Revision Notes

Class 11 physics

Chapter 1- Physical World

Science and its origin

Science can be defined as a systematic understanding of natural phenomena in a very detailed manner so that we can predict, control and modify it. Science is all about experimenting and exploring speculating phenomena occurring around us.

- The term Science has been originated from a Latin verb Scientia which means 'to know'.
- Scientific method can be called as a method to acquire knowledge in a systematic and in-depth way. It is having:
- Systematic observations
- Controlled experiments
- Qualitative and Quantitative reasoning
- Mathematical modelling
- Prediction and verification (or falsification) of theories
- Speculation or Prediction
- Science will be not having any final theory. The observations which are made using improved, accurate tools will be creating improved knowledge and perspective. Tycho Brahe's research on planetary motion has been used by Johannes Kepler for improving Nicolas Copernicus theory.
- Quantum mechanics was developed in order to deal with atomic and nuclear phenomena. Work of Ernest Rutherford on nuclear model of atom made the basis of quantum theory suggested by Niels Bohr. The discovery of antielectron (positron) was led by the Antiparticle theory of Paul Dirac by Carl Anderson.

Natural Sciences

Natural science can be considered as a branch of science which is discussing about the description, prediction, and understanding of the natural phenomena which is on the basis of an observational and empirical evidence. It will be included of the disciplines mentioned below:

- Physics

- Chemistry
- Biology

Physics

Physics can be defined as a study of basic laws of nature and their usage in various natural phenomena. Physics can be called as the study of physical world and matter and its movement through space and time, along with the connected concepts like energy and force.

- Word Physics has been originated from a Greek word phusikḗ which means nature.
- There are two principal kinds of approaches in Physics which are listed below:

1. Unification: This is a method including all of the phenomena in the world in the form of a group of universal laws in various domains and conditions. The law of gravitation will be applied both on a falling apple from a tree and the movement of planets around the sun can be considered as examples. Every electric and magnetic phenomena will be controlled by Electromagnetism laws.

2. Reduction is a method for deriving characteristics of complex systems from the properties and interaction of its constituent parts. We can take an example that the temperature studied under thermodynamics can be also connected to the average kinetic energy of molecules in a system (kinetic theory).

Effect and uses of Physics:

- We can describe a phenomena occurring over a bigger magnitude using a simple theory.
- We can use the experiments and observations for developing new theories in the case of unidentified phenomena and make improvement for old theories in the existing phenomena.
- We can develop devices by the use of physics laws.

Scope of Physics

Scope of Physics will be wide since it covers quantities with length magnitude as big as 1040m and more than that (astronomical studies of universe) and as low as 10-14m or less (study of the electrons, protons

etc). In the same way, the time scale is ranging from 10-22s to 1018s and mass is ranging from 10-30kg to 1055kg.
Physics can be categorised broadly into two kinds on the basis of its scope - Classical Physics and Modern Physics. Classical physics is a branch which is dealing with the macroscopic phenomena while the modern physics will be dealing with the microscopic phenomena.

Macroscopic Domain
Macroscopic domain is having phenomena's involved at large scales such as laboratory, terrestrial and astronomical. It will be including subjects listed below:
1. Mechanics – This is a branch on the basis of Newton's laws on motion and the gravitational laws. It will be related with motion/equilibrium of particles, rigid and deformable bodies and general system of particles. Examples are listed below:
a. Propulsion of rocket using the ejecting gases
b. Water or Sound waves
c. Under a load, a bent rod is in equilibrium.

2. Electrodynamics is a branch which is involved with electric and magnetic phenomena related with charged and magnetic bodies. Here are some examples for it:
a. Movement of a current-carrying conductor in a magnetic field
b. The response of a circuit to an ac voltage (signal)
c. The generation of radio waves in the ionosphere

3. Optics – This branch is discussing about the natural processes involving light. The examples will be,
a. Reflection and refraction of light
b. Dispersion of light through a prism
c. Colour shown by thin films

4. Thermodynamics is a branch with systems in macroscopic equilibrium and varies in internal energy, temperature, entropy and so on , of systems under the application of the external force or heat. Examples are,
a. The efficiency of heat engines
b. Direction of physical and chemical process

Microscopic Domain

Microscopic domain will be processed at small scales such as atomic, molecular and nuclear. It will be discussing about the interaction of probes such as electrons, photons and other elementary particles. Quantum theory has been made to discuss these phenomena.
There are some reasons for the improvement of Physics

- Qualitative analysis along with quantitative analysis.
- Universal laws are applicable in various contexts.
- Approximation approach (complex phenomena broken down into collection of basic laws).
- Extracting and focusing on necessary characteristics of a phenomenon.

