

**Volume 1, Issue 1**

**Research Article**

**Date of Submission:** 05 May, 2025

**Date of Acceptance:** 02 July, 2025

**Date of Publication:** 16 July, 2025

## Matter and Mass

**Nainan K. Varghese\***

Independent Researcher, India

**\*Corresponding Author:** Nainan K. Varghese, Independent Researcher, India.

**Citation:** Varghese, N. K. (2025). Matter and Mass. *Energy Sci Eng Policy*, 1(1), 01-06.

### Abstract

Matter is the only substance that can provide objective existence in space and physical reality to an entity. Matter constitutes all real entities. Due to lack of a reference, we have no measuring scale to determine the matter contents of real objects. Instead, one attribute of matter (mass) is taken to represent the equivalent of matter contained in material objects. Mass, used for this purpose, is itself often bifurcated into inertial mass, gravitational mass, etc. Inertial mass is a measure of inertia, a property attributed to the 3D material bodies. Gravitational mass is derived from the magnitude of gravitational attraction experienced by a 3D material body. However, the importance accorded to mass (in place of 3D matter contained in an object) caused the matter to be regarded as an unnecessary entity even for the existence of material bodies and encouraged the developments of exotic theories and assumptions of mysterious particles. Devising a logical measurement scale can help restore the glory to matter, rightly due to it being the only substance that can provide existence to all real objects.

**Keywords:** Matter, Mass, Force, Inertial Mass, Gravitational Mass, Universal Medium, Mass Defect, Photon, Biton

All conclusions expressed in this article are taken from an alternative concept, presented in the book 'MATTER (Re-examined)' [1]. For details, kindly refer to the same.

### Matter

An entity is a thing with distinct existence. It has existence in itself. To exist is to have a place in objective reality in space. Although space is very vague, a place of existence is always presupposed by rational beings whenever a real entity is envisaged. The perceived entity has a distinct but separate existence from the perceiver. Perceiver (rational beings) may name an entity. A name is a word (or group of words) referring to an individual entity. Name singles out an entity by directly pointing to it. An entity may be real or imaginary. An entity that can be perceived by senses or is tangible and is relatively stable in its form is a real object or real entity. An imaginary entity is functional in its character.

All real entities are materialistic. They are material objects made out of matter. Matter is the substance/stuff that gives real entities their materialistic existence. Matter is a physical substance that occupies space and can be perceived by one or more senses. Matter is distinct from qualities, properties, thoughts, mind and spirit. Only the matter is real. All others are functional and are results of organised performance of matter particles. Having matter-content, makes an entity a real object that can be perceived by sensory organs. In (Aristotelian and Scholastic) philosophy, matter is in itself undifferentiated and formless and which, when subjected to change and development, receives form and becomes substance. Hence, matter is the substance any physical object consists of or is composed of, or simply, matter is something that exists in space.

At different stages of history, the concept of matter had many variations in light of the scientific knowledge prevailing at the time of what are considered basic building blocks and their interactions. At one stage, atoms were considered as basic building blocks, and all matter was considered to be constituted by atoms. Later, matter was viewed as solid, massive and movable particles. Still later, smaller fundamental constituents of matter were discovered to change the constitution of matter. Currently, in physics and chemistry, matter is assumed to exhibit both wave-like and particle-like properties, the so-called wave-particle duality. Often, matter is disregarded, and one of its attributes, the mass, is accorded the status of reality. This attitude caused numerous unnecessary assumptions in modern physics.

Matter is the 'material substance that constitutes the observable universe and, together with energy, forms the basis

of all objective phenomena' (Wikipedia). All matter shares certain fundamental properties, as understood from the observation of nature. Every physical entity is assumed to have properties of mass, gravitation, inertia, etc. All primary properties of matter are amenable to mathematical description. Nevertheless, its secondary properties (or qualities) are not considered mathematically. Although, mass of an object is a measure of its inertia, it is commonly taken as a measure of the amount of material contained in it. Matter in bulk may have several states of existence in nature. A common definition of matter is 'anything that has mass and occupies volume'.

