B
$A \times B$	A times B
$x \in A$	x in A, x belongs to A, x belonging to A

Miscellaneous

5%	five percent
30°	thirty degrees
x_k	x k
x_i^j	x i j [if j is an index, not an exponent!]
$\sum_{k=1}^{n} k^2$	sum k equals 1 to n of k^2, sum for k (running) from 1 to n of k^2, summation k from 1 to n of k^2
$\prod_{k=1}^{n} \frac{2k+1}{2k+2}$	product k equals 1 to n of $2k+1$ over $2k+2$ product for k (running) from 1 to n of $2k+1$ over $2k+2$
$n!$	n factorial
partie entière de x	integer part of x
$\lvert x \rvert$	absolute value of x (if x is a real number)
$\lvert z \rvert$	modulus of z (if z is a complex number)
$\mathrm{Re}(z)$, $\mathrm{Im}(z)$	real part of z, imaginary part of z
$\parallel x \parallel$	norm of x
$\langle v, w \rangle$	scalar product of v and w
cos sin tan etc.	cosine/cosinus sine/sinus tangent etc.
η θ ξ	eta [íta] theta [thíta] xi [ksái]
π σ χ ψ	pi [pái] sigma [zígma] chi [kái] psi [sái]
$\mathbb{R}^2$, $\mathbb{R}^3$, $\mathbb{R}^n$	$\mathbb{R}$ 2, $\mathbb{R}$ 3, $\mathbb{R}$ n
$(blablabla) \cdot (blbl)$	*blablabla*, the whole times *blbl*
$\frac{blablabla}{blbl}$	*blablabla*, the whole divided by *blbl*
$x_1, \ldots, x_n$	x_1 up to x_n

Calculus

f'	f prime, f dashed
$\frac{d}{dx}$	d by dx
$\frac{df}{dx}$, $\frac{\partial f}{\partial x}$	df by dx
$\partial_x f$	$d\ x\ f$, partial derivative of f with respect to x
$\int_a^b f(s)ds$	integral from a to b (of) $f(s)\ ds$
$\iint_D$, $\iiint_D$	double integral, triple integral over the domain D
$\pm\infty$	plus/minus infinity
$\lim_{x\to a} f(x)$	(the) limit of $f(x)$ as x tends/goes to a,
	(the) limit of f of x as x tends/goes to a
$\log(x)$, $\log_a x$	logarithm of x, logarithm in base a of x
$\exp(x)$, e^x	exponential of x, e to the x

Functions

$f : U \to V$	f from U to V
$f(x)$	f of x
$x \mapsto f(x)$	x maps to $f(x)$
of class C^k	of class $C\ k$
of class C^∞	of class C infinity
the Lebesgue spaces L^p, L^∞	the Lebesgue spaces $L\ p$, L infinity
the Sobolev spaces H^k, $W^{k,p}$	the Sóbolev spaces $H\ k$, $W\ k\ p$

Chemistry

Introduction

- Chemistry is the science of the materials that make up our physical world (physical science). Chemistry tends to focus on the properties of substances and the interactions between different types of matter, particularly reactions that involve electrons.
- No person could expect to master all aspects of such a vast field, so it has been found convenient to divide the subject into smaller areas. For example:
  - **Organic chemists** study compounds of carbon. Atoms of this element can form stable chains and rings, giving rise to very large numbers of natural and synthetic compounds.
  - **Biochemists** concern themselves with the chemistry of the living world.

Introduction

- **Inorganic chemists** are interested in all elements, but particularly in metals, and are often involved in the preparation of new catalysts.
- **Physical chemists** study the structures of materials, and rates and energies of chemical reactions.
- **Theoretical chemists** with the use of mathematics and computational techniques derive unifying concepts to explain chemical behavior.
- **Analytical chemists** develop test procedures to determine the identity, composition and purity of chemicals and materials. New analytical procedures often discover the presence of previously unknown compounds.

- One of the main functions of the chemist is to rearrange the atoms of known substances to produce new products.

Atomic and Molecular Structure

- **Atoms** are single units of an element. Ions can be made up of one or more types of elements and carry an electrical charge.
- Atoms cannot be divided using chemicals. They do consist of parts, which include protons, neutrons, and electrons.
- Each electron has a negative electrical charge.
- Each proton has a positive electrical charge. The charge of a proton and an electron are equal in magnitude, yet opposite in sign.
- Each neutron is electrically neutral.
- The nucleus of an atom contains protons and neutrons.
- Electrons move around outside the nucleus.

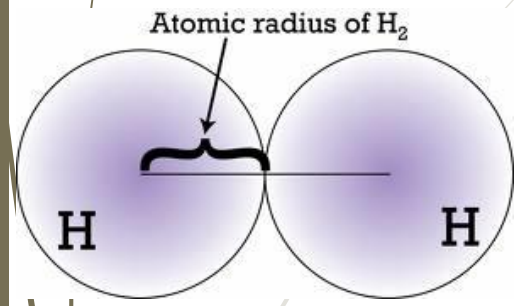
Atomic Numbers and Atomic Mass

- **The atomic number** is the number of protons in an atom
- **The atomic mass** is the mass of protons, neutrons, and electrons in an atom
- Atomic number doesn't always equate to increasing mass because many atoms don't have a number of neutrons equal to the number of protons.
- In other words, several **isotopes** of an element may exist (elements with the same atomic number but with different atomic mass).

Periodic Table

- A **periodic table** is a tabular display of the chemical elements, organized on the basis of their atomic numbers, electron configurations, and recurring chemical properties. Elements are presented in order of increasing atomic number (number of protons).
- A **group or family** is a vertical column in the periodic table. Elements in the same group tend to have a shared chemistry and exhibit a clear trend in properties with increasing atomic number.
- Elements in the same group tend to show patterns in atomic radius, ionization energy, and electronegativity.

