

point of suspension, so that it may be at rest in any position; and we see that to do so, we must suspend it by a support passing through its centre of gravity. Let us now suppose we wish to communicate motion to any body, so that all its parts shall be impelled in the same direction, and with uniform velocities; how are we to proceed? Take a billiard ball for an example. If one side of the ball is struck, that side is impelled to move faster than the other; but if the ball is hit exactly in the centre, its tendency is to move straight forward in the direction of the impelling force. Thus we see that, if an object is struck, so that the line of the force acting upon it passes exactly through its centre of gravity, the whole body is impelled to move straight forward with equal velocities affecting all its parts. If struck to the right of its centre of gravity, one side is impelled to move quicker than the other, and consequently the body rotates round its centre of gravity as well as moves forwards, if it is free to do so. The centre of gravity of a body has therefore two noticeable properties—a support passing through it will suspend the body, so that its balance is not disturbed by change of position, and a force passing through it impels the whole body to move equally forward in front of the impelling force.

A body is in a state of equilibrium when the action of gravitation does not tend to alter its position; but there are three distinct kinds of equilibrium—*stable*, *unstable*, and *neutral*. Stable equilibrium indicates a decided preference for a particular position of equilibrium. This is the case when a cone is allowed to stand on its base. If you lift the base up a little on one side, it falls back to its previous position; and in order to make it fall over, you must lift one side of the base so much, that a perpendicular from the cone's centre of gravity shall fall beyond the base, and then it will fall over on its side. Any body in stable equilibrium has its centre of gravity so far from the edge of its base, that if thrown slightly, or even considerably, out of position, it tends to fall back to where it was before. A centre of gravity is in its normal position when it has fallen as low—that is, as near the centre of the earth—as it can. If elevated above the lowest point it can reach, and allowed freedom for motion, it will get back to the lowest point by the shortest route.

Neutral equilibrium is when a body cannot alter the position of its centre of gravity by any motion it can take. It is thus equally at rest, or in equilibrium, in all its possible positions. A ball resting on a plane is in this condition, because its revolution leaves its centre of gravity at all times exactly as high above the plane as it was before.

To return to our scales: let the piece of card already spoken of represent the beam. If the needle by which it is suspended passes exactly through its centre of gravity, it is in neutral equilibrium, and the two arms balance each other in whichever way they are placed. But if the needle is moved so as to be a little above the centre of gravity, a slight motion of the beam elevating or depressing either arm is resisted by its weight, because any such motion lifts the centre of gravity above its lowest point, to which it will immediately fall back, and at which it will settle after a few oscillations. If the needle is again moved, so that it is placed considerably below the centre of gravity, the slightest force will throw the beam on either side, and it will not oscillate, but remain fixed as soon as the centre of gravity has reached its lowest point.

This sort of explanation is dry to read, but may readily be made interesting by the performance of the experiments described. In making scales, two things have specially to be considered—firstly, the elimination of friction, so that the least possible obstacle of that kind may hinder the free motion of the beam; and, secondly, the arrangement of the point of suspension above the centre of gravity, so that the beam may be in stable equilibrium, to the extent of always desiring to return to one and the same position, but with this tendency sufficiently weak as to be counteracted by a slight force. The exact distance between the centre of gravity and the point of suspension must be determined by the use to which the scales are to be put—the greatest delicacy and freedom of motion being required for the most precious articles, and the most accurate weighing.

It seems a sudden jump from a pair of scales to a percussion cap, but yet the transition is easy. A good pair of scales are just within the conditions of stable equilibrium, and a percussion cap contains a substance—fulminate of mercury—which is just outside those conditions. Chemical forces are capable of balancing each other as mechanical forces do. The balance may be upset with difficulty, and then the body belongs to the class of stable compounds, such as all ordinary earths and stones; or it may be upsettable with facility, and then the body belongs to the class of unstable compounds, of which fulminate of mercury is one, and which we find is decomposed by a smart blow. Some bodies of this latter kind, such as chloride of nitrogen, explode violently on mere contact with most other substances.

