

WORK, MOTION AND ENERGY

According to 'MATTER (Re-examined)'

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Abstract: Energy, an undefined entity derived from work, is generally equated to motion. This has necessitated the introduction of certain motions of physical bodies, wherever energy is envisaged. All actions are results of work done rather than energy. Although energy has no definite form, structure or existence, it has gradually come to usurp the rightful status of work about a physical body. The author proposes an alternative concept that may restore work, motion and energy to their fair and logical status.

Key words: Work, motion, energy, universal medium.

Present concept:

In contemporary physics, 'energy' appears to be the most important and most fundamental entity in our universe. It is assumed to create, develop and sustain us and all other things in nature. Mass, representing matter, is believed to be converted from it. It is supposed to appear in many forms and could be transferred from one place to another or from one body to another (somewhat similar to fluids). Energy from the sun is assumed to sustain everything on Earth, including the living organisms in numerous varieties. There are numerous theories dealing with various properties of energy. In fact, it seems that everything about energy is known, except what energy is, or where and how it is created, stored or transferred?

Energy, in various forms, appears to affect material bodies/particles in diverse ways. This gives rise to the classification of energy into different types; each type associated with a different phenomenon. Energy is often represented as heat, frequency, motion, speed, pressure, electromagnetic, atomic, radiation, potential, potency, etc. They are often used as convenient parameters in mathematical treatments. However, all these are attributes of physical states of material bodies/particles. They symbolize changes in physical parameters/states of material bodies. Attributes define physical states of material bodies/particles, rather than 'energy'. As such, energy has no proper definition or logical form of existence.

Although it was not essential for the development of mechanics, the concept of 'energy' was vaguely introduced into mechanics by Galileo in the 17th century, in the form of a 'living force' that was required as the cause of actions. Thus, 'energy' originally signified a cause or an effort of an action. Energy came into prominence as the measure of the capacity for work much later.

Newton's laws of motion recognize a relation between the magnitude of external 'force' on a material body and the body's acceleration in the direction of the 'force'. In this relation, ($F = ma$), 'F' (force) represented the rate of action (work) accomplished, 'm' (mass) represented a quantity corresponding to the matter contained in the material body, and 'a' (acceleration) represented the rate of change of the body's motion with respect to another functional entity, the time. Arguments on the superiority of evaluation between spatial and temporal integrations of this relation with respect to moving bodies, in the 19th century, helped to establish the following definitions;

1. Acceleration (rate of change of state of a body's motion) is the result of work done on a body.
2. Force is associated with the acceleration of a mass.
3. (Kinetic) energy, associated with the motion of a mass (representing the matter contained in a body), is the result of spatial integration of 'force' acting on the mass.
4. Momentum is the result of temporal integration of 'force' acting on a mass.

5. Energy is the measure of capacity to do work.
6. Power is the time-rate of energy transfer.

These definitions are derived from mathematical operations of empirical data obtained from moving macrobodies. Generally, 'force' became a representative of an effort or cause of an action. Since no logical mechanisms of action of 'force', creation/development of work, or transfer of energy are envisaged, these definitions have no conceptual basis. Currently, scientists in general consider 'energy' as the primary entity in nature. Energy is a very vague assumption that could be used in numerous ways to suit any phenomenon. It is represented in a number of (assumed and) assorted types of functional entities existing along with material bodies (real entities). Energy has different forms and properties to suit diverse occasions. Although energy has no substance or real existence, it is treated for all purposes as a real entity. Even while the energy has no real existence, it is assumed as a tangible entity that can affect material bodies in all fashions by doing work on them. Energy could be transferred from one material body to another, like a fluid from one container to another.

The first type of energy recognised was the kinetic energy, or the energy of motion. The notion of energy was progressively widened to include many other types of energy, each one associated with an empirical phenomenon. Towards the middle of the 19th century, even the heat was considered a form of energy. Recognition of heat as a form of energy and the assumption that energy can neither be created nor destroyed led to the 'energy conservation laws'. The conception of energy continued to expand to include many other types of energy, such as electric, magnetic, chemical, etc. The advent of relativity theory caused the mass (a representative equivalent of matter contained in a body) to be equated with energy. At times, even undefined space is recognized as a storehouse for (flux or field) energy, from which exotic matter particles or characteristic properties may be produced. There are many occasions where phantom states of energy (e.g., potential energy) are used in rationalizations. Energy is considered differently in different branches of science.