Hypothesis, Axiom and Models

a) Hypothesis can be defined as an act of supposing without assuming that it is correct. It cannot be proven although can be verified by the use of a series of experiments.
b) Axiom will be a self-evident truth that it is acceptable by not having any question or controversy.
c) Model can be defined as a theory put forward for describing the observed phenomena.
d) Assumption can be defined as the basis of physics. Using this, a huge number of phenomena are being explained. These assumptions are created from experiments, observation and a huge number of statistical data.

Technological applications of Physics

There are numerous examples in which Physics and its concepts paved the way to inventions as mentioned below.

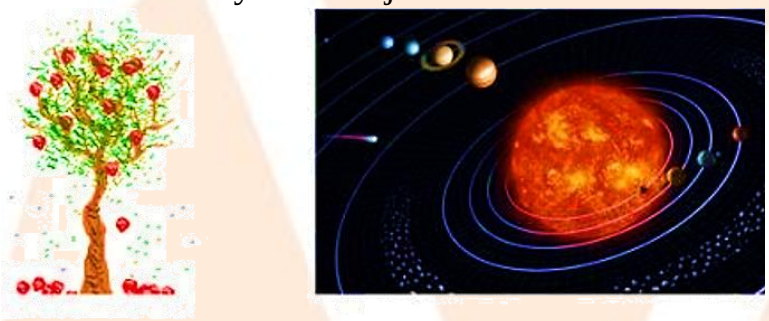
- Steam engine got invented from the industrial revolution in eighteenth century.
- Development of wireless communication after the discovery of laws of electricity and magnetism.
- Neuron-induced fission of uranium, attempted by Hahn and Meitner in 1938, showed to the formation of nuclear power reactors and nuclear weapons.
- Electricity has been produced from solar, wind, geothermal etc.

Fundamental Forces in nature

The forces which is visible in our daily life such as muscular, friction, forces due to compression and change in length of strings and springs, fluid and gas pressure, magnetic, electric, interatomic and intermolecular forces are derived forces since their originations are because of a few fundamental forces in nature.

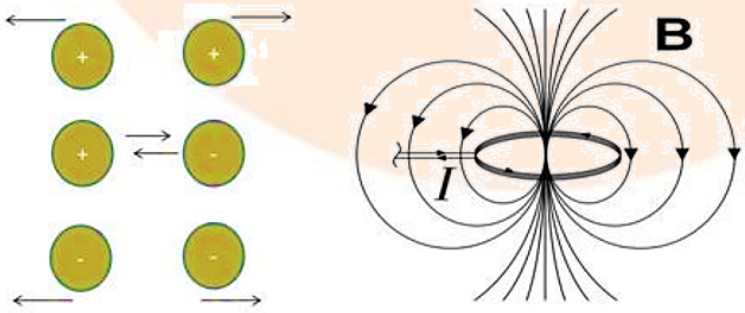
These fundamental forces are as mentioned below:

1. Gravitational Force ca be defined as a force of mutual attraction between any two objects because of their masses. This has been considered as a universal force since every object is feeling this force because of every other object in the universe.



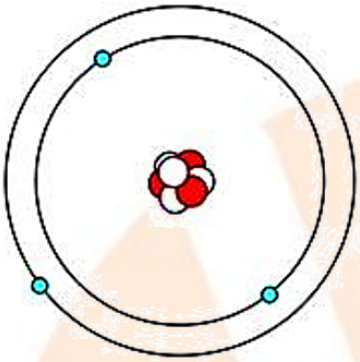
The gravitational force causes the apple to fall as well as planets to revolve around the sun.

2. Electromagnetic Force can be called as a force existing between charged particles. Charges at rest is having electric attraction which is visible between unlike charges and repulsion which is between like charges. Charges in motion will be creating magnetic force. Together they are known as Electromagnetic Force.



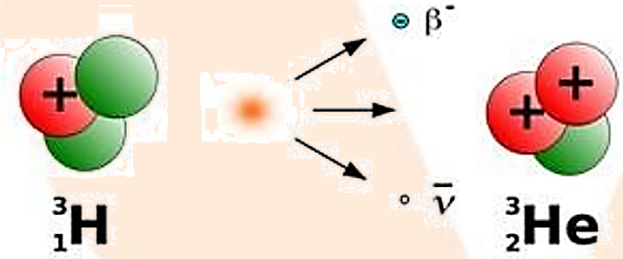
The unlike charges attract each other while like charges repel each other. A current carrying wire generates magnetic field around it, giving rise to electromagnetism.

