What is Physics?

Physics is the most fundamental of the sciences. Its goal is to learn how the Universe works at the most fundamental level and to discover the basic laws by which it operates. Theoretical physics concentrates on developing the theory and mathematics of these laws, while applied physics focuses attention on the application of the principles of physics to practical problems. Experimental physics lies at the intersection of physics and engineering; experimental physicists have the theoretical knowledge of theoretical physicists, and they know how to build and work with scientific equipment.

Physics is divided into a number of sub-fields, and physicists are trained to have some expertise in all of them. This variety is what makes physics one of the most interesting of the sciences and it makes people with physics training very versatile in their ability to do work in many different technical fields.

The major fields of physics are:

- Classical mechanics is the study the motion of bodies according to Newton's laws of motion, and is the subject of this course.
- Electricity and magnetism are two closely related phenomena that are together considered a single field of physics.
- Quantum mechanics describes the peculiar motion of very small bodies (atomic sizes and smaller).
- Optics is the study of light.
- Acoustics is the study of sound.
- Thermodynamics and statistical mechanics are closely related fields that study the nature of heat.

- Solid-state physics is the study of solids most often crystalline metals.
- Plasma physics is the study of plasmas (ionized gases).
- Atomic, nuclear, and particle physics study of the atom, the atomic nucleus, and the particles that make up the atom.
- Relativity includes Albert Einstein's theories of special and general relativity. Special relativity describes the motion of bodies moving at very high speeds (near the speed of light), while general relativity is Einstein's theory of gravity.

The fields of cross-disciplinary physics combine physics with other sciences. These include astrophysic (physics of astronomy), geophysics (physics of geology), biophysics (physics of biology), chemical physics (physics of chemistry), and mathematical physics (mathematical theories related to physics).

Besides acquiring a knowledge of physics for its own sake, the study of physics will give you a broad tech- nical background and set of problem-solving skills that you can apply to wide variety of other fields. Some students of physics go on to study more advanced physics, while others find ways to apply their knowledge of physics to such diverse subjects as mathematics, engineering, biology, medicine, and finance.

1. Measurement

Physics is a science based upon exact measurement of physical quantities. Therefore it is essential that student first becomes familiar with the various methods of measurement and the units in which these measurements are expressed.

A **unit** is a value quantity or magnitude in terms of which other values, quantities or magnitudes are expressed.

2. Fundamental Quantities And Units

A **fundamental quantity** also known as **base quantity** is a quantity which cannot be expressed in terms of any other physical quantity. The units in which the fundamental quantities are measured are called fundamental units. In mechanics (study of the effects of external forces on bodies at rest or in motion), the quantities **length**, **mass** and **time** are chosen as fundamental quantities.

Fundamental Quantity	Fundamental Unit	Unit Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s

3. Dynamics

Dynamics is a branch of mechanics which deals with the forces that give rise to motion. Just as kinematics describes how objects move without describing the force that caused the motion, Newton's laws of motion are the foundation of dynamics which describes the motion and force responsible for the motion.

4. Force

Force is that which changes the velocity of an object. Force is a vector quantity. An external force is one which lies outside of the system being considered.

4.1 Types Of Forces

Contact Force is that in which one object has to be in contact with another to exert a force on it. A push or pull on an object are examples of contact force.

Tension $\vec{T}$ is the force on a string or chain tending to stretch it.

Normal force $\vec{F}_N$ is the force which acts perpendicular to a surface which supports an object.

Weight $\vec{W}$ of an object is the force with which gravity pulls downward upon it.

It is given as $\vec{W} = m\vec{g}$. It is equal to the gravitational force on the body.

Frictional force $\vec{f}$ is the force on a body when the body when the body slides or attempts to slide along a surface and is always parallel to the surface and directed so as to oppose the motion of the body.

Other important forces include **gravitational force** or simply gravity, **electromagnetic force**, **nuclear force**.

4. 2 Net Force

The net force is the vector sum of all force vectors that act on an object. It is expressed as:

$$\vec{F}_{net} = \sum_{i=1}^{n} \vec{F}_i = \vec{F}_1 + \vec{F}_2 + \cdots + \vec{F}_n \quad \ldots \quad 4.1$$

