UNIT 4: DEVELOPMENT OF INDUSTRIES

Industry is defined as the skill of making other products from raw materials. It involves extraction and processing into finished products of raw materials

Early Sources of Energy.

Energy is the ability to do work. The following are the early sources of energy that can be identified.

Wood.

Wood developed as a source of energy after the discovery of fire. It was used as follows;

a) Making fire which provides heat to warm people during cold seasons lighting, to cook roots and roast meat, for hunting (bushfires), tool-making to harden tips, means of communication, food preservation

b) Charcoal made from wood fuel provided heat that was used for steaming water to provide steam power for steam engines during the industrial revolution.

This is a form of energy still in use today since it is cheaper and easily available.

Wind.

Wind was used to drive sailing ships during the trade between East African Coast and the Far East

Windmills were used in China to grind grain and process foods

They were also used to pump water from polders in Netherlands

Windmills are also used to generate electricity

Windmills are mainly used in areas with fewer trees like in Isiolo, Garissa, Wajir and Mandera

However the use of wind as a source of energy is disadvantaged by its being irregular and inconsistent in direction and strength.

Water.

Water has been harnessed to produce HEP

Water was used to turn wooden propellers (water wheels) which in turn turned grindstones to grind grains into flour.

In England, it was used in the Textile and paper industry to turn spinning machines

In Italy water-powered machines were used to make copper pots, weapons of war, to spin silk and to sharpen various tools

Water also is not reliable as a source of energy since the levels may be too low during dry weather for HEP production.

Uses of metals in Africa

The age of metals in Africa is divided into the Bronze and Iron Age.

Man moved from the Stone Age to the age of metals because metals had the following

Advantages;

a. Metallic tools were more durable. They could not break easily.
b. Cutting edges of metals could be sharpened.
c. Malleable Metals could be heated and reworked into deferent usable designs when need arose
d. Metals are not prone to waste. Broken pieces can be smelted and reworked into useful items. For example a broken spear into an arrow.

The following are examples of metals that were used in Africa.

Gold.

This was the first metal to be used by humankind. It was used in Meroe, Egypt, Wangara in Ghana and in Central Africa.

Gold is malleable and therefore it could be easily moulded into the desired shape withoutsmelting it. Its softness however implied that tools made from gold could bend easily. It was also heavy and could not be found everywhere.

Uses of Gold.

i) It was used to make ornaments and decorations. In Egypt, it was used to make jewellery like rings, bangles and bracelets.
ii) It was used to make utensils, such as plates, vases and drinking vessels.
iii) It was used to make swords and flint knife handles among the rich in Egypt.
iv) It was used to make coins in Egypt.
v) It was used as a trade item in East, central and West Africa
vi) It was used to make weapons such as sword and knife blades.
vii) Gold was also a measure of wealth in Egypt.

Copper.

Though quite soft, copper as harder than Gold and could make better tools. The Egyptians were the earliest people to use copper by 3000 BC.

The metal could further be hardened by mixing it with other metals to form alloys during smelting.

Uses of copper.

i) Making utensils and containers such as pots and pans.
ii) The Egyptians used copper to make axes, tools, Chisels, Pins and fish hooks.
iii) It was used to make ornamental bangles, rings, helmets, needles, wire chains and statues.
iv) It was used as a medium of exchange in the form of copper bars.
v) It was used to make daggers (weapons).
vi) It was used as a trade commodity. Those with copper exchanged it with other goods that they did not have.
vii) It was used to make alloys like Bronze and Brass.

Bronze.

Bronze is a mixture of copper and tin which makes it harder than copper. It was used during the Bronze Age.

In Africa Bronze was used among the Yoruba, Dahomey and Asante in Nigeria and in Benin. And also in Egypt. Benin was the centre of Bronze.

Uses of Bronze.

i) Making stronger weapons such as shields, spears, arrowheads, swords and daggers.
ii) Making sculptures and decorations. For example, in Benin it was used to make objects for religious ceremonies, masks and decorating the king's palace. It decorated temples, palaces and pyramids in Egypt.
iii) Making knives, containers, pans and vases.
iv) It was a store of wealth.
v) It was used to make tools, shields and chariots.

Disadvantages of Bronze.

i) The tools lost their sharpness and became blunt quickly since the metal was relatively soft.
ii) They required constant sharpening.
iii) Bronze was not cheap. The mixture of copper and yin had to be acquired through trade thus making bronze expensive.
iv) It was difficult to get an appropriate proportion of each of the two metals.

Iron.

Two theories that explain the origin and spread of iron working in Africa are;
1) It was first introduced in North Africa from the Middle East by the Phoenicians and the Assyrians, and then spread to west, East Central and South Africa.
2) The art of iron working probably developed independently in Africa as evidenced by the Archaeological evidence in Buhaya (the oldest iron age site that existed between 5th and 6th C AD) , North –West of Tanzania. The Buhaya iron is associated with the pottery style known as Urewe-ware
The Hittites were the first people to smelt and use iron in around 1500BC. The skill then spread to the Assyrians. The idea then spread to Africa between 400 and 500 BC and became widespread in the Nile Valley.
By 5th c it had spread upto Meroe (the Birmingham of Africa) then to Ethiopia. From Carthage and Tunisia, it spread to West Africa, at Taruga in Nigeria's Jos plateau at around 580BC, then to Lake Chad by 500 AD

Ways in which the iron culture spread in Africa.