Matter has many definitions in physics, but the most common one currently used is that it is any substance which has mass and occupies space and exists in one of the physical states. All physical objects are composed of matter in the form of atoms, which are in turn composed of protons, deuterons, neutrons, electrons, etc. Currently, the photons (corpuscles of radiation) are assumed to have no mass, so they are an example of something real in present-day physics, which is not comprised of matter. They are also not considered as objects, in the traditional sense, as they cannot remain static. In cosmology, the term matter includes dark matter and dark energy, concepts used to explain some anomalous phenomena observed in the universe.

These exotic forms of 'matter' do not refer to matter as a substance that occupies space but rather to unknown entities of mass and energy. The definition of matter is revised in light of quantum mechanics, where the concepts of 'having mass' and 'occupying space' do not have the same meaning as in everyday life. Some similar theories hold the view that the physical bodies are made of several substances and properties of matter (including mass and volume) that are determined not only by the constituent substances themselves but also by how they interact. In other words, matter is made of interacting 'building blocks'. According to the special theory of relativity, matter (considered as mass) and energy are equivalent. Accordingly, mass (matter) can be converted into energy and energy into mass (matter). Usually, matter is ignored altogether in this theory.

The term 'matter' traditionally refers to the substance that all physical objects are made of. One common way to identify this substance is through its physical properties. The concept of substance is essentially a philosophical term of art. In its generic sense, therefore, substances in any philosophical system are those things which, according to that system, are foundational or fundamental entities of reality. For an atomist, atoms are substances because they are the basic things from which everything else is constructed. In certain philosophies (David Hume's system), impressions and ideas are substances for the same reason. Etc. Although in different senses, all philosophical systems acknowledge the existence of substances. Substances are a particular kind of basic entity. Some philosophical theories acknowledge them as such, and others do not. The conception of substance as a basic entity derives from our notion of the individuality of a 'thing' or 'object' in contrast with the 'properties' of entities and 'events'.

In its physical sense, the substance is that which exists in itself and does not depend upon anything else for its existence. Attributes or characteristic properties are inherent in (and about) the substances and depend on substances for their existence. Existence is recognised by the rational mind. This may be the result of correct sensory perceptions; it may be the result of incorrect perception, or it may be a mere thought process. If existence is recognised by sensory perception, in order to exist, the substance needs a place. Hence, it is essential for a rational mind to presuppose a space for the existence of a real entity. This is how we created a functional entity of space in the universe. Space is purely a functional entity. Its sole function is to provide a place of existence for real objects. It has neither a form nor a structure nor physical properties. Such an entity cannot move, distort or act. In the case of functional entities, space for existence is not required. They exist in the minds of perceivers.

Rational beings perceive real entities by their sensory organs. Perceived information is then processed and compared with previous experience by the rational being's mind to know and experience the entity and its existence. Existence is always particular and individual. This does not mean that all that is perceived by the senses is real. Different sensory organs may perceive the same object in different ways. Only one of them can correspond to reality. A stick, partially dipped in water, may appear by sight as a bent object – an imaginary stick. By touch, it would appear in its real shape, a straight object the real stick. Both imaginary and real sticks appear to exist in the same location. If they exist in the same location, surely, they cannot be different but the same entity. In this case, the bent stick has no existence, but the straight one exists in space. Both the real (straight) stick and the imaginary (bent) stick are perceptions of the mind, but by different sensory organs. The real (straight) stick exists in space, and the imaginary (bent) stick does not exist in space. Only the real (straight) stick occupies space. It is a real entity. It has positive existence in space. The bent stick, perceived by rational beings, is an imaginary entity. It has no existence in space. It exists only in the mind of the perceiver. This is an example of aberration of sensory perceptions. All entities which have no real existence in space but have their existence only in the mind of the perceiver are imaginary entities. They are functional and fulfil functions assigned to them.

