From R. Descartes, *Principles of Philosophy*, Part II: “Descartes’ Laws of Motion”

36. **God is the primary cause of motion and always conserves the same quantity of motion in the universe**

The nature of motion being thus understood, it is necessary to consider its cause, and that in two ways: that is, first its universal and primary cause, which is the general cause of all motions in the world, and then its particular cause, by which it happens that individual parts of matter acquire motions that they did not have before. As regards the general cause, it seems clear to me that it is nothing other than God Himself, who in the beginning created matter together with motion and rest and now conserves just as much motion and rest as a whole as He then posited. Now, although this motion in moved matter is nothing other than its mode, nevertheless it has a certain and determinate quantity, which we easily understand to be able to be always the same in the whole universe of things, even though it be changed in its individual parts. So it is evident, as we think, that when one part of matter is moved twice as fast as another, and this second [part of matter] is twice as large as the first, there is as much motion in the smaller as in the larger; and by as much as the motion of one part is made slower, the motion of some other equal to it is made faster. We also understand perfection to be in God, not only that He is immutable in Himself, but that he works in a most constant and immutable way, such that, save those changes that clear experience or divine revelation renders certain and that we believe or perceive to be made without any change in the Creator, we should suppose no other [changes] in His works, lest one then argue an inconstancy in Him. Whence it follows that it is most wholly in accord with reason that we think on this basis alone that God moved the parts of matter in various ways when He first created them and that He now conserves all of this matter clearly in the same way and for the same reason that He formerly created, and that He also conserves the same amount of motion in it always.

37. **The first law of nature: that any object, in and of itself, always perseveres in the same state; and thus what is moved once always continues to be moved.**

Indeed, from the same immutability of God can be known certain rules or laws of nature, which are the secondary and particular causes of the diverse motions that we perceive in individual bodies. The first of these is that any object, insofar as it is simple and undivided, remains, in and of itself, always in the same state and is never changed, unless by external causes. Thus, if some part of matter is square, we may easily persuade ourselves that it will continue perpetually to be square, unless something should come from elsewhere that changes its shape. If it were at rest, we do not believe it would ever begin to be moved, unless it were impelled to do so by some cause. Nor is there any greater reason, if it were moved, why we should think that it would ever of its own accord, and impeded by nothing else, interrupt its own motion. And therefore one should conclude that that which is moved is, in and of itself, always moved. But, because we are here talking about the earth, the constitution of which is such that all motions that take place near to it are shortly halted, and often due to causes that are hidden from our senses, we have often from earliest times judged that these motions, which were so halted by causes unknown to us, cease of their own accord. And then we are inclined to posit of all what we seem to have experienced in many, namely that these [motions] by their nature cease, or tend toward rest. Actually, it is wholly in opposition to the laws of nature; for rest is contrary to motion, and nothing can be moved to its contrary, or to its own destruction, by its own nature.

38. **On the motion of projectiles.**

Certainly, everyday experience of things that are thrown wholly confirms our rule. For there is no other reason why thrown [bodies] should continue in motion for any time after they have been separated from the thrower than that once moved they continue to be moved, until they are slowed by contrary bodies. And it is manifest that they usually are gradually retarded by the air, or some other fluid bodies in which they are moved, and hence their motion cannot last long. For we can experience air resisting the motions of other bodies by our sense of touch if we strike it with a fan; the flight of birds also confirms the same thing. And there is no other fluid which does not, even more manifestly than air, resist the motions of projectiles.

39. **The second law of nature: that every motion of itself is rectilinear; and hence what is moved circularly tends always to recede from the center of the circle it describes.**

The second law of nature is that any part of matter, considered apart, never tends to continue to be moved along any
oblique lines, but only along straight lines, even if many are often forced to deflect due to the collision of others, and, as has been said shortly before, in any motion a circle is somehow made from all the matter moved at the same time. The cause of this rule is the same as that of the one preceding, namely the immutability and simplicity of the operation by which God conserves motion in matter. For He does not conserve it other than precisely the way it is in the moment of time in which He conserves, with no relation to what perhaps was shortly before. Although no motion occurs instantaneously, it is nevertheless manifest that everything that is moved, in the single instants that can be designated while it is moved, is determined to continue its motion toward some direction along a straight line, and never along any curved line. For example, stone A, rotated in sling EA around circle ABF, at the instant in which it is at point A is determined to motion in some direction, namely along a straight line toward C, such that the straight line AC is tangent to the circle. But one cannot arrange that it be determined to any curved motion; for, even if it previously came from L to A along a curved line, nevertheless nothing of this curvity can be understood to remain in it when it is at point A. This is also confirmed by experience, because if it then left the sling it would not continue to be moved toward B, but toward C. From which it follows that everybody that is moved circularly, perpetually tends to recede from the center of the circle it describes. We experience this by tactile sense in a stone that we move in a circle with a sling. And, because we will often use this consideration in the things that follow, it should be diligently understood and will be expounded in more detail below.

