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Kinetic Energy of a Particle Independent of its Mass & Velocity

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Abstract:
This research work proves that the kinetic energy of a body or particle with a defined mass and moving under uniform velocity could be defined without its mass and velocity and momentum as well, contrary to the conventional wisdom. A novel formula for kinetic energy has also been derived in this work, using which it is possible to find the kinetic energy of a body purely based on its frequency of motion alone, without the need of its mass and velocity and momentum as well. A novel equation for the momentum of a body has also been derived, which interestingly proves that the momentum of a body could be found without its velocity of motion.
Key Words:
Kinetic Energy, mass, velocity, frequency, motion, particle, moving particle, momentum, wave, wave length, uniform velocity;

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I. Introduction

The modern physics has the knowledge to find out the kinetic energy (KE) [ref. 1] of a moving body from its mass (m) and velocity (v) and it is defined by the famous equation [ref. 2], 0.5 m*v*v. It means that the kinetic energy of a moving body with mass "m", under constant velocity "v", is equal to, half of the product of its mass and the square of its velocity. There is another way to find the kinetic energy [ref. 3] of a body, if we know both, the momentum of the body under motion and its velocity, this equation is given as eq. 13 at the end of this document. These are the two famous methods to find the kinetic energy of a body under uniform motion. These equations demand mass and velocity or mass and momentum of the moving body respectively, in order to find the kinetic energy of the body concerned. Apart from these two, there are some other equations as well for kinetic energy, which are functional in some different branches of modern physics. But, most of these equations are dependent upon two of these three factors: mass, velocity, momentum – of the body or particle under motion.

However, there are some exceptions to this. Certain branches of physics, for example, statistical mechanics, thermodynamics and quantum mechanics contain formulae for kinetic energy, which in fact doesn't contain any of the terms from the set; {mass, velocity, momentum}. These formulae are statistical in nature and are applicable only to a collection or set of entities or bodies but they can't be applied to individual bodies or entities.

Nevertheless, the conventional belief is that the kinetic energy of a moving body depends solely upon its velocity and mass. But, much against to the traditional belief, this research work proves and predicts that the kinetic energy of a moving particle under uniform velocity could be found although we are not aware of the velocity, mass and momentum of the object under motion. If we know only the frequency of the object under motion, we could find its kinetic energy according to this research work and the corresponding derivations and the final formula are also presented here, in this treatise.

Apart from the kinetic energy, a novel equation is derived for the momentum of a moving body as well. This momentum equation is also novel in the sense that, it doesn't contain the term velocity. That is, the momentum is defined without the velocity of the body under motion. This result as well breaks the conventional belief that the momentum is dependent upon both, the mass and velocity of the moving body or particle.

At present, the kinetic energy equations in vogue for a moving body, each of them consists of at least two variables hence, they require at least two inputs in order to find the kinetic energy but, this research work discovered a novel formula that contains only one variable hence, it requires only one input in order to find the kinetic energy. Hence, it seems better, in terms of the number of variables involved, hence the number of inputs required to find the kinetic energy.

II. Novel Kinetic Energy Equation

The kinetic energy (KE) of a body is very well defined in the modern physics using the following famous formula [ref. 2], in which the term "m" is the mass of the body under uniform velocity and "v" is the velocity of that body. Its mass "m" is defined by the units of kilograms or Kg and velocity "v" is defined by the units of meters per second or m / sec in the metric system of units. If the units are not mentioned explicitly anywhere in this treatise for a variable, please note that they bear only the S.I units. Both "*" and "." are used for multiplication symbol in this treatise.

$$K.E = 1/2 * m.v.v \qquad \textbf{EQ. 1}$$

For a body under uniform motion, almost all the formulae of kinetic energy known to the modern physics are based upon the above equation in one or the other way; in the sense that all these equations are related with the velocity and / or mass of the body under motion. Few formulae are based upon the momentum of the moving body but, the momentum in turn is based upon the mass and velocity of the body in a direct way.

