Technical English 1

Booklet

4th Edition

TEXAS A&M ENGINEERING

Universidad de San Carlos deGuatemala | EngineeringFaculty

Discover the new Technical English Office | T-4 building, 2nd. Floor
TEXTBOOK
English Department

Estudiantes de la Facultad de Ingeniería

Conscientes del vertiginoso avance de la globalización nos damos cuenta de la necesidad de mantener una comunicación adecuada en el comercio, industria y mercadotecnia dentro de nuestra sociedad y considerando el desarrollo de competencias adecuado, se ha construido un novedoso programa para contribuir a que la GloriosaTricentenaria Universidad de San Carlos de Guatemala se mantenga con ese alto nivel que la ha distinguido durante años.

Este proyecto nació a principios del año 2008 con el afán de lograr que todo estudiante egresado de la Facultad de Ingeniería tenga conocimiento de Inglés Técnico para poder aplicarlo tanto en sus estudios como en su desempeño profesional.

Demostrando que hoy y siempre SOMOS LOS LIDERES de la ingeniería y pioneros en el cumplimiento de las necesidades de formación de nuestros profesionales, dedicamos este trabajo a todos aquellos estudiantes a quienes les interese mejorar competentemente la aplicación de los procedimientos de ingeniería y tengan el deseo de aprender nuevas técnicas desarrollando habilidades que constantemente expanden la efectividad y campos de aplicación de Ingeniería. Esta primera edición de este folleto fue creado para cumplir y llenar los requisitos del programa cuyo objetivo es contribuir a la preparación integral para llenar de los perfiles de los profesionales de hoy.

Logrando el cambio propuesto.

Ing. Murphy Olimpo Paiz Recinos

Decano

Students of Engineering School

Conscious of the vertiginous advance of the globalization we realize the necessity to maintain an adapted communication in commerce, industry and marketing research within our society and considering the development of appropriated competences, we have developed a novel program to contribute that the Glorious Tricentennial University of San Carlos of Guatemala stays with that high level that has distinguished it during years.

This project started the first semester 2008 with the eagerness to obtain that all withdrawn students of the Faculty of Engineering have knowledge of Technical English, becoming it a necessity that the students apply this knowledge in their studies as in their professional performance.

Demonstrating that today and always WE ARE LEADERS of engineering, pioneers in the fulfilment of the necessities of formation of our professionals, we present to all students who, by their competent application of engineering procedures and their readiness to learn new techniques and to develop skills that constantly expand the effectiveness and fields of application of engineering. The First Edition of this booklet was created to carry out and to fill the requirements of the program which objective is to contribute to the integral preparation of the students in order to fill the profiles of nowadays professionals.

Reaching goals through change.

MURPHY OLIMPOPAIZRECINOS

ENGINEERING SCHOOL DEAN

AWARENESS / ACKNOWLEDGMENT

PREFACE

The second edition of the Technical English Booklet was collected as a guide to fulfill the objectives proposed in the restructuring of the curriculum of the course. This new curriculum was developed by IngenieraSorayaMartínez with the help of the different contributors that has worked as assistants of the area. Each of the assistants has a different specialization in the field of engineering, so it helped to work in a multidisciplinary environment.

After it was finished, it was reviewed and authorized by the Board of Directors of the Engineering School who decided to implement the new curriculum since the first semester 2008.

It is advice to make a revision every two years, and thanks to the flexibility of the program, it will allow to make different changes in the themes studied.

It has been interesting to look at the real applications this new curriculum can lead. It wakes up the creativity, reasoning, and awareness of development in different areas of engineering. It is done through problem solving proposed in classes and developed in their field of work, enhancing engineering techniques.

Syllabus And Approach

The technical English booklet uses high interest themes to integrate speaking, grammar, vocabulary, pronunciation, listening, reading, and writing. There is a strong focus on both accuracy and fluency. It includes real life situation that leads to a meaningful learning.

Themes

The themes were selected based in the analysis of the curriculum of each career, and selecting the courses in common. The Booklet No. I covers the basic sciences or the common area. The Booklets No. II and III cover the courses of the mid term curriculum, it means the courses of the fourth, fifth and sixth semester. The Booklet IV covers courses of the professional areas specially the ones focused to the Administrative Bachelor which is proposed to the different careers in the school.

Grammar

Every theme is organized around grammatical topics. It is tried to present grammar in context.

Vocabulary

This section includes new technical words that the students have to learn for each reading.

Speaking

It includes lectures, technical language from various contexts. Listening strategies that include summarizing main ideas, making inferences, give opinions.

Listening

Listening for specific information.

Reading

It emphasizes reading strategies such as skimming, scanning, guessing meaning from context, understanding the structure and organization of a text, increasing reading speed.

Writing

It helps to use correct form and mechanics, use coherent structure, edition, and revision to create a final draft.

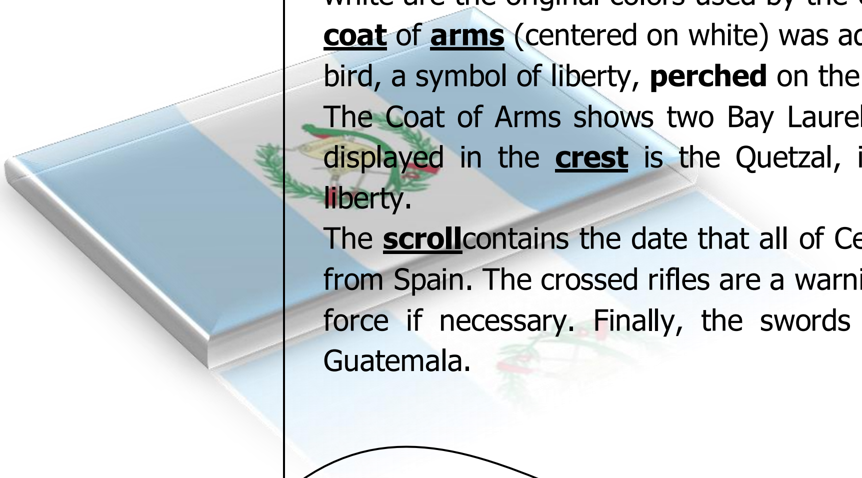
To The Teachers

It is important for teachers to adapt the course materials to the needs, interest, and learning styles of their students.

Assessment must be done through oral quizzes, written quizzes and development of projects.

Contenido

GUATEMALA



The flag of Guatemala was officially adopted on August 17, 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
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.

A. Read the following sentences. Complete each sentence with one of the words in the box.

gatherers	*cabinet*	*landowners*	*parties*	*gained*
deputies	*settlers*	*free trade agreement*	*overthrow*	*coups*
regimes	*conquered*	*leftist*	*leadership*	*battlefield*
ran	*led a coup*	*Death squads*	*crop*	*bans*

- There is archeological proof that early Guatemalan _________________ were hunters and _________________.
- Guatemala was _________________ by Spanish Pedro de Alvarado in 1524.
- After the _________________ of the Spanish King by Napoleon, Guatemala and others declared their independence from Spain.
- Guatemala _________________ independence from Spain on September 15, 1821.
- Unfortunately (*like many new countries*) this new country experienced a lengthy series of _________________, **dictatorships**, **insurgencies**, human atrocities, and long stretches of brutal military rule.

- Guatemala's Liberal Revolution came in 1871 under the ________________ of Justo Rufino Barrios
- After the revolution, coffee became an important ________________ for Guatemala.
- Justo Rufino Barrios died on the ________________ in 1885 against force in El Salvador.
- Dictator Manuel Estrada Cabrera ________________ the country from 1898 to 1920.
- JacoboArbenzGuzmán instituted social and political reforms that strengthened the **peasantry** and urban workers at the expense of the military and big ________________.
- Carlos Castillo Armas ________________ in 1954 and Arbenz took refuge in Mexico.
- A series of repressive ________________ followed, and the country was **plunged** into a 36 years of civil war.
- ________________ murdered an estimated of 50,000 leftist and political opponents during the 70's.
- In 1996, the government signed a peace agreement with the ________________ rebels.
- In June 2000, a ________________ was signed with Mexico, El Salvador and Honduras.
- In July 2003, Efrain Rios Montt was eligible to run for president, although the Political Constitution ________________ anyone who **seized** power in a **coup** from running for the presidency.
- The president serves as both thechief ofstate and the head of government and has the authority to appoint departmental governors and ________________ members.
- The Congress of the Republic **comprises** 158 ________________, who are elected by direct universal **suffrage** to serve four-year terms
- It is not uncommon that Congress Members change ________________ during the legislature term.

B. Fill in the blank spaces with the correct information about Gautemala.

- Chief of the state: ____
- Government type: ____
- Independence: ____
- Currency: ____
- OfficialLanguage: ____
- Ethnicgroups: ____
- ImportantAgricultural Products____
- Legal System ____

- HighestCourt: ______________________________
- MajorLaw: ______________________________

C. Look up the following words in a dictionary.

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

SPEAKING

D. Discuss this questions:

- What happened with the Maya Civilization? Why did they disappear?
- Where is Iximche? Where's Uaxactun? Where's Zaculeu? Where's Gumarcaaj?
- Which other Maya cities are in Guatemala?
- Who was Pedro de Alvarado?
- Who was TecunUman?
- Who was Justo Rufino Barrios?
- Why is the Zone 6 IGSS building called Dr. Juan José Arevalo Bermejo?
- Who was the Guatemala's president when the peace agreement was signed?
- What are the requirements for voting in the elections?
- When is the next presidential election going to be?

Guatemalan 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.

For somewhat mysterious reasons, the Maya society began its general decline across the entire area in the 10th century, yet **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.

When the Spanishconquistadors and their leader, Pedro de Alvarado, arrived in 1523, they quickly defeated the weaker Maya forces and aggressively began the colonization of the land; large farms were established and the remaining Indians were forced to work them. 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.


Pedro Alvarado

After the independence from Spain in 1821, Guatemala, Costa Rica,El Salvador, Hondurasand Nicaragua formed the United Provinces of Central America, but that federation quickly dissolved, and Guatemala became an independent republic in 1838.Unfortunately (like many new countries) 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. In 1949 the Guatemalan Party of Labor (PGT), the communist party in Guatemala was formed. It gained prominence during the government of Col. JacoboArbenz.

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.Eventually the USA -the major supplier of military assistance to the country- tired of the civil war eliminated all of its financial aid; this action finally forced the election of a civilian, but controversies and coups would quickly return.

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.

And then what happened? Well, currently the country has stabilized, but I would stay tuned, as Guatemala's government (be it civilian or military) frequently alters it course.

E. Answer the following questions:

- Why do you think that the period of the two reformist president was called "Ten Years of Spring"?

  ____

  ____

- Who were the reformist presidents in the "Ten Years of Spring"?

  ____

- What was the relation between Guatemala and USA in the past?

  ____

  ____

F. Read the text.

GUATEMALA'SLEGISLATION

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 legislative branch consists of the National Congress, a 1-house legislature composed of 158 members, while the judicial branch is headed by the Supreme Court of Justice. The president serves as both the chief of state and the head of government and has the authority to appoint departmental governors and cabinet members.

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.

The Congress of the Republic is the unicameral legislature of the Republic of Guatemala. It comprises 158 deputies, who are elected by direct universal **suffrage** to serve four-year terms (the number was increased from 113 for the 2003 election). Twenty-nine of these are elected from nationwide lists, with the on a district list basis. Each of the country's 22 departments serves as a district, with the exception of the department of Guatemala, containing the capital, which, on account of its size, is divided into two (central district and Guatemalan district). 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.

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 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. There also is a separate Constitutional Court.

GUATEMALA'S LAWS

Besides the Constitution Guatemala has a series of laws that can be divided into the following categories:

- Constitutional Law
- Human Rights
- Litigation and Court Procedures
- Electoral Law
- Administrative and Public Law
- Criminal Law
- Civil Law
- Commercial Law
- Company Law
- Labor Law
- Health Law
- Mining Law
- Tax Law
- Banking Law
- Insurance Law
- Communication and Media Law
- Transport and Maritime Law
- Environmental Law
- Intellectual Property Law
- Energy Law
- Construction Law
- Agriculture Law
- E-Commerce
- Arbitration Law

ENVIRONMENTALLAWS

Guatemala, like so many Latin American and Caribbean (LAC) nations, has many environmental rules on the books that more often than not are honored in the breach rather than with compliance.By the count of its Environment and Natural Resources Ministry (MARN), Guatemala already has on the books some 3,500 norms of various levels (primary, secondary, tertiary) in the legal hierarchy about various topics related to environmental quality and protection of natural resources that have never been fully and properly enforced, including some 200 related international treaties Guatemala has ratified but never fully implemented. Until now MARN has not had the size, resources and clout to set up and implement a credible, comprehensive environmental enforcement regime.

Guatemala says that is all about to change. MARN has created a Legal Compliance Program and a new Ministerial Accord has set up an inter-institutional Technical Advisory Council on Legal Compliance to get all governmental actors involved in enforcing the country's environmental norms.The Compliance Program is tasked with improving attention to reports of environmental violations, strengthening research related to compliance issues, promoting greater awareness of environmental rights and obligations, and strengthening the capacity of other government institutions to be involved in environmental monitoring and enforcement.

G. Answer the following questions:

- Which of the titles is/are not using descriptive paragraphs?
- Are the previous paragraphs correctly structured? Discuss your answer.

EXTENDING SKILLS

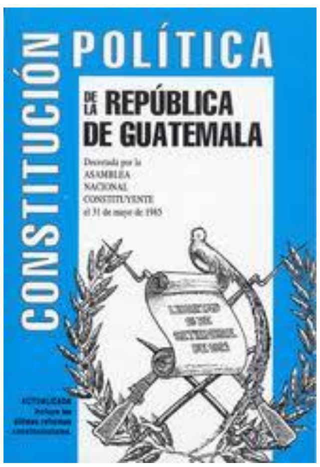
H. Activity 1

- In your own words, why is Guatemala beautiful? Begin your sentence: "Guatemala is …
- Have you ever visited a Mayan ancient city? If so, which and when?
- What are you going to do for your country when you are an engineer

I. Activity 2

- Study the following reading

CONSTITUTION OF GUATEMALA



[1]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.

[2]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.

- What is the main purpose of these paragraphs?

  ____

  ____

  ____

- How many sentences are there in the first paragraph? ____________________
- How many sentences are there in the second paragraph? __________________
- Underline the subject of each sentence.
- How many times is "Constitution" the subject of the sentence? ______________
- Highlight each verb in the paragraphs. What tense are the verbs in paragraph 1? _______
- What tense are the verbs in paragraph 2? ______________________________
- What type of paragraph are they? _____________________________________

J. Activity 3

GUATEMALANTAXSYSTEM

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. 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.

- In your own words, what is the meaning of the following words?

  Taxation ____

  ____

  Revenue ____

  ____

  Steadfast____

  ____

  Excises ____

  ____

  Value-added tax ____

  ____

- Look up the words and compare the results with your own meanings?

K. Activity 4

How much do you know about Guatemala? Write an **F** if the statement is false or a **T** if it is true. Correct false statements to change them into true statements.

- The Council of Ministers is named by the president. _______
- It is compulsory for everyone to vote when reach 18 years old. _______
- Labor Day is celebrated on May the 1st . _______
- The Constitutional Court is composed by 10 judges elected by the Congress. _______
- Guatemala has a tropical climate because all the country has the same altitude. _______
- Atitlan is the biggest lake in Guatemala. _______

- Tajumulco volcano is the highest point in Guatemala. _______
- The rainy season in Guatemala usually last from May to November. _______
- After Spanish, K'iche' is the most spoken language. _______
- Columbus Day is celebrated on October the 12th . _______
- Guatemala means "Land of the trees" in the Mayan-Toltec language. _______
- Active duty members of the armed forces may not vote. _______
- Guatemala is bordered on the east by Belize and the Gulf of Honduras. _______
- Religion in Guatemala is predominantly Catholic. _______
- Only 5 political parties are permitted to participate in each presidential election. _______

GLOSSARY

Ban	Death squad	Peasantry
Bar association	Deputy	Perch
Battlefield	Dictatorship	Plunge
Cabinet	Excise	Regime
Chief of state	Fabled	Remnant
Coat of arms	Feature	Revenue
Comprise	Free trade agreement	Ruthlessly
Compulsory	Gatherer	Scroll
Conquer	Insurgency	Seize
Council	Insurgency	Settler
Coup	Landowners	Steadfast
Court	Leadership	Suffrage
Crest	Leftist	Taxation
Crop	Overthrow	Value-added tax
Currency	Party	

INVESTING IN GUATEMALA

VOCABULARY

A. Read the text. Underline the correct word in each sentence.

- Guatemala offers the necessary **infrastructure / roads** to satisfy the expectations of any business.
- Guatemala also provides life conditions where the natural paradise is combined with a colonial past, cultural and historic treasures and **landscapes / passages** that inspire contemplation.
- It also provides a legal **skeleton / framework** that does not discriminate between foreign and local investments with freedom to move the capital and to repatriate dividends.
- Guatemala's geographical location is strategic; it is the perfect **platform / policy** for the largest markets in the World.
- We have privileged access to both the Atlantic and the Pacific Oceans, facilitating direct commerce with Asia, North America and Europe, through modern **seaports / ships**.
- Employee **salaries / revenues** are subject to private agreements between the employer and the employee.
- Nonetheless, the Department of **Labor / Workers** sets the minimum wages, in terms of the sector.
- In Guatemala the minimum **wage / income** for 2011 is US$ 7.96 daily for agricultural and non agricultural activities except for drawback, which has a minimum wage of US$ 7.43 daily.
- In 2004, the Renewable Energy Incentive Law was approved, seeking to fuel investments in wind, geothermal and hydroelectric power **generation / creation**.
- The telecommunications sector in Guatemala has shown a constant growth and is one of the most dynamic sectors of the economy, supported by the **Law of Telecommunications / Law of Cellphones** of 1996.