1) Through wars of conquest e.g. Egypt versus Assyrians where the Assyrians forced the Egyptians to learn to use iron from Meroe to make strong weapons.
2) Trade e.g. the Mesopotamians traded with Africans. The North African then traded with the West Africans, thus spreading the iron smelting technology across the Sahara.
3) Intermarriages e.g. Arabs and Africans intermarried and hence a new iron culture and technology developed.
4) Through learning and acquiring the technology from neighbors.
5) Increased demand for iron tools for agriculture, weapons and iron products increased trade in iron.
6) Migrations. E.g in east Africa where the Bantus and nilotes arrived from West African region with the iron culture which they introduced to east Africa.
7) Travelers and messengers who gave out and received the gifts of iron

Uses of Iron

a) It was used as medium of exchange. Iron bars were used as currency.
b) To make agricultural tools such as hoes and pangas this increased food production.
c) Weapons such as spears and arrows were made of iron, which strengthened some communities while others who lacked the same were easily defeated.
d) Iron was used as a trade item where those who did not have it acquired it through barter trade.
e) It was used for storing wealth. Smithers used iron bars as a measure of value.

Effects of iron working.

a) It promoted empire building. Many kingdoms and empires relied on strong iron, weapons s to fight expansionist wars e.g. Egypt, Benin and Mwene Mutapa empires.
b) It led to migrations especially of the Bantus who war able to protect themselves during the journeys using iron weapons.
c) It promoted agriculture since large tracts of land could now be used to produce more food using stronger tools.
d) Adequate food resulted in population increase and later migration to areas with sparse population.
e) It resulted in specialization and division of labour as some people became iron smelters while others engaged in other activities like trade.
f) It stimulated construction and building works using stronger metals like iron. Better houses, temples and bridges were built.
g) Metal technology also had an impact on religion in that metals began to be used when performing religious rites and in royal palaces e.g. the golden stool among the Asante.
h) Trading and industrial towns developed within and around the major mining centres like Meroe Axum, in Ghana, in Zimbabwe and in Benin.
i) Trade was promoted in that sometimes iron was used as currency and others became important items of long distance and regional trade.

INDUSTRIAL REVOLUTION IN EUROPE.

The **Industrial Revolution** was a period from 1750 to 1850 where changes in agriculture, manufacturing, mining, transportation, and technology had a profound effect on the social, economic and cultural conditions of the times. It began in the United Kingdom, and then subsequently spread throughout Western Europe, Northern America, Japan, and eventually the rest of the world.

The industrial revolution in Europe occurred in two phases;

The old phase was from 175-1850 and began in Britain and spread to other European countries like France (1825), Germany (1840), Belgium (1870) and Russia (1890). In USA, it began after the American civil war of 1861 to 1865. In Japan it began in 1900. In Kenya, it is hoped to be done by 2030.

Characteristics of industrial revolution in Europe.

i. The use of machines to replace human and animal labour.
ii. The use of steam power as a new source of energy to replace water, wind and animal power.
iii. Increased exploitation and use of coal, iron and steel.
iv. The rise of the factory system in owns instead of the cottage industries in homes.
v. The development of better forms of transport including the use of railways, roads and water.
vi. Improved living standards and an increase in the human population who required more manufactured goods.
vii. The production of goods on large scale. Machines worked faster than human labour.
viii. The development of science and the application of scientific knowledge in production.
ix. There was development of trade as manufactured goods were sold locally and abroad.
x. The rise of modern capitalism that provided enough wealth which was then invested back into industry.
xi. The growth of trade Union Movements to carter for the rights of industrial workers.

Uses of Various Sources of Energy.

Coal.

This is a compact black or dark brown, carbonaceous rock which is a fuel and source of coke, coal gas and coal tar.

Abraham Darby invented the process by which coal was turned into coke in 1709 thus discovered that coal produced immense heat. Coke was used to smelt iron.

Uses of coal.

i. To heat water to high temperatures so as to produce steam.
ii. To provide lighting.
iii. To drive steam engines in factories. Some generators depended on coal heat to produce steam.
iv. To drive locomotives. This promoted transport.
v. It was a raw material in the manufacturing of dye and pharmaceutical products.

Disadvantages of Coal.

a) It is bulky and transporting it is difficult.

b) It produced too much smoke when used in locomotives. Also gases released during the burning of coal e.g sulphur dioxide polluted the air and caused acid rain.

c) Coal was expensive to mine and to transport to the required destination.

d) Coal mining was risky to miners who often lost their lives when mines collapsed and buried them.

Petroleum.(often referred to as oil)

Before 1850, oil was known to American farmers as a substance that affected food production in farms. It was an American Don, Bissel who carried out an analysis of oil samples at a university lab and established that oil was both a fuel and lubricant.

The use of oil became widespread with the invention of the internal combustion engine by Gotlieb Daimler.

Uses of oil.

a) To power vehicles, aeroplanes and ships

b) To generate electricity used in lighting and cooking.

c) To run engines in industries

d) Tar (Bitumen), a by-product of petroleum is used to tarmac roads.

e) Greasing of metals in industries was also done by petroleum by-products such as grease.

f) Certain petroleum chemicals are used in making of drugs, fertilizers, synthetic fibre and plastics.

Disadvantages of oil

a) For countries importing oil, it is expensive to transport.

b) Prospecting for oil is quite expensive.

c) Oil may also affect the environment, since extracting large quantities of petroleum may cause land to sink.

Steam.

Steam is boiling water turned into gas. It was used for first time around 100 AD in a steampowered engine developed by a Greek scientist called Hero.

In the 16th century, Thomas Savery, a Briton, built a steam engine which could pump water out of a coal mine.

In 1712, Thomas Newcomen improved Savery's design, though he design was still ineffective.

In 1764, James Watt improved on Newcomen's engine to make it more effective and by 1800,

320 of Watt's engines were in use in Britain.

In 1801, Richard Trevithick installed one of Watt's engines in a road vehicle. Three years later, he produced a steam-driven locomotive that ran on rails.

In 1830, George Stephenson improved on Trevithick's work and invented the first steam locomotive, the rocket.
In all these engines, coal was used to produce steam.

Uses of steam.
a) It was used to drive heavy machinery in factories and to turn turbines that generated power for industrial use, e.g driving, spinning and weaving machines.
b) It was used for pumping water out of coal mines.
c) It was used in steam –powered locomotives and ships.
d) The massive temple doors in Egypt were only opened using steam.