Interestingly, here, in this section we will derive an alternative and novel equation for the kinetic energy of a particle, having mass "m" and moving with uniform velocity "v" but, without involving any of these terms, mass and velocity and momentum as well in the final equation. Now, let's proceed to derive this novel equation for kinetic energy.

In the particle physics, de Broglie had discovered a famous equation [ref. 4] that deals with the moving particles. He proved that when a particle of mass "m" is moving with a uniform velocity "V", it should move not in a straight line but, it should move rather like a wave with a defined wave length "ʎ", known on his name as the de Broglie wave length. The below figure, fig. 1 in fact depicts the path of a moving particle as claimed by de Broglie. In the figure, the dark, wave like path is the path traced by the moving particle, the straight line indicates the mean position of the wave (path) and the arrow shows the direction of motion of the particle. Note that the particle in the figure is moving from the left to the right side.

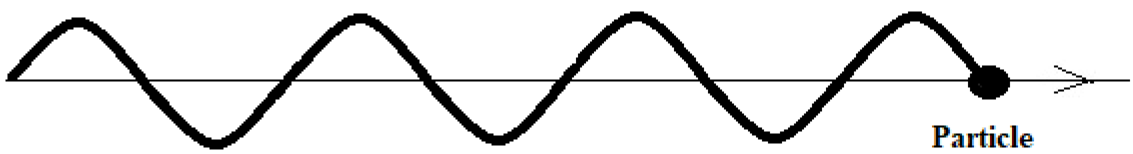

Fig. 1 - A Particle in Uniform Motion

De Broglie had derived the equation for the wave length "ʎ" of such a particle as well, that is under uniform motion. That equation, now famous on his name as the de Broglie wave equation is defined as follows, "h" in the equation is nothing but, the famous Planck's constant.

$$\lambda = h / m.v \qquad \textbf{EQ. 2}$$

On the other hand, the velocity of a wave moving with a constant velocity "V" and having frequency "n" and wave length "ʎ" is given by the following equation [ref. 5];

$$V = n.\lambda \qquad \textbf{OR} \qquad \lambda = V / n \qquad \textbf{EQ. 3}$$

The above equation is applicable not only to a wave under uniform motion. Rather it is also equally applicable to a particle moving like a wave as in figure fig. 1 or to a moving particle in general (fig. 1), of course under uniform velocity. This is because, a moving particle exhibits wave nature, according to de Broglie, hence it moves not in a straight line, but like a wave as shown in the figure fig. 1, has a wave length "ʎ" as predicted by the de Broglie's wave equation given by the eq. 2 already mentioned above, it has a frequency of motion "n" and it moves with a defined velocity "V" and all these three factors are strictly connected by the equation eq. 3, given just above.

Stressing again, both the equations given above, eq. 2 and eq. 3, could describe the same wave created by a moving particle under uniform velocity. This implies that for a moving particle or body under uniform velocity, the wave length defined by the equation eq. 3 is the same as [*that,*] the wave length defined by the equation eq. 2. So, from the above equations, EQ. 2 and EQ. 3 we get the following equation, by equating them, by their wave length(s), ƛ.

V / n = h / m . v

Rearranging the terms in the above equation, we get the following. Please note that, both the terms "V" and "v" [upper case and lower case] are the same here, as they both indicate the same, the velocity of the moving body or particle under discussion.

m .v . v = h .n   EQ. 4

Now, by multiplying the above equation both sides with "1/2" we get the following;

1 / 2 * m .v . v = 1 / 2 * h. n

The left hand side of the above equation is nothing but, the kinetic energy, KE of a particle of mass "m" moving with a uniform velocity "v" given by the famous equation for Kinetic Energy [ref. 2] that has already been mentioned in the eq. 1 earlier. That is,

K. E = 1 / 2 * m . v .v

So, from the two equations, present immediately above, it follows that;