A body may be in the state of rest called equilibrium, and yet be

far from actual and absolute repose. Thus a scale beam, equally heated throughout its length, is in active internal motion; but as both arms are lengthened at the same time, and in the same proportion, the equilibrium of gravity is not disturbed. Astronomy furnishes remarkable instances of groups of balanced motions producing the equilibrium of systems, every part of which moves in harmony with the rest. Astronomy also brings before us the conception of compensated disturbances, or aberrations, an arrangement which permits certain departures from the main plan, in such a manner as to consist with the stability of the whole. If we descend from great things to small, and pass from Nature's grand clockwork in the starry orbs to man's little clockwork with his chronometers, we find analogies in the mode of operation; and that form of pendulum, in which the expansion and consequent lengthening of the pendulum-rod is counteracted by the expansion and rise of mercury in the glass vessel which constitutes the pendulum-rod, illustrates to some extent the mutually compensating irregularities by which the true relation between suns and planets is maintained.

It is by establishing the kind of equilibrium we have described that bodies are preserved as *wholes*, notwithstanding the motion of their parts, or the change of their constituent atoms. The inorganic world affords us continual instances of the first of these actions, and the organic world of the second. In the latter there is an approximate equilibrium of waste and supply. The two processes are seldom equal. When the supply predominates in a healthy individual, growth is obtained; and when the waste predominates, dissolution ensues.

The social world has its equilibriums, stable and unstable, like the physical and the chemical worlds. In societies in which rights are respected and duties performed, the stable equilibrium is attained; and if disturbance ensues, and the fabric shakes under hostile assaults, it may still regain its condition of individual activity and collective repose; while in other societies in which injustice is the predominant force, the resulting equilibrium of despotism is unstable, and when a shock comes the

"Castles topple on their warders' heads."

It has been well said that "harmonious motion is divine repose." Absolute rest, with its negations, so appalling to the European mind, constitutes the highest felicity of the Buddhist; but in a healthy human being, a higher kind of rest is achieved in the compensating movements and harmonious working of divers faculties. The muscular system relieves the nervous, the nervous excites the muscular; the affections not only stimulate the intellect, but they relieve its labours; and by a grateful alternation of different modes of action, life's varied functions are performed in due season, so that to exist is to enjoy.—*Intellectual Observer*.

Wonderful Properties of Figures.

Though figures constitute a universal language among the civilized nations of the earth, and maintain such an exalted character for honesty and truth that it has passed into a proverb that "figures can not lie," yet they are treated as the mere slaves of calculation, without any regard for that respect and consideration to which their peculiar qualities entitle them. To rescue them from the degradation of being looked upon as mere conveniences, let us see if they are not possessed of certain intrinsic properties which shall excite our wonder and admiration.

Few people have a clear conception of even "a million of dollars." Mr. Longworth, who recently died at Cincinnati, was said to be worth fifteen millions of dollars. How many days would it take to count that sum, at the rate of fifty dollars a minute, working steadily ten hours each day? While some are guessing four or five days, another a week, another two weeks or a month, the operation may be made mentally. Fifteen millions divided by fifty gives three hundred thousand minutes; divided by sixty gives five thousand hours; divided by ten gives five hundred days! An answer which is sure to strike your guessers with amazement; a remarkable instance of the difference between guessing and thinking.

The powers of the human understanding are limited. The increase of figures has no limits. Our knowledge of numbers, therefore, must necessarily be limited. But, like every other subject, the more we study and think about it, the more we shall know. A distinguished philosopher, to whom the world is indebted for some of the grandest truths of science, has said that, without any extraordinary endowment of mind, by thinking long and deeply, on this subject, point after point gradually unfolded itself to his mental vision, until he was able to comprehend the mighty laws which control the universe.

The child who has learned to count as far as three, has an idea of that number; but the number thirteen is quite beyond his comprehension.