- Guatemala's coffee, sugar and banana exports are an important source of **foreign / distant** exchange.

B. Match the words that are missing in the blank spaces according with their definitions.

AGROINDUSTRY SECTOR

The (1)____________________ sector is one of the sectors with the greatest development and competitive (2) ____________________ for Guatemala, at world level, with a range of related industries that contribute to the productivity of different industry branches. For this reason, joint actions between the Government and the private sector, have developed and executed (3)____________________ that enable the strengthening and development of the sector and its (4)____________________, which in turn provides stability to agro industrial (5)____________________.

Guatemala is the fifth largest sugar (6)______________ at world level and the 2nd largest in Latin America, offering the most (7)______________________ sugar prices in the Meso American region.

Guatemala's climate and climatic conditions, skilled labor and geographical position makes it the main Central American destination for investment in agribusiness. Its geographical proximity to the US, Mexico and South America makes Guatemala a natural platform for the (8)_________________ and export of agro industrial products. Additionally Guatemala strategic location is a door to the Meso-American (9)_________________ . Guatemala is presently the only country of the DR-CAFTA with (10)____________________ infrastructure on both the Pacific and the Atlantic coasts. Its international airport also ensure and facilitate the marketing of perishable products.

C. Infer the meanings of the words in **bold**in the passage and write them in the spaces provided.

1. The various businesses collectively that process, distribute, and support farm products.	seaport
2. The quality of being doable or usable .	Agribusiness
3. Strategy that is extending over a long time.	production
4. A group of the same or similar elements gathered or occurring closely together.	clusters
5. Money that is invested with an expectation of profit .	Long-term strategy
6. International trader.	Feasibility
7. Sufficiently low in price or high in quality to be successful against commercial rivals.	Exporter
8. Manufacturing or growing something (usually in large quantities) for sale.	competitive
9. The trading or selling opportunities provided by a particular group of people.	markets
10. A port or harbor accessible to seagoing vessels.	Investment

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.

The **manufacture** sector represented 30% of the total exports of Guatemala during 2007, which amounted to US$2,000 million. 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 with the European Union and those already signed with Panama, Colombia and Chile, 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. Guatemala is the perfect platform to supply directly to the biggest market in the world.

AdvantagesFromInvesting 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 skillscurves; 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 to the manufacture sector.

- Apparel ______________________________
- Position ______________________________
- Manufacture ______________________________
- Marketintelligence ______________________________
- Profitability ______________________________
- Commitment ______________________________

Reading

D. Read the text. Underline the errorsand correct them.

Tourism

Touristic sector provide a huge potential for investment, becoming the main entry of the commercial balance, surpassing coffee, sugar, cardamom and other exports.

Given the importance of the tourism sector as a issue of national priority and as part of the National Competitiveness Strategy and 2004-2008 Government Plan, a 2004-2014 National Policy for the Development of Sustainable Tourism were created and intend to prioritizes tourism as the country's development focus.

For this reason, the main objective of Invest 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.

Guatemala's privileged geographic position, political stability, natural and cultural richness and its climate of "eternal spring" are competitive advantages that makes the country an attractive travel destination. Unlike the other Central American countries, Guatemala provide a comprehensive supply and have 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

The largest and greatest hotels are locate in the Capital City, home to international hotels such as Marriot, Westin Camino Real, Intercontinental, Clarion Suites, Radisson, Holiday Inn and Quinta Real, among others.

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.

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. El Mirador, cradle of the Maya Civilization, is the most impressive archeological site and project which "cultural value, vision and scope elevates Guatemala to a prominent position among tourist destinations in the world"

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 Petén rainforest's Mirador Basin is the last tract of virgin rainforest remaining in Central America

CARIBBEAN COAST: IZABAL

Izabal is the third tourism destination more visite of the country. Amatique Bay, Río Dulce, and Izabal Lake, due to its geographic location are protected from hurricanes. There is an short distance from Quirigua, declared "World Heritage" by UNESCO (1981), Tikal National Park (Petén), Belize Keys & other Caribbean Islands

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, attracts 58% of the incoming tourists seeking for culture and adventure.

Guatemala City

Guatemala City is still the main door for all its visitors and have become insufficient with the increasing number of visitors to the capital city. It 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. This are very favorable for businesses and conventions.For this reason, many multinational firms establishes its headquarters for the Latin and/or Central American region in Guatemala

E. How many mistakes did you find? ____________________________

Glossary

Agribusiness	Income	Position
Agroindustry	Infraestructure	Production
Apparel	Landscape	Profitability
Commitment	Long-term strategy	Revenue
Competitive	Manufacture	Salary
Esporter	Market	Seaport
Feasibility	Market intelligence	Wage
Foreign	Platform	
Framework	Policy	

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." The term engineering is sometimes more loosely defined, especially in Great Britain, as the manufacture or assembly of engines, machine tools, and machine parts.

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." Thus the engines of war were devices such as catapults, floating bridges, and assault towers; their designer was the "engine-er," or military engineer. The counterpart of the military engineer was the civil engineer, who applied essentially the same knowledge and skills to designing buildings, streets, water supplies, sewage systems, and other projects.

Associated with engineering is a great body of special knowledge; preparation for professional practice involves extensive training in the application of that knowledge. Standards of engineering practice are maintained through the efforts of professional societies, usually organized on a national or regional basis, with each member acknowledging a responsibility to the public over and above responsibilities to his employer or to other members of his society.

The function of the scientist is to know, while that of the engineer is to do. The scientist adds to the store of verified, systematized knowledge of the physical world; the engineer brings this knowledge to bear on practical problems.

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. Usually efficiency costs money; safety adds to complexity; improved performance increases weight. The engineering solution is the optimum solution, the end result that, taking many factors into account, is most desirable.

It may be the most reliable within a given weight limit, the simplest that will satisfy certain safety requirements, or the most efficient for a given cost. In many engineering problems the social costs are significant.

Engineers employ two types of natural resources, materials and energy. Materials are useful because of their properties: their strength, ease of fabrication, lightness, or durability; their ability to insulate or conduct; their chemical, electrical, or acoustical properties. Important sources of energy include fossil fuels (coal, petroleum, gas), wind, sunlight, falling water, and nuclear fission. Since most resources are limited, the engineer must concern himself with the continual development of new resources as well as the efficient utilization of existing ones.

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 bc. Imhotep's successors Egyptian, Persian, Greek, and Roman carried civil engineering to remarkable heights on the basis of empirical methods aided by arithmetic, geometry, and a smattering of physical science. 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, testify to their skill, imagination, and daring. Of many treatises written by them, one in particular survives to provide a picture of engineering education and practice in classical times: Vitruvius'*De architectura*, published in Rome in the 1st century ad, a 10-volume work covering building materials, construction methods, hydraulics, measurement, and town planning.

In construction medieval European engineers carried technique, in the form of the Gothic arch and flying buttress, to a height unknown to the Romans. The sketchbook of the 13th-century French engineer Villard de Honnecourt reveals a wide knowledge of mathematics, geometry, natural and physical science, and draftsmanship.

In Asia, engineering had a separate but very similar development, with more and more sophisticated techniques of construction, hydraulics, and metallurgy helping to create advanced civilizations such as the Mongol empire, whose large, beautiful cities impressed Marco Polo in the 13th century.

Civil engineering emerged as a separate discipline in the 18th century, when the first professional societies and schools of engineering were founded. Civil engineers of the 19th century built structures of all kinds, designed water-supply and sanitation systems, laid out railroad and highway networks, and planned cities. 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.

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 (named after the Belgian Z.T. Gramme) led to the development of electrical andelectronics engineering. The electronics aspect became prominent through the work of such scientists as James Clerk Maxwell of Britain and HeinrichHertz of Germany in the late 19th century. Major advances came with the development of the vacuumtube by Lee De Forest of the United States in the early 20th century and the invention of the transistor in the mid-20th century. In the late 20th century electrical and electronics engineers outnumbered all others in the world.

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.

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. The answer or design is always checked for accuracy and adequacy. Finally, the results for the simplified problem are interpreted in terms of the original problem and reported in an appropriate form.

In order of decreasing emphasis on science, the major functions of all engineering branches are the following:

- ✓ ***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.
- ✓ ***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.
- ✓ ***Managementandotherfunctions***. 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.

The laws of physical chemistry and physics govern the practicability and efficiency of chemical engineering operations. Energy changes, deriving from thermodynamic considerations, are particularly important. 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. In each case, data and predictions often have to be obtained or confirmed with pilot experiments. Plant operation and control is increasingly the sphere of the chemical engineer rather than the chemist. Chemical engineering provides an ideal background for the economic evaluation of new projects and, in the plant construction sector, for marketing.

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. From earliest times, however, engineers have engaged in peaceful activities, and many of the civil engineering works of ancient and medieval times—such as the Roman public baths, roads, bridges, and aqueducts; the Flemish canals; the Dutch sea defenses; the French Gothic cathedrals; and many other monuments—reveal a history of inventive genius and persistent experimentation.

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).

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. A competent computer engineer can secure work in any environment where computers play a role in the operation of

the business. Because a computer engineer will have an extensive understanding of such electronic devices as microprocessors, local and wide area networks, and even supercomputers that form the basis for worldwide communications, the career paths are wide and varied. 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. Operating systems that are peculiar to the culture of a given company often require the input of a computer engineer, ensuring that the functionality of the custom design meets all the needs of the application. In general, 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, and in implementing additional customizations or fixes to existing software.

One area where opportunities are expanding for qualified computer engineers is in the robotics industry. The unique skills of the computer engineer is helping to move robotics forward, by making the best use of traditional electronic technology and the latest in computer generated applications. The computer engineer can find significant opportunities within robotic s to purse the design of new motors, improved communication devices, and more sensitive sensors that can help robotic equipment function more efficiently.

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.

In engineering practice, the distinction between electrical engineering and electronics is based on the comparative strength of the electric currents used. In this sense, electrical engineering is the branch dealing with "heavy current"—that is, 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.

The distinction between the fields has become less sharp with technical progress. For example, in the high-voltage transmission of electric power, large arrays of electronic devices are used to convert transmission-line current at power levels in the tens of megawatts. Moreover, in the regulation and control of interconnected power systems, electronic computers are used to compute requirements much more rapidly and accurately than is possible by manual methods.

The functions performed by electrical and electronics engineers include basic research in physics, other sciences, and applied mathematics in order to extend knowledge applicable to the field of electronics, applied research based on the findings of basic research and directed at discovering new applications and principles of operation, development of new materials, devices, assemblies, and systems suitable for existing or proposed product lines, design of devices, equipment, and systems for manufacture, field-testing of equipment and systems, establishment of quality control standards to be observed in manufacture, supervision of manufacture and production testing, postproduction assessment of performance, maintenance, and repair, and engineering management, or the direction of research, development,

The rapid proliferation of new discoveries, products, and markets in the electrical and electronics industries has made it difficult for workers in the field to maintain the range of skills required to manage their activities. Consulting engineers, specializing in new fields, are employed to study and recommend courses of action.

The educational background required for these functions tends to be highest in basic and applied research. In most major laboratories a doctorate in science or engineering is required to fill leadership roles. Most positions in design, product development, and supervision of manufacture and quality control require a master's degree. In the high-technology industries typical of modern electronics, an engineering background at not less than the bachelor's level is required to assess competitive factors in sales engineering to guide marketing strategy.

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 endeavours 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.

Environmental engineering is a field of broad scope that draws on such disciplines as chemistry, ecology, geology, hydraulics, hydrology, microbiology, economics, and mathematics. It was traditionally a specialized field within civil engineering and was called sanitary engineering until the mid-1960s, when the more accurate name *environmental engineering* was adopted.

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. Mathematical modeling and computer analysis are widely used to evaluate and design the systems required for such tasks.

Chemical and mechanical engineers may also be involved in the process. Environmental engineering functions include applied research and teaching; project planning and management; the design, construction, and operation of facilities; the sale and marketing of environmental-control equipment; and the enforcement of environmental standards and regulations.

The education of environmental engineers usually involves graduate-level course work, though some colleges and universities allow undergraduates to specialize or take elective courses in the environmental field. Programs offering associate (two-year) degrees are available for training environmental technicians. In the public sector, environmental engineers are employed by national and regional environmental agencies, local health departments, and municipal engineering and public works departments. In the private sector, they are employed by consulting engineering firms, construction contractors, water and sewerage utility companies, and manufacturing industries.

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; the redesign and standardization of manufacturing processes and methods for handling and transporting materials; the development of production planning and control procedures; and the determination and maintenance of output standards for workers and machines. Today the field is characterized by an emphasis on mathematical and computer modeling.

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, common to all branches of mechanical engineering, can be cited. The first is the understanding of and dealing with the bases of mechanical science. These include dynamics, concerning the relation between forces and motion, such as in vibration; automatic control; thermodynamics, dealing with the relations among the various forms of heat, energy, and power; fluid flow; heat transfer; lubrication; and properties of materials.

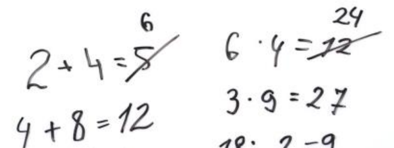
Second is the sequence of research, design, and development. This function attempts to bring about the changes necessary to meet present and future needs. Such work requires a clear understanding of mechanical science, an ability to analyze a complex system into its basic factors, and the originality to synthesize and invent.

Third is production of products and power, which embraces planning, operation, and maintenance. The goal is to produce the maximum value with the minimum investment and cost while maintaining or enhancing longer term viability and reputation of the enterprise or the institution.

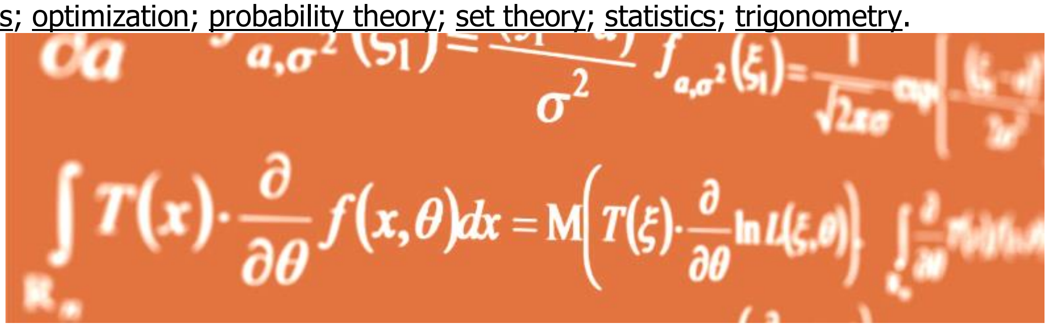
Fourth is the coordinating function of the mechanical engineer, including management, consulting, and, in some cases, marketing.

In these functions there is a long continuing trend toward the use of scientific instead of traditional or intuitive methods. Operations research, value engineering, and PABLA (problem analysis by logical approach) are typical titles of such rationalized approaches. Creativity, however, cannot be rationalized. The ability to take the important and unexpected step that opens up new solutions remains in mechanical engineering, as elsewhere, largely a personal and spontaneous characteristic.