Electricity.
Electricity was discovered by an English Scientist called Michael Faraday (1791-1861) in 1831 when he invented the electric Dynamo. His principal of electromagnetic induction was the beginning of both the dynamo and the electric Motor. The energy used energy from coal, oil, steam or water to produce electricity
The use of electricity became widespread from 1900.

Uses of electricity.
a) Lighting.
b) Heating and cooking.
c) Powering machines in factories.
d) Communication. Electric signals are used in communication gadgets.
e) Powering transport vehicles such as electric trains and electric cars.

Disadvantages of electricity.
a) It can be dangerous if not properly installed or used.
b) The generation and distribution of electricity is very expensive thus making its use limited to fewer people in developing countries.

Other sources of energy.

Atomic energy.
In 1896, A French physicist, Antoine Henri Beckquerel (1852-1903), discovered that uranium produces radiation or energy in waves. (Radioactivity). This was the birth of the development of Atomic energy.
In 1938, Hahn and Stressman discovered the process of Atomic fusion which leads to production of Atomic energy.
In 1942, a group of scientists led by Enrico-Fermi at the University of Chicago, USA, built the first
Nuclear research Station which resulted in the invention of the nuclear reactor and later the discovery of an Atomic Bomb like one which was used Hiroshima and Nagasaki in 1945.
In Belgium and France, 60% of the electricity is produced from atomic power
However, atomic energy when used in war can be very fatal
Radioactivity also endangers both animal and plant life.
Polluted air, where radioactivity has taken place causes fever, diarrhea and death. For example the radioaction accident in 1985 at Three Mile Island in the USA and at Chernobyl near Kiev in Ukraine in 1986 had fatal consequences.

Solar Energy.
It is obtained directly from the sun and is used to dry firewood, clothes and to cook food.
In 1714, Antoine Lavoisier made a solar furnace which could melt metals.
An engine using solar power was used to run a printing press in Paris in 1880.
The use of solar water heaters was widespread in USA by 1900.
In 1954, the first solar cell which turned sunlight into electricity was made. The energy was then used to heat water and generate electricity.

Uses of Solar energy.
a) Drying agricultural products.
b) Distilling of salty water to get salt crystals.
c) Heating water in homes and industry
d) Heating and lighting buildings
e) Cooking using solar cookers
f) Irrigating using solar water pumps,
g) Powering satellites in space.

Advantages of solar energy.
a) It is clean and is available in places where sunlight is readily available.
b) It is natural and therefore free, non-pollutant and inexhaustible source of energy.

Iron and steel
Iron was not really a source of energy but the industrial revolution was dependant on the availability of iron
Uses of iron.

a) Production of machines for textile industry. Water pipes and ploughs were made of iron.
b) Production of steam engines.
c) Building of trains, railway lines ships, wheels, bridges and coach frames.
In an attempt to overcome the disadvantages of iron (it was too heavy and could rust easily), in
1856, an Englishman, Henry Bessemer produced steel out of Iron and Carbon. (Steel is an alloy of iron and Carbon and is lighter, flexible, stronger and harder than iron) Stainless steel, commonly used in cutlery is an alloy of Steel and Chromium.

Uses of steel.
a) The construction of rail lines, bridges, cars and ships.
b) The manufacturing of machinery especially in the agricultural and industrial sector.
c) Reinforcement of concrete in buildings and roofing houses.
d) Making of containers and utensils.

INDUSTRIALIZATION IN BRITAIN.
This change, which occurred between 1750 and 1830, happened because conditions were perfect in Britain for the Industrial Revolution. The transformation was facilitated by the following factors;
a) Availability of coal and iron ore which served as a basis for heavy industries. Coal was a source of energy for use in the industries. Iron was used in the manufacture of machinery.
b) The agrarian revolution ensured that important raw materials were available for the industries and also made food more available for the many factory centres
c) Existence of a large population which provided steady internal market for the manufactured goods/domestic local markets. There was also Availability of external markets in her colonies for the industrial produce.
d) Existence of cottage industries which acted as a base for industrial take-off in Britain. It was easier to turn to mass production of goods on the basis of the small scale production in cottage industries.
e) Due to the enclosure act, many peasants became available to offer unskilled labour especially following their displacement from the rural areas.
f) Political stability and strong leadership that existed at the time created a contusive environment for investments when compared to other European countries.
g) Well developed transport and communication network e.g railway, canals, bridges, harbors and roads which promoted industrialization.
h) Existence of good banking and insurance systems which gave financial help and security to the industries.
i) Britain had a strong navy that guarded her trade routes thus protecting her merchants from foreign competition.
j) Policy of free trade encouraged industrialization/ existence of the merchant and middle class who formed pressure groups that forced the government to adopt measures favoring their industries. Britain had no internal customs barrier to hurt her industrial growth.
k) Availability of wealth/capital that stimulated industrial revolution. Britain had accumulated a lot of wealth from her trade with other countries and her colonies in America and Africa. e.g. The steam engine was made in Britain by a wealth Briton.
l) Availability of industrial raw materials in her vast colonies.

INDUSTRIALIZATION IN CONTINENTAL EUROPE.
The Industrial Revolution on Continental Europe came a little later than in Great Britain.

Reasons why other European countries delayed in the industrialization process.
a) The political upheavals in France, Germany and Italy were responsible for the delay in the take- off of industrialization.
b) The existence of a feudal economy in which the peasant farmers could not afford to buy industrial goods nor raise capital to invest in industry.
c) The system of farming implied that inadequate raw materials came from the farms thus making it difficult for industrial development.
d) Their system of transport was not developed.
e) Unlike Britain, these countries did not have an enterprising class of people and scientists ready to take up the task of industrial investment and invention.