Periodic Table

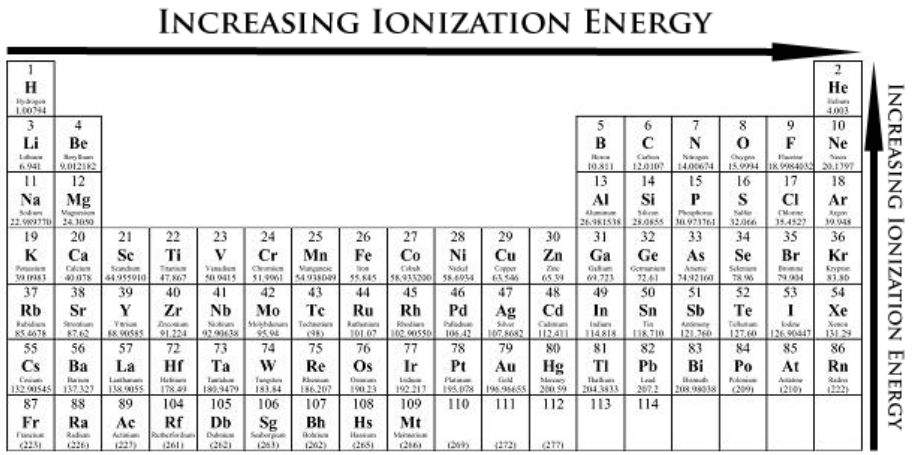


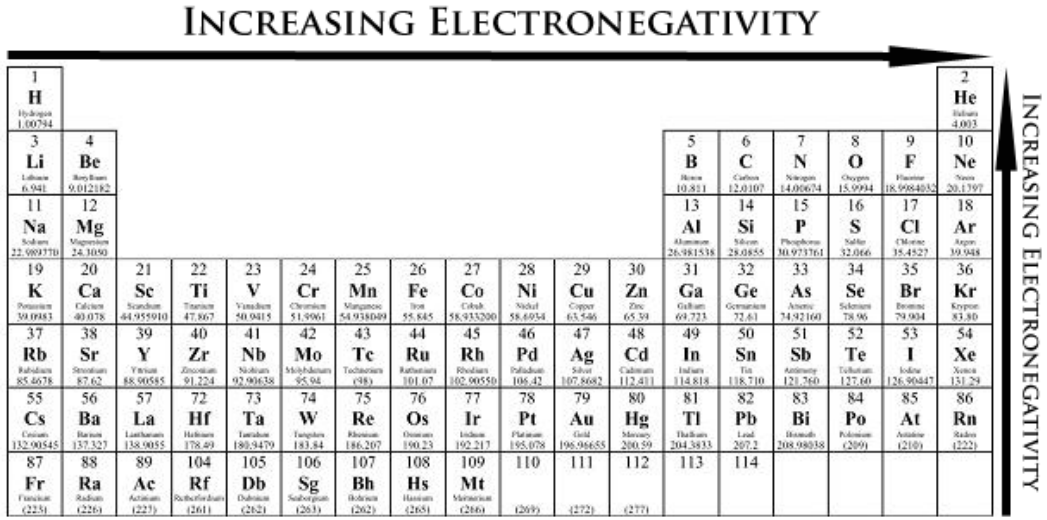
- **Atomic radius:** The radius of an atom; the distance from the atomic nucleus to the outermost stable electron orbital in an atom at equilibrium
- **Ionization energy:** It is the energy required to remove an electron from a gaseous atom or ion.
- **Electron affinity:** Amount of energy released or spent when an electron is added to a neutral atom or molecule in the gaseous state to form a negative ion
- **Electronegativity:** A measure of the ability of a specified atom to attract electrons in a molecule

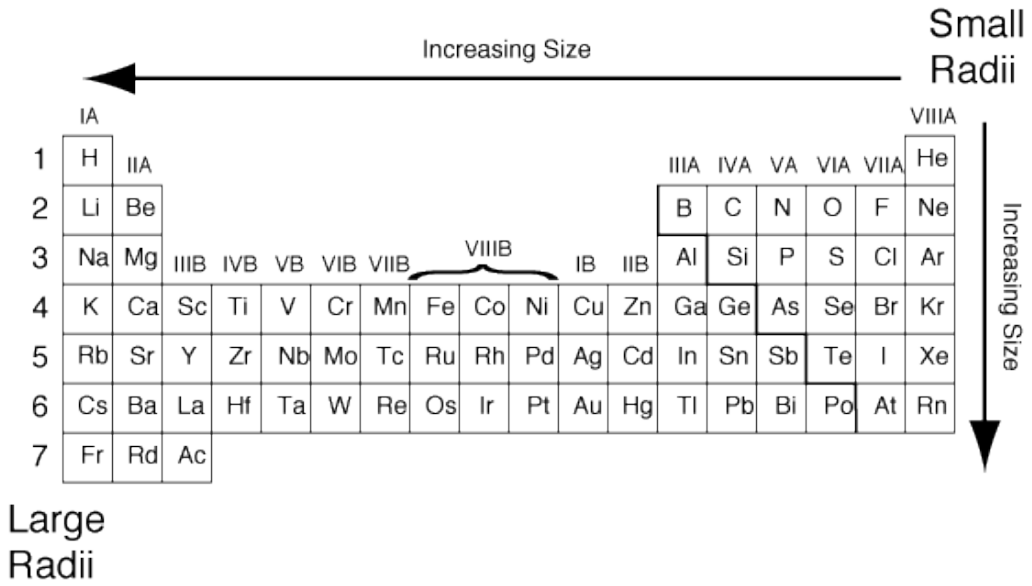
Periodic Table

- A **period** is a horizontal row in the periodic table. Elements in the same period show trends in atomic radius, ionization energy, electron affinity, and electronegativity.
- Moving left to right across a period, atomic radius usually decreases. This occurs because each successive element has an added proton and electron which causes the electron to be drawn closer to the nucleus.
- This decrease in atomic radius also causes the ionization energy to increase when moving from left to right across a period.
- Electronegativity increases in the same manner as ionization energy because of the pull exerted on the electrons by the nucleus.

Periodic Table







Molecules

$$mol = \frac{weight\ of\ sample\ (g)}{molar\ weight\ (\frac{g}{mol})}$$

- Molecules are small particles that make up all living and non-living things. Every molecule is unique due to its chemical properties. They are made up of even tinier particles called atoms.
- A **mole** is defined as the quantity of a substance that has the same number of particles as are found in 12.000 grams of carbon-12. This number, Avogadro's number, is 6.022x1023.
- One mole of a compound contains 6.022x1023 molecules of the compound. The mass of 1 mole of a compound is called its molar weight or molar mass. The units for molar weight or molar mass are grams per mole.