One school of philosophy (led by David Hume) denied the existence of substance, using epistemological principles. They argued that since all human knowledge must be traced back to sensation, the idea of substance must also be traced to the same. Since sensory perceptions themselves cannot provide knowledge of substance, no one can know substance as distinct stuff from that of a collection of particular qualities or attributes. Thus, substances are nothing but a collection

of simple ideas that are united by imagination and have a particular name assigned to them. In its essence, knowledge of an aesthetic object becomes knowledge of the aesthetic experience itself. This school of thought adopts the approach that puts aesthetic experience first and then examines the aesthetic object as an intentional object of that experience.

This consideration is suitable for functional entities like imaginary particles, art forms, etc. Imaginary entities are created by rational beings in their minds, and all their attributes are also subscribed to by them. A painting is nothing but a collection of canvas and colours. It is the rational mind that attributes its functionality and qualities. However, many scientists, in dealing with modern physics, engaged this philosophy to produce exotic theories, based on imaginary particles and mysterious properties, which are acquiescent with complicated mathematical treatments. Simple logical reasoning is not allowed to question their genuineness or logic.

## Mass

Scientists and philosophers searched for long to define the nature of matter. Other than to observe certain qualities of matter, they were not successful in their attempt to know the true nature of matter. Frustrated, more influential among them sought an easy way out of this predicament. Instead of considering matter itself as fundamental substance or stuff, a quality of matter was enthroned in its place as a real entity. Thus, mass, a measure of the inertia of a real object, came to be regarded as a real entity that represents the equivalent of its matter content. All further development in physics was based on this illogical assumption. Mass is distinct from matter. Since we have no measuring scales to directly measure the matter content of an object, we depend on indirect measurements. One of the measuring systems used in physics to represent the matter content of an object is its mass. Because matter is a poorly defined concept and different definitions of matter agree on its property of mass, mass is used to represent the equivalent of matter, often in physics. Hence, we say that all real entities (made of matter) have the attribute of mass. All matter has the property of mass, but not all mass is associated with identifiable matter. Mass is defined as the cause of the inertial property (resistance to being accelerated when acted on by external effort) of an object. Since functional entities contain no matter, they do not have the attribute of mass. They can provide only intentional objects. An intentional object is part of a state of mind, whereas a material object always has independent (and objective) existence. However, the reverse is not always held true. For, there are real objects, which are assumed to have no mass.

'Mass' commonly refers to any of three properties of matter: inertial mass, active gravitational mass, and passive gravitational mass, which have been shown experimentally to be equivalent. Mass is also considered to have many attributes in various theories; It measures the matter content of an object (material mass). It measures an object's resistance to change of its state of motion when an external effort is applied (inertial mass). It produces a gravitational field in space, surrounding the object (active gravitational mass). It causes an object's interaction with an external gravitational field (passive gravitational mass). In certain theories, mass is assumed to curve space-time or as a difference between an object's quantum frequency and its wave number (quantum mass). Differences between inertial mass, gravitational mass and various other mass-related phenomena are distinct and can suit only the concept that is using a particular attribute. No practical experiments so far have shown any non-proportional difference in values of mass. Therefore, mass is generally accepted as an abstract concept.

In physics, 'mass' is defined as 'quantitative measure of inertia', a fundamental property presently attributed to matter. It is the resistance that a material body offers to change in its state of motion upon application of external effort. Mass of a body is the mathematical relation between the external effort on it and the rate of change of its state of motion – acceleration. Mathematically this relation is expressed as  $F = M \times a$ , where 'M' is the magnitude of mass, 'F' is the magnitude of external 'force', and 'a' is the magnitude of acceleration. Since 'F' and 'a' can have only positive values, the mass of a body can only be a positive number, larger than zero. However, depending on the relative magnitudes of external 'force' and acceleration produced by the action of effort, the mass of a body can vary from a very small value to infinity. Hence, no real body (constituted by matter) can be massless.

Magnitude of matter content of a body, measured by determining its mass, can have a reasonable relation to its matter content only if the magnitudes of external force and the body's acceleration are within reasonable limits. If for any reason the external force, by its action on the body, cannot change the state of motion of a body, by the above-given relation, the mass of the body will reach infinite proportion, even under the steady magnitude of its matter content. This is a fallacy created by the equation rather than an increase in the matter content of the body.

