B.Sc. Part I

Paper I

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Lorentz Transformation

Q. What are Inertial and non-inertial frames of reference? Mention Newtonian relativity. Show that Newton's laws of Motion are invariant in all inertial frames under Galilean transformations.

Ans

Frames of reference :-

Rest and Motion are relative terms. To define Motion, the observer must define a frame of reference relative to which the Motion is considered.

A body in motion can be located with reference to some coordinate system called the frame of reference. If the coordinates of all the points of a body remain unchanged with time and with respect to the frame of reference, the body is said to be at rest. However, if the coordinates of any point of the body change with time and with respect to the frame of reference, the body is said to be in motion.

Inertial frame of reference :-

Inertial frame of Reference is also called the Galilean or Newtonian frame of reference. In this frame of reference Newton's first and second law of Motion hold good.

In this reference frame no acceleration is observed for a particle free of any force or constraint.

It is convenient to take a fixed star (Pole) as a standard inertial frame of reference. For Practical Purposes, Earth can be taken as an inertial frame of reference. Its rotation around its own axis can be taken to be negligibly small. It depends on the experiment to be performed whether earth can be taken an inertial frame of reference or not.

Non inertial frame of Reference :-

The basic laws of Physics are not changed in form in inertial frames of reference. But when a frame of reference is accelerated relative to an inertial frame, the form of basic Physical law such as Newton's 2nd law of motion becomes completely different. Such frame of reference having an accelerated motion relative to an inertial frame are called non-inertial frames of reference. Since a uniformly rotating frame has a centripetal acceleration, it is also a non-inertial frame. Thus a non inertial frame may either be a frame having uniform linear acceleration or be a frame which is

uniformly rotating.

Newtonian Relativity :-

The newtonian Principle of relativity States That "Absolute motion, which is the translation of a body from one absolute Place to another absolute Place, can never by defected. Translatory motion can be perceived only in the form of motion relative to other material bodies. This implies That if we are drifting along at a uniform Speed in a closed spaceship all the Phenomena observed and all the experiments performed inside the ship will appear to be the same as if the ship were not in motion. This Means that the fundamental Physical laws are identical in all inertial frames of reference. This is the Concept of Newtonian relativity.

But the Concept of Mass, length and time, and their Mutual dependance which is so fundamental to Newtonian Mechanics, are neither invariant nor independent of one another in a Moving frame of reference. Thus, these quantities appear to vary depending upon the relative Motion of the body itself or of the observer. If the relative speed is relatively Small as Compared to the velocity of light, this variation is negligible. When the relative Speed approaches the Speed of

light, This variation becomes larger. For example, when we consider the motion of sub-atomic particles inside the atom itself, the variation is considerable large.