Mathematics



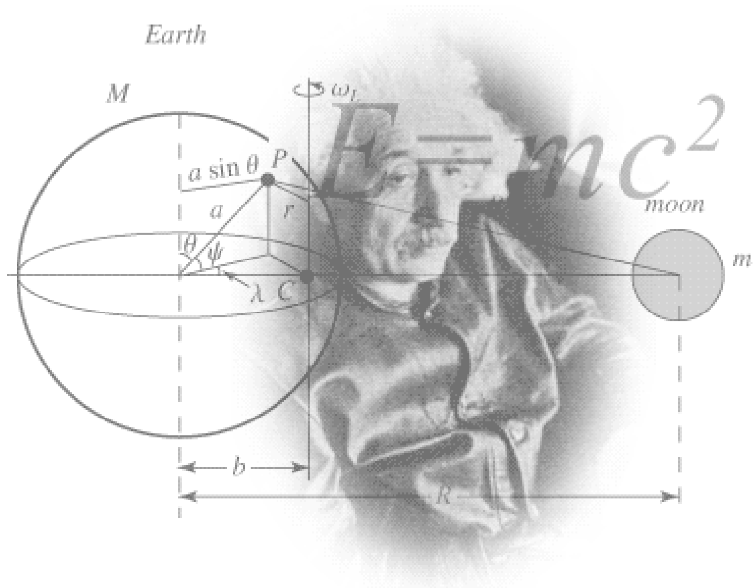
It is the science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects. It deals with logical reasoning and quantitative calculation, and its development has involved an increasing degree of idealization and abstraction of its subject matter. Since the 17th century, mathematics has been an indispensable adjunct to the physical sciences and technology, and in more recent times it has assumed a similar role in the quantitative aspects of the life sciences.The substantive branches of mathematics are: algebra; analysis; arithmetic; combinatorics; game theory; geometry; number theory; numerical analysis; optimization; probability theory; set theory; statistics; trigonometry.



Physics

It is the science that deals with the structure of matter and the interactions between the fundamental constituents of the observable universe. In the broadest sense, physics (from the Greek *physikos*) is concerned with all aspects of nature on both the macroscopic and submicroscopic levels. Its scope of study encompasses not only the behaviour of objects under the action of given forces but also the nature and origin of gravitational, electromagnetic, and nuclear force fields. Its ultimate objective is the formulation of a few comprehensive principles that bring together and explain all such disparate phenomena.

Physics is the basic physical science. Until rather recent times *physics* and *natural philosophy* were used interchangeably for the science whose aim is the discovery and formulation of the fundamental laws of nature. As the modern sciences developed and became increasingly specialized, physics came to denote that part of physical science not included in astronomy, chemistry, geology, and engineering. Physics plays an important role in all the natural sciences, however, and all such fields have branches in which physical laws and measurements receive special emphasis, bearing such names as astrophysics, geophysics, biophysics, and even psychophysics. Physics can, at base, be defined as the science of <u>matter</u>, <u>motion</u>, and <u>energy</u>. Its laws are typically expressed with economy and precision in the language of <u>mathematics</u>.



MEASUREMENT SYSTEMS

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.

Man understandably turned first to parts of his body and his natural surroundings for measuring instruments. Early Babylonian and Egyptian records, and the Bible, indicate that length was first measured with the forearm, hand, or finger and that time was measured by the periods of the sun, moon, and other heavenly bodies. When it was necessary to compare the capacities of containers such as gourds or clay or metal vessels, they were filled with plant seeds that were then counted to measure the volumes. With the development of scales as a means for weighing, seeds and stones served as standards. For instance, the "carat," still used as a mass unit for gems, is derived from the carob seed.

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. For these more sophisticated uses, it was necessary not only to weigh and measure more complex things it was also necessary to do it accurately time after time and in different places. However, with limited international exchange of goods and communication of ideas, it is not surprising that different systems for the same purpose developed and became established in different parts of the world - even in different parts of the same country.

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 last three are, of course, closely related.

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. These measures had their origins in a variety of cultures –Babylonian, Egyptian, Roman, Anglo-Saxon, and Norman French. The ancient "digit," "palm," "span" and "cubic" units of length slowly lost preference to the length units "inch," "foot," and "yard."

Roman contributions include the use of 12 as a base number (the foot is divided into 12 inches) and the words from which we derive many of our present measurement unit names. For example, the 12 divisions of the Roman "pes," or foot were called unciae. Words like "inch" and "ounce" are both derived from that Latin word.

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. 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. The length of a furlong (or furrow-long) was established by early Tudor rulers as 220 yards. This led Queen Elizabeth I to declare in the 16th century, that henceforth the traditional Roman mile of 5000 feet would be replaced by one of 5280 feet, making the mile exactly eight furlongs and providing a convenient relationship between the furlong and the mile.

Differences between the U.S. and British Customary Systems

Measures of Length

After 1959, the U.S. and the British inch were defined identically for scientific work and were identical in commercial usage (however, the U.S. retained the slightly different survey inch for specialized surveying purposes).

Measures of Volume

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. The English of that period used this wine gallon and they also had another gallon, the ale gallon of 282 cubic inches. In 1824, the British abandoned these two gallons when they adopted the British Imperial gallon, which they defined as the volume of 10 pounds of water, at a temperature of 62°F, which, by calculation, is equivalent to 277.42 cubic inches. At the same time, they redefined the bushel as 8 gallons.

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. As discussed above, the Imperial and USA systems have evolved without any such constraints, resulting in a complex set of measurements that fit everyday life in a simple agricultural society but which are unsuited to the requirements of science and modern trade. Consequently, 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.
- **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). It's nearest equivalent is a mile which is 5280 feet (8 * 10 * 22 * 3; based on the calculation that a mile is 8 furlongs, 10 chains to a furlong, 22 yards to a chain, 3 feet to a yard). Although complex calculations can be done using the English system, almost all calculations can be done easier and faster in the metric system.
- **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). Consequently, for any international communication (trade, science, etc.) the metric system is the most widely used and accepted.

CONVERSION FACTORS

Length

English toMetric			Metricto English		
1 inch (in)	=	2.5 centimeters (cm)	1 millimeter (mm)	=	0.04 inch (in)
1 foot (ft)	=	30 centimeters (cm)	1 centimeter (cm)	=	0.4 inch (in)
1 yard (yd)	=	0.9 meter (m)	1 meter (m)	=	3.3 feet (ft)
1 mile (mi)	=	1.6 kilometers (km)	1 meter (m)	=	1.1 yards (yd)
			1 kilometer (km)	=	0.6 mile (mi)

Area

English toMetric			Metricto English		
1 square inch (sq in, in^2)	=	6.5 squarecentimeters (cm^2)	1 squarecentimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square foot (sqft, ft^2)	=	0.09 square meter (m^2)	1 square meter (m^2)	=	1.2 square yards (sqyd, yd^2)
1 square yard (sqyd, yd^2)	=	0.8 square meter (m^2)	1 squarekilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
1 square mile (sq mi, mi^2)	=	2.6 squarekilometers (km^2)	10,000 squaremeters (m^2)	=	1 hectare (ha)
1 acre = 0.4 hectare (he)	=	4,000 squaremeters (m^2)	10,000 squaremeters (m^2)	=	2.5 acres

Volume

English toMetric			Metricto English		
1 teaspoon (tsp)	=	5 milliliters (ml)	1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 tablespoon (tbsp)	=	15 milliliters (ml)	1 liter (l)	=	2.1 pints (pt)
1 fluid ounce (fl oz)	=	30 milliliters (ml)	1 liter (l)	=	1.06 quarts (qt)
1 cup (c)	=	0.24 liter (l)	1 liter (l)	=	0.26 gallon (gal)
1 pint (pt)	=	0.47 liter (l)	1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 quart (qt)	=	0.96 liter (l)	1 cubic meter (m^3)	=	1.3 cubicyards (cu yd, yd^3)
1 gallon (gal)	=	3.8 liters (l)			
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)			
1 cubicyard (cu yd, yd^3)	=	0.76 cubic meter (m^3)			

Mass – Weight

English toMetric			Metricto English		
1 ounce (oz)	=	28 grams (gm)	1 gram (gm)	=	0.036 ounce (oz)
1 pound (lb)	=	0.45 kilogram (kg)	1 kilogram (kg)	=	2.2 pounds (lb)
1 short ton	=	0.9 tonne (t)	1 tonne (t)	=	1,000 kilograms (kg)
2,000 pounds (lb)	=	0.9 tonne (t)	1 tonne (t)	=	1.1 short tons

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.

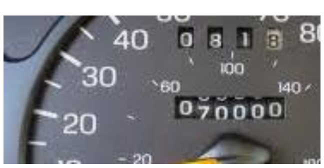
Chronometer:A chronometer is a very accurate time-keeping device that is used for determining precise duration of events.

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.

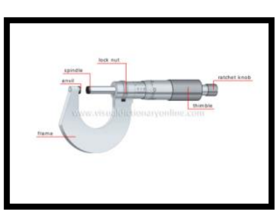
FOR LENGTH

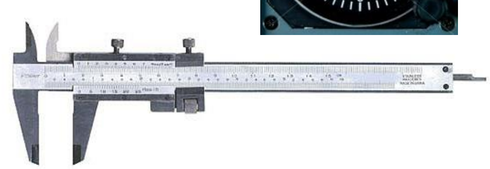
Tape Measure: It is a measuring instrument consisting of a narrow strip (cloth or metal) marked in inches or centimeters and used for measuring lengths.



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

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





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.

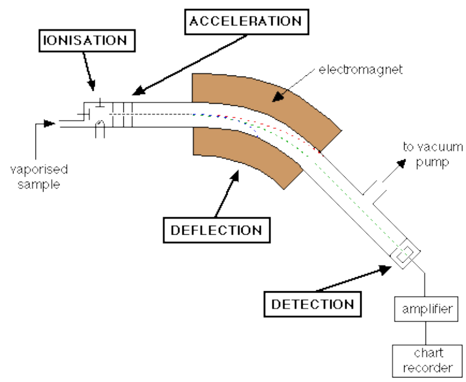
Tachometer: Used to measure the speed of rotation of a gear or shaft or other rotating part of the engine.

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. Mass spectrometers are sensitive detectors of isotopes based on their masses.



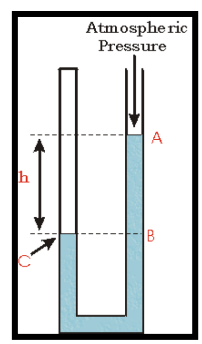
FOR PRESSURE:

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.

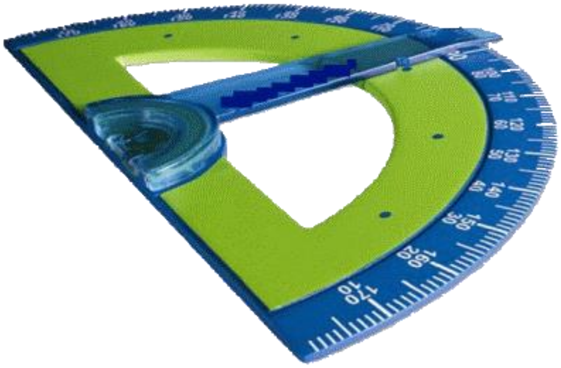
Ammeter:A meter that measures the flow of electrical current in amperes.

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 electronicmeasuring 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. There are two categories of multimeters, analog multimeters and digital multimeters (often abbreviated DMM or DVOM.)

For Angles

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



SCIENCE AND TECHNOLOGY

DEFINITION

When you hear the term science, it is typically associated with the term technology. Although these two terms are often interchanged, there is actually a sparse difference between the two.

Perhaps the best way to differentiate science from technology is to have a quick definition of each term. **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, on the other hand, 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. 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.

Science focuses more on analysis, generalizations and the creation of theories, while technology focuses more on analysis and synthesis of design. Science is controlled by experimentation, while technology also involves design, invention and production. If science is all about theories, technology is all about processes. Finally, in order to excel in science, it's needed to have experimental and logical skills. Meanwhile, technology requires a myriad of skills including design, construction, testing, quality assurance and problem-solving.

Differences Between Science and Technology

Kingsley Davis (1908 – 1997), identified by the American Philosophical Society as one of the most outstanding social scientists of the twentieth century, tried to distinguish between science and technology. According to him, science is the part of the cultural heritage which represents a systematic knowledge of nature, while technology contains the application of this knowledge.

Other distinction between these two terms is that the ends of technology are empirical, which can be practically demonstrated. These ends are purely instrumental, which isn't the case with the science.

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. Therefore, the usefulness of technology is always apparent, whereas the usefulness for the search of truth is not so apparent.

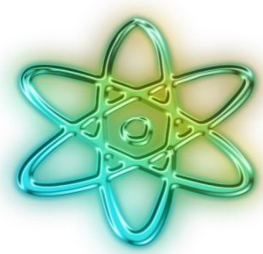
Summarizing all of the above, the differentiation between science and technology can be characterized by three key factors:

1. *The domain's core business (its purpose)*
2. *Its view of what exists in the world (its ontological stance)*
3. *How it defines and validates knowledge (its epistemology)*

To have a better idea of these key factors, let's check the following chart:

	SCIENCE	**TECHNOLOGY**
Mostobservedquality:	Drawing correct conclusions based on good theories and accurate data	Taking good decisions based on incomplete data and approximate models
Skillsneededtoexcel:	Experimental and logical skills needed	Design, construction, testing, planning, quality assurance, problem solving, decision making, interpersonal and communication skills

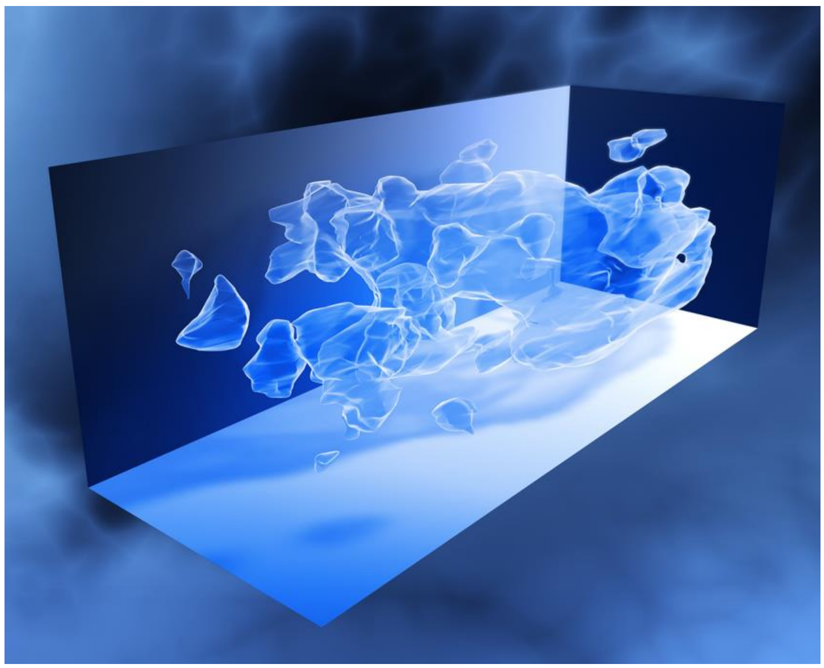
Mission:	The search for and theorizing about cause	The search for and theorizing about new processes
Motto:	Reductionism, involving the isolation and definition of distinct concepts	Holism, involving the integration of many competing demands, theories, data and ideas
ResultRelevance:	Making virtually value-free statements	Activitiesalwaysvalue-laden
Goal:	Pursuit of knowledge and understanding for its own sake (New knowledge)	The creation of artifacts and systems to meet people's needs (New products)
Goalsachievedthrough:	CorrespondingScientificProcesses	Key TechnologicalProcesses
DevelopmentMethods:	Discovery (controlledbyexperimentation)	Design, invention, production
EvaluationMethods:	Analysis, generalization and creation of theories	Analysis and synthesis of design



HOW DO SCIENCE AND TECHNOLOGY RELATE?

Scientific knowledge and methodologies themselves provide a major source of input into the development of technological practices and outcomes. They are also key tools in the establishment of explanations of why technological interventions were, or were not, successful. In short, science can provide powerful explanations for the why and why not behind technological intervention. However, as these interventions rely on more than an understanding of the natural world, they can only provide partial justification for technological practices and outcomes.

Technological practices, knowledge and outcomes can provide mechanisms for science to gain a better view of its defined world, and in fact can provide serious challenges to the defining of that world. For example, the development of the technological artefactsthat extend the observation capabilities of humans (such as the telescope and microscope), made visible and available new worlds for science to interrogate and explain.



MATHEMATICS

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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. The research required to solve mathematical problems can take years or even centuries of sustained inquiry. Since the pioneering work of Giuseppe Peano (1858–1932), David Hilbert (1862–1943), and others on axiomatic systems in the late 19th century, it has become customary to view mathematical research as establishing truth by rigorous deduction from appropriately chosen axioms and definitions. When those mathematical structures are good models of real phenomena, then mathematical reasoning can provide insight or predictions about nature.