Factors that led to industrial development in continental Europe.
a) Political stability and strong leadership that followed the unification of Italy and Germany and end of Napoleonic rule in France created a contusive environment for investments when compared to other European countries. Feudalism was also abolished.
b) The agrarian revolution that had taken place in continental Europe ensured that the countries had raw materials for their industries. Other strategic raw materials like coal and iron were readily available.
c) There was adequate capital from the rich traders who willingly invested in industry. Britain also gave loans to the European countries to industrialize.
d) Existence of good banking and insurance systems which gave financial help and security to the industries.
e) Existence of a large population which provided both skilled and unskilled labour required by the industries.
f) The European governments supported the industrial ventures that were aimed at enhancing economic development. French and Germany governments gave tax concessions and subsidies to encourage industrialization.

g) Existence of a steady internal and external market for the manufactured goods/there was a high European population that consumed most goods locally.
h) Well developed transport and communication network e.g better roads, railway and water transport which meant that industrial workers, raw materials and finished goods could be transported easily.
i) Countries in continental Europe had vast sources of energy such as coal, steam power and electricity which enhanced industrial development.
j) The development of new skills in science and technology facilitated industrial growth. Some
European countries like France and Germany sent their people to Britain to acquire skills and ideas in science and also invited English technicians to their countries.

Effects of the industrial revolution in Europe.
a) *Creation of employment opportunities.* Ordinary working people found increased opportunities for employment in the new mills and factories.
b) *Emergence of Factories and urbanization.* Industrialization led to the creation of the factory system was largely responsible for the rise of the modern city, as large numbers of workers migrated into the cities in search of employment in the factories.
c) *Improved Standards of living.* Living conditions and health care improved during the 19th century. The famines that troubled rural areas did not happen in industrial areas.
d) *Population increase.* As living conditions and health care improved during the 19th century,
Europe's population doubled every 50 years. Infant mortality reduced.
e) *Local and international trade developed.* Manufactured goods were sold locally while others were exported to America. The industries also created market for raw materials from Africa and Asia.
f) *European economies became diversified as a result of industrial growth.* This led to specialization e.g. traders, bankers, mechanics and agriculturalists.
g) Development and use of machinery in agriculture led to increased production
h) *Improvement in Transportation and technology.* The expansion of business and factories expanded Canals, highways and railways were expanded.
i) Large scale production of a wide range of goods. New methods of farming, such as the use of fertilizers and new crop breeds were developed
j) *The industrial revolution promoted development of science and technology*. There was increased utilization of knowledge in production of goods as well as scientific inventions such as invention of electricity.
k) *The emergence of trade union movement.* The Industrial Revolution concentrated labour into mills, factories and mines, thus facilitating the organization of *combinations* or trade unions to help advance the interests of working people.
l) Eventually *effective political organization* for working people was achieved through the trades unions who began to support socialist political parties that later merged to become the British Labour Party.
m) It led to Political corruption - the amount of money generated by the Industrial Revolution created a class of super rich who could buy any politician or process.
n) *Environmental damage* - there were few if any rules regarding how resources could be removed and used. The air was horribly polluted from factories, as was the soil and rivers.
o) There was increased exploitation of natural resources in Europe during the revolution. Iron, coal and steel production increased.
p) *Industrial revolution was accompanied with economic Exploitation of people.* While jobs were created, sometimes the jobs were dangerous and people died. Harsh working conditions, Child labour, dirty living conditions, and long working hours were prevalent.
q) *Rise of unemployment.* The rapid industrialization cost many craft workers their jobs. Many weavers found themselves suddenly unemployed since they could no longer compete with machines to produce cloth.
r) The industrial revolution was responsible for the scramble and partition of Africa. The colonies produced raw materials for industries in Europe and also acted as markets for goods processed in Europe. For this reason, many European nations sought to have as many colonies as possible.

The scientific Revolution.
Science is the systematic study of the nature and behaviour of the material and physical universe based on observation
The **scientific revolution** refers to the history of science in the early modern period, where sudden development in mathematics, physics, astronomy, biology, medicine and chemistry transformed views of society and nature.

Causes of scientific revolution.
a) *Discovery of the New World*. Exploration/conquest leading to discovery of new plant/animal life. Traditional link between navigation and astronomy + great advances made my
Portuguese navigators fueled an interest in learning more about the stars
b) *Invention of the Printing Press*. Allowed for rapid dissemination of scientific knowledge.
Numerous books and newsletters were in circulation keeping people informed of science
c) *Rivalry among Nation-States*. Constant warfare among nation-states pushed for scientific development by placing an importance on technology, or applied science. Powerful leaders of nation-states funded scientific development.
d) *Renaissance / birth of knowledge*. During this period, Human interest in the classical world increased. Renaissance time made people to develop interest in research/ learning.
e) The need to solve their daily life problems like shortages, disease etc. necessity is the mother of all inventions.

f) *Financial support for governments and individuals*. Governments and individuals financed scientific research.
g) Religion failed to answer all questions. This sometimes betrayed man's belief in supernatural power thus emphasizing research.