Chemical Bonds

- An **ionic bond** is formed when one atom accepts or donates one or more of its valence electrons to another atom.
- A **covalent bond** is formed when atoms share valence electrons. The atoms do not always share the electrons equally, so a polar covalent bond may be the result.
- When electrons are shared by two metallic atoms a **metallic bond** may be formed.

Definitions

- An **ion** is an atom or a molecule in which the total number of electrons is not equal to the total number of protons, giving the atom or molecule a net positive or negative electrical charge.
- If a neutral atom loses one or more electrons, it has a net positive charge and is known as a **cation (positive ion)**.
- If an atom gains electrons, it has a net negative charge and is known as an **anion (negative ion)**.

Definitions

- **Acids** are ionic compounds (a compound with a positive or negative charge) that break apart in water to form a hydrogen ion (H+).
- **Bases** are ionic compounds that break apart to form a negatively charged hydroxide ion (OH-) in water.
- **Oxidation number** is the state of an element or ion in a compound with regard to the electrons gained or lost by the element or ion in the reaction that formed the compound, expressed as a positive or negative number indicating the ionic charge of the element or ion.

Chemical Reactions

- A chemical reaction is a process that is usually characterized by a chemical change in which the starting materials (reactants) are different from the products. Chemical reactions tend to involve the motion of electrons, leading to the formation and breaking of chemical bonds.
- **Direct Combination or Synthesis Reaction:** In a synthesis reaction two or more chemical species combine to form a more complex product.

A + B --> AB

Chemical Reactions

- The combination of iron and sulfur to form iron (II) sulfide is an example of a synthesis reaction:

$$8\ Fe + S_8 \rightarrow 8\ FeS$$

- **Chemical Decomposition or Analysis Reaction:** In a decomposition reaction a compound is broken into smaller chemical species.

$$AB \rightarrow A + B$$

Chemical Reactions

- The electrolysis of water into oxygen and hydrogen gas is an example of a decomposition reaction:

$$2\,H_2O \dashrightarrow 2\,H_2 + O_2$$

- **Single Displacement or Substitution Reaction:** A substitution or single displacement reaction is characterized by one element being displaced from a compound by another element.

$$A + BC \dashrightarrow AC + B$$

Chemical Reactions

- An example of a substitution reaction occurs when zinc combines with hydrochloric acid. The zinc replaces the hydrogen:

$$Zn + 2\,HCl \rightarrow ZnCl_2 + H_2$$

- **Metathesis or Double Displacement Reaction:** In a double displacement or metathesis reaction two compounds exchange bonds or ions in order to form different compounds.

$$AB + CD \rightarrow AD + CB$$

Chemical Reactions

- An example of a double displacement reaction occurs between sodium chloride and silver nitrate to form sodium nitrate and silver chloride.

$$NaCl(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgCl(s)$$

- **Acid-Base Reaction:** An acid-base reaction is type of double displacement reaction that occurs between an acid and a base. The H+ ion in the acid reacts with the OH- ion in the base to form water and an ionic salt:

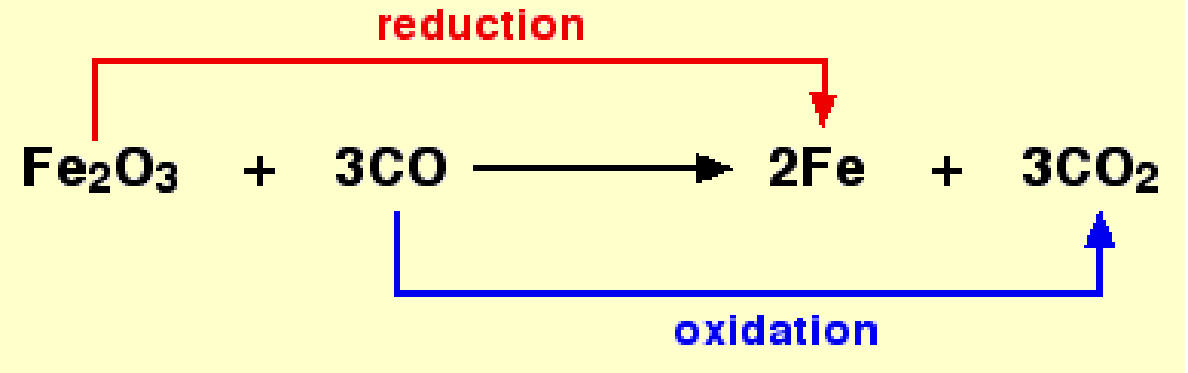
$$HA + BOH \rightarrow H_2O + BA$$

Chemical Reactions

- The reaction between hydrobromic acid (HBr) and sodium hydroxide is an example of an acid- base reaction:

$$HBr + NaOH \text{ -->} NaBr + H_2O$$

- **Oxidation-Reduction or Redox Reaction:** In a redox reaction the oxidation numbers of atoms are changed. Redox reactions may involve the transfer of electrons between chemical species.



Chemical Reactions

- **Combustion:** A combustion reaction is a type of redox reaction in which a combustible material combines with an oxidizer to form oxidized products and generate heat (exothermic reaction). Usually in combustion reactions oxygen combines with another compound to form carbon dioxide and water. An example of a combustion reaction is the burning of naphthalene:

$$C_{10}H_8 + 12\ O_2 \text{ ---> } 10\ CO_2 + 4\ H_2O$$

Chemical Reactions

- **Hydrolysis Reaction:** A hydrolysis reaction involves water. The general form for a hydrolysis reaction is:

$$X^-(aq) + H_2O(l) \leftrightarrow HX(aq) + OH^-(aq)$$

STATISTICS

INTRODUCTION

- Statistics can be defined as the practice of collecting, organizing, describing, and analyzing data to draw conclusions from the data to apply to a cause. Data must either be numeric in origin or transformed by researchers into numbers.
- There are two main branches of statistics: descriptive and inferential. **Descriptive statistics** is used to say something about a set of information that has been collected only. **Inferential statistics** is used to make predictions or comparisons about a larger group (a population) using information gathered about a small part of that population.