40. Third law: that a body, in colliding with another larger one, loses nothing of its motion; but, in colliding with a smaller one, loses as much as it transfers to that one.

The third law of nature is this: where a body that is moved meets another, if it has less force \[vis\] to continue along a straight line than the other has to resist it, then it is deflected in another direction and, retaining its motion, loses only the determination of motion; if it has greater force, then it moves the other body with it and gives it as much of its motion as it loses. Thus we learn by experience that any hard bodies that, when thrown, strike against another hard body do not therefore cease from motion, but are reflected in the opposite direction. On the contrary, however, when they meet a soft body, they are then immediately brought to rest, because they easily transmit all of their motion to that body. Indeed, all particular causes of the changes that befall bodies are contained in this third law, at least those that are themselves corporeal; for whether, and in what way, human or angelic minds have the force to move bodies, we do not now inquire but reserve for our treatise On Man.

41. Proof of the first part of this rule.

The first part of this law is demonstrated on the basis that there is a difference between motion considered in itself and its determination in a certain direction, by which [difference] it happens that this determination can be changed, the motion remaining unchanged \[integer\]. For, since, as was said before, whatever [the nature of] the motion of any thing that is not composite but simple, it continues to be [such], as long as it is not destroyed by any external cause; and, in the collision with a hard body, it appears as the cause that impedes the motion of the other body, which it meets, from remaining determined toward the same direction, but not a [cause] that takes away or diminishes that motion, because motion is not contrary to motion, whence it follows therefore that it cannot be diminished.

42. Proof of the second part.

Furthermore, the second part is demonstrated from the immutability of the operation of God, now continually conserving the world by the same action by which He formerly created. For, since all things are filled with bodies and, nevertheless, the motion of any body tends in a straight line, it is most clear that, from the beginning, God, in creating the world, not only moved its various parts in different ways but at the same time also brought it to pass that some would impel others and transfer their motions to them; in order that now, in conserving that [world] by the same action and by the same laws by which He created, He conserves motion not always fixed in the same parts of matter but passing from some parts into others according as they collide with one another. And thus this continuous change of things created is itself to be argued of the immutability of God.
From I. Newton, *Mathematical Principles of Natural Philosophy*
(first English translation (from Latin) of 1729 by Andrew Motte two years after Newton's death)

**Axioms or Laws of Motion (Axiomata sive Leges Motus)**

**LAW I**

*Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.*

Projectiles persevere in their motions, so far as they are not retarded by the resistance of the air, or impelled downwards by the force of gravity. A top, whose parts by their cohesion are perpetually drawn aside from rectilinear motion, does not cease its rotation, otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in more free spaces, preserve their motions both progressive and circular for a much longer time.

**LAW II**

*The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*

If a force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both.

**LAW III**

*To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.*

Whatever draws or presses another is as much drawn or pressed by that other. If you press a stone with your finger, the finger is also pressed by the stone. If a horse draws a stone tied to a rope, the horse (if I may so say) will be equally drawn back towards the stone: for the distended rope, by the same endeavour to relax or unbend itself, will draw the horse as much towards the stone, as it does the stone towards the horse, and will obstruct the progress of the one as much as it advances that of the other. If a body impinge upon another, and by its force change the motion of the other, that body also (because of the equality of the mutual pressure) will undergo an equal change, in its own motion, toward the contrary part. The changes made by these actions are equal, not in the velocities but in the motions of the bodies; that is to say, if the bodies are not hindered by any other impediments. For, because the motions are equally changed, the changes of the velocities made toward contrary parts are reciprocally proportional to the bodies. This law takes place also in attractions, as will be proved in the next scholium.