Scientific inventions.
Scientific inventions have roots in the ancient civilization in Egypt, Mesopotamia, Greece, China and India. Early inventions were witnessed in the field of medicine, astronomy, agriculture, medicine and mathematics as follows;
a) The Egyptians discovered geometry which they used on farms. They discovered dead body preservation method (mummification). Build pyramids for their pharaohs using knowledge in mathematics.
b) Greeks like Pythagoras contributed to mathematics, especially the right angled triangle as early as 200BC, Euclid did some work in geometry. Archimedes discovered how the lever works. Ptolemy is remembered for geographical work especially production of the Atlas.
c) The Chinese made cloth from silk and developed acupuncture skills. They invented paper making in 70 AD. They made gunpowder and the calendar.
d) The Indians invented the decimal system in mathematics.
e) The Muslim Arabs developed the art of architecture as evidenced by the construction of unique mosques.
Period Inventor and invention
1473-1543 Nicolas Copernicus a polish astronomer. He discovered that Celestial bodies possess uniform, circular motion around a central point.
1564 - 1642 **Galileo Galilei.** In 1609 the Italian mathematician invented the telescope and observed the universe. He accepted Copernican astronomy and the implicit necessity of a 'new' physics to replace Aristotelian mechanics.
1571 - 1630 **Johannes Kepler**. Used Brahe's data to confirm that the sun was the center of the universe and the earth and other planets revolved around it.
1642 - 1727 **Sir Isaac Newton**). He explained theories of motion and inertia with the force of gravity. Newton also described the composition of light.
1743-1794 Antoine Lavoisier, a Frenchman. He showed that air was made of hydrogen and oxygen elements.
He stated that chemical substances comprised different elements.
1766-1844 **John Dalton**, an English Teacher was the founder of modern chemistry and is famous for the atomic theory *"all matter is made up of tiny particles called atoms."*
1706-1790 **Benjamin Franklin** (USA) he stated that lightning was a form of electricity. He came up with the theory of electricity and invented the lightning rod.
1791 - 1867 **Michael Faraday** creates the electric motor, and develops an understanding of electromagnetic induction, which provides evidence that electricity and magnetism are related. In 1831, he invented the electric dynamo, a machine which produced electricity from a magnet.
1799 - 1878 **Joseph Henry's** research on electromagnetic induction is performed at the same time as Faraday's. He constructs the first motor; his work with electromagnets leads directly to the development of the telegraph.

Impact of scientific inventions
Impact of scientific inventions on agriculture
a) Food production has been increased thanks to the use of farm machinery, fertilizers, pest
1831-1979 **James Clerk Maxwell** pointed out that acceleration of electric charges emitted electromagnetic radiation. The ideas underlying Maxwell's theories of electromagnetism describe the propagation
of light waves in a vacuum.
1787-1854 . In 1827, **George Simon Ohm** determined that the current that flows through a wire is proportional to its cross sectional area and inversely proportional to its length or Ohm's law.
1876 **Nicolaus Otto**, A German traveling salesman named constructed the first practical internal combustion engine; it used a four stroke cycle of a piston to draw a fuel-air mixture into a cylinder, compress it, mechanically capture energy after ignition, and expel the exhaust before beginning the cycle anew.
1847-1869 Alexander Graham Bell, In 1876, at the age of 29, invented his telephone.
1701 Tull, Jethro invented a horse-drawn seed drill.
1764 Water frame invented by **Richard Arkwright** - the first powered textile machine.
1888-1946 John Logie Baird is remembered as the inventor of mechanical television (an earlier version of television). Baird also patented inventions related to radar and fiber optics.
1755
Robert Bakewell produces Leicester sheep through selective breeding methods. In 1769, Bakewell
breeds Longhorn cattle through selective breeding
1786 Andrew Meikle, a Scottish engineer, develops threshing machine
1831 Cyrus McCormick invents the first commercially successful horse-drawn reaper for harvesting wheat
1837 John Deere develops and manufactures the first commercially successful cast-steel plough
1831 – 1860s John Fowler pioneers the use of engines for ploughing and drainage channels
1879 Anna Baldwin patents a milking machine—a vacuum device connected to a hand pump to replace hand milking. Invention receives a patent but not commercially successful.
1842 The first grain elevator is built by Joseph Dart in the U.S.
1850 Edward Quincy invents the corn picker

1764 Spinning jenny invented by James Hargreaves - the first machine to improve upon the spinning wheel.
1733
Flying shuttle invented by John Kay - an improvement to looms that enabled weavers to weave faster.
1779
Crompton invented the spinning mule that allowed for greater control over the weaving process.
1785 Cartwright patented the power loom. It was improved upon by William Horrocks, known for his invention of the variable speed batton in 1813.
1847 -1931 Thomas Alva Edison is Most famous for his invention of the electric incandescent light bulb.
1853 - 1937 Elihu Thomson. His experiments eventually led to the adoption of alternating current technology.
1913 Robert Adler. He is Most famous for his invention of the wireless TV remote control.
1856 -1943 Nikola Tesla is Recognized as one of the outstanding pioneers in the electric power field
1765-1825
Eli Whitney invented the cotton gin in 1794. The cotton gin is a machine that separates seeds, hulls and other unwanted materials from cotton after it has been picked.
1895 **Wilhelm Röntgen** discovers x rays.
1898 **Marie and Pierre Curie** separate radioactive elements.
1898 **Joseph Thompson** measures the electron, and puts forth his "plum-pudding" model of the atom that the atom is a slightly positive sphere with small, raisin-like negative electrons inside. and control methods and scientific breeding. Hybrid seeds have been developed together with new animal breeds.
b) Scientific inventions have stimulated scientific research in the field of agriculture. This is done in schools, agricultural institutes and colleges.
c) Farming of perishable foods has been made possible due to invention of preservation methods for foods like canning and refrigeration.
d) Increased food production has led to increase in population. There is increased food security. There is also increased trade.
e) Biotechnology has contributed to diversification of agriculture leading to greater crop and animal production.
f) Farming has been revolutionized from small-scale subsistence farming to large –scale economic activity due to mechanization on farms

Negative impacts of scientific inventions on agriculture.
a) The consumption of chemically –treated and stored food has raised concern for food elated disease such as cancer and heart diseases
b) Use of pesticides and fertilizers sometimes poses the challenges of cost. Some pesticides are toxic and therefore harmful to humans and animals.
c) Consistence use of fertilizers impoverishes the soil fertility. The more the fertilizer is used the more the soil becomes infertile.
d) Traditional crops are being threatened by biotechnology and development of hybrids.