Energy, in its initial form of kinetic energy, began its development from being associated with mechanical motion. The motion of a body is easily observable, compared to some of its other parameters. Gradually, the association of energy and motion became so strong that for many purposes, energy replaced the often unobservable 'work done' in topics of motion. The advantage of this association is that for lower magnitudes of linear speeds, the magnitude of energy in non-rotating bodies could be derived in proportion to their linear speed.

Equating energy with motion paved the way for many illogical developments. Considering heat as a form of energy necessitated certain invisible motion of constituent particles within a material body. For this, molecules and their constituents were required to have additional motion (vibrations) over and above their natural motions. In order to satisfy certain parameters of gaseous bodies (in terms of an ideal gas) 'kinetic theory of gases' was proposed. In this theory, gas molecules were considered to have inherent linear motion in a random direction, the magnitude of which depended on the state of energy (heat) of the gaseous body. In fact, it has become imperative to have some type of motion to indicate the presence of energy. However, no logical mechanisms were provided for the development of these assumed motions by energy. When the proportionality of linear acceleration of a macro body and 'energy' input broke down at higher linear speed, energy was alleged to be converted into the 'mass' of a material body.

Energy is considered a transferable or receivable attribute of a real entity. In the steady state of (motion of) a material body, energy associated with the body resides in the form of work done about the body. Energy is usually associated with movements of real entities (or their constituent particles). Greater motion is understood to be associated with a higher magnitude of 'energy' associated with a body. Since only real entities can have objective reality and be displaced in space, in classical theories, real entities were essential to mysteriously bear or transfer energy. However, gradually, the importance of this requirement is deteriorating. In few modern theories, energy is often associated with imaginary entities, or sometimes the energy is assumed to exist independently in imaginary forms. Energy is considered to be convertible into work or, in some cases, even into mass (vaguely suggesting a change in the matter contained in a body). Currently, there are no explanations on energy's form, structure, shape, existence, origin, working, etc. Nevertheless, 'energy' is often assigned independent physical (real) existence in its own right.

'Energy' is defined in dictionaries as the 'capacity or ability to do work'. In everyday language, it is understood as the creator of an effect. Capacity or ability is a qualification and hence a functional entity. A functional entity fulfils all functions assigned to it by rational beings and nothing else. It does not need to have

independent objective existence or a physical form. Energy is a mathematical relation and an attribute of a real entity. Energy, being a quality (to perform work), should naturally qualify as some other real entity that can be the performer of work. Then, energy will be a measure of that entity's ability (one of its qualifications) to accomplish work. Since energy is a quality, it cannot have many forms or types. All energies are of the same type. They may be associated with different types of (apparent) interactions and named differently to indicate their associations. Energy is always designated according to the associated physical effect. Belief in the storage and conversion of energy, from one type to another, produced the branch of physics called 'thermodynamics'.

Energy seems to have no independent existence in any form. It is a shadowy entity, derived from and complementary to work that produces physical changes in material bodies. Wherever work is present, energy of corresponding magnitude develops. This caused the misconception that energy is the entity that performs work. Due to energy's assumed ability to be converted into work, it is also measured in the same units of work. Yet we have no accepted mechanism of action in contemporary mechanics. It is this absence of a mechanism of action that caused the functional entity of 'energy' to usurp the rightful place of the real entity of 'work' in mechanics. 'Energy' gained its acceptance as a convenience for mathematical operations. Since (due to its undefined status) it has no definite existence or form, it can be used in any theory to suit its convenience.

Since energy has no objective reality (physical form or structure), it can neither transform (to become physical objects) nor occupy space. For a logical understanding of the universe and its nature, we may consider only one type of fundamental entity that is the basis of all entities, their properties, and all actions found in the universe. We cannot avoid matter because it provides objective reality to all physical objects. Therefore, we must conclude that matter is the most fundamental entity, and all other things (including energy and work) and all other actions noticed in nature are derived from matter.