In Cartesian components, the net force are given by

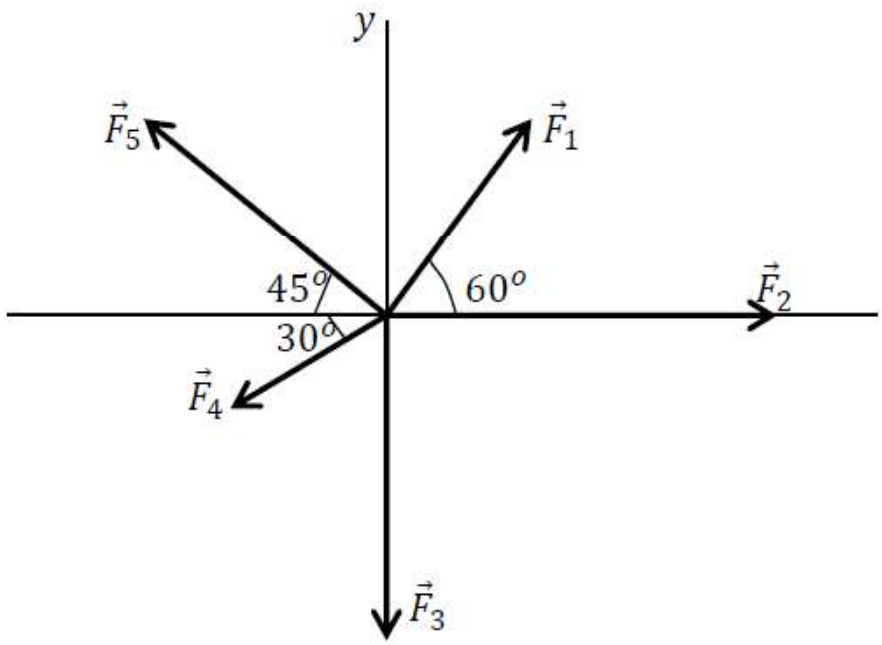
$$\vec{F}_{net,x} = \sum_{i=1}^{n} F_{i,x} = \vec{F}_{1,x} + \vec{F}_{2,x} + \cdots + \vec{F}_{n,x}$$

$$\vec{F}_{net,y} = \sum_{i=1}^{n} F_{i,y} = \vec{F}_{1,y} + \vec{F}_{2,y} + \cdots + \vec{F}_{n,y} \quad \ldots \quad 4.2$$

$$\vec{F}_{net,z} = \sum_{i=1}^{n} F_{i,z} = \vec{F}_{1,z} + \vec{F}_{2,z} + \cdots + \vec{F}_{n,z}$$

Example 15:

Five coplanar forces act on an object as shown in the figure below. Find the resultant of the forces. The magnitude of the forces are: $F_1 = 15N$, $F_2 = 19N$, $F_3 = 22N$, $F_4 = 11N$, $F_5 = 16N$.



Solution:

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{F}_5$$
$$\vec{F}_1 = \vec{F}_{1,x} + \vec{F}_{1,y} = F_1 \cos 60^o \hat{\imath} + F_1 \sin 60^o \hat{\jmath}$$
$$\vec{F}_2 = \vec{F}_{2,x}\hat{\imath} = F_2\hat{\imath}$$
$$\vec{F}_3 = -\vec{F}_{3,y}\hat{\jmath} = -F_3\hat{\jmath}$$
$$\vec{F}_4 = -\vec{F}_{4,x}\hat{\imath} - \vec{F}_{4,y}\hat{\jmath} = -F_4 \cos 30^o \hat{\imath} - F_4 \sin 30^o \hat{\jmath}$$
$$\vec{F}_5 = -\vec{F}_{5,x} + \vec{F}_{5,y} = -F_5 \cos 45^o + F_5 \sin 45^o$$

$$\vec{F}_1 = 15 \cos 60^o \hat{\imath} + 15 \sin 60^o \hat{\jmath} = 7.5\hat{\imath} + 12.99\hat{\jmath}$$
$$\vec{F}_2 = 19\hat{\imath}$$
$$\vec{F}_3 = -22\hat{\jmath}$$
$$\vec{F}_4 = -11 \cos 30^o \hat{\imath} - 11 \sin 30^o \hat{\jmath} = -9.53\hat{\imath} - 5.5\hat{\jmath}$$
$$\vec{F}_5 = -16 \cos 45^o + 16 \sin 45^o = -11.31\hat{\imath} + 11.31\hat{\jmath}$$

$$\vec{F}_{net,x} = (7.5 + 19 - 9.53 - 11.31)\hat{\imath}\ N = 5.66\hat{\imath}\ N$$
$$\vec{F}_{net,y} = (12.99 - 22 - 5.5 + 11.31)\hat{\jmath}\ N = -3.2\hat{\jmath}\ N$$
$$\vec{F}_{net} = \sqrt{(5.66)^2 + (-3.2)^2} = 6.5N$$

H.W

A mass of $55kg$ was suspended with two ropes as shown in the figure below. What is the tension in each rope if $\theta = 45^o$?