K. E = 1 / 2 * h. n   OR   K. E = h. n / 2   EQ. 5

The above equation is nothing but, a novel equation, in fact a novel formula for the kinetic energy of a body or particle under uniform motion. It is interesting to see that the above equation predicts the kinetic energy of a particle without its mass and velocity and momentum as well. But, the only constraint we need is the frequency of the particle that is under uniform motion, "h" being a constant. Neither the mass nor the velocity nor the momentum of the particle is required to find its kinetic energy as per the predictions of this formula, this research work. This novel equation predicts that the kinetic energy of a particle moving with uniform velocity is simply equal to the product of, the Planck's constant and half of the frequency of the particle under motion.

For example, when a particle like an electron or a proton is moving with uniform velocity, then the above equation could be applied. In order to find the kinetic energy of such a particle, all the required data is nothing but, the frequency of motion of that particle and nothing else. Much against to the conventional wisdom, the velocity and mass of the particle are not at all required to find its kinetic energy! Hence, this work is a breakthrough as it breaks the conventional rules.

The novel kinetic energy equation derived and discovered above is a generalized equation applicable to any, body or particle in general, which is under motion with uniform velocity and a frequency that is also defined. According to the modern science, the photons of electromagnetic radiation exhibit dual nature, they behave like waves and particles at the same time. The particle nature of the "photons" has been proved by the great scientist Albert Einstein in his work on the Photo-Electric effect [ref. 6]. Hence, the above novel kinetic energy equation, is equally applicable to photons as well without any exception along with the material particles, as the photons behave like particles too.

The equation EQ. 3 could also be rewritten as follows, if the velocity of the particle is equal to the velocity of light C [ref. 7];

C = n. ƛ   OR   n = C / ƛ   EQ. 6

Now, from the just above equations, EQ. 5 and EQ. 6, we get the following equation;

K. E = 1 / 2 * h. C / ƛ   OR

K. E = h .C / 2. ƛ   EQ. 7

Where, λ – is the wave length of the particle under motion. Using the just above equation we could calculate the kinetic energy of a particle, which is moving at the speed of light, without the need of its mass, if we know just its wave length alone. The other two terms, the "h" and the "C" being constants in the above given equation.

Please note that although the two novel kinetic energy formulae, which have been derived above are similar to look at, in fact they work in different domains. The second formula, the equation eq. 7 is applicable to the non - material bodies or particles only but, the first one, the equation eq. 5 is applicable to all, the material (matter) and non – material bodies or particles as well. As it has been shown above, the equation eq. 7 could be derived from the equation eq. 5.

The eq. 5 is applicable to all the moving bodies or particles with a uniform velocity (less than or equal to light velocity), for both the matter and non – matter particles or bodies as well and having a defined frequency. On the other hand, the eq. 7 is applicable to the particles that are moving only at the velocity of light "C". To the best of the knowledge of the modern physics, what we know is that only the light rays or the "photons" or the electromagnetic radiation and neutrinos could travel at the velocity of light and no material body at all. So, the equation eq. 7 is only applicable to the photons, the parcels of energy, the electromagnetic rays, as per the modern ideas in physics.

Stressing again, from the novel kinetic energy equation eq. 5, if we know only the frequency of the particle under uniform motion, then we could find its kinetic energy, even though we are not aware of its mass and velocity and momentum as well. This is the breakthrough of this research work, much against to the conventional thought.