Impact of scientific inventions on industry.
a) Large quantities of goods can be produced due to scientific inventions. This has led to enjoyment of economies of scale.
b) Efficient sources of energy necessary for industrial production have been developed. New forms of energy such as nuclear, solar and electricity have been invented.
c) Improvements in transport and communication have stimulated industrial development. Movement of labour, raw materials and manufactured goods is efficient.
d) There has been increased exploitation of resources like factories, fisheries, minerals etc as factories yearn for raw materials due to increased production.
e) The large scale manufacture of goods has led to growth of trade. This in turn has created wealth for industrialized nations.
f) Space exploration has been enhanced through science. Satellites are used in photographing of the earth's surface and in weather research.
g) Science has revolutionized military technology. Dangerous weapons have been manufactured.
h) There is faster dissemination and spread of ideas or knowledge and skills due to development of printing press, and internet development.
i) Industries have created job opportunities. Exploitation of mineral deposits has created employment.

Negative impact of scientific inventions on industry.
a) Scientific inventions in industry have led to industrial wastes and pollutants that contribute to environmental pollution. Smoke pollutes the air, machines cause noise pollution etc.
b) Human life has suffered unnecessarily due to development of war weapons and accidents on roads and aero planes.
c) Many people have been rendered unemployed due to development of machines.

Impact of scientific inventions on medicine
a) Discovery of various medicines to treat both animals and human diseases has boosted both curative and preventive measures in promoting health.
b) Improved nutrition has reduced the number of disease that kills man. Population has there increased as a result of reduced death rate.
c) Proper diagnosis of disease is now possible with the use of x-rays and other modern scientific methods. With accurate diagnosis, proper treatment can be given.

d) The manufacture of various drugs has been facilitated by scientific discoveries. Many companies produce drugs that prevent and cure diseases.

Factors undermining scientific revolution in third world countries.
a) Lack of enough funds for scientific research.
b) High level of ignorance and illiteracy.
c) The educational systems do not allow for development of inquisitive mind and development of interest in science. The system is not science oriented.
d) The brain –drain; the few specialized scientists have migrated to areas with greener pastures like Europe and America.
e) There is too much dependence on developed countries for nearly everything manufactured or scientifically produced.
f) Lack of adequate support from the government. This is clear in the type of budgetary allocations to scientific research.

Measures that can be undertaken to promote scientific research in third world countries.
a) Putting emphasis on the teaching of sciences in schools.
b) Making available financial resources for scientific research.
c) Emphasizing on competitions and congresses in schools and colleges.
d) The government of Kenya has set up research institutions and centres of science and technology.
e) Scientists have been trained locally and abroad on new knowledge in science and technology.
f) International cooperation conferences in science, which bring scientists together, are organized and attended by Kenyan scientists.

Emergence of selected world industrial powers
United States of America.
This is the third largest nation in the world after Canada and China
Industrialization of the USA began in the mid 19th c and she had emerged as a major industrial power by mid 20th c. USA remains the only superpower in the world after collapse of USSR in
1990.

Factors influencing the industrialization of USA.
a) Abundance of natural resources like iron ore, oil from the oilfields of Texas, copper and coal. There were also agricultural raw materials like cotton, corn, wheat and Tobacco plus forest resources which boosted industrial development.
b) Good transport and communication. The USA government developed transport systems in the country. For example railway (opened in 1869), roads, and water transport. Electronic communication was also developed.
c) Availability of both skilled and unskilled labour some of which came from the immigrant population. The American system of education gave room for acquisition of necessary skills.
d) There were scientific and technological advances to support the industrial process especially by the Europeans who moved to USA. The education system also promoted research which further boosted industrialization.
e) Foreign investments in the 19th c from countries like Britain led to industrial development.
f) The high American population was a source of domestic market for her industrial products. Her high quality products were also on high demand outside America.
g) Enterprising citizens. The Americans were ready to venture into business. Some had good managerial skills. For example John Rockfeller ventured in the petroleum sector, Andrew Carnegie and James Hill in the steel and iron industry. Henry Ford in the mass production of cars.
h) Long periods of political stability since her independence assured investors of security and thus paving way for industrialization.
i) Availability of sources of energy like coal, petroleum, gas and HEP and later Atomic energy.
j) The capitalism policy encouraged both local and external investors since it allowed private ownership of property.
k) Government support. President Franklin Delano Roosevelt (1933-1945) and Woodrow Wilson (1913-1921) provided capital to develop transport systems.
l) The 1st and 2nd World wars. During the war period, European nations were unable to produce goods since they were busy fighting. This enabled USA to expand her market as she initially kept away from the war.

Germany.
The unification of Germany took place in 1871 after which she began to emerge as an industrial power.
Emergence of Germany as an industrial power was aided as by the following factors.
a) Establishment of the customs union, Zollverein. This linked the german states and removed trade barriers hence leading to free trade and economic growth in Germany. Transportation of goods and communication was eased by the customs union.
b) Germany was rich in coal which was an important source of energy for the industries. HEP and Atomic energy was also produced o boost industrialization.
c) Abundance of natural resources like water and minerals like iron ore from Alsace and Lorraine, coal, oil and copper which were vital industrial raw materials.
d) The large Germany population was a source of both skilled and unskilled labour. The system of education also ensured availability of skilled labourers.
e) There was also a large domestic market from the large population. Her products were also on high demand from the rest of Europe. For example, her vehicles (Volkswagen, BMW and Mercedes Benz)

f) Existence of good transport and communication networks of roads, railway and waterways. This ensured easy transportation of raw materials to factories and finished goods from industries to the market.
g) Existence of long periods of political instability in Germany after unification in 1871 under the leadership of Otto Von Bismarck which ensured investor security.
h) The availability of finance for industrial growth from the rich german citizens and from loans granted by USA in 1924. The Marshal Plan after 1945 was another source of finance.
i) The existence of a hard working and enterprising people in Germany. For example, Krupp Meyer Thyssen who promoted the development of industries in steel. Egells and Harkoft Borsig made great contributions in the field of machinery. German's industrialization was however interrupted during the two world war periods. At the end of world war Germany was able to recover and progress in industrial development.