DESCRIPTIVE STATISTICS

- Descriptive statistics describe patterns and general trends in a data set. In most cases, descriptive statistics are used to examine or explore one variable at a time. However, the relationship between two variables can also be described as with correlation and regression.
- The first phase of data analysis involves the placing of some order on some sort of "chaos". Typically the data are reduced down to one or two descriptive summaries

FREQUENCY DISTRIBUTIONS

- These types of distributions are a way of displaying “chaos” of numbers in an organized manner so such questions can be answered easily. A frequency distribution is simply a table that, at minimum, displays how many times in a data set each response or "score" occurs.

MEASURES OF CENTRAL TENDENCY

- This type of measurements gives a single description of the average or "typical" score in a data distribution. These measures attempt to quantify what we mean when we think of as the "average" score in a data set. The concept is extremely important and we encounter it frequently in daily life.
- For example, we often want to know before purchasing a car its average distance per liter of petrol. Or before accepting a job, you might want to know what a typical salary is for people in that position so you will know whether or not you are going to be paid what you are worth.

MEASURES OF CENTRAL TENDENCY

- 1. **Median:** It is the middle number of a set of numbers arranged in numerical order. If the number of values in a set is even, then the median is the sum of the two middle values, divided by 2.
- 2. **Mode:** the mode is the most frequent value in a set. A set can have more than one mode; if it has two, it is said to be bimodal. The mode is useful when the members of a set are very different, for example the comparison of grades of a test (A, B, C, D, E).
- 3. **Mean:** the mean is the sum of all the values in a set, divided by the number of values. The mean of a whole population is usually denoted by μ, while the mean of a sample is usually denoted by $\bar{x}$.

MEASURES OF VARIABILITY

- The average score in a distribution is important in many research contexts. So too is another set of statistics that quantify how variable or how dispersed the scores in a set of data tend to be. Sometimes variability in scores is the central issue in a research question. Variability is a quantitative concept, so none of this applies to distributions of qualitative data.
- **1. Range:** the range is the difference between the largest and smallest values of a set, but is not very useful because it depends on the extreme values, which may be distorted.

MEASURES OF VARIABILITY

- **2. Variance:** the variance is a measure of how items are dispersed about their mean. The variance of a whole population is given by the equation: $\sigma^2 = \frac{\sum(x-\mu)^2}{N}$. The variance of a sample is calculated differently: $s^2 = \frac{\sum(x-\bar{x})^2}{n-1}$
- **3. Standard deviation:** The standard deviation "σ" (or "s" for a sample) is the square root of the variance.
- **4. Relative variability:** The relative variability of a set is its standard deviation divided by its mean. The relative variability is useful for comparing several variances.

INFERENTIAL STATISTICS

- Inferential statistics are used to judge the meaning of data. Inferential statistics assess how likely it is that group differences or correlations would exist in the population rather than occurring only due to variables associated with the chosen sample.
- Two basic uses of inferential statistics are possible:
  - **Confidence intervals,** which is also referred to as Interval estimation.
  - **Hypothesis testing,** which is also referred to as Point Estimation.

THE HYPOTHESIS TESTING

- Often times we want to determine whether a claim is true or false. Such a claim is called a hypothesis. It is important to clear up some terms such as:

1. **Null hypothesis:** a specific hypothesis to be tested in an experiment. The null hypothesis is usually labeled Ho.

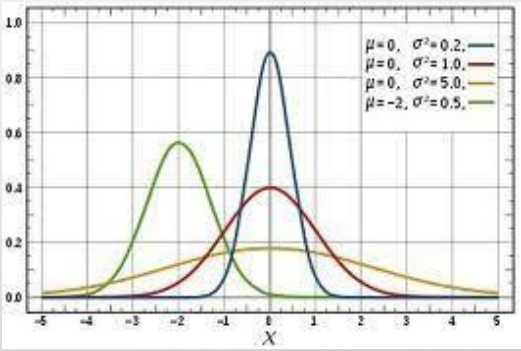
2. **Alternative hypothesis:** a hypothesis that is different from the null hypothesis, which we usually want to show that is true (thereby showing that the null hypothesis is false). The alternative hypothesis is usually labeled Ha.

THE HYPOTHESIS TESTING

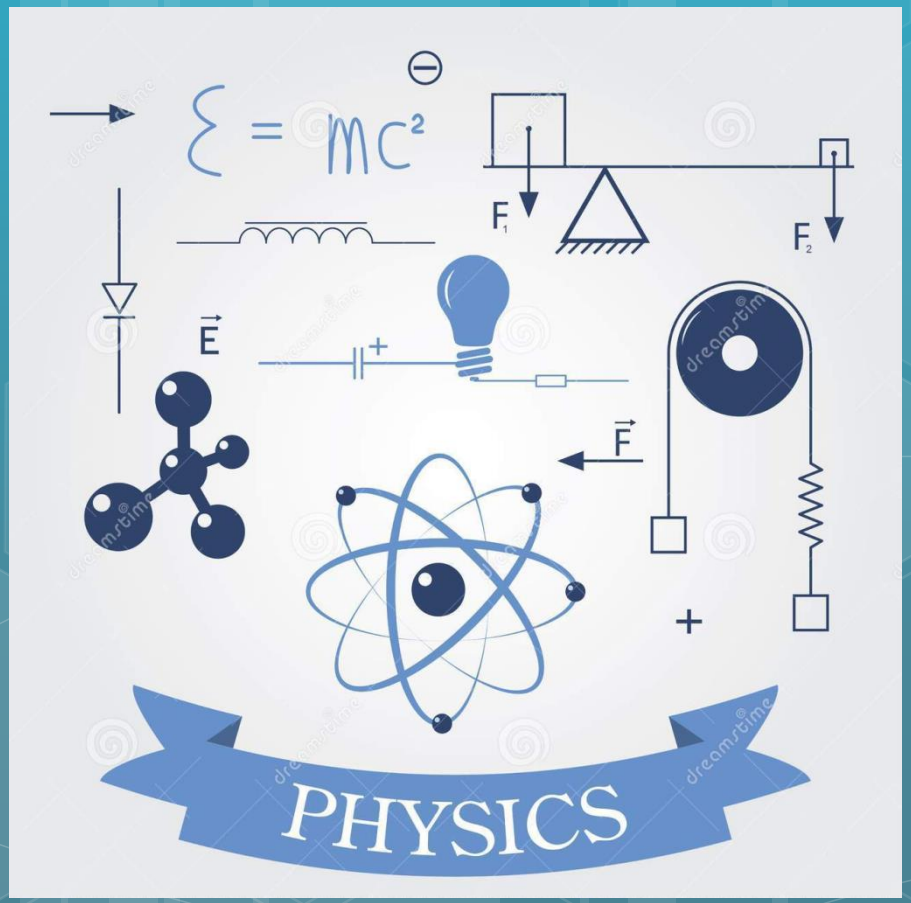
- The null hypothesis is tested through the following procedure:
  - Determine the null hypothesis and an alternative hypothesis.
  - Pick an appropriate sample.
  - Use measurements from the sample to determine the likelihood of the null hypothesis.
- Other important concepts when studying hypothesis test are:
  - **Type 1 Error:** If the null hypothesis is true but the sample mean is such that the null hypothesis is rejected, a Type I error occurs. The probability that such an error will occur is the risk.
  - **Type 2 Error:** If the null hypothesis is false but the sample mean is such that the null hypothesis cannot be rejected, a Type II error occurs. The probability that such an error will occur is called the risk.