An alternative concept:

The alternative concept, proposed in the book 'MATTER (Re-examined)', envisages matter as the only one and the most basic fundamental entity. Matter provides substance (stuff) to all physical entities to have objective reality so they may exist in space as real bodies. In its primary nature, matter exists in the form of quanta of matter (one and the only postulation used in this concept). Quanta of matter, by their inherent properties, structure a universal medium, which fills the entire space. Universal medium provides structure, form, and reality to space. Universal medium performs all other actions and apparent interactions in nature, including the creation of 3D material bodies, their sustenance, and gradual destruction to revert 3D matter into quanta of matter.

In this concept, the author of this essay advances a clear and logical mechanism of action (of a 'force'). It shows the work as a real and primary entity in the form of structural distortions in the (all-encompassing) universal medium, in and about a three-dimensional material body. Since the universal medium is structured by real matter-particles, structural distortions in the universal medium are genuine relative displacements of its constituents and hence real. Transfer of these distortions from one place in the universal medium or from (the region of) one body to another is the work done. Wherever structural distortions in the universal medium are present, its constituent matter-particles are under strain due to the relative displacements from their stable configurations. Stress in the strained part of the universal medium is the 'energy'. Since the work is proportional to the structural distortions in the universal medium (energy or stress) developed in the region of the structural distortion, it is also proportional to the magnitude of work.

In mechanics, work is often defined as the result of 'force' acting over a distance. This indicates that the 'force' is the cause of work or the transfer of energy. 'Force' is the rate of work done. It is the mathematical relation between work done and the (rate of change of) distance moved by the material body during the action of a 'force'. Hence, by doing work, it is the work itself that is being transferred and not the energy. Energy, corresponding to the magnitude of work, is always present where the work is present. Energy, defined as the capacity to do work, is the magnitude of work itself, available for transfer from one location/body to another.

Work is required to create, develop, and change the state (of motion) of a real entity. A certain magnitude of work is needed for the creation, development, and sustaining of the integrity of a material body. This part of work may be called intrinsic work (corresponding to the internal energy of a body) associated with the material body. This part of the work may be released only on the disintegration of the material body. Doing additional work on and about a real entity enables it to move or change its state (of motion). Only this part of the work can be released from a material body to do additional work on other material bodies. Investment of additional

work on or about a real entity (material body) develops/changes the real entity's ability to do additional work on or about other real entities. Thus, it is seen that additional work on and about a real entity is the primary entity that is being produced/transferred to or from/about another real entity. A vague and undefined entity of energy is the result of the presence of (additional) work about the real entity. The transfer of additional work is generally considered the transfer of energy from one material body to another. In reality, it is the additional work that is being transferred from and about one real entity to another, and the energy, in the form of stress in the universal medium, is inherently developed along with the additional work, in the form of additional structural distortions in the universal medium in and around a material body.

Additional work in and about a material body confers the body with its ability to do further (additional) work (on other material bodies). Work, being structural distortions (relative displacements) in the universal medium in and about a macrobody, is a real and tangible entity. Energy is a functional entity that is inherently present wherever (additional) work is present. Work is tangible in the sense that it is the magnitude of structural distortions in the universal medium in and about a material body. Unfortunately, since the universal medium is not directly observable by three-dimensional rational beings, (additional) work done about a macro body remains obscure to us.

Since energy and work are complementary to each other, energy may continue to be used to represent (additional) work. However, assigning the status of 'real and primary entity' to work may help to redefine the above given definitions, related to motion, as;

1. Acceleration (rate of change of state of a body's motion) is the result of additional work done on a material body.
2. Force (the rate of additional work done) is associated with the acceleration of ('rest mass' representing) the matter content of a body.
3. (Kinetic) energy, associated with the motion of a material body, is the result of spatial integration of 'force' acting on the 'rest mass' of the material body.
4. Momentum is the result of temporal integration of 'force' acting on the matter content of a material body.
5. Energy is the measure of stress in the universal medium due to (additional) work, present in the structurally distorted region of the universal medium. It corresponds to (additional) work done on or about a material body and may represent the material body's capacity or ability to transfer (additional) work to other material bodies.
6. Power is the time-rate of work transfer.