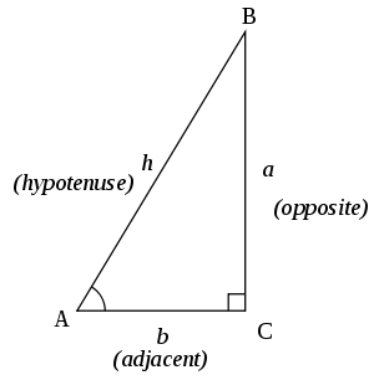
Aristotle defined mathematics as "the science of quantity", and this definition prevailed until the 18th century. Starting in the 19th century, when the study of mathematics increased in rigor and began to address abstract topics such as group theory and projective geometry, which have no clear-cut relation to quantity and measurement, mathematicians and philosophers began to propose a variety of new definitions. Some of these definitions emphasize the deductive character of much of mathematics, some emphasize its abstractness, some emphasize certain topics within mathematics. Today, no consensus on the definition of mathematics prevails, even among professionals. 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. Some just say, "Mathematics is what mathematicians do."

TRIGONOMETRIC FUNCTIONS

In mathematics, the trigonometric functions (also called circular functions) are functions of an angle. 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 have a wide range of uses including computing unknown lengths and angles in triangles (often right triangles). In this use, 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.

In modern usage, there are six basic trigonometric functions, tabulated here with equations that relate them to one another. Especially with the last four, these relations are often taken as the definitions of those functions, but one can define them equally well geometrically, or by other means, and then derive these relations.



To define the trigonometric functions for the angle A, start with any right triangle that contains the angle A. The three sides of the triangle are named as follows:

- 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.

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

EQUATIONS

An equation, in a mathematical context, is generally understood to mean a mathematicalstatement that asserts the equality of two expressions.[1] In modern notation, this is written by placing the expressions on either side of an equals sign (=), 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, … . The process of expressing the unknowns in terms of the knowns is called solving the equation. In an equation with a single unknown, a value of that unknown for which the equation is true is called a solution or root of the equation. In a setsimultaneous equations, or system of equations, multiple equations are given with multiple unknowns. A solution to the system is an assignment of values to all the unknowns so that all of the equations are true.

Equations can be classified according to the types of operations and quantities involved. Important types include of equations include:

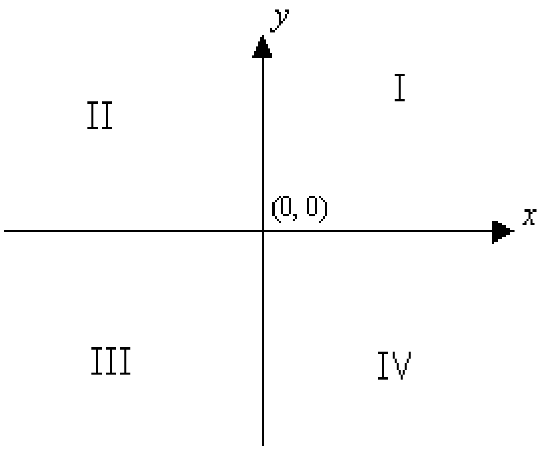
- An algebraic equation or polynomial equation is an equation in which a polynomial is set equal to another polynomial. These equations are further classified by their degree:
  - a linear equation has degree one,
  - quadratic equation has degree two,
  - cubic equation has degree three,
  - quartic equation has degree four,
  - quintic equation has degree five,
- A Diophantine equation is an equation where the unknowns are required to be integers.
- 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).

In mathematics, an inequation is a statement that an inequality holds between two values.[1] It is usually written in the form of a pair ofexpressions denoting the values in question, with a relational sign between them indicating the specific inequality relation. Some examples of inequations are:

$$\begin{gathered} a < b, \\ x + y + z \leq 1, \\ n > 1, \\ x \neq 0. \end{gathered}$$

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 if 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 co-ordinate system**. This consists of:

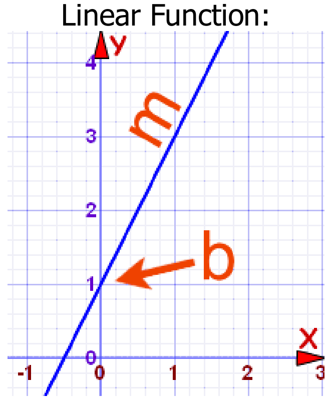
- The x-axis;
- The y-axis;
- The origin (0,0); and
- The four quadrants, normally labelled I, II, III, IV.

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 theco-ordinates of the point P.

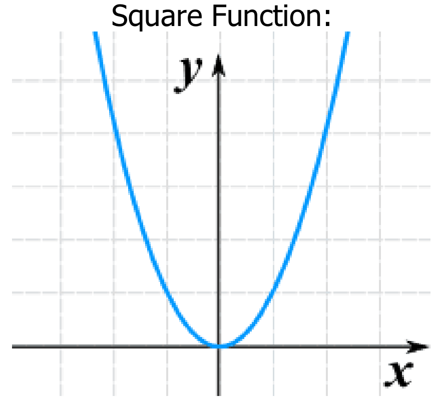
Here are some of the most commonly-used functions, and their graphs:

Linear Function:



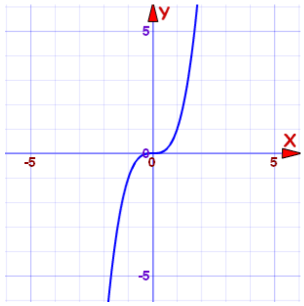
f(x) = mx + b

Square Function:



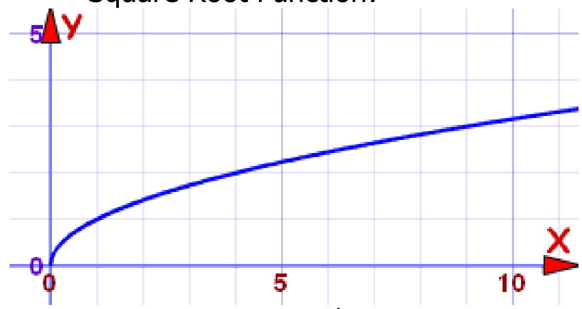
f(x) = x2

Cube Function:



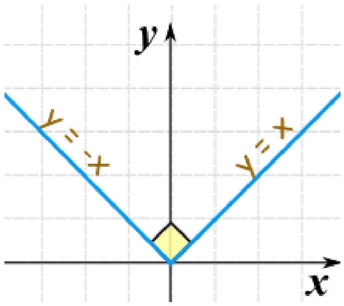
f(x) = x3

Square Root Function:



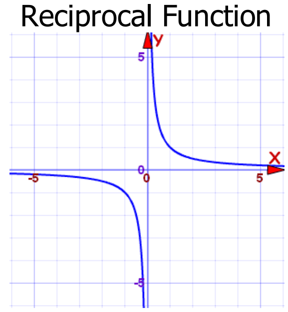
f(x) = √x

Absolute Value Function:



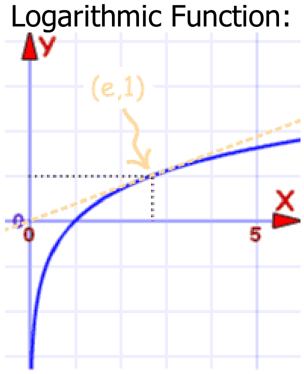
f(x) = |x|

Reciprocal Function



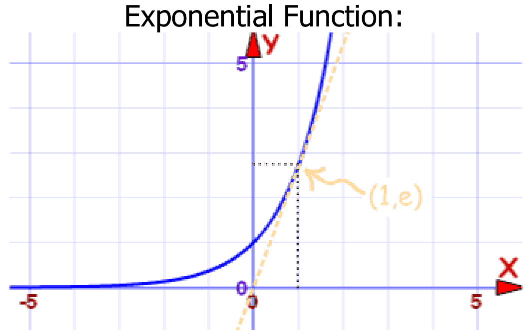
f(x) = 1/x

Logarithmic Function:



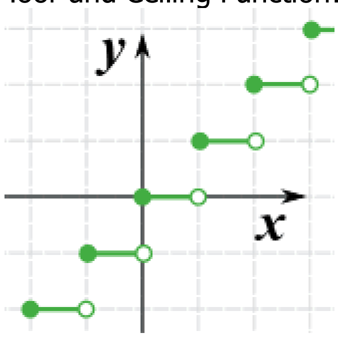
f(x) = ln(x)

Exponential Function:



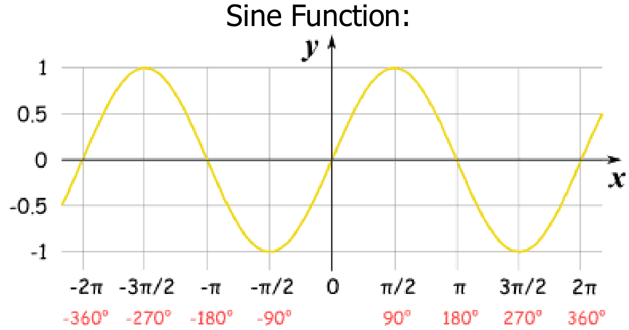
f(x) = ex

Floor and Ceiling Function:

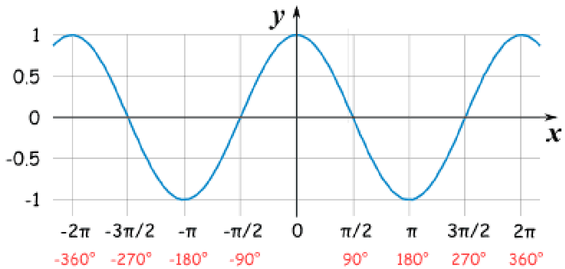


The Floor Function

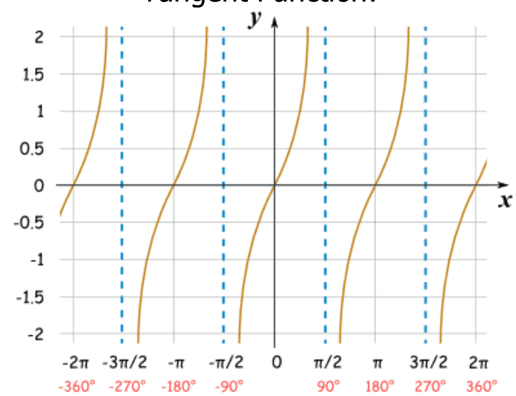
Sine Function:



Cosine Function:



Tangent Function:



CHEMISTRY

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. **Physics** tends to focus more on the nuclear part of the atom, as well as the subatomic realm. 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.
- **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.

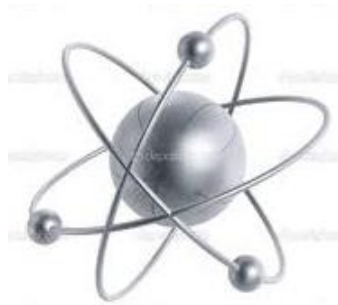
One of the main functions of the chemist is to rearrange the atoms of known substances to produce new products. For example, chemists have developed previously unknown synthetic fibers such as Kevlar, which has desirable qualities not found in natural fibers. The development of plastics such as polyethylene and Teflon has resulted in the production of many new items previously unavailable because no natural product could do the job. New alloys and special fuels allow us to travel in outer space. Chemists have helped to develop these and thousands of other new and useful products.

ATOMIC AND MOLECULAR STRUCTURE

All matter consists of particles called atoms. Atoms are single units of an element. Ions can be made up of one or more types of elements and carry an electrical charge. Learn about the parts of an atom and how to identify the different types of ions.

Atoms cannot be divided using chemicals. They do consist of parts, which include protons, neutrons, and electrons, but an atom is a basic chemical building block of matter.

- 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. Electrons and protons are electrically attracted to each other.
- Each neutron is electrically neutral. In other words, neutrons do not have a charge and are not electrically attracted to either electrons or protons.
- Protons and neutrons are about the same size as each other and are much larger than electrons. The mass of a proton is essentially the same as that of a neutron. The mass of a proton is 1840 times greater than the mass of an electron.
- The nucleus of an atom contains protons and neutrons. The nucleus carries a positive electrical charge.
- Electrons move around outside the nucleus.
- Almost all of the mass of an atom is in its nucleus; almost all of the volume of an atom is occupied by electrons.
- The number of protons (also known as its atomic number) determines the element. Varying the number of neutrons results in isotopes. Varying the number of electrons results in ions. Isotopes and ions of an atom with a constant number of protons are all variations of a single element.
- The particles within an atom are bound together by powerful forces. In general, electrons are easier to add or remove from an atom than a proton or neutron. Chemical reactions largely involve atoms or groups of atoms and the interactions between their electrons.



ATOMIC NUMBERS AND ATOMIC MASS

Since atomic number is the number of protons in an atom and atomic mass is the mass of protons, neutrons, and electrons in an atom, it seems intuitively obvious that increasing the number of protons would increase the atomic mass, but the reality is different: 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). If a sizeable portion of an element of lower atomic number exists in the form of heavy isotopes, then the mass of that element may (overall) be heavier than that of the next element. If there were no isotopes and all elements had a number of neutrons equal to the number of protons, then atomic mass would be approximately twice the atomic number (approximately because protons and neutrons don't have exactly the same mass... the mass of electrons is so small that it is negligible).

PERIODIC TABLE

Group	Name
1	alkali metals
2	alkaline earth metals
11	coinage metals
12	volatile metals (rarely used)
13	icosagens (rarely used)
14	crystallogens (rarely used)
15	pnictogens
16	chalcogens
17	halogens
18	noble gases (rarely aerogens)

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.

Some of these groups have been given trivial (unsystematic) names, although some are rarely used. Groups 3–10 have no trivial names and are referred to simply by their group numbers or by the name of the first member of their group (such as 'the scandium group' for Group 3), since they display fewer similarities and/or vertical trends.

Elements in the same group tend to show patterns in atomic radius, ionization energy, and electronegativity. From top to bottom in a group, the atomic radii of the elements increase. Since there are more filled energy levels, valence electrons are found farther from the nucleus. From the top, each successive element has lower ionization energy because it is easier to remove an electron since the atoms are less tightly bound. Similarly, a group has a top to bottom decrease in electronegativity due to an increasing distance between valence electrons and the nucleus. There are exceptions to these trends, however, an example of which occurs in group 11 where electronegativity increases farther down the group.

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. The more tightly bound an element is, the more energy is required to remove an electron. Electronegativity increases in the same manner as ionization energy because of the pull exerted on the electrons by the nucleus. Electron affinity also shows a slight trend across a period. Metals (left side of a period) generally have a lower electron affinity than nonmetals (right side of a period), with the exception of the noble gases.

The electron configuration or organization of electrons orbiting neutral atoms shows a recurring pattern or periodicity. The electrons occupy a series of electron shells (numbered shell 1, shell 2, and so on). Each shell consists of one or more subshells (named s, p, d, f and g). As atomic number increases, electrons progressively fill these shells and subshells more or less according to the Madelung rule or energy ordering rule, as shown in the diagram to the right. The electron configuration for neon, for example, is $1s^2\ 2s^2\ 2p^6$. With an atomic number of ten, neon has two electrons in the first shell, and eight electrons in the second shell—two in the s subshell and six in the p subshell.