CONFIDENCE INTERVALS

- Interval estimation is used when we wish to be fairly certain that the true population value is contained within that interval. When we attach a probability statement to an estimated interval, we obtain a confidence interval.
- Confidence is defined as 1 - alpha (1 minus the significance level). Thus, when we construct a 95% confidence interval, we are saying that we are 95% certain that the true population mean is covered by the interval - consequently, of course, we have a 5% chance of being wrong.



- Any statistic that can be evaluated in a test of significance ("hypothesis testing") can be used in constructing a confidence interval.



PHYSICS

Technical English

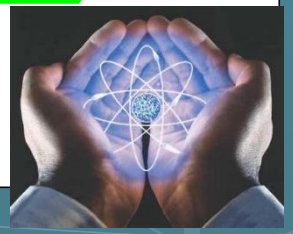
Basic Concepts

Physics is the science of natural phenomena, the relationship between space and time, based on their properties. It is divided into several branches:

- **Kinematics**: Examines the consequences of the motion of bodies in space and time.
- **Dynamics**: Examines the causes of the motion of bodies in relation to space and time.
- **Geometric Optics**: Studies all the phenomena of light by means of analytical geometry.
- **Electromagnetic Optics**: Studies all the phenomena of light by means of their frequencies.

Basic Concepts

- **Acoustic**: Studies all phenomena linked to mechanical waves and electromagnetism.
- **Thermodynamics**: Studies all phenomena related to the temperature (not just with the heat, as many believe).
- **Electricity**: Studies all phenomena related to electricity. This is sometimes subdivided into: *Static* which studies everything related to electrical energy stored in objects and *Dynamic which* Studies everything related to the movement of electrons.
- **Electromagnetism**: Studies everything about the causes and effects of magnetic fields.



Applications

The most known application areas are:

- **Low temperatures:** These laboratories research on superconductivity and highly correlated electronic systems. Also in the manufacture of nanostructured materials.
- **Atomic collisions:** Research groups in this area carry out experimental and theoretical research on the interactions of atomic particles (charged and neutral) with solid or gaseous phase matter
- **Physics of metals:** Here research is directed to the thermodynamic and mechanical properties of metal alloys and materials in general.

Applications

- **Statistical Physics:** These research groups apply statistics techniques - physical in origin - to biological, social and economic systems with emphasis on issues of epidemiology, neurosciences, ecology and cultural evolution.
- **Forensic physics:** They develop new techniques useful in the judicial forum. Expert advice is also provided to the judiciary using electronic microscopy scanning, analysis by neutron activation or innovative methodologies.
- **Nuclear fusion and physics of Plasmas:** Groups working on this area perform studies on balance, stability, transport, sustaining the flow and heating in plasmas

Applications

- **Optical properties:** These laboratories characterize materials by optical means. They also study light and ultra-fast vibration at the nanoscale, and ultra-sensitive detection of molecules and pollutants.
- **Magnetic resonance:** Here, researchers perform characterization and measurement of magnetic, thermodynamic, elastic properties and transportation of new magnetic materials in both nanostructured and massive systems
- **Particles and field theory:** These groups carry out research in the areas of Physics of high energies, astroparticle, mathematical Physics, field theory and strings.

Vectors and Scalars

- ***Scalars*** are completely specified by a single value with an appropriate unit and have no direction.
- *A* ***Vector*** is a quantity that has both magnitude and direction. *Displacement, velocity, acceleration, and force* are the vector quantities.
- There are examples of vectors that are directed in two dimensions - upward and rightward, northward and westward, eastward and southward, etc.

MECHANICS

Technical English

Definition

- Mechanics is defined as the science that describes and predicts the conditions of rest or motion of bodies under the action of forces. It is divided into three parts: Mechanics of Rigid Bodies, Mechanics of Deformable Bodies and Mechanics of Fluids.
- The Mechanics of Rigid Bodies is subdivided into Statics, dealing with bodies at rest, and Dynamics, that attends bodies in motion.

Definition

- Mechanics is a physical science, since it is closely related with the study of physical phenomena. Mechanics is the foundation of most engineering sciences and is an indispensable prerequisite to their study.
- The purpose of mechanics is to explain and predict physical phenomena and thus to lay the foundations for engineering applications.

Fundamental Concepts

- The basic concepts used in Mechanics are: space, time, mass, and force.
- The **concept of space** is associated with the notion of the position of a point P. Three lengths measured from a certain reference plane having a common point, called origin, in three given directions may define the position of P. These lengths are known as the coordinates of P. The space is assumed to be uniform.

Fundamental Concepts

- To define an event, it's not sufficient to indicate its position in space. **The time** of event should also be given.

- **The concept of mass** is used to characterize and compare bodies on the basis of certain fundamental mechanical experiments. Two bodies of the same mass, for example, will be attracted by the Earth in the same manner; they will also offer the same resistance to a change in translational motion.

Fundamental Concepts

- **A force** represents the action of one body in another. It may be exerted by direct contact or at a distance, as in the case of gravitational forces and magnetic forces. A force is characterized by its point of application, its magnitude, and its direction; a force is represented by a vector.