All actions are understood by motion or changes in state of motion of objects. If there is no change in state of motion, it is understood that the external effort is unable to act on the object. The action of an effort always presupposes the ability of the 'force-applying body' to move faster than the 'force-receiving body'. For action of external effort, the 'force-applying body' has to move towards the 'force-receiving body' at greater speed. Although the 'force-applying body', when in contact with the 'force-receiving body', does not apparently move faster, there has to be a minute difference in their speeds. It is this speed difference which enables the 'force-applying body' to press into the 'force-receiving body'. By interacting, the 'force-applying body' compels the 'force-receiving body' to change its state of motion. This is possible only as long as the speed of the 'force-receiving body' is less than the speed of the 'force-applying body'.

As the difference in their speeds reduces, the quantum of action of the 'force-applying body' on the 'force-receiving body' diminishes. As and when their speeds become equal, the 'force-applying body' will no longer be able to act on the 'force-receiving body'. This is simple logical reasoning. If the mass of the 'force-receiving body' were now determined by the relation ( $M = F/a$ ), it would have reached infinity in magnitude. Taking this as the magnitude of its matter content is absurd. Direction of motions being the same, a slow-moving macro body cannot act on a faster-moving macro body. Similarly, however large the magnitude of (mathematical) 'force' may be, if the linear speed of the 'force-receiving body' is restricted by a limit, its mass may appear to approach infinite proportions. Both these situations indicate the inability of external effort to produce desired results rather than a change in the constitution of the 'force-receiving body'.

This situation, where the mass of an object approaches infinite proportions in calculations, is rescued by an equally illogical suggestion that all energy (an undefined entity) supplied by the 'force-applying body' is being converted into mass in the 'force-receiving body' and thus taking the magnitude of its mass to infinity. Unfortunately, no one has ever devised a logical mechanism for this conversion. The fact that the object's matter-content has not varied at all is left to the reader's imagination. Changes to the matter content of the 'force-receiving body' or the ability of the 'force-applying body' to act on the 'force-receiving body' are not considered. This mysterious energy/mass conversion is the phenomenon of 'relativistic mass'. The unchanged part of the mass of the 'force-receiving body', as may be determined, with its (absolute) speed being zero, is its 'rest mass'. Rest mass is assumed to be equivalent to the matter content of the object.

While considering the magnitude of external effort, speed or ability of the 'force-applying body' to act on the 'force-receiving body' also needs to be considered. While forming the above-given equation of motion, no thought was spared about the ability of the 'force-applying body' to move. It was simply considered that any 'force-applying body' could move with infinite linear speed, if required. This thoughtlessness led to ignoring the efficiency of external effort's action. Efficiency of external effort's action on an object is determined by the relation between the magnitude of the possible highest linear speed of the 'force-applying body' ( $V_{max}$ ) and the current linear speed of the 'force-receiving body' ( $V$ ).

Efficiency of effort,  $\eta$ , depends on the highest possible speed,  $V_{max}$ , of matter bodies and the present speed,  $V$ , of the 'force-applying body'.

$$\text{Efficiency of external effort, } \eta = \frac{(V_{max} - V) \times 100}{V_{max}} \%$$

Efficiency of external effort is highest (100%) when (absolute) speed of the 'force-receiving body' is zero. Efficiency of external effort is zero, or it is unable to act on the 'force-receiving body' when its (absolute) speed becomes equal to the highest possible speed (in the direction of motion) of the 'force-applying body'. Since mass is only a functional entity, it can neither act nor be acted upon. External effort on an object acts on its matter-content. Magnitude of action depends on the magnitude of matter-content and the efficiency of the effort. Normally, the matter content of an object does not vary due to the action of effort. Nevertheless, depending on the (absolute) linear speed of the object, its mass varies. This is the result of variations in the efficiency of external effort to act on the object.

This phenomenon limits the linear speed of (photon) light to its highest possible linear speed in space. Hence, the speed of light is a critical constant [1]. Incidentally, an attempt to increase the linear speed of a photon tends to increase its matter content rather than its linear speed. Similarly, an attempt to reduce a photon's linear speed tends to reduce its matter content rather than reduce its linear speed. This mechanism keeps the linear speed of a photon constant with respect to an absolute reference.

