General Science and Miscellany.

NATURAL PHILOSOPHY.
No. III.

THE LAWS OF MOTION AND THE CENTRE OF GRAVITY.

The science of mechanics is founded on the laws of motion; it will therefore be necessary to explain these laws before we examine the mechanical powers. Motion consists in a change of place. A body is in motion whenever it is changing its situation with regard to a fixed point. Now, as one of the general properties of bodies is inertia, it follows that a body cannot *move* without being *put* in motion. The power which puts a body into motion is called *force;* the stroke of the hammer is the force which drives the nail; the exertion of the horse in pulling, that which draws the carriage. Gravitation is the force which occasions the fall of bodies; cohesion, that which binds the particles of bodies together; and heat, a force which drives them asunder. When a body is acted on by a single force, the motion is always in a straight line, and in the direction in which it received the impulse.

The rate at which a body moves, is called its *velocity;* and it is one of the laws of motion, that the velocity of the moving body is proportional to the force by which it is put in motion. The velocity of a body is called *absolute,* if we consider its motions without any regard to that of other bodies. When, for instance, a horse goes fifty miles in ten hours, his velocity is five miles an hour. It is termed *relative,* when compared with that of another body which is itself in motion. Thus a man asleep in a ship under sail, remains at rest relatively to the vessel, though he partakes of its absolute motion. If two carriages go along the same road, their relative velocity will be the difference of their absolute velocities.

The motion of a body is said to be *uniform,* when it passes over equal spaces in equal times. It is produced by a force having acted on a body once, and having ceased to act, such as the stroke of a bat on a cricket-ball. It may be said, that the motion of the ball is neither uniform nor in a straight line. In answer to this objection, you must observe that the ball is inert, having no more power to stop than to put itself in motion; if it fall, therefore, it must be stopped by some force superior to that by which it was projected; and this force is gravity, which counteracts and finally overcomes that of projection. If neither gravity nor any other force opposed its motion, the cricket-ball, or even a stone thrown by the hand, would continue to proceed onwards in a right line and with a uniform velocity. We have no example of perpetual motion on the surface of the earth; because gravity, the resistance of the air or friction, ultimately destroys all motion. When we study the celestial bodies, we find that nature abounds with examples of perpetual motion, and that it conduces as much to the harmony of the system of the universe, as the prevalence of it would be destructive of all stability on the surface of the globe

Retarded motion is produced by some force acting on a body in a direction opposed to that which first put it in motion, and thus gradually diminishing its velocity.

Accelerated motion is produced, when the force which puts a body in motion continues to act upon it during its motion, so that its velocity is continually increased. Let us suppose, that the instant a stone is let fall from a high tower, the force of gravity were annihilated: the stone would nevertheless descend; for a body, having once received an impulse, will not stop, but move on with a uniform velocity. If, then, the force of gravity be not destroyed after having given the first impulse to the stone, but continue to act upon it during the whole of its descent, it is easy to understand that its motion will be thereby accelerated. It has been ascertained, both by experiment and calculations, that bodies descending from a height by the force of gravity, fall about sixteen feet in the first second of time, three times that distance in the next, five times in the third second, seven times in the fourth, and so on, regularly increasing according to the number of seconds during which the body has been falling. Thus the height of a building or the depth of a well may be known, by observing the length of time which a stone takes in falling from the top to the bottom. If a stone be thrown upwards, it takes the same length of time ascending, that it does descending. In the first case, the velocity is diminished by the force of gravity; in the second it is accelerated by it.

The *momentum* of bodies is the force or power with which one body would strike another. The momentum of a body is measured by the product of its weight and velocity. The quicker a body moves, the greater will be the force with which it will strike against another body; and we know also, that the heavier a body is, the greater is its force; therefore, the whole power or momentum of a body is composed of these two properties. It is found by experiment, that if the weight of a body be represented by the number 3, and its velocity also by 3, its momentum will be 9.

The *reaction* of bodies is the next law of motion to be explained. When a body in motion strikes another body, it meets with resistance; the resistance of the body at rest will be equal to the blow struck by the body in motion; or, in philosophical language, action and reaction will be equal and in opposite directions. Birds, in flying, strike the air with their wings, and it is the reaction of the air which enables them to rise or advance forwards.

If we throw a ball against a wall, it rebounds; this return of the ball is owing to the reaction of the wall against which it struck, and is called *reflected motion.*

Compound motion is that produced by the action of two forces. If a body be struck by two equal forces, in opposite directions, it will not move. But if the forces, instead of acting on the body in opposition, strike it in two directions inclined to each other, at an angle of 90 degrees, it will move in the diagonal of a square: thus, [Fig. 1,] if the ball A be struck by equal forces at x and y, the force x would send it towards B, and the force y towards C; and since these forces are equal, the body cannot obey one impulse rather than the other, yet as they are not in direct opposition, they cannot entirely destroy the effect of each other; the body will therefore move, but, following the direction of neither, it will move in a line between them, and reach D in the same space of time that the force x would have sent it to B, and the force y would have sent it to C.

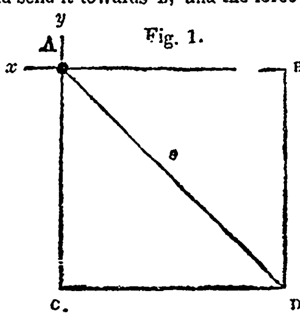

Fig. 1.

Now, if two lines be drawn from D to join B and C, a square will be produced, and the oblique line e, which the body describes, is the diagonal of a square. Supposing the two forces to be unequal—that x, for instance, is twice as great as y; then x will drive the ball twice as far as y, consequently the line A B will be twice as long as the line A C; the

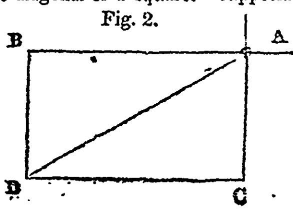

Fig. 2.