- The conditions of rest or motion of particles and rigid bodies must be studied in terms of the four basic concepts we have introduced. By **particles** we mean a very small amount of matter, which may be assumed to occupy a single point in space. A **rigid body** is a combination of a large number of particles occupying fixed positions with respect to each other.

Fundamental Concepts

- The study of the **Mechanics of Particles** is obviously a prerequisite to that of rigid bodies. Besides, the results obtained for a particle may be used directly in a large number of problems dealing with the conditions of rest or motion of actual bodies.

- The study of Elementary Mechanics rests on four fundamental principles based on experimental evidence:

Principles of Elementary Mechanics

- **1. The parallelogram law for the addition of forces:** This states that two forces acting on a particle may be replaced by a single force, called their resultant, obtained by drawing the diagonal of the parallelogram, which has sides equal to the given forces.
- **2. The principle of transmissibility:** This states that the conditions of equilibrium or motion of a rigid body will remain unchanged if a force acting at a given point of the rigid body is replaced by a force of the same magnitude and the same direction, but acting at a different point, provided that the two forces have the same line of action.

3. Newton's three fundamental laws

- **I.** If the resultant force acting on a particle is zero, the particle will remain at rest (if originally at rest) or will move with constant speed in a straight line (if originally in motion).

- **II.** If the resultant force acting on a particle is not zero, the particle will have an acceleration proportional to the magnitude of the resultant and in the direction of this resultant force.

3. Newton's three fundamental laws

- **III.** The forces of action and reaction between bodies in contact have the same magnitude, same line of action, and opposite sense.
- **4. Newton's law of gravitation:** This states that two particles of mass "M" and "m" are mutually attracted with equal and opposite forces "F" and "-F" of magnitude "F" given by the formula in which "r" is the distance between the two particles, and "G" is the universal constant called the constant of gravitation

International System of Units (SI) and Derived Units

- In this system, used worldwide, the base units are:
  - **Meter (m)** for measuring a length (L) property
  - **Second (s)** for measuring time (t) flow
  - **Kilogram (kg)** for measuring the mass (M) of a body
- The three base units are independent of the location where measurements are made.

International System of Units (SI) and Derived Units

- In Physics, as well as in Engineering Sciences, there is a need to use secondary dimensional quantities. The units of these quantities are referred to as **derived units**.
- For example, the unit of force is a derived unit Newton (N), defined as the force which gives an acceleration of 1 m/s2 to a mass of 1 kg.

Strength of Materials

Introduction

- **Strength of Materials** can be simply defined as the ability of a material to resist the application of force. The effects of dynamic loading are probably the most important practical part of the strength of materials, especially the problem of fatigue.
- The study of Strength of Materials is concerned specifically with the following issues:

Introduction

- 1. The internal forces of a member caused by the external forces acting on the system.
- 2. The changes in dimension of a member caused by these forces.
- 3. The physical properties of the material the member is made of.
- **Static** is the study of the behavior of rigid bodies at rest as external forces act upon them.

Introduction

- Although most of these bodies are not absolutely rigid, **the assumption of rigidity** is valid for the purpose of determining the reactions of the system. Actually, every material will get deformed under a load. Even concrete slabs get microscopically deformed when a person walks on it.
- **External loads** on a structural system create resisting forces within all of the members that form the load path from the load's point of application to the ground beneath the foundation.

Definitions

- The following are basic definitions and equations used to calculate the strength of materials:
- **Stress** is the ratio of applied load to the cross-sectional area of an element in tension or compression and is expressed in pounds per square inch (psi) or N/m2

$$Stress\ (\sigma) = \frac{Load}{Area} = \frac{P}{A}$$

- **Strain (normal):** A measure of the deformation of the material and is dimensionless.

$$Strain\ (\varepsilon) = \frac{Change\ in\ length}{Original\ length} = \frac{\Delta L}{L}$$

- **Modulus of elasticity:** Since stress is proportional to load, and strain is proportional to deformation, this implies that stress is proportional to strain.

$$E = \frac{\sigma}{\varepsilon} = \frac{Stress}{Strain}$$

Definitions

- Hooke's law is the statement of that proportionality. The constant is the modulus of elasticity, Young's or the tensile modulus and is the material's stiffness, If a material obeys Hooke's law, it is elastic.
- **Proportional Limit:** the greatest stress at which a material is capable of sustaining the applied load without deviating from the proportionality of stress to strain

Definitions

- **Ultimate Strength (tensile):** maximum stress a material stands when subjected to an applied load; dividing the load at failure by the original cross-section area determines the value.
- **Elastic Limit:** The point on the stress-strain curve beyond which the material permanently stays deformed after removing the load.
- **Yield Strength:** point at which material exceeds the elastic limit and will not return to its original shape or length if the stress is removed.

Definitions

- **Poisson's ratio:** is the ratio of the lateral to longitudinal strain, a dimensionless constant used for stress and deflection analysis of structures such as beams, plates and rotating discs.

$$\nu = \frac{lateral\ strain}{longitudinal\ strain}$$

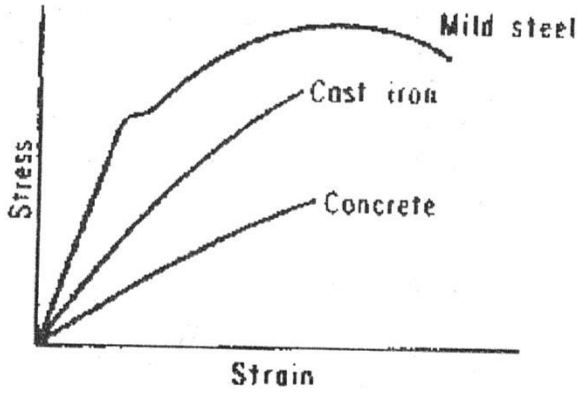
- **Bending stress:** When bending a piece of metal, one surface of the material stretches in tension, while the opposite surface compresses. There is a line or region of zero stress between the two sides of the beam, called neutral axis, where the beam doesn't get compressed neither tensed.

Definitions

- **Yielding:** It occurs when the design stress exceeds the material yield strength. The yield point of a material is defined in engineering as the stress at which a material begins to plastically deform.
- **Fatigue** is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. It is also the maximum stress limit of the material.