The speed of light (photon) is the highest limit at which any material particle can move. Efficiency of an external effort trying to act on a photon, in the direction of its motion, is zero. That is, no external effort is able to act on a photon in its direction of motion. Thus, by the above definition of mass, the magnitude of the mass of a photon is infinity. Absurdness of this result is removed by declaring photons as massless entities. This also contends that as photons are massless, they have no matter content. Without matter content, they are no more real objects. Hence, although they can be perceived by our sensory organs, they are treated as functional entities. This is one of many examples, developed as a result of assuming mass as equivalent to matter content. Nevertheless, the ability of a photon, a mass-less entity, to have momentum is maintained for the sake of some theories. This is contrary to the definition of momentum (another attribute of matter), which is given by the result of mass multiplied by linear velocity.

It is a fact of observation that light (photons) moves. In the current state of physics, light has no logical mechanism of motion; neither its cause nor its mechanism is understood. Hence, it is simply assumed that light (photon) moves at its observed speed without external influence or an accelerating stage. This is against basic physical laws. Because of this ignorance, it is simply assumed that a light corpuscle achieved its steady linear speed without action of external effort on it. Considering action in this way, by the above equation, the mass of a corpuscle of light becomes zero. Thus, light or photons appear as massless bodies. The reason for this confusion is our unawareness of the structure of photons and the mechanism of their motion.

It is due to the critical linear speed of light that no external effort, in the direction of its motion, can act on it. If the direction of external effort is different from the direction of its linear motion, external effort is found to act on light (photon) and cause its displacement in the direction of external effort. Light is noticed to bend its path while passing near very large macro bodies. Being shy to accept the fact of the matter-content of a photon, this phenomenon is illogically attributed to the assumed physical curvature of space (an entity without physical structure) due to gravitational fields instead of gravitational attraction between photons and large macro bodies.

By definition, matter causes sensory perception. Sight is a sensory perception. Irrespective of the fact that light is instrumental to the sense of sight, it is considered a functional (massless) entity. Light is considered as mere wave motions of certain energy particles (defined only in mathematical equations) through empty space. This is not right. Since photons cause sensory perceptions, they are made of matter that has positive existence in space. Their high speed of motion should not deprive them of their true nature. Corpuscles of light have matter cores with definite structure and shape. Nature provides a simple and logical mechanism for their creation, motion and other actions. Photons (corpuscles of light) are basic 3D matter-particles and they form all other superior 3D material bodies.

### **Weight**

Although mass is defined in terms of inertia, it is also conventionally expressed as weight on or near the surface of Earth. Weight is essentially the 'force' of attraction due to gravity on a 3D material body. Therefore, it varies from place to place on earth's surface. In contrast, under ordinary circumstances, the mass of a macrobody remains constant, regardless of its location. 'Weight' is created when an object is acted upon by a gravitational attraction and the object is not allowed to free-fall but is supported or retarded by a mechanical effort. In gravitational weight, weight is the magnitude of 'force', which must support a real object (at rest) in a gravitational field. Such a 'force' confers weight to a 3D material body. Additional mechanical efforts enhancing its retardation may increase its weight.

Though they are in fact different concepts and quantities, in everyday use, mass and weight are used interchangeably. This is made possible by assigning the value of unity to the magnitude of gravitational attraction between Earth and 3D material bodies on its surface in an equation relating weight, mass and gravitational attraction. Units of weight and mass are the same for general purposes. However, for proper scientific use, mass is measured in kilograms (or similar units in different systems), and weight is measured in terms of units of 'force'. The two terms refer to different, yet related, properties of matter. An object's weight depends on its environment, while its mass does not.

### **Measurement of Matter**

Rightly, the rest mass of a 3D material body (with respect to absolute reference) represents the magnitude of its matter content. They are not equal or the same. Matter content of a 3D material body is the quantity of substance it has, and its mass is the quantitative measurement of inertia associated with it. It is our inability to find a 'reference-material body' that compelled us to use rest mass to represent a 3D matter-body's matter-content and paved the way for many subsequent misunderstandings. Since we had no reference, no measuring system could be devised to measure the magnitude of matter-content of an object. Instead, we had been using measurements of properties attributed to matter to indirectly assess its matter content. As explained above, this often gave improper results and encouraged the development of exotic theories with virtual particles and mysterious assumptions.