As we have derived a novel equation to find the kinetic energy of a moving particle without its mass and velocity and momentum as well, now on the similar grounds we will find a novel equation for the momentum of a particle, as well. In conventional physics, the momentum "p" of a particle moving with a uniform velocity "v" and having mass "m" is given by the following equation [ref. 8].

$$\mathbf{p = m \,.v \qquad EQ.\ 8}$$

Let's start with the equation eq. 4 mentioned earlier, it's again given below for convenience.

$$\mathbf{m \,.v \,.\, v = h.\, n}$$

Multiply both sides of the above equation with "m", the mass of the moving object that is under discussion. It turns out like the following equation.

$$\mathbf{m \,.m \,.v \,.\, v = m.\, h.\, n}$$

Rearranging the terms in the above equation, it turns out as follows. The "sqr" used below stands for the mathematical function, "square".

$$\mathbf{m.\, v.\, m.\, v = h.\, n.\, m \qquad OR}$$

$$\mathbf{sqr\ (m\ .\ v) = h.\, n.\, m \qquad EQ.\ 9}$$

It is evident that the left side of the above equation is nothing but, the square of the momentum of the particle. So, we could write the above equation eq. 9 as follows, in terms of its momentum "p" using the eq. 8 given already.

$$\mathbf{sqr\ (p) = h.\, n\ .\ m \qquad OR}$$

$$\mathbf{p = sqrt\ (h.\, n\ .\ m) \qquad EQ.\ 10}$$

The "sqrt" used above stands for the "square root" mathematical function. It is evident that the above equation is a novel formula that describes the momentum of a body under uniform velocity. Using the above novel momentum equation, it is possible to find the momentum of a moving body without the need of its velocity but, only with its frequency of motion and mass, "h" being a constant. Please note that contrary to the conventional knowledge, the above momentum formula doesn't contain velocity, hence it doesn't require the velocity of the body under motion in order to find its momentum.

We could get a different equation as well to find the momentum of the particle. Consider the equation eq. 4 again.

$$\mathbf{m\,.v\,.\,v = h.\,n}$$

The above equation could be rearranged as follows.

$$\mathbf{m\,.v\ = h\,.\,n\,/\,v}$$

Using the equation eq. 8, the above equation will take the following form.

$$\mathbf{p = h\,.n\,/\,v} \qquad \textbf{Eq. 11}$$

The above equation is nothing but, it's a formula for the momentum "p" of a particle under uniform motion. This equation is yet another equation (formula) to find the momentum of a particle. It has only two variables, the frequency "n" and the velocity "v" of the particle under motion but, interestingly without involving the mass "m" of the body or particle, contrary to the conventional wisdom.

The above equation eq. 11 could be rewritten as follows using the equation, eq. 3.

$$\mathbf{p = h\,.n\,/\,v = h\,/\,\lambda} \qquad \textbf{OR}$$

$$\mathbf{p = h\,/\,\lambda} \qquad \textbf{Eq. 12}$$

This is yet another equation to find the momentum of a particle under uniform motion. It is interesting to see that the just above equation could be derived directly from the de Broglie wave equation eq. 2 itself, by rearranging the terms present in the equation, as follows.

$$\mathbf{\lambda\ =\ h\,/\,m\,.\,v} \quad \mathbf{=>} \quad \mathbf{m\,.\,v = h\,/\,\lambda}$$

So, we have found a novel equation for the momentum of a moving particle as well and as it has been mentioned already the other momentum formulae that have been derived above are related to the de Broglie wave equation hence, are not novel. Note that only one momentum equation, the eq. 10 alone is original and novel amongst the three momentum equations derived above.

The conventional belief is that the momentum of a moving body depends upon both, its mass and velocity as well. But, this novel momentum equation (eq.10) too looks strange (like the novel kinetic energy equation derived earlier) in the sense that contrary to the conventional belief, this novel momentum equation doesn't contain the velocity term at all. It implies that the momentum is not dependent upon the velocity of the body in a direct way, contrary to the conventional wisdom. Hence this research work is successful in establishing a momentum formula, which goes against the conventional wisdom.

One interesting point to note here is that, the kinetic energy equation derived in this work, the eq. 5 requires only one input value in order to find out the kinetic energy value of the particle or body under motion, as it has only one variable. That is we need only the frequency of motion "n" of the particle under motion and nothing else to find its kinetic energy, "h" being a constant.

But, the other equations in vogue to determine the kinetic energy of a moving body, each one of them, in fact requires at least