of for making the comparison. The pound ought, therefore, to be regarded as the unit of mass, not of weight. This is further indicated by the fact that the weight of a pound is different in different latitudes and at different altitudes, while its mass remains invariable, so that if a material standard were adopted as a unit of *weight*, that is, of *force*, it would have to be varied whenever it is moved from place to place, and would only remain the standard so long as it is kept in the same place.

The metric unit of mass is the kilogramme, but the gramme, which is one thousandth of the kilogramme, is the unit generally adopted for scientific purposes. The gramme is approximately equal to the mass of a cubic centimetre of distilled water at the temperature corresponding to its maximum density. It is equal to about 15·43234874 grains, or ·0022046212 lb. avoirdupois.

Every person is supposed to be provided with the requisite means for measuring time, length, and mass, and when the measurement of any other physical quantity can be reduced to the determination of these three fundamental quantities, it may be regarded as completed, at least theoretically. When any quantity is measured in terms of the fundamental units of time, length, and mass only, it is said to be expressed in *absolute* measure. It will be one of our objects in these lectures to show that all electrical quantities may be expressed in terms of the second, the centimetre, and the gramme, or in terms of any other set of fundamental units. The system, which is based on the centimetre, gramme, and second, is called the C.G.S. system of units.

Geometry is the science which deals with pure space. If we consider space and time together we enter on the subject of kinematics. When we introduce the notion of mass as well as space and time we have dynamics. Thus dynamics must be regarded as the basis of all physical science.

Except when otherwise stated, we shall confine ourselves to the units of the C.G.S. system and the practical units derived from them.

DEF. Velocity is the degree of quickness with which anything is moving. The unit of velocity is the velocity of a point which traverses the unit of length in the unit of time. Hence our unit of velocity will be a centimetre per second. The measure of the velocity of any point moving uniformly will then be equal to the number of centimetres passed over by it in the course of a second.

DEF. Acceleration is the rate of increase of velocity. The unit of acceleration is that of a point whose velocity is increased by unity in the unit of time, or by one centimetre per second in each second, so that the measure of a uniform acceleration is equal to the number of units of velocity added in the unit of time.

DEF. The momentum of a body is the product of its mass and its velocity. The C.G.S. unit of momentum is that of a gramme moving at the rate of a centimetre per second.

When we pass from the consideration of pure kinematics to that of the motion of material bodies, we must have recourse to observation and experiment. Newton summed up the results of such observations and experiments in three brief statements, called the *Laws of Motion*. These, like other physical laws, must be regarded simply as concise statements of the results of experience.

LAW I. *A body under the action of no external force will remain at rest or continue to move uniformly in a straight line.*

Hence we deduce the definition of force, viz. :—

Force is that which changes or tends to change a body's state of rest or motion.

The first law of motion thus furnishes a *qualitative* definition of force. The second law gives its *quantitave* measure.

LAW II. *Rate of change of momentum is proportional to the impressed force, and takes place in the direction in which that force acts.*

A force is, therefore, proportional to the change of momentum it produces in the unit of time. If we take as unit force that force which produces the unit of momentum in the unit of time, the measure of any force will be equal to the number of units of momentum which it generates in the unit of time. The C.G.S. unit of force is that force which acting on a gramme for a second produces in it a velocity of a centimetre per second, and is called a *dyne*.

DEF. A force is said to do work when it moves its point of application in its own direction, or an agent is said to do work when it overcomes resistance.

The work done is proportional to the product of the force and the distance through which its moves its point of application in its own direction, or proportional to the product of the resistance overcome and the distance through which it is overcome. If the force act vertically, and the body be moved along an incline, in estimating the work done we must measure only the vertical height through which the body is raised or falls, and generally, in whatever direction the force acts, the displacement must be measured in that direction. If the body moves in the *sense* in which the force acts, work is done *by the force*, but if it be made to move in the opposite *sense*, work is done *against the force*. The unit of work is the work done by the unit of force in moving its point of application over the unit of length. The C.G.S. unit of work is the work done by a dyne in moving its point of application over a centimetre, and is called an *erg*.

The weight of some particular body, such as the unit of mass, is sometimes taken as the unit of force, and is called a *gravitation* unit. The objection to such a unit is that it varies in different localities, being about one-half per cent. less near the equator than near the poles. If the weight of a pound be taken as the unit of force, the unit of work will be the work done in lifting a pound one foot high against gravity, and this is called a foot-pound. It is equal to about 13,560,000 ergs.

DEF. The power of an agent is the rate at which it can work. The unit of power is that of an agent which can do the unit of work in the unit of time. The C.G.S. unit of power is that of an agent which can do one erg in one second, and one erg per second is the C.G.S. unit rate of doing work.

DEF. An agent which can perform 33,000 foot-pounds of work in one minute, or 550 foot-pounds in one second, is said to be of *one horse-power*. The horse-power is equal to about 7,458,000,000 C.G.S.