The concept, explained in the book 'MATTER (Re-examined)', concludes that the matter content of one type of 'primary particles' (Bitons), when in free space, is of constant magnitude. (Free space is the region where there are no other 3D matter-particles other than the 3D matter-particle considered and where the universal medium is in a perfect homogeneous state, except for the accommodation of the considered 3D matter-particle.) This property of constancy in magnitude of matter-content could be used to devise a measuring scale for matter-content. Matter-contents of bitons change during changes in their external environment. This could happen during the accumulation of many bitons for the formation of superior 3D matter-particles, like fundamental particles, atoms, molecules, etc. Changes could also take place if the nature of the universal medium surrounding the bitons is varied.

'Matter-content level' of a 3D matter-body is the measure of matter-content in each of its primary particles. Changes in the matter-content level of a 3D material body are indicated by changes in its heat level. A macro body in free space (in its coolest state) has the highest matter content. Since matter content and energy about a 3D material body are proportional to each other, energy associated with it is also at the highest level when it is in free space. In this state, the 3D material body is in its coolest condition. (This is contrary to present belief that a body's energy level increases as its temperature increases [1].)

Primary particles (bitons) lose parts of their matter and energy contents as structural distortions in the surrounding universal medium are increased, either by accumulation of more primary particles or by the presence of other 3D material bodies in the vicinity or by the transfer of structural distortions from other regions of the universal medium. Because of this phenomenon, whenever two or more primary (or fundamental) matter particles or even macrobodies combine to make a single macrobody, certain parts of their matter and energy contents are lost from the composite macrobody. Similarly, whenever a composite fundamental particle or even a macro body splits into different fragments,

each of the fragments absorbs matter and energy contents from the surrounding universal medium to increase total matter and energy contents. This gives rise to the phenomenon of 'packing fraction' or 'mass defect'. This is associated with changes in the matter content of 3D matter bodies rather than association with assumed mass/energy conversion.

A combination of smaller 3D material bodies to form a larger macrobody changes the composite macrobody's heat level. As a composite macro body becomes larger, its 3D matter-particles tend to lose their matter and energy contents. Hence, the matter-content level of a macrobody can be related to its state of heat (temperature measurement). Using the magnitude of the constant matter content of a primary matter particle in free space as a reference and relating it to the matter content of a primary particle in a macrobody, in its present state, the total matter content of the macrobody can be estimated. Primary particles at the centre of a macro body experience the greatest amount of structural distortions in the surrounding universal medium. Hence, they are at the lowest matter-content level of all other 3D matter-particles in the macrobody. If the macrobody is huge, matter-content levels of primary particles nearer to its centre may correspond to different physical states of matter. This phenomenon causes the interior of large macro bodies to be in a liquid/fluid/plasma state, even while its exterior may be in a solid state. Although matter-content levels at the centre are lower, matter-density in that region is held higher than that at the solid exterior by 3D matter-particles staying nearer to each other. If the weight of the atmosphere of such macrobodies is higher, they may have no solid exterior at all. Very huge macro bodies may have gaseous exteriors with the matter towards their centres in a plasma state.

### **Conclusion**

Matter provides the substance of the existence of real objects in nature. Matter content of a body is presently represented and measured in terms of its mass. The method of estimation of matter content in terms of mass and undue importance given to mass have caused many misinterpretations and given rise to illogical theories. Mass is one of the attributes of a material body. It is a mathematical relation between the magnitude of external 'force' acting on a material body and the body's linear acceleration. By accepting an absolute reference, provided by the constant magnitude of matter content of a primary-particle in free space, it is possible to devise a measuring scale to directly estimate the matter content of a real object.

### **Reference**

1. Nainan K. Varghese, MATTER (Re-examined), <http://www.matterdoc.info>