Periodic Table of the Elements

1 1IA 11A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.0079																	2 He Helium 4.00260
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797
11 Na Sodium 22.989768	12 Mg Magnesium 24.305											13 Al Aluminum 26.981539	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.95591	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.64	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9072	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90543	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium [208.9824]	85 At Astatine 209.9871	86 Rn Radon 222.0176
87 Fr Francium 223.0197	88 Ra Radium 226.0254	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Uuq Ununquadium [289]	115 Uup Ununpentium unknown	116 Uuh Ununhexium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.9655	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium 237.0482	94 Pu Plutonium 244.0642	95 Am Americium 243.0614	96 Cm Curium 247.0703	97 Bk Berkelium 247.0703	98 Cf Californium 251.0796	99 Es Einsteinium [254]	100 Fm Fermium 257.0951	101 Md Mendelevium 258.1	102 No Nobelium 259.1009	103 Lr Lawrencium [262]

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Semimetals | Nonmetals | Halogens | Noble Gas | Lanthanides | Actinides

AtomicNumber	AtomicMass	Name	Symbol	AtomicNumber	AtomicMass	Name	Symbol
1	1.0079	Hydrogen	H	**31**	69.723	Gallium	Ga
2	4.0026	Helium	He	**32**	72.64	Germanium	Ge
3	6.941	Lithium	Li	**33**	74.9216	Arsenic	As
4	9.0122	Beryllium	Be	**34**	78.96	Selenium	Se
5	10.811	Boron	B	**35**	79.904	Bromine	Br
6	12.0107	Carbon	C	**36**	83.8	Krypton	Kr
7	14.0067	Nitrogen	N	**37**	85.4678	Rubidium	Rb
8	15.9994	Oxygen	O	**38**	87.62	Strontium	Sr
9	18.9984	Fluorine	F	**39**	88.9059	Yttrium	Y
10	20.1797	Neon	Ne	**40**	91.224	Zirconium	Zr
11	22.9897	Sodium	Na	**41**	92.9064	Niobium	Nb
12	24.305	Magnesium	Mg	**42**	95.94	Molybdenum	Mo
13	26.9815	Aluminum	Al	**43**	98	Technetium	Tc
14	28.0855	Silicon	Si	**44**	101.07	Ruthenium	Ru
15	30.9738	Phosphorus	P	**45**	102.906	Rhodium	Rh
16	32.065	Sulfur	S	**46**	106.42	Palladium	Pd
17	35.453	Chlorine	Cl	**47**	107.868	Silver	Ag
18	39.948	Argon	Ar	**48**	112.411	Cadmium	Cd
19	39.0983	Potassium	K	**49**	114.818	Indium	In
20	40.078	Calcium	Ca	**50**	118.71	Tin	Sn
21	44.9559	Scandium	Sc	**51**	121.76	Antimony	Sb
22	47.867	Titanium	Ti	**52**	127.6	Tellurium	Te
23	50.9415	Vanadium	V	**53**	126.905	Iodine	I
24	51.9961	Chromium	Cr	**54**	131.293	Xenon	Xe
25	54.938	Manganese	Mn	**55**	132.906	Cesium	Cs
26	55.845	Iron	Fe	**56**	137.327	Barium	Ba
27	58.9332	Cobalt	Co	**57**	138.906	Lanthanum	La
28	58.6934	Nickel	Ni	**58**	140.116	Cerium	Ce
29	63.546	Copper	Cu	**59**	140.908	Praseodymium	Pr
30	65.39	Zinc	Zn	**60**	144.24	Neodymium	Nd

AtomicNumber	AtomicMass	Name	Symbol	AtomicNumber	AtomicMass	Name	Symbol
61	145	Promethium	Pm	**86**	222	Radon	Rn
62	150.36	Samarium	Sm	**87**	223	Francium	Fr
63	151.964	Europium	Eu	**88**	226	Radium	Ra
64	157.25	Gadolinium	Gd	**89**	227	Actinium	Ac
65	158.925	Terbium	Tb	**90**	232.038	Thorium	Th
66	162.5	Dysprosium	Dy	**91**	231.036	Protactinium	Pa
67	164.93	Holmium	Ho	**92**	238.029	Uranium	U
68	167.259	Erbium	Er	**93**	237	Neptunium	Np
69	168.934	Thulium	Tm	**94**	244	Plutonium	Pu
70	173.04	Ytterbium	Yb	**95**	243	Americium	Am
71	174.967	Lutetium	Lu	**96**	247	Curium	Cm
72	178.49	Hafnium	Hf	**97**	247	Berkelium	Bk
73	180.948	Tantalum	Ta	**98**	251	Californium	Cf
74	183.84	Tungsten	W	**99**	252	Einsteinium	Es
75	186.207	Rhenium	Re	**100**	257	Fermium	Fm
76	190.23	Osmium	Os	**101**	258	Mendelevium	Md
77	192.217	Iridium	Ir	**102**	259	Nobelium	No
78	195.078	Platinum	Pt	**103**	262	Lawrencium	Lr
79	196.967	Gold	Au	**104**	261	Rutherfordium	Rf
80	200.59	Mercury	Hg	**105**	262	Dubnium	Db
81	204.383	Thallium	Tl	**106**	266	Seaborgium	Sg
82	207.2	Lead	Pb	**107**	264	Bohrium	Bh
83	208.98	Bismuth	Bi	**108**	277	Hassium	Hs
84	209	Polonium	Po	**109**	268	Meitnerium	Mt
85	210	Astatine	At				

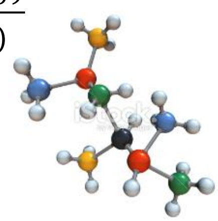
Molecule

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. Molecules in living things are made from only about 25 of more than 100 known atoms in the universe. Molecules are made from as few as two atoms to hundreds of millions of atoms. Molecule´s main characteristic is it´s geometry or structure, which is unique to every molecule.

The Mole

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 $6.022x10^{23}$. The mass in grams of one mole of a compound is equal to the molecular weight of the compound in atomic mass units. One mole of a compound contains $6.022x10^{23}$ 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. Here is the formula for determining the number of moles of a sample:

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



CHEMICAL BOND

It is a region that forms when electrons from different atoms interact with each other. The electrons that participate in chemical bonds are the valence electrons, which are the electrons found in an atom's outermost shell. When two atoms approach each other these outer electrons interact. Electrons repel each other, yet they are attracted to the protons within atoms. The interplay of forces results in some atoms forming bonds with each other and sticking together.

The two main types of bonds formed between atoms are ionic bonds and covalent 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. In a covalent bond, electrons are shared between two atoms. The electrons that participate in metallic bonds may be shared between any of the metal atoms in the region.

If the electronegativity values of two atoms are:

- Similar...
  - Metallic bonds form between two metal atoms.
  - Covalent bonds form between two non-metal atoms.
  - Nonpolar covalent bonds form when the electronegativity values are very similar.
  - Polar covalent bonds form when the electronegativity values are a little further apart.
- Different...
  - Ionic bonds are formed.

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. There are several different types of chemical reactions and more than one way of classifying them. Here are some common reaction types:

- **Direct Combination or Synthesis Reaction**
  In a synthesis reaction two or more chemical species combine to form a more complex product.

$$A + B \dashrightarrow AB$$

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

$$8\ Fe + S_8 \dashrightarrow 8\ FeS$$

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

$$AB \dashrightarrow A + B$$

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.

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

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

$$Zn + 2\ HCl \dashrightarrow ZnCl_2 + H_2$$

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

$$AB + CD \dashrightarrow AD + CB$$

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

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

- **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:

$$HA + BOH \dashrightarrow H_2O + BA$$

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

$$HBr + NaOH \dashrightarrow NaBr + H_2O$$

- **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.

The reaction that occurs when In which I_2 is reduced to I^- and $S_2O_3^{2-}$ (thiosulfate anion) is oxidized to $S_4O_6^{2-}$ provides an example of a redox reaction:

$$2\ S_2O_3^{2-}(aq) + I_2(aq) \dashrightarrow S_4O_6^{2-}(aq) + 2\ I^-(aq)$$

- **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:

$$C_{10}H_8 + 12\ O_2 \dashrightarrow 10\ CO_2 + 4\ H_2O$$

In an isomerization reaction, the structural arrangement of a compound is changed but its net atomic composition remains the same.

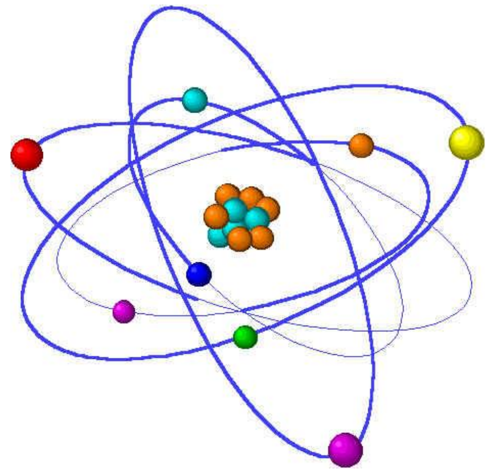
- **Hydrolysis Reaction**

A hydrolysis reaction involves water. The general form for a hydrolysis reaction is:

$$X^-(aq) + H_2O(l) \leftarrow\!\!\dashrightarrow HX(aq) + OH^-(aq)$$

WHY STUDY CHEMISTRY?

Understanding chemistry helps you to understand the world around you. Cooking is chemistry. Everything you can touch or taste or smell is a chemical. When you study chemistry, you come to understand a bit about how things work. Chemistry isn't secret knowledge, useless to anyone but a scientist, it's the explanation for everyday things, like why laundry detergent works better in hot water or how baking soda works or why not all pain relievers work equally well on a headache. If you know some chemistry, you can make educated choices about everyday products that you use.



Chemistry is involved with everything with which we come in contact. The life processes of all organisms involve chemical changes. Chemists play a key role in the development of drugs, which are helping to cure and alleviate diseases and prolong life span. Chemists are involved in biochemistry and genetic engineering.

For example, there is much interest in producing new bacterial strains, which can synthesize useful products such as human insulin or interferon. Chemists are also at the forefront of developing fields such as nanotechnology. They are actively involved in environmental issues and are helping to tap new sources of energy to replace the earth's finite reserves of petroleum.

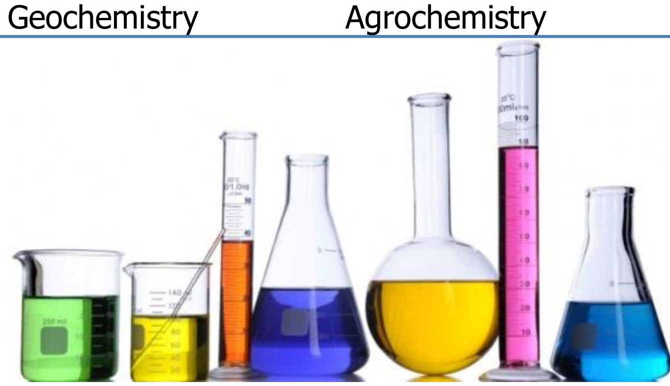
Our high standard of living depends heavily on the contributions of chemists to agriculture, manufacturing, new technologies, and the development of efficient means of transportation and communication. Thus, with its broad scope, chemistry offers an exciting array of intellectual adventures and opportunities.

WHAT FIELDS OF STUDY USE CHEMISTRY?

You could use chemistry in most fields, but it's commonly seen in the sciences and in medicine. Chemists, physicists, biologists, and engineers study chemistry. Doctors, nurses, dentists, pharmacists, physical therapists, and veterinarians all take chemistry courses. Science teachers study chemistry. Fire fighters and people who make fireworks learn about chemistry. So do truck drivers, plumbers, artists, hairdressers, chefs... the list is extensive. The career options in chemistry are practically endless!

Chemistry is a part of biology and physics, plus, there are lots of categories of chemistry! Here's look at some of the career options related to chemistry:

Chemistry	**Engineering**	**Environmental Law**	**Pharmaceuticals**
Patent Law	Technical Writing	Space Exploration	Biotechnology
Oceanography	Software Design	Government Policy	Ceramics Industry
Metallurgy	Plastics Industry	Forensic Science	Paper Industry
Medicine	Teaching		
Ethnobotany	Geochemistry	Agrochemistry	Military Systems



STATISTICS

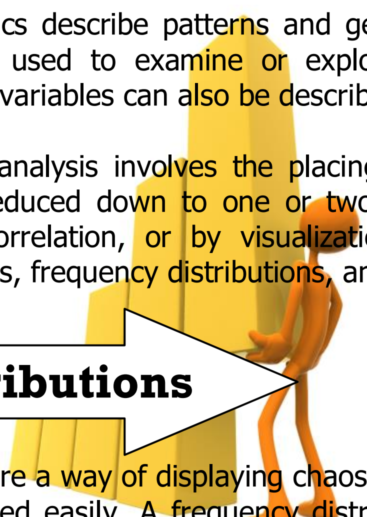
Statistics can be defined as the practice of collecting, organizing, describing, and analyzing data to draw conclusions from the data to apply to a cause. Data must either be numeric in origin or transformed by researchers into numbers.

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. Thus, inferential statistics involves generalizing beyond the data, something that descriptive statistics does not do.

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 like the mean and standard deviation or correlation, or by visualization of the data through various graphical procedures like histograms, frequency distributions, and scatter plots.



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. A good frequency distribution will display more information than this although with just this minimum information, many other bits of information can be computed.

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.

In the mathematical world, where everything must be precise, we define several ways of finding the center of a set of data, such as:

1. Median: the median 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.

The median is not affected by the magnitude of the extreme (smallest or largest) values. Thus, it is useful because it is not affected by one or two abnormally small or large values, and because it is very simple to calculate. (For example, to obtain a relatively accurate average life of a particular type of lightbulb, you could measure the median life by installing several bulbs and measuring how much time passed before half of them died. Alternatives would probably involve measuring the life of each bulb.)

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). On the other hand, the fact that the mode is absolute (which means that, for instance 2.99 and 3 are considered completely different) can make the mode a poor choice for determining a "center".

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. The principal measures of variability are described in the following subtopics.

1. Range: the range is the difference between the largest and smallest values of a set. The range of a set is simple to calculate, but is not very useful because it depends on the extreme values, which may be distorted.

2. Variance: the variance is a measure of how items are dispersed about their mean. The variance σ^2 of a whole population is given by the equation:

$$\sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}$$

The variance s^2 of a sample is calculated differently:

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

3. Standard deviation: The standard deviation "σ" (or "s" for a sample) is the square root of the variance. (Thus, for a population, the standard deviation is the square root of the average of the squared deviations from the mean. For a sample, the standard deviation is the square root of the sum of the squared deviations from the mean, divided by the number of samples minus 1.)

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:

a) Confidence intervals, which is also referred to as Interval estimation.
b) Hypothesis testing, which is also referred to as Point Estimation.

Confidence Intervals and point estimation are two different ways of expressing the same information. Using Confidence Intervals we make statements like the following:

- The probability that the population mean (μ, or the 'true' value of the population mean) lies between 19 and 23 is 0.80;
- The probability that the population correlation value (r, or the 'true' value of the correlation between these two variables) lies between 0.20 and 0.24 is 0.60

Using Hypothesis testing we say:

- The probability that our sample mean comes from a population with a mean of 21 is greater than 0.95
- The probability that our sample comes from a population in which the true correlation is zero is 0.60.

The most remarkable topics regarding this type of statistics are dealt as it follows.

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 H_0.
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 H_a.

If the alternative involves showing that some value is greater than or less than a number, there is some value "c" that separates the null hypothesis rejection region from the fail to reject region. This value is known as the critical value.

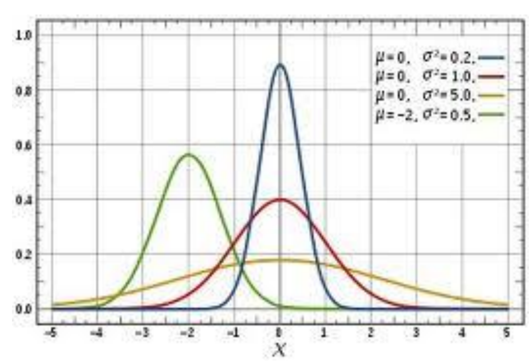
The null hypothesis is tested through the following procedure:

a) Determine the null hypothesis and an alternative hypothesis.
b) Pick an appropriate sample.
c) Use measurements from the sample to determine the likelihood of the null hypothesis.

Other important concepts when studying hypothesis test are:

1. **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 α risk.
2. **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 β 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.

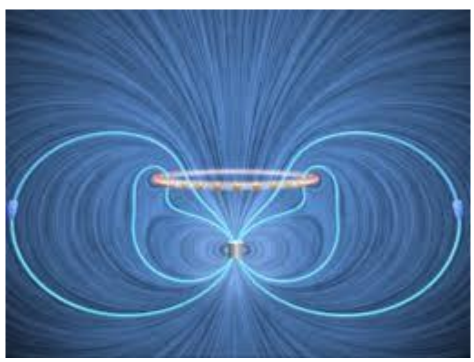
Confidence is defined as $1-\alpha$ (1 minus the significance level).

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. Always, when constructing a confidence interval, two limits ("Upper" and "Lower") are computed. For each limit, the information needed is the **computed statistic** (e.g., $\bar{x}$), the two-tailed **critical values** (e.g., $t_{\alpha/2}$), and the standard error for the statistic.

PHYSICS

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.
- **Acoustic**:studiesall phenomena linked to mechanical waves and electromagnetic.
- **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:* studies everything related to electrical energy stored in objects. * *Dynamic:*Studieseverythingrelatedtothemovement of electrons.
- **Electromagnetism**:Studies everything about the causes and effects of magnetic fields.



PHYSICS AND ITS APPLICATIONS

Many applications of physics illustrate and use concepts from across a wide range of topics. *Physics applications* will eventually contain collections of experiments covering applications such as communications, transport and medical imaging.

Ultimately, the goal of physics is not only to understand the workings of the universe, but to use that understanding to useful ends, frequently through the development of some technological device.

Research in physics and its applications is performed in the laboratories of theManagement of physicswhich aims to:

a) Promote the activities of research in physics, in the basic sciences of nuclear technology, and related to promote interdisciplinary activities from physics to other sciences, especially chemistry, biology activities, medical physics and Sciences the forensic. physical

b) Promote the transfer of the results of research in technological developments and applications and providing technical assistance, advice and expertise in the area of its competence.

