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Degrees of freedom

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Abstract:-

Today's article is about degrees of freedom which is a very important concept in classical mechanics, thermal physics and many other disciplines of physics.

The term number of degrees of freedom of a dynamical system may be defined in more than one way. A definition that will suit us at present is to call it the minimum number of independent variables that is necessary to describe uniquely the configuration of the given dynamical systems.

In three dimensional space, a free particle has three degrees of freedom, because it's position at any instant can be uniquely specified by uta positional coordinate. They may be either the x,y,z coordinate of a Cartesian system or the r, theta and phi of a spherical polar system , or row, phi,z of a cylindrical system.

A system of N particles has 3N degreed of freedom of motion corresponding to the 3N coordinate(x1,y1,z1; x2,y2,z2; x3,y3,z3;.....xn,yn,zn), which can change independently of one another if motions were free. Whereas the number of degrees of freedom in a constrained motion is always less than that if the motion is free, that is, without a constraint. If the motion of the particle is confined to a plane only two coordinate x,y, or r, phi is suffice to fix the position. In this case number of freedom is two. For a motion in a straight line, the number is one. And when two particles are rigidly connection together, they cannot move as they like, but will have to keep a constant distance between them as they move. So there will be five degree of freedom, because of one equation of constraints has to satisfy.

A rigid body is one in which the distance between any two given points always remain fixed. The number of degrees of freedom of a freely moving rigid body is six. Consider three non collinear points in the points in the body fixed relative to it and forming a triangle. When we fixed position of this triangle on space, we know uniquely to the position of the rigid body. The three points require nine coordinate to fix their positions. But they have three constraints to obey

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namely the lengthd of the three sides of the triangle they form, must remain constant. These three constraints eliminate three of the nine coordinate, leaving six of them free.

A dynamical system of N particles subjected to k constraints will have n degree of freedom given by n= 3N-k, in three dimensional space. Where N= number of particles and k is the number of constraints. The number of degrees of freedom is also defined as the number of independent motion , a system can execute, without violating any constraints imposed on it.

Reference:-

Classical mechanics :- prof. Chowdhary