Factors which enabled Germany to recover after world war two.

a) West Germany still had a high population which was an important resource in terms of labour. There were also a high number of immigrants from European countries like Turkey and Italy.
b) The USA marshal Plan ensured that the required finance was available to assist her industries.
c) Germany industries were not totally destroyed by the two wars.
d) Industrial \unrests was not very common in Germany, and therefore, industrialization was not interrupted.
e) Good leadership accelerated the industrialization process. Between 1949 and 1955, Germany chancellor Konrad Adenaur proved to be an able leader who encouraged industrial growth. Japan. Japan is a nation that has achieved a great deal in industrialization. In the 18th c, Japan was faced with civil wars. Later she made contacts with the west, through which her leaders realized that industrialization could strengthen Japan as a nation. Great strides towards industrialization were made during the reign of Emperor Meiji from 1896.

Factors that enabled Japan to emerge as an industrial power.

1. She had enterprising citizens who were hard working and determined. They are always ready to undertake risks in business. The national motto 'just in time' confirms their efficiency.
2. The Long period of political stability especially after World War II has promoted industrialization.
3. The role played by America in financing the industrialization process in Japan as a means of preventing her from falling under the influence of communists after world war II. This enabled Japan to build many industries in the post war period.
4. Japan is a country whose industrial growth has never been slowed down by industrial disputes. The Japanese work for life. When one is employed in Japan, they put the interest of the employer first. This therefore reduces industrial disputes.
5. The Japanese goods are always of high quality and affordable. For example the vehicles, thus ensuring a steady market both local and international.
6. The Japanese education system is technically oriented ensuring production of skilled. Unskilled manpower has been made availability thanks to the abolition of the policy of feudalism that enabled labourers to move from the farms to the industries.
7. Japan has a well developed transport and communication network of railway, roads, water transport, large airports and electric trains. This has enabled improved transportation of raw materials to factories and manufactured goods to markets
8. Existence of an industrial base. Before World War II, Japan had already attained a certain level of industrial development. Many industries were not completely destroyed during the war period. The industries were repaired after the war.
9. Japan has a highly developed renewable hydro-electric power given the existence of large and fast flowing rivers.
10. The government invited expatriates and deployed them to local industries. In 1870, a group of 100 Japanese were sent out to western European factories to learn.
11. Geographical factors. The country's terrain did not favour agriculture thus making industrialization the best option to improve her economy.
12. The open investment policy encouraged the west to invest in her industrialization. The government encouraged foreign industrialists to plough back their capital and resources into the Japanese economy.

Industrialization in the third world countries.

The term 'Third world' refers to developing nations of Africa, Asia and South America.
Most of them are former colonies of European powers and there resources were used to develop the mother countries during the colonial period.

Reasons why many developing countries have lagged behind in industrialization.

a) Long periods of colonization relegated them to the role of suppliers of raw materials and as markets for industrial goods from developed nations at the expense of their own industries.
b) Poor transport and communication systems has undermined industrialization since raw materials and manufactured goods cannot be transported to their various destinations.
c) Inadequate capital. Most of the third world countries have poor agricultural-based economies which cannot support meaningful industrialization.
d) Poor technology. The use of appropriate technology in third world countries is lagging behind and this hampers exploitation of natural resources and manufacturing of goods.
e) Many developing countries face stiff completion from the industrialized nations that produce high quality products and have an advanced marketing system for their goods.
f) High levels of illiteracy among majority of the population in developing countries leads to lack of technical and scientific skills necessary for industrial take –off.
g) The protectionist policies adopted by developing countries have discouraged private enterprises and foreign investment. Policies like nationalization and imposition of import duties discourage investors in many countries.

h) High levels of poverty in third world countries mean low domestic market. Governments also spent most of their resources to provide for the basic needs of their citizens at the expense of industrialization.
i) Many third world countries have been faced with political instability problem. This has hampered industrialization. There are numerous civil wars or cross-border conflicts in many countries.
j) Third world countries often poor disaster management strategies. The devastating effects of natural disasters affect industrialization.
k) Lack of skilled personnel. Many well trained people migrate to the developed nations in search of well paying jobs. Since independence however, some have made tremendous effort to industrialize. For example South Africa, Brazil and India.

Brazil.

The fourth largest nation in the world after Canada, China and USA, she was colonized by
Portugal and attained her independence in 1882
In the last 25 years, she has been able to expand and diversify production of manufactured goods.
Her industrialization has been in four main sectors namely;
1. Petroleum and petrochemical industries. She has petrochemical complexes based in the states of Balica, Rio Grande, Dosul and Sao Paulo.
2. Motor vehicle industry. The country has earned a lot of forex through the massive manufacture and sale of motor vehicles since 1997.
3. Aircraft and aerospace industry. The Brazilian Space Agency (AEB) and the National Institute of Space Research (NPE) have been involved in the Brazilian space programme which comprises the construction of satellites and launching of space craft.
4. *Electricity generation industry.* The main source of Brazilian electric energy is water. In 1996, 92 % of all her electricity power generation was HEP.

Factors that have facilitated industrialization in Brazil.

a) Availability of Cheap and both skilled and unskilled labour from the country's large population especially after the abolition of slave trade.
b) Plentiful natural resources. For example mineral supplies like gold, coal, iron ore, uranium, manganese etc, agricultural raw materials like coffee, sugarcane, cocoa and maize and forest resources are a great boost to industrialization
c) Availability of hydro-electricity as early as 1905 to boost industrialization. Coal is also available.
d) Foreign capital. There was heavy influx of foreign capital from countries such as the USA, Canada, Britain, Portugal and France which led to establishment of industries in the country.
e) Improved transport and communication. Railway lines were constructed in most parts of Brazil thus opening the interior areas for the exploitation of natural resources and transportation of manufactured goods.
f) Good economic policies adopted by President Getulio Vargas (1930-1945) have contributed to industrialization in Brazil. He encouraged the development of transport and communication. He encouraged the harnessing of HEP. He Provided loans and subsidies to certain industries. Adopted protectionist policies of imposing heavy duties on imports. He encouraged exploitation of oil.
g) Development of banking in major Brazilian cities such as Manaus, Salvador, Brasilia and Sao Paulo facilitated provision of loans to individuals who wanted to venture in business.
h) Large Internal and external markets. Increased Trade between Brazil and other countries has led to growth of external market to supplement the available market locally.
i) The World War II which made it hard for her to import goods from Europe thus compelling her to manufacture her own goods.