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, with growth of single crystals and thin films of metals and multifunctional oxide materials. Also performs design, manufacture and characterization of micro systems and nanoelectromechanics.
- **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 and the physical and chemical properties of pure solid surface or with atoms and molecules adsorbed on them.
- **Physics of metals: H**ere, research is directed to the thermodynamic and mechanical properties of metal alloys and materials in general. Defects and materials nanostructured by electronic transmission microscopy are also studied.
- **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. Its members participate in the training and development of those acting directly or indirectly in judicial proceedings.
- **Nuclear fusion and physics of Plasmas:** Groups working on this area perform studies on balance, stability, transport, sustaining the flow and heating in plasmas with settings similar to those existing in a nuclear fusion by magnetic confinement reactor. They also integrate these studies in analysis and design of different concepts of confinement.
- **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 (nanoparticles, nanowires, nanotubes, thin films, multilayered and supernetting).
- **Particles and field theory:** These groups carry out research in the areas of Physics of high energies, astroparticle, mathematical Physics, field theory and strings. It also participates actively in the Auger project, both in experimental and theoretical aspects.
- **Theory of solids:** Research is oriented to the theory of mesoscopic and nanostructured solid-state systems, correlated electronic systems, magnetism, the phenomenology of superconductivity and soft condensed matter.
- **Medical physics:** These researchers perform statistical analysis, and medical imaging. Development of techniques of cancer treatment: radiation therapy and brachytherapy. Study of the interaction of radiation with biological tissues. Nuclear medicine.

- **Technological physics:** These laboratories performs development, research and innovation in materials, processes, and devices with technological objectives. Among the topics: development of superconducting material cables for fuel cells, instrumentation and ultra-sensitive detection, micro-machined devices, nuclear materials etc.
- One of the most recent applied physics projects is The Large Hadron Collider (LHC) that is the world's largest and highest-energy particle accelerator. The LHC lies in a tunnel 27 kilometres (17 mi) in circumference, as much as 175 metres (574 ft) beneath the Franco-Swiss border near Geneva, Switzerland.

This synchrotron is designed to collide opposing particle beams of either protons at an energy of 7 teraelectronvolts (1.12 microjoules) per particle, or or lead nuclei at an energy of 574 TeV (92.0 µJ) per nucleus. The term hadron refers to particles composed of quarks. It is expected that it will address the most fundamental questions of physics, advancing our understanding of the deepest laws of nature.

The Large Hadron Collider was built by the European Organization for Nuclear Research (CERN) with the intention of testing various predictions of high-energy physics, including the existence of the hypothesized Higgs boson and of the large family of new particlespredicted by supersymmetry. It is funded by and built in collaboration with over 10,000 scientists and engineers from over 100 countries as well as hundreds of universities and laboratories.

On 10 September 2008, the proton beams were successfully circulated in the main ring of the LHC for the first time, but nine days later, operations were halted due to a serious fault between two superconducting bending magnets. Repairing the resulting damage and installing additional safety features took over a year.

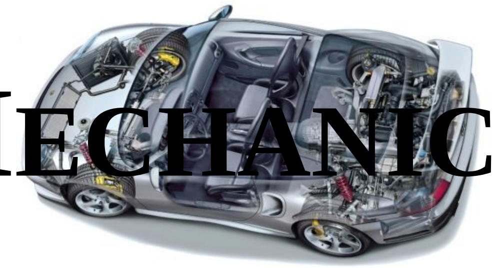
On 20 November 2009, the proton beams were successfully circulated again, with the first proton–proton collisions being recorded three days later at the injection energy of 450 GeV per beam. The LHC became the world's highest-energy particle accelerator on 30 November 2009, achieving a world record 1.18 TeV per beam and surpassing the record previously held by the Tevatron at Fermilab in Batavia, Illinois.

After the 2009 winter shutdown, the LHC was restarted and the beam was ramped up to 3.5 TeV per beam, half its designed energy, which is planned for after its 2012 shutdown. On 30 March 2010, the first planned collisions took place between two 3.5 TeV beams, which set a new world record for the highest-energy man-made particle collisions.

Vectors

A vector is a quantity that has both magnitude and direction. Displacement, velocity,acceleration, and force are the vector quantities. When there was a free-body diagram depicting the forces acting upon an object, each individual force was directed in *one dimension* - either up or down or left or right. When an object had an acceleration and we described its direction, it was directed in *one dimension* - either up or down or left or right. There are examples of vectors that are directed in *two dimensions* - upward and rightward, northward and westward, eastward and southward, etc.

MECHANICS



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.

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 AND PRINCIPLES

The basic concepts used in Mechanics are: space, time, mass, and force. These concepts can't be truly defined; they should be accepted on the basis of our intuition and experience and used as a mental frame of reference for our study of mechanics.

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.

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.

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.

In **Newtonian Mechanics**, space, time, and mass are absolute independent concepts, whereas in Relativistic Mechanics, the time of events depends upon its position and the mass of a body varies with its velocity. On the other hand, the concept of force is not independent of the other three. Indeed, one of the fundamental principles of Newtonian Mechanics listed below indicates that the resultant force acting on a body is related to the mass of the body and the manner in which its velocity varies with time.

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. The study of the **Mechanicsof 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:

I. 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.

II. 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.

III. Newton's three fundamental laws

4. 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).

5. If the resultant force acting on a particle is zero, the particle will have an acceleration proportional to the magnitude of the resultant and in the direction of this resultant force.

$$\vec{F} = m\vec{a}$$

6. The forces of action and reaction between bodies in contact have the same magnitude, same line of action, and opposite sense.

IV. Newton's law of gravitation

V.

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

$$\boxed{F = G\frac{Mm}{r^2}}$$

where r – distance between the two particles

G – universal constant called the constant of gravitation

BASIC DIMENSIONS AND UNITS OF MECHANICS

In the study of Mechanics, scientists examine quantitatively certain aspects of the mechanical actions of bodies so they can communicate their findings clearly. To do this, they must establish abstractions to describe those manifestations of the body in which they are interested. These artificial concepts are called dimensions.

The dimensions picked at first, which are independent of all other dimensions, are referred to as primary or basic dimensions and the ones that are then developed in terms of basic dimensions are called secondary dimensions. One of the many possible sets of basic dimensions that can be used in the study of Mechanics includes the dimensions of length, time and mass.

- ***Length****: a concept for describing size quantitatively.* In order to determine the size of an object, it's necessary to place a second object of known size next to it. This second object is called pattern or standard. For example, a straight line scratched on a metal bar that was kept at uniform thermal and physical conditions was used as a simple standard for length a long time ago.

- ***Time***: *a concept for ordering the flow of events.* For an accurate description of "when has happened an event", there must be found a completely repeatable action. Then, the events under study can be ordered by counting the number of these repeatable actions and fractions that occurred while the events transpire. In ancient times, the rotation of the Earth served as a good measure of time, but smaller units were needed in order to develop Engineering jobs, leading to the definition and establishment of the second, which is an action repeatable 86,400 times a day.

- ***Mass***: *a property of matter.* Mass can be determined from two different actions of bodies. To study the first action, consider two rigid bodies of entirely different composition, size shape, color, etc. If the bodies are attached to identical springs, each spring will extend some distance as a result of the attraction of gravity for the bodies.

Even if the springs are risen to a new height above the Earth's surface, thus lessening the deformation of the springs, the extensions induced by the pull of gravity will be the same for both bodies. In consequence, it's concluded that the bodies have an equivalent property. This property of each body that manifests itself in the amount of gravitational attraction is called mass.

The equivalence of these same bodies also can be indicated in a second action. If both bodies are moved an equal distance downward, by stretching each spring, and then released at the same time, they will begin to move in an identical manner (except for small variations due to differences in wind friction and local deformations of the bodies). It has been imposed, in effect, the same mechanical disturbance on each body and it has been elicited the same dynamical response. Hence, despite many obvious differences, the two bodies again show equivalence.

The property of mass, then, characterizes a body both in the action of gravitational attraction and in the response to a mechanical disturbance.

To communicate this property quantitatively, an independent body can be used as a standard to compare other bodies with it in any of the two actions listed above. For example, the mass of a body can be found by comparing the extension of a spring it causes with that of a given body at the same location on the Earth.

International System of Units (SI) and Derived Units

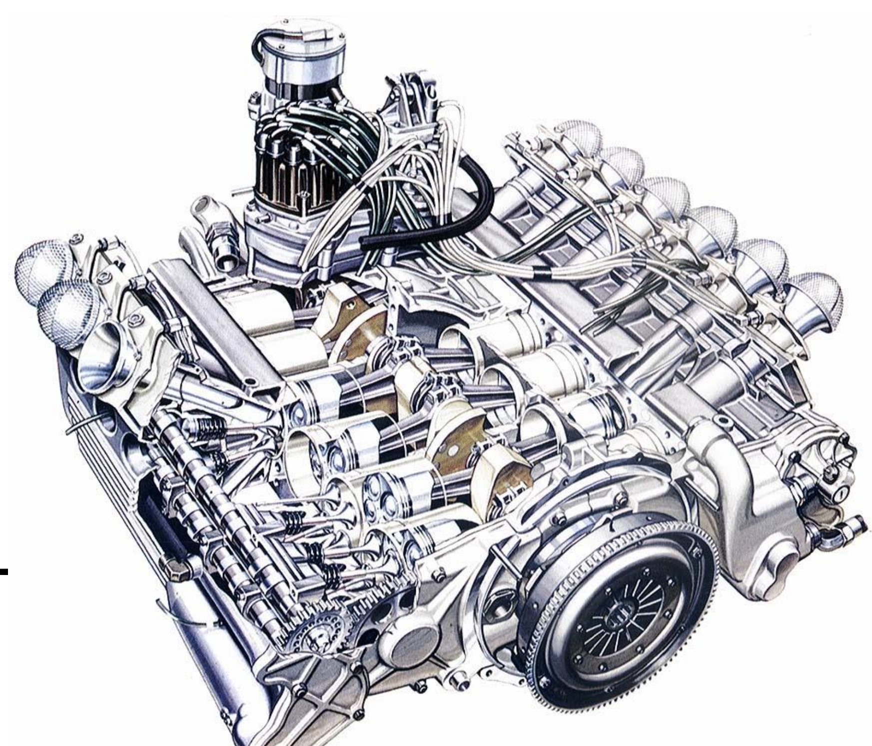
In this system, used worldwide, the base units are:

- *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 SI units are said to form an absolute system of units. This means that the three base units are independent of the location where measurements are made. The meter, the kilogram, and the second may be used anywhere on the Earth; they may be even used on another planet. They will always have the same significance.

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 $1m/s^2$ to a mass of 1 kg.

$$1\ N = (1\ kg)(1m/s^2) = 1\ kg*m/s^2$$



MATERIALS SCIENCE

What is Materials Science?

Material science and engineering (**MSE**) is an interdisciplinary field concerned with inventing new materials and improving previously known materials by developing a deeper understanding of the microstructure-composition-synthesis-processing relationships. The term composition means the chemical make-up of a material. The term structure means a description of the arrangement of atoms, as seen at different levels of detail.

Materials Science through Time

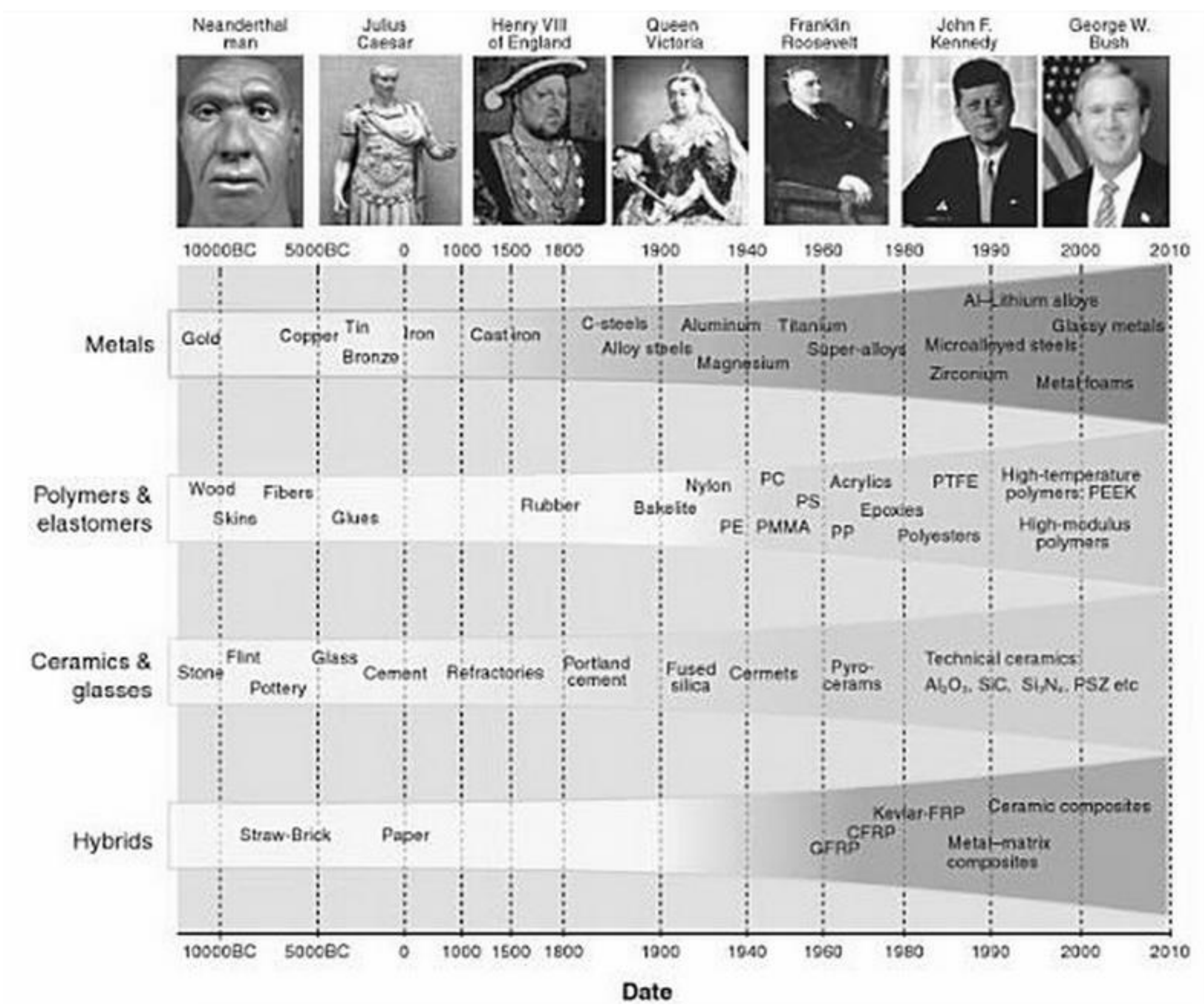
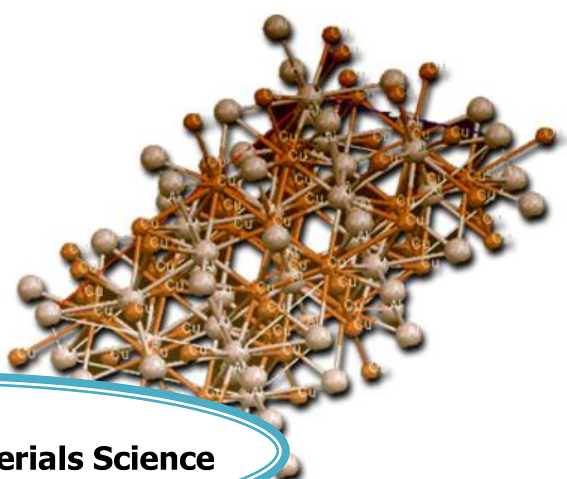


FIG. 1.1 – The development of materials over time. The materials of pre-history, on the left, all occurred naturally; the challenge for the engineers of that era was shaping them. The development of thermochemistry and (later), of polymer chemistry, enabled man-made materials, shown in the colored zones. Three–stone bronze, and iron–were of such importance that the era of their dominance is named after them.

The designation of successive historical periods as the Stone, Copper, Bronze, and Iron ages reflects the importance of materials to mankind. Human destiny and materials resources have been inextricably tangled since the dawn of history; however, the association of a given material with the age or era that it defines is not only limited to antiquity. The present nuclear and information ages owe their existences to the exploitation of two remarkable elements, uranium and silicon, respectively. Even though modern materials ages are extremely time compressed relative to the ancient metal ages they share a number of common attributes. For one thing, these ages tended to define sharply the material limits of human existence. Stone, copper, bronze and iron meant successively higher standards of living through new or improved agricultural tools, food vessels and weapons. Passage from one age to another was (and is) frequently accompanied by revolutionary, rather than evolutionary, changes in technological endeavors. A major breakthrough occurred in the late 19^{th} century; Willard Gibbs demonstrated that the thermodynamic properties relating to atomic structure in various phases are related to the physical properties of a material.