Stress-strain curve

- The relationship between the stress and the strain that a material shows is known as a **Stress-Strain Curve**. It is unique for each material and is given by plotting the amount or deformation (strain) at distinct intervals of tensile or compressive loading.



Beams

- A **beam** is a structural member which carries loads; these loads are applied generally perpendicular to its longitudinal axis (the longest side), often they have a rectangular cross-sectional shape, but they can be of any geometry.
- **Beam types** are determined by method of supports, not by method of loading. The beam types: **simple and cantilever**, are statically determinable, meaning that the reactions in the supports, shears and moments can be calculated

Beams

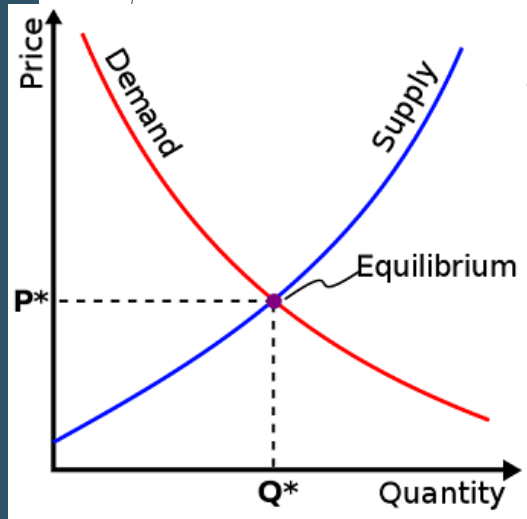
- **Continuous beams** are statically indeterminate; the internal forces of these beams cannot be found by using the laws of static alone. A number of formulas have been derived to simplify their analysis.
- Two beam loading conditions that either occur independently, or combined are: **Concentrated**, either a force or a moment can be applied as a concentrated load. Both are applied at a single point along the beam axis; these loads are shown as a "jump" in the shear or moment diagrams. **Distributed**, these loads can be uniformly or non-uniformly distributed.

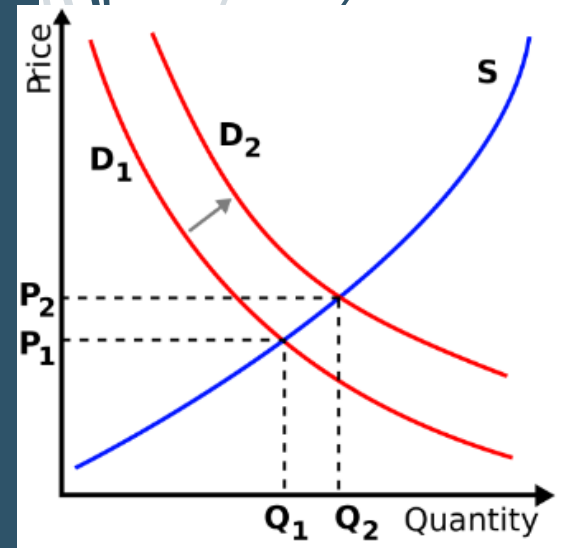
Economy

Macroeconomics

- **Macroeconomics** analyzes overall economic issues such as employment, inflation, productivity, interest rates, the foreign trade deficit, and the federal budget deficit, and examines the effect that employment or inflation is likely to have on the economy. It is the study of economic activity by looking at the economy ***as a whole***.
- Some examples of business that will be part of the macroeconomics field are Toyota, McDonald's, etc. Because those are business with branches on several countries worldwide, those are affected by factors like national politics, currency exchange, etc.

Microeconomics





- **Microeconomics** is the study of decision making by small economic units, including individuals, households, businesses, and industries. Microeconomics examines issues such as pricing, supply, demand, costs, and revenues.
- Microeconomic theory uses formal models that attempt to explain and predict, using simplifying assumptions, the behavior of consumers and producers, and the allocation of resources arising as a result of their interaction in the market. This applies to every business like warehouses, family drugstores because they have less than ten workers.

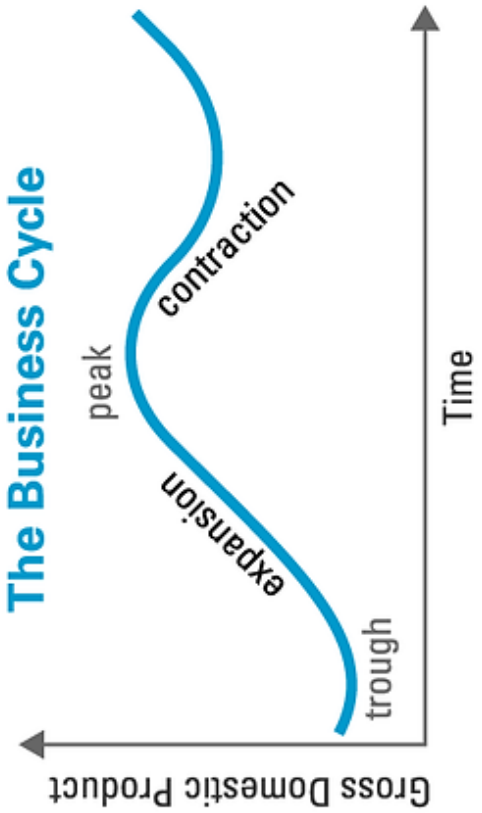
Important Notes

- The bottom line is that microeconomics takes a bottoms-up approach to analyzing the economy while macroeconomics takes a top-down approach. Regardless, both micro- and macroeconomics provide fundamental tools for any finance professional and should be studied together in order to fully understand how companies operate and earn revenues and thus, how an entire economy is managed and sustained.
- **Inflation** is defined as the sustained increase in the general level of prices for goods and services. It is measured as an annual percentage increase. As inflation rises, every bill you own buys a smaller percentage of a good or service)

ISI

- A very important policy in the economic framework for Latin America was the introduction of the model of import substitution industrialization (ISI), during 1950 and 1970. This policy was based on local production of products hitherto imported, i.e. to make oneself manufactures its economy acquired abroad.
- This industrialization model however did not reduce the volume of imports, but simply changed the type of imports. Before importing the full right, no matter what it takes to produce it.

GDP and GNP



- **Gross Domestic Product (GDP)** is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports.
- **Gross national product (GNP)** is the market value of all the products and services produced in one year by labor and property supplied by the citizens of a country. Unlike gross domestic product (GDP), which defines production based on the geographical location of production, GNP suggested it allocated production based on location of ownership.