Obstacles to industrialization in Brazil.

a) High levels of poverty (*more than 40% of the population is poor*) meaning low purchasing power. Governments also spent most of their resources to subsidize the basic needs of their citizens at the expense of industrialization.
b) Inability to fully exploit her natural resources especially those found in low population zones like the south where labour for exploitation is lacking.
c) Huge foreign debt. A lot of money is being used to service these debts at the expense of industrialization.
d) Poor technology. The use of appropriate technology for exploitation of natural resources and manufacturing of goods is still lagging behind in Brazil.
e) Stiff completion from the industrialized nations like USA and Western Europe that produce high quality products and have an advanced marketing system for their goods.
f) The resources of Brazil are monopolized by the multinational companies that are based here. The government therefore has no freedom to exploit them for use in industries.

SOUTH AFRICA.

She attained majority rule in 1994 after a long struggle against the apartheid regime. The country has achieved great strides in industrialization with many industries including iron and steel industries, engineering, locomotive, chemical, textile, cement, light industries and tourism

Factors influencing industrialization in South Africa.

i) The country is endowed with mineral resources such as gold, diamonds. Iron etc.
ii) Availability of Cheap and both skilled and unskilled labour from the country's large population.
iii) Availability of natural resources. For example mineral supplies like gold, lead, iron ore, uranium, manganese, Zinc, Bauxite, Tin, Chromium, Tungsten, Phosphate etc. some of these resources are in plenty and are exported to earn forex.
iv) Development of hydro-electricity has boosted industrialization. Coal is also available from the Witwatersrand.

v) Development of transport and communication. Railway lines, water and road network have been improved thus opening the resources for the exploitation and for transportation of manufactured goods. Air transport is also well developed thus enhancing business operations.
vi) Availability of capital from her trade in other materials.
vii) Government support. The government has adopted sound economic policies that promote industrialization. For example imposing heavy tariffs on the imported commodities as a means of protecting local industries, encouraging foreign entrepreneurs to invest in the country and encouraging local investors.
viii) South Africa is endowed with a variety of tourist attractions like wildlife which boost the tourism industry.
ix) Large Internal and external markets. Increased Trade between South Africa and other countries especially after end of the apartheid rule has led to growth of external market to supplement the available market locally.

Challenges facing industrialization in South Africa.

i) Long periods of apartheid rule was accompanied with sometimes violent resistance and struggle for majority rule which created an atmosphere not conducive for investment
ii) The country suffered long periods of economic sanctions imposed by the United Nations between 1948 and 1994 which affected her manufactured goods that could not access external markets.
iii) There were rampant industrial strikes in the country, during the apartheid regime which affected industrialization.
iv) The HIV and AIDS scourge has ravaged the country's labour force thus seriously undermining the industrial efforts.
v) There is stiff completion from the industrialized nations in Western Europe that produce high quality products and have an advanced marketing system for their goods.
vi) High levels of insecurity which, at times, discourages would-be foreign investors.
vii) High levels of poverty in South Africa mean low purchasing power. Manufactured goods perform poorly locally.

India.

Since India's independence from Britain in 1947, the country has continued to experience extensive industrialization

Factors that facilitated India's industrialization.

i. Existence of good industrial base from the textile and leather industries. The British governor Lord Dalhousie also laid a good foundation for industrialization by promoting road construction and cotton growing.
ii. Also cottage industries like smithing and textiles existed in India long before colonialism. This formed the basis for modern industries
iii. Availability of Cheap and both skilled and unskilled labour from the country's large population which is almost at a billion mark
iv. Existence of raw materials. For example mineral supplies like iron ore, manganese and coal allowed development of heavy industries. Cotton was also available as a textile industry raw material
v. Development of energy sources like coal and hydro-electricity has boosted industrialization. Other sources of energy include oil, natural gas and nuclear energy..
vi. Development of transport and communication. The great trunk road from Calcutta to Punjab and sea transport development has led to resource exploitation and transportation of manufactured goods. Communication services have also been greatly improved.
vii. Good technical and scientific education available in India has produced experts who are in great demand in industry and agriculture.
viii. Availability of capital from her trading contacts with European countries like Portugal, Britain, France and Holland.
ix. Good national development plans. In the first five-year development plan of 1951, the government adopted sound economic policies that prioritized agriculture especially modern farming. The second phase emphasized industrialization, especially decentralization if industries to high population areas where labour and market existed.
x. The government has imposed protective tariffs on the imported commodities as a means of protecting local industries.
xi. Political stability. India has enjoyed a long period of political stability since her independence thus giving investors' confidence.
xii. Development of banking in India has enabled farmers and industrialists to access credit facilities.

Challenges facing industrialization in India.

i. Competition from goods manufactured in the developed countries; the developed nations produce goods of high quality than those manufactured by the Indian industries.
ii. High population in India requires that the government spare enough capital to feed the people. The government spends a lot of revenue in developing agriculture to feed her people.
iii. High poverty levels i.e. majority of the Indian population is poor and do not have adequate purchasing power for her manufactured goods/ the local market is therefore limited.
iv. Lack of efficient communication and transportation infrastructure hence poor movement ofgoods and labour.
v. Natural calamities e.g. drought and floods that destroy raw materials for industries.
vi. Political conflicts e.g. with neighboring Pakistan, and the civil unrest hinders industrial development.