Fundamentals of Materials Science

Material scientists and engineers not only deal with the development of materials, but also with the synthesis and processing of materials and manufacturing processes related to production of components. "Synthesis" refers to how materials are made from naturally occurring or man-made chemicals. On the other hand "processing" means how materials are shaped into useful components to cause changes in the properties of different materials. One of the most important functions of materials scientists and engineers is to establish the relationships between a material or a device's properties and the performance and the microstructure of that material, its composition, and the way the material or the device was synthesized and processed. In materials science, the emphasis is on the underlying relationships between the synthesis and processing, structure and properties of materials. In materials engineering the focus is on how to translate or transform materials into useful devices or structures.

One of the most fascinating aspects of materials science involves the investigation of a material's structure. The structures of materials have a profound influence on many properties of materials, even if the overall composition does not does not change. For example, if you take a pure copper wire and bend it repeatedly, the wire not only becomes harder but also becomes increasingly brittle. Eventually, the pure wire becomes so hard and brittle that it will break. The electrical resistivity of the wire will also increase as it is bent repeatedly. In this simple example, take note that the material's composition was not changed. The changes in the material's properties are due to a change in its internal structure. If you look the wire after bending, it will look the same as before; however, its structure has been changed at a very small or microscopic scale. The structure at this microscopic scale is known as microstructure. If we can understand what has changed microscopically, we can begin to discover ways to control the material's properties.

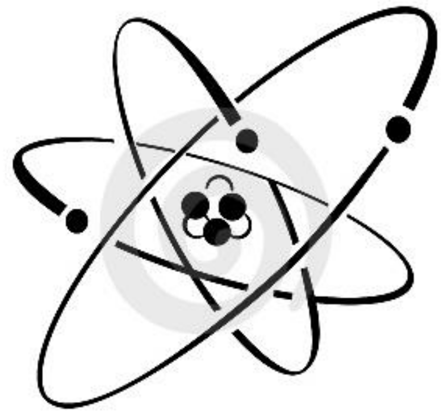
Classification of Materials

There are different ways of classifying materials. One way is to describe five groups:

1. Metals and alloys;
2. Ceramics, glasses and glass-ceramics;
3. Polymers (plastics);
4. Semiconductors and
5. Composite materials

Materials can also be classified based on whether the most important function they perform is mechanical (structural), biological, electrical, magnetic, optical, etc.

-Aerospace
-Biomedical
-Electronic Materials
-Energy and Environmental Technology
-Magnetic Materials
-Photonic or Optical Materials
-Smart Materials
-Structural Materials
-Nanotechnology
-Metallurgy
-Crystallography

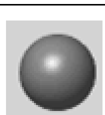


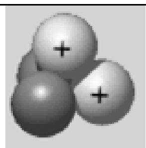
What is an atom?

Atoms are the smallest particles of what everyone and everything around us are made. There are 93 naturally occurring elements and scientists have made another 15, and there are some unknown which add up to 118 elements. When different chemicals react with each other, the reaction takes place between individual atoms, at an atomic level. The processes that cause materials to be radioactive (emission or particles and energy) also occur at an atomic level.

Atomic Structure

At the beginning of the 20th Century, a New Zealand scientist working in England, Ernest Rutherford, and a Danish scientist, Niels Bohr, developed a way of thinking about the structure of an atom, which described that it was similar to our solar system. At the center of the atom there was a nucleus, which can be compared to the sun in a solar system. Electrons moved around the nucleus in "orbits" in a similar way that planets move around the sun. Obviously it is known and the scientists knew that the atomic structure is more complex, the Rutherford-Bohr model is still a useful approximation to have a simple understanding about the atomic structure.

	Protons---are positively charged particles. All atoms of an element (radioactive and non-radioactive) have the same number of protons
	Neutrons---have no electrical charge, and like proton, are about 1800 times as heavy as an electron and almost as heavy as a protons

	Nucleus---contains protons and neutrons; together these are called "nucleons"
	Electrons---These particles that orbit the nucleus. They are negatively charged and balance the positive electrical charge of the protons in the nucleus.

Protons and neutrons in the nucleus, and the forces among them, affect an atom's radioactive properties.

The interactions with electrons in the outer orbits affect an atom's chemical properties.

For example, two different forms, or isotopes, of carbon are:

- Carbon, which has 6 protons and 6 neutrons, or an atomic mass of 12. This is the most common form of carbon.
- Carbon having 6 protons and 8 neutrons. This form of carbon is radioactive and used in determining the age of archeological artifacts.

$_{6}C^{12}$ You will frequently see these forms of carbon referred to as "Carbon-12" and "Carbon-14." $_{6}C^{14}$

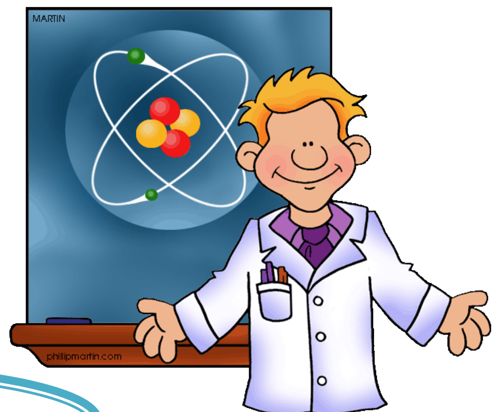
What holds the Parts of an Atom together?

Opposite electrical charges of the protons and electrons do the work of holding the electrons in orbit around the nucleus. Electrons closer to the nucleus are bound more tightly than the outer electrons because of their distance from the protons in the nucleus. The electrons in the outer orbits, or shells, are more loosely bound and affect an atom's chemical properties.

The nucleus is held together by the attractive strong nuclear force between nucleons: proton-to-proton, neutron-neutron, and proton-neutron. It is extremely powerful, but extends only a very short distance, about the diameter of a proton or neutron.

There are also electromagnetic forces, which tend to shove the positively-charged protons (and as a result the entire nucleus) apart. In contrast to the strong nuclear force, the electric field of a proton falls off slowly over distance extending way beyond the nucleus, binding electrons to it.

The balance between the strong nuclear force pulling the nucleus together and the positive charges of the protons pushing it apart is largely responsible for the properties of a particular kind of atom or nuclide. The delicate balance of forces among nuclear particles keeps the nucleus stable. Any change in the number, the arrangement, or energy of the nucleons can upset this balance and cause the nucleus to become unstable or radioactive. (Disruption of electrons close to the nucleus can also cause an atom to emit radiation.)



Properties of Materials

A property or a material is an intensive, regularly a quantitative property of a material, usually with units that may be used as metric of value to compare the benefits of one material versus another to aid in materials selection.

A material property may be a constant or may be a function of one or more independent variables, for example the temperature. Material's properties often change to some degree according to the direction in the material in which they are measured.

Material’s properties may be determined by standardized testing methods. Many of those test methods have been documented by their respective user communities and have been published through ASTM International, an organization that is in charge of developing norms and standards for the different materials.

Some of the properties of materials are listed below:

- ***Hardness***: Resistance to scratching or indentation

- ***Strength***: Amount of force needed to break a material usually by pushing or pulling down.
- ***Toughness***: Resistance to breaking by cracking, opposite to “brittle”
- ***Stiffness***: Amount of force needed to change the shape of a material, opposite to flexible.
- ***Elasticity***: ability to return to the original shape when a force is removed, for example: a rubber band
- ***Plasticity***: Ability to retain the new shape when a force is removed. E.g.: play dough
- ***Absorbency***: Ability of a material to soak up a liquid.
- ***Waterproof***: Resistance to liquids; repels water.

A material can be described in different ways, for example it may be strong but brittle, and the combination of its properties may determine its use. The property of a material can change according to how the material is treated, clay is very different once it has been heated, rolled up newspaper is very different to a flat laying down newspaper.

Properties can be divided into the following categories:

Physical Properties	Density, melting and boiling temperature
Mechanical Properties	Including basic mechanical properties, such as elastic modulus, shear modulus, Poison’s Ratio, and mechanical strength properties, i.e., yielding stress, ultimate stress and elongation.
Thermal Properties	Coefficient of thermal expansion, thermal conductivity.
Electric Properties	Electric resistivity.

Acoustic Properties	Compression of wave velocity, shear wave velocity, bar velocity.

STRENGTH OF MATERIALS

Materials science applied to the study of materials used in engineering and their mechanical behavior in general. Materials resistance can be associated with the strength of materials which 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:

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. 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. Some deformations in a structure can be determining to the overall system's performance, while others might only be an issue of comfort. The recognition of the relative importance of these deformations is an important part of the study of structures.

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. This internal resistance exists within every member and joint included in the load path and are known simply as the internal forces acting on a member.

The distribution of the internal forces with cross-sectional area of a member may or may not be uniformly distributed; it is dependent on the loading condition, the type of member, and how it its supported. The following are basic definitions and equations used to calculate the strength of materials:

Stress (normal): Is the ratio of applied load to the cross-sectional area of an element intension or compression and is expressed in pounds per square inch (psi) or kg/m m^2.

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

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: metal deformation is proportional to the imposed loads over a range of loads. Since stress is proportional to load, and strain is proportional to deformation, this implies that stress is proportional to strain. 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.

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

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, in psi (lb/in^2).

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. This value is determined by evaluating a stress strain diagram produced during a tensile test.

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.

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.

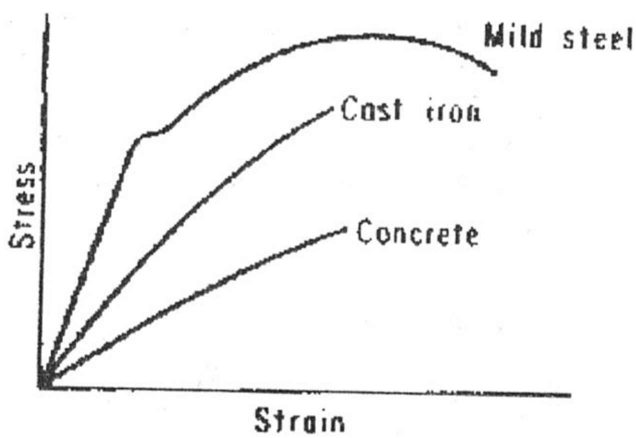
STRESS-STRAIN CURVE

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. These curves reveal many of the properties of a material.

What does a comparison of the curves for mild steel, cast iron and concrete illustrate about their respective properties?

It can be seen that the curve corresponding to concrete is almost a straight line. There is an abrupt end to the curve. This, and the fact that it is a very steep line, indicates that it is a brittle material. The curve for cast iron has a light curve to it. It is also a brittle material. Both these materials will fail and break with little warning once their limits are exceeded. Notice that the curve for mild steel seems to have a long gently curving "tail". This indicates a behavior that is very different to both former materials. The graph shows that after a certain point, mild steel will continue to deform (in case of tension to stretch) as the stress (and loading) remains more or less constant. The steel will actually stretch, that's why it is called a ductile material.

There are several significant points on a stress-strain curve that help to understand and predict the way how the different materials are going to behave.



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. A beam supporting any load develops internal stresses to resist applied loads. **Beamtypes** 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 and found with the use of the laws of static alone. 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; both types are commonly found on all kinds of structures. Distributed loads are shown as an angle or curve in the shear moment diagram. These loads are often replaced by a singular resultant force in order to simplify the structural analysis.

Beam Failure Modes

Structures fail in many ways; there are two important categories: stability and strength failures. Stability failures usually relate to structural systems, whereas strength failures relate to the members comprising a structure.

The most common beam failures are: **bending**, is probably the most common type of failure, in which the "fibers" along the bottom face of the beam are torn and those along the top face of the beam are crushed. **Vertical shear** is an idealized mode of failure. There is a tendency for a short beam to fail in this way. This is the way in which a pair of "shears" or scissors cuts pa piece of paper.

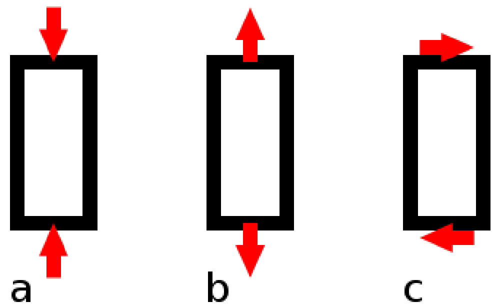
Horizontal shear is the tendency of a material to separate in a parallel form to the neutral axis as its "internal layers" try to slide past each other. Excessive deflection can also be cause of a failure.

INTERNAL FORCES

Internal forces are generated within loaded structural elements. These forces are generated within every type of element; if they were not developed, the structure would fail. These are known as Shear, Moment and Normal forces. The normal force is found in columns and beams with an axial load. Shear and moment forces are found in beams and frames. Shear and moment are essential for developing an understanding of how structures behave. In order to quantify the internal forces of any par of a beam, a FBD (free body diagram) must be drawn, with the analysis of shear, moment and deflection diagrams.

Shear (V) is the tendency for one part of a beam to slide past another part. The magnitude of the shear at any section is equal to the algebraic sum of loads and reactions acting perpendicular to that section. A shear diagram is a graphic representation of the shear at every point along the length of a member.

The **Moment (M)** within a beam is a representation of the magnitude of the internal couple found within the beam an every point. A moment diagram is a graphic representation of the moment at every point along the length of the member.



a) compressive loading
b) tensile loading
c) shear loading

ELECTRICAL SCIENCE

What is electricity? This word has been defined in several ways, but according to the Merriam-Webster dictionary, electricity is: "a fundamental form of energy observable in positive and negative forms that occurs naturally (as in lightning) or is produced (as in a generator) and that is expressed in terms of the movement and interaction of electrons". Since the previous statement defines electricity in terms of the interactions between electrons it is obvious why studying the atom and its components has been a priority for humanity.

The study of electricity begins by assuming electricity as a manifestation of electromagnetism; therefore, it begins with the study of the atom and its components, specifically the charged ones: the electron (negatively charged) and the proton (positively charged). There are two specific branches of science that study the different interactions between charged particles or bodies:

- ***Electrostatics***: this is the branch of science that studies charges which remain still.
- ***Electrodynamics***: this is the branch of science that studies charges in motion.

BASICS OF ELECTROMAGNETISM

Objects can be charged in several ways, although it is basically the same process taking place: electrons flowing from a material to another. As explained before, there are only two types of charge: **positive and negative**. When an interaction between charges occurs the results are indeed very simple; charges of the same polarity repel, while charges of different polarities attract each other. Another fact to keep in mind is that there is a charge conservation principle which is the equivalent to the Law of Conservation of Matter. There have been several great discoveries when it comes to the field of electromagnetism, but most of them are not that recent, as **Coulomb'sLaw**.

Coulomb's law

Charles-Augustin de Coulomb *(1736-1806)* was a great French physicist that developed what is now called "Coulomb's Law" which states the formula to calculate the strength of the attraction or repulsion forces within charges. Coulomb's Law states that the force between two charged objects is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. It is important to note that such a law is used at electrostatics.

Ohm's law

Georg Simon Ohm *(1789-1854)* was a German physicist and mathematician that developed what is now called "Ohm's Law" which states relationship between voltage and current is called resistance. In 1827, George Simon Ohm defined this relationship with the following formula:

$$V = I * R$$

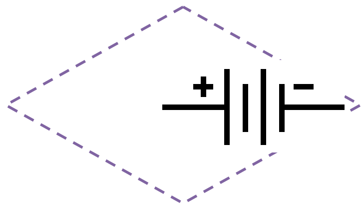
In which:

- **V** = Voltage
- **I** = Current
- **R** = Resistance

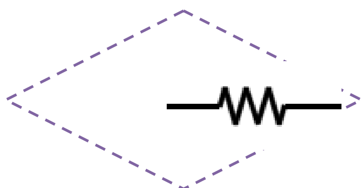
ELECTRIC CIRCUITS BASICS

Electric circuits are of great importance to engineers, they are the essential element of any electrical device. An electrical circuit is made of various components, some of which are described below:

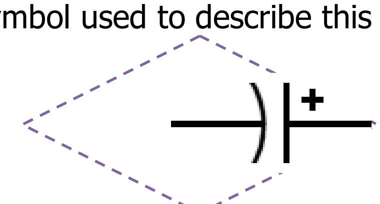
- **Battery**: this is source of direct current which has a fixed voltage. The symbol used to describe this device can be seen below:



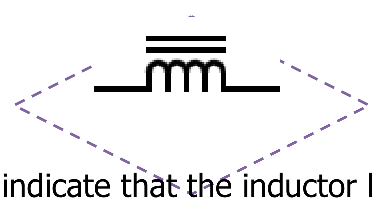
- **Resistor**: this is a very important element that can be used in a circuit; its main use is to vary the amount of resistance offered by a wire. The symbol used to describe this device can be seen below:



- **Capacitor**: this is a component made by placing a plate of an insulating material between two plates of conductive material. These devices can hold a determined quantity of energy in the form of voltage and free it later, acting as a non-regulated power supply. The symbol used to describe this device can be seen below:

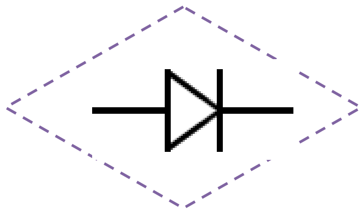


- **Inductor**: this is basically a coil of wire, similarly to the capacitor; this device can store a determined quantity of energy, but in the form of a magnetic field. This device can also be used as a power supply, but it provides current rather than voltage. The symbol used to describe this device can be seen below:



In this case, the two bars indicate that the inductor has an iron core on it.