3. Strong Nuclear Force is an attractive force found in between protons and neutrons in a nucleus. It is charge-independent and is acting equally between a proton and a proton, a neutron and a neutron, and a proton and a neutron. According to the latest discoveries, the protons and neutrons are made up of elementary particles known as quarks.



Bohr Model of Lithium Atom. Nucleus is a tightly bound entity with a strong force of attraction between protons and neutrons. Electrons revolve around the nucleus.

4. Weak Nuclear Force can be defined as a force which appear only in specific nuclear processes like the β-decay of a nucleus. In β-decay, the nucleus will be emitting an electron and an uncharged particle called known as neutrino. In 1931, this particle has been predicted for the first time by Wolfgang Pauli.



B-decay of a nucleus.

Table drawn below is representing the difference between the above forces.

Name	Relative Strength	Range	Operates among
Gravitational force	10^{-39}	Infinite	All objects in the universe
Weak nuclear force	10^{-13}	Very short, Sub-nuclear size (-10^{-16} m)	Some elementary particles,

			particularly electron and neutrino
Electromagnetic force	10^{-2}	Infinite	Charged particles
Strong nuclear force	1	Short, nuclear size (-10^{-15} m)	Nucleons, heavier elementary particles

5. Unification of Forces: So many physicists tried for combining a few of the above fundamental forces. It has been shown in a table below.

Name of physicist	Year	Achievement in Unification
Isaac Newton	1687	The celestial and terrestrial mechanics were unified.
Hans Christian Oersted and Michael Faraday	1820 and 1830 respectively	Electric and magnetic phenomena were unified to give rise to electromagnetism.
James Clerk Maxwell	1873	Electricity, magnetism and optics were unified for representing that light is an electromagnetic wave.
Sheldon Glashow, Abdus Salam, Steven Weinberg	1979	Put forward the idea of electro-weak force which is a combination of electromagnetic and weak nuclear force.
Carlo Rubia, Simon Vander Meer	1984	The theory of electro-weak force was verified.

Conserved Quantities

Physics has been provided laws for summarising the investigations and observations about the phenomena happening in the universe.

- Physical quantities will be held fixed with time can be defined as conserved quantities. In the case of a body under external force, the kinetic and potential energy will be varying over time but the total mechanical energy (kinetic + potential) will be a constant.
- Conserved quantities will be scalar (Energy) or vector (Total linear momentum and total angular momentum)

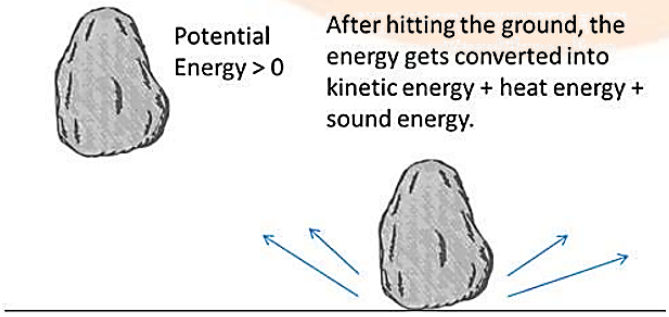
A ball in air falling to ground has some Potential energy and zero Kinetic energy. As soon as it touches the ground the potential energy gets converted into kinetic energy. The total Mechanical energy remains same.

Conservation Laws

A conservation law can be defined as a hypothesis on the basis of observation and experiments which is not able to be proven. These are verifiable through experiments.

Law of conservation of Energy

- In accordance to the general Law of conservation of energy, the energies will be fixed over time and get transformed from one form to another.
- The law of conservation of energy will be applied to the whole universe and it has been considered that the total energy of the universe is fixed.
- The nature develops symmetric results at different time under similar conditions.



Law of conservation of Mass

It can be defined as a principle which is usable in the analysis of chemical reactions.

- Basically a chemical reaction can be defined as a rearrangement of atoms among various molecules.
- The difference will be formed as heat and the reaction is exothermic when the total binding energy of the reacting molecules will be less than the total binding energy of the product molecules.
- The opposite will be correct for energy absorbing reactions such as endothermic reactions.
- As the atoms are not destroyed, only just rearranged, the summation of mass of the reactants will be identical as the total mass of the products in a chemical reaction.
- Mass will be in relation to energy through Einstein theory, $E=mc^2$, where c will be the speed of light in vacuum.

Law of conservation of linear momentum

- Law of conservation of linear momentum can be defined as the symmetry of laws of nature with respect to translation in space.
- The law of gravitation is exactly identical on earth and moon even when the acceleration due to gravity at moon is $\frac{1}{6}^{th}$ than that at earth.

Law of conservation of angular momentum

- Isotropy of space which means that no intrinsically preferred direction in space specifies the law of conservation of angular momentum.