Guatemalan Economy

- Guatemala is the most populous of the Central American countries with a GDP per capita roughly one-half that of the average for Latin America and the Caribbean. Guatemala's economy is dominated by the private sector, which generates about 90% of GDP. Agriculture contributes 13.4% of GDP and accounts for 26% of exports.
- Over the past several years, tourism and exports of textiles, apparel, and nontraditional agricultural products such as winter vegetables, fruit, and cut flowers have boomed, while more traditional exports such as sugar, bananas, and coffee continue to represent a large share of the export.

Guatemalan Economy

- The 1996 peace accords, which ended 36 years of civil war, removed a major obstacle to foreign investment, and since then Guatemala has pursued important reforms and macroeconomic stabilization. The Central American Free Trade Agreement (CAFTA) entered into force in July 2006 spurring increased investment and diversification of exports.
- The USA is the country's largest trading partner, providing 36.5% of Guatemala's imports and receiving 40.7% of its exports. The government has its business activities limited to public utilities (some privatized now) such as: ports and airports, and several financial institutions.

Guatemalan Economy

- The United States, along with other donor countries especially France, Italy, Spain, Germany, and Japan and the international financial institutions, have increased development project financing since the signing of the peace accords. However, donor support remains contingent upon Guatemalan Government reforms and counterpart financing.

Guatemalan Economy

- According to the World Bank, Guatemala has one of the most unequal income distributions in the hemisphere. The wealthiest 20% of the population consumes 51% of Guatemala's GDP. As a result, about 51% of the population lives on less than $2 a day and 15% on less than $1 a day. Guatemala's social development indicators, such as infant mortality, chronic child malnutrition, and illiteracy, are among the worst in the hemisphere.
- The economy contracted in 2009 as export demand from US and other Central American markets fell and foreign investment slowed amid the global recession.

Programming

Introduction

- The field of computer programming begins with the definition of a computer: “a programmable usually electronic device that can store, retrieve, and process data”.
- In plain language, a computer is a device that can perform mathematic and logical operations much faster than any human could (and accurately).
- A useful analogy can be made between humans and computers, as both of us have several input and output mechanisms, in the case of humans: eyes, ears, mouths, etc. On the other hand, computers have keyboards, mice, speakers, etc.

Basics

- All computer programs take place within the intangible elements of a computer; therefore, there is a need for a programming language to provide the necessary framework.
- A programming language is: “a computer’s language of instruction and information”. The information expressed in such a language is what we call “data”.

Definitions

- **Booleans:** Data that can either be true or false, also represented by 0 or 1.
- **Char:** This is the name given to a character, usually a single letter, since although a number can be stored by this type of data it cannot be later modified by arithmetical operations applied to it.
- **Floats:** They are essentially numbers, but they can have decimals.
- **Integers:** They are the opposite of the previous type, they are numbers, but they cannot have decimals.

Definitions

- **Strings:** This data is basically a combination of several char, it can therefore store text of any type.
- Even though the different types of data have been defined this is not enough to build a first program. A program has two important elements, the variables or data types and the flow control.
- There are essentially three instructions that contribute to flow control in every single programming language:

Flow Control

- **If:** by far the most common way of controlling the actions of a program, this statement takes a decision based upon the comparison of a condition between one or more variables.
- **For:** a very common way of generating iterations, it generates a cycle that remains in effect until a condition becomes false.
- **While:** very similar to the option before, it is preferred when the code within the loop must be executed at least once.

Programming Definitions

- **Computer Programming:** Process of designing, writing, testing, debugging, and maintaining the source code of computer programs.
- **Debugging:** Methodical process of finding and reducing the number of bugs, or defects, in a computer program or a piece of electronic hardware, thus making it behave as expected.
- **Source Code:** Text written in a computer programming language, specially designed to specify the actions to be performed by a computer.
- **Computer Program:** Sequence of instructions written to perform a specified task with a computer.

Programming Definitions

- **Programming Language:** Artificial language designed to communicate instructions to a machine.
- **Algorithms:** A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps.
- **Compiler:** Computer Program (or set of programs) that transforms source code written in a programming language into another computer language. The most common reason for wanting to transform source code is to create an executable program.

Programming Definitions

- **Readability:** Ease with which a human reader can comprehend the purpose, control flow, and operation of source code.
- **Operating system:** Software consisting of programs and data, that runs on computers, manages computer hardware resources, and provides common services for execution of various application software.
- **Software bug:** Term used to describe an error, flaw, mistake, failure, or fault in a computer program or system that produces an incorrect or unexpected result, or causes it to behave in unintended ways.

Programs Requirements

Whatever the approach to software development may be, the final program must satisfy some fundamental properties. The following properties are among the most relevant: efficiency, reliability, robustness, portability, usability, maintainability, and programming style.

Programs Requirements

- **How often the results of a program are correct:** This depends on conceptual correctness of algorithms, and minimization of programming mistakes, such as mistakes in resource management (e.g., logic errors such as division by zero or off-by-one errors).
- **How well a program anticipates problems not due to programmer error:** This includes situations such as incorrect, inappropriate or corrupt data, unavailability of needed resources such as memory, operating system services and network connections, and user error.

Programs Requirements

- **The ease with which a person can use the program for its intended purpose, or in some cases even unanticipated purposes:** This involves a wide range of textual, graphical and sometimes hardware elements that improve the clarity, intuitiveness, cohesiveness and completeness of a program's user interface.
- **The range of computer hardware and operating system platforms on which the source code of a program can be compiled/interpreted and run:** This depends on differences in the programming facilities provided by the different platforms, including hardware and operating system resources, expected behavior of the hardware and operating system, and availability of platform specific compilers (and sometimes libraries) for the language of the source code.

Programs Requirements

- **The ease with which a program can be modified by its present or future developers in order to make improvements or customizations, fix bugs and security holes, or adapt it to new environments:** Good practices during initial development make the difference in this regard. This quality may not be directly apparent to the end user but it can significantly affect the fate of a program over the long term.
- **The amount of system resources a program consumes:** This also includes correct disposal of some resources, such as cleaning up temporary files and lack of memory leaks.