- **Diode**: this is a device that allows current to flow only in a single direction. Typically diodes are made of a semiconductor material, specifically Silicon or Germanium. A very common kind of diode is the **LED (Light Emitting Diode)**: This special type of diode is capable of emitting light when current flows in the correct direction.



ELECTRICITY APPLIED: NANOTECHNOLOGY

The term nanotechnology refers to manipulation of materials on an atomic or molecular scale in order to build microscopic devices such as robots. When working in this branch of electronics, one of the greatest difficulties is that the size of the metallic junctures is decreased, the more their resistance is raised. This higher resistance induces greater heat dissipation, according to the theory of the Joule Effect; such a temperature increase can be enough to melt the junctures and damage the circuit.

Recent investigations at the University of Ohio have reported that they discovered a molecule chain made from organic salt that exhibits superconductivity obtaining therefore such a low resistance that it can be ignored. Originally this discovery was published in "Nature Nanotechnology" describing how the researchers' team was able to synthesize the molecules of the organic salt ((BETS)2-GaCl4), place them on a silver substrate and observe that when placed in small groups they exhibited superconductivity.

The researchers not only discovered this molecule chain, they also investigated the smallest limit to the superconductivity, noting that the best results were found in chains longer than 50nm in length. With this discovery, several scientists have claimed that the researchers have created the smallest known superconductor. This investigation might allow to reopen the option of using metallic interconnects at a nanometer scale.

ECONOMY

Macroeconomics

The study of economic activity by looking at the economy as a whole. 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.

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. Those companies have a really big workforce, great productive capacity, enough spending capital and due to their big importance those companies can be highly influential.

Microeconomics

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. Microeconomic analysis in general is associated with price theory and its derivatives.

Every business like warehouses, family drugstores because they have less than ten workers, limited spending capital, the worker sometimes is the owner of the business and those are being influenced by the previously mentioned factors.

What's the difference between macroeconomics and microeconomics?

Macro and microeconomics, and their wide array of underlying concepts, have been the subject of a great deal of writings. The field of study is vast; here is a brief summary of what each covers:

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.

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, ie 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, now matter what it takes to produce it. The ISI not only involves changes in the import, but it also means a growth in the industrial sector, a change in exports and economic growth.

GDP

Gross Domestic Product. 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.

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.

Most manufacturing is light assembly and food processing, geared to the domestic, U.S., and Central American markets. 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. 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, with the largest increases in ethanol and non-traditional agricultural exports.

The United States is the country's largest trading partner, providing 36.5% of Guatemala's imports and receiving 40.7% of its exports. The government's involvement is small, with its business activities limited to public utilities--some of which have been privatized--ports and airports, and several development-oriented financial institutions.

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.

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.

President COLOM entered into office with the promise to increase education, healthcare, and rural development, and in April 2008 he inaugurated a conditional cash transfer program, modeled after programs in Brazil and Mexico, that provide financial incentives for poor families to keep their children in school and get regular health check-ups.

The economy contracted in 2009 as export demand from US and other Central American markets fell and foreign investment slowed amid the global recession. The economy will likely recover gradually in 2010 and return to more normal growth rates by 2012.

PROGRAMMING

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. One of the greatest advantages of a computer over a human is that it is always accurate, and considering the average computer now in our days can perform up to a trillion operations per second, one could assume that no human stands a chance to beat such a device.

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. Although such a hardware relationship is very useful, it is undoubtedly the relationship between the two mindsets which gives us the greatest hint on how computers actually work. While a human being has a single brain and all thinking activities take place on it, each computer has a processor, a set of ram memories and a hard drive, which cover all the "thinking" elements.

Basics of programming

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, but what is a programming language? Basically a programming language is: "a computer's language of instruction and information". The information expressed in such a language is what we call "data". Even though the word data has such a simple definition, it comprises a whole series of different kinds of information.

- **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.

- **Strings**: This data is basically a combination of several char, it can therefore store text of any type.

When information is stored in any of the kinds of data listed above, a variable is created. Variables are known by a name given to them according to the programming language that was chosen and to the programmer's choices, but they basically can store any kind of data if used correctly.

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. In order to take advantage of the ability of a computer to perform operations so fast, a programmer must be able to control a large quantity of actions in a repetitive manner, creating the need for flow control.

There are essentially three instructions that contribute to flow control in every single programming language:

- **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.

Different needs, different languages

Programming is not about a single language, as we can learn more than just a single language; a computer can understand any language we teach it. Among this various language types there is a very useful classification:

- **Compiled languages**: these languages provide a single executable file which contains all the instructions to be run when using a specific program; these are often used for a final release in which the user will not be changing the program's source code. As you might expect this kind of languages are very common in commercial programming as it is more complicated to obtain the actual instructions of a program of it. Some examples of these languages are: Visual Basic, C, C++, etc.

- **Interpreted languages**: they are the opposite of the previous kind of languages in the sense that here the source code can easily be found and read. Interpreted languages are not compiled into a single file, they are left in plain text and an interpreter executes the actions that the code on it describes. Interpreted languages are usually slower at executing than compiled languages, but they also provide more adaptability since as long as there is an interpreter they can be run at any operating system.

Programming applied: object recognition

Object recognition is one of the most researched topics in computer research. Usually a computer can only recognize what it has been shown before, but researchers at MIT, working with colleagues at the University of California, Los Angeles, have developed new techniques that should make better object recognition systems. A conventional object recognition system, when trying to discern a particular type of object in a digital image, will generally begin by looking for the object's salient features. A system built to recognize faces, for instance, might look for things resembling eyes, noses and mouths and then determine whether they have the right spatial relationships with each other. The design of such systems, however, usually requires human intuition: A programmer decides which parts of the objects are the right ones to look for. That means that for each new object added to the system's repertoire, the programmer has to start from scratch, determining which of the object's parts are the most important.

In a paper that they'll present at the Institute of Electrical and Electronics Engineers' Conference on Computer Vision and Pattern Recognition in June, postdoc Long (Leo) Zhu and Professors Bill Freeman and Antonio Torralba, all of MIT's Computer Science and Artificial Intelligence Laboratory, and Yuanhao Chen and Alan Yuille of UCLA describe an approach that solves both of these problems at once. Like most object-recognition systems, their system learns to recognize new objects by being "trained" with digital images of labeled objects. But it doesn't need to know in advance which of the objects' features it should look for. For each labeled object, it first identifies the smallest features it can -- often just short line segments. Then it looks for instances in which these low-level features are connected to each other, forming slightly more sophisticated shapes. Then it looks for instances in which these more sophisticated shapes are connected to each other, and so on, until it's assembled a hierarchical catalogue of increasingly complex parts whose top layer is a model of the whole object.

References

https://standards.nasa.gov/history_metric.pdf

VOCABULARY

A. Match the definitions with the concepts.

1.	Computer Programming	( )	Text written in a computer programming language, specially designed to specify the actions to be performed by a computer.
2.	Debugging	( )	Artificial language designed to communicate instructions to a machine.
3.	Source Code	( )	A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps.
4.	Computer Program	( )	Software consisting of programs and data, that runs on computers, manages computer hardware resources, and provides common services for execution of various application software.
5.	Programming Language	( )	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.
6.	Algorithms	( )	Sequence of instructions written to perform a specified task with a computer.
7.	A compiler	( )	Ease with which a human reader can comprehend the purpose, control flow, and operation of source code.
8.	Readability	( )	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.
9.	Operating system	( )	Process of designing, writing, testing, debugging, and maintaining the source code of computer programs.
10.	Software bug	( )	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.

B. Write the properties in the correct spaces, according to the concepts.

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.

- 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., buffer overflows and race conditions) and 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.

- 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 behaviour of the hardware and operating system, and availability of platform specific compilers (and sometimes libraries) for the language of the source code.

- 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.

READING

C. Read the following passage.

PROGRAMMING LANGUAGE HISTORY

The first programming languages predate the modern computer. Herman Hollerith realized that he could encode information on punch cards when he observed that railroad train conductors would encode the appearance of the ticket holders on the train tickets using the position of punched holes on the tickets. The first computer codes were specialized for the applications. In the first decades of the twentieth century, numerical calculations were based on decimal numbers. Eventually it was realized that logic could be represented with numbers, as well as with words.

Like many "firsts" in history, the first modern programming language is hard to identify. From the start, the restrictions of the hardware defined the language. Punch cards allowed 80 columns, but some of the columns had to be used for a sorting number on each card. Fortran included some keywords which were the same as English words, such as "IF", "GOTO" (go to) and "CONTINUE". The use of a magnetic drum for memory meant that computer programs also had to be interleaved with the rotations of the drum. Thus the programs were more hardware dependent than today.

Jacquard looms and Charles Babbage's Difference Engine both had simple, extremely limited languages for describing the actions that these machines should perform. In the 1940s the first recognizably modern, electrically powered computers were created. The limited speed and memory capacity forced programmers to write hand tuned assembly language programs. It was soon discovered that programming in assembly language required a great deal of intellectual effort and was error-prone. Some important languages that were developed in this time period include:

1943 - Plankalkül (Konrad Zuse)
1943 - ENIAC coding system
1949 - C-10

In the 1950s the first three modern programming languages whose descendants are still in widespread use today were designed:

FORTRAN, the, invented by John W. Backus et al.;
LISP, , invented by John McCarthy et al.;
COBOL, the, created by the Short Range Committee, heavily influenced by Grace Hopper.

Another milestone in the late 1950s was the publication, by a committee of American and European computer scientists, of "a new language for algorithms"; the Algol 60 Report (the "ALGOrithmic Language"). Algol 60 was particularly influential in the design of later languages, some of which soon became more popular. The Burroughs B5000 was designed to be programmed in an extended subset of Algol. Some important languages that were developed in this time period include:

1951 - Regional Assembly Language
1952 - Autocode
1954 - FORTRAN "FORmula TRANslator"
1958 - LISP "LISt Processor"
1958 - ALGOL
1959 - COBOL "COmmon Business Oriented Language"
1962 - APL
1962 - Simula
1964 - BASIC
1964 - PL/I

The 1960s and 1970s also saw considerable debate over the merits of "structured programming", which essentially meant programming without the use of GOTO. This debate was closely related to language design: some languages did not include GOTO, which forced structured programming on the programmer. Although the debate raged hotly at the time, nearly all programmers now agree that, even in languages that provide GOTO, it is bad style to use it except in rare circumstances. As a result, later generations of language designers have found the structured programming debate tedious and even bewildering. Some important languages that were developed in this time period include:

1970 - Pascal	1972 - Prolog
1972 - C	1973 - ML
1972 - Smalltalk	1978 - SQL

The 1980s were years of relative consolidation. C++ combined object-oriented and systems programming. The United States government standardized Ada, a systems programming language intended for use by defense contractors. In Japan and elsewhere, vast sums were spent investigating so-called "fifth generation" languages that incorporated logic programming constructs. The functional languages community moved to standardize ML and Lisp. Rather than inventing new paradigms, all of these movements elaborated upon the ideas invented in the previous decade.

However, one important new trend in language design was an increased focus on programming for large-scale systems through the use of modules, or large-scale organizational units of code. Modula, Ada, and ML all developed notable module systems in the 1980s. Module systems were often wedded to generic programming constructs---generics being, in essence, parameterized modules (see also parametric polymorphism).

The 1980s also brought advances in programming language implementation. The RISC movement in computer architecture postulated that hardware should be designed for compilers rather than for human assembly programmers. Aided by processor speed improvements that enabled increasingly aggressive compilation techniques, the RISC movement sparked greater interest in compilation technology for high-level languages.

Language technology continued along these lines well into the 1990s. However, the adoption of languages has always been driven by the adoption of new computer systems, and in the mid-1990s one of the most important new systems in computer history suddenly exploded in popularity. The rapid growth of the Internet in the mid-1990s was the next major historic event in programming languages. By opening up a radically new platform for computer systems, the Internet created an opportunity for new languages to be adopted. In particular, the Java programming language rose to popularity because of its early integration with the Netscape Navigator web browser, and various scripting languages achieved widespread use in developing customized applications for web servers. Neither of these developments represented much fundamental novelty in language design; for example, the design of Java was a more conservative version of ideas explored many years earlier in the Smalltalk community, but the widespread adoption of languages that supported features like garbage collection and strong static typing was a major change in programming practice.

Some important languages that were developed in this time period include:

1990 - Haskell	1991 - Java	1994 - PHP
1990 - Python	1993 - Ruby	2000 - C#

Programming language evolution continues, in both industry and research. Some current directions:

- Mechanisms for adding security and reliability verification to the language: extended static checking, information flow control, static thread safety.
- Alternative mechanisms for modularity: mixins, delegates, aspects.
- Component-oriented software development.
- Increased emphasis on distribution and mobility.
- Integration with databases, including XML and relational databases.
- Open Source as a developmental philosophy for languages, including recent languages such as Python, Ruby, and Squeak.
- Support for Unicode so that source code (program text) is not restricted to those characters contained in the ASCII character set; allowing, for example, use of non-Latin-based scripts or extended punctuation.

D. Summarize the previous passage into 2 or 3 narrative paragraphs.

E. Java is a widely-used programming language that's relatively easy to use. Are you a programming guru or a novice? Take the quiz to find out.

1. What is the name for an application that changes a human-readable programming language into a machine-readable language?
    a. Compile
    b. Converter
    c. Encoder

2. What is the Java development environment?
    a. Sun Microsystems headquarters
    b. A customized, partitioned hard drive
    c. A software development kit

3. What is an applet?
    a. A small apple
    b. A simple computer application
    c. A Java-specific program

4. When programming in Java, which of the following must you keep in mind?
    a. Java can handle parentheses, but not brackets
    b. Java doesn't recognize spaces
    c. Case matters

5. What's the extension for a compiled Java file?
    a. .class
    b. .java
    c. .xml

6. What kind of programming language is Java?
    a. An object-oriented programming language
    b. An array programming language
    c. A logic programming language

7. What's another word for the programming term "method?"
    a. Theme
    b. Function
    c. Madness

8. What's the common term for an error within a computer program's code that prevents it from functioning properly?
    a. A glitch
    b. A hack
    c. A bug

9. What's another name for an execution error?
    a. Sysfail
    b. Run-time error
    c. Noncompile error

10. What is a variable?
    a. An unpredictable element in a Java program
    b. A program that can run fast or slow depending on user input
    c. A way to hold data temporarily in a program

F. What does the following program do?

```
#include <iostream.h>
#include <conio.h>
void main()
{
  clrscr();
  int x = 10;
  int y = 2;
  int sum, difference, product, quotient;
  sum = x + y;
  difference = x - y;
  product = x * y;
  quotient = x / y;
  cout << "The sum of " << x << " & " << y << " is " << sum << "." << endl;
  cout << "The difference of " << x << " & " << "y <<  is " << difference <<
"." << endl;
  cout << "The product of " << x << " & " << y << " is " << product << "."
<< endl;
  cout << "The quotient of " << x << " & " << y << " is " << quotient << "."
<< endl;
  getch();
}
```

- What does this program do? ____

  ____

- What does the instruction cout do? ____
- Sum, difference, product and quotient are instructions? ___________________________
- What is the function of the instruction clrscr? ___________________________________
- Write the output of the program.

G. And this?

```
#include <iostream.h>
#include <conio.h>
void main()
{
clrscr();
int v,u,a,t;
cout << "Enter the velocity, acceleration, time as integers : " << endl;
cin>>u>>a>>t;
v=u+a*t;
cout << "The final velocity is " << v << "." << endl;
getch();
}
```

- What does it do? ____
- Which are the variables of the program ________________________________
- Do a probe running and write the output.

H. Write a program that calculate the age of a person, the user has to enter the current year.

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I. Answers for the quiz.

ACBCAABCBC

GLOSSARY

Algorithm

Applet

Bug

Compiler

Computer Program

Computer Programming

Debug

Java

Operating System

Programming Language

Source Code