By considering energy in its true functional nature and bestowing its rightful place to work, as the primary and real entity, many misconceptions may be corrected. Work is a real entity. Energy is a functional entity, developed due to the presence of work. Energy cannot create work; instead, it is developed in the universal medium due to the presence of work (structural distortions in the universal medium). The inherently stable nature of the universal medium causes the development of stress (energy) in it during any type of deformation. Additional work may be transferred or stored, whereas energy can neither be transferred nor stored. Energy, being stress, and work, being structural distortions in the universal medium, cannot exist in different forms.

'Force', being the rate of doing additional work, there is only one type of 'natural force' in nature. However, uniformity of structural distortions in certain degrees or directions may give rise to different physical phenomena as part of their action, developed by the additional work. Linear distortions give rise to magnetic phenomena, angular distortions give rise to electrical phenomena, radial distortions give rise to nuclear phenomena, compressive distortions give rise to gravitational phenomena, moving distortions give rise to inertial (causing motion) phenomena, etc. The random nature of structural distortions in the universal medium about a macrobody produces its neutral state.

This concept envisages that every matter-particle or group of matter-particles is created, developed, and sustained by the structural distortions in the surrounding universal medium. [These distortions are ultimately produced by gravitational actions within the universal medium]. Structural distortions in the surrounding universal medium are an integral part of a physical body. Transfer of structural distortions through the universal medium carry basic matter-particles of a macrobody to affect its motion. In fact, matter is inert, and it is the surrounding universal medium that performs all actions, currently attributed directly to material bodies.

Every matter-particle (physical body) is a composition of its constituent elementary particles and the structurally distorted region in the surrounding universal medium. Its matter-part is enveloped by a distorted region in the universal medium. Additional work can be done on a material body in the form of increasing the structural distortions in the surrounding universal medium (compression). As the universal medium is a compressible entity, all matter-particles and macrobodies formed by them, together with the structural distortions in the surrounding universal medium, are compressible units. Due to the presence of structural distortions in the surrounding universal medium, all molecules (including those of gases) are compressible. Depending on the external compression on the distorted region, a matter-particle may change its volume. Gaseous bodies, contained in a closed container, are able to exert pressure on the walls of the container by constituent atoms' compressible envelopes. While heating, the matter particles lose matter-content and expand in volume. This accounts for the pressure on a closed container by the enclosed gas when heated. Heating of a material body need not have additional motion of its constituent matter-particles. It can be accounted for by the loss of matter-content and corresponding expansion of matter particles in a macrobody. Atoms of the gaseous body need not have the assumed random motion (as in the kinetic theory of gases) for this purpose. Atoms in a macrobody need not have additional vibration to indicate their energy level.

Mass is a mathematical relation. It is a quantitative measure of resistance (inertia) experienced by a macrobody during a change of its state of motion. Since we have no other standard reference, it is generally used to represent the equivalent of matter contained in a material body. The mass of a body does not (always) give a quantitative measure of the matter contained in the body. As the inertia of a macrobody depends also on its current linear speed, the mass of a macrobody is likely to change as its linear speed changes, without corresponding changes in its matter-content. This phenomenon paved the way for the misconception that at very high linear speeds of a macrobody, 'energy' supplied to accelerate the body is converted to increase its mass (representing its matter-content) rather than to increase its linear speed. An external effort attempts to transfer more additional work in association with the moving body to accelerate it. No energy is transferred from a 'force-applying mechanism' to the 'force-receiving body'. If the magnitude of additional work (associated with a body) increases, it accelerates the body, and corresponding energy is developed in the structurally distorted region of the universal medium around the body.

Heat produces a change in the matter-content of a macrobody rather than in the structural distortions in the universal medium in or about it. Structural distortions in the universal medium, about the body, are modified only so much as required to maintain the integrity of the macrobody in its current state and matter-content. Additional work involved (and associated energy) during heating is minimal. Therefore, heat is not a form of energy, but heat is a process of changing the matter-content of a material body.

As the universal medium fills the entire space, work and corresponding energy may exist anywhere in space (in association with material bodies or otherwise), even in vacuum. Wherever the universal medium is structurally distorted, a corresponding magnitude of energy exists in association with the distortions. Energy and matter are entirely distinct entities. Any one of them cannot be converted or reverted to the other.

References:

- [1] Nainan K. Varghese, '*MATTER (Re-examined)*', <https://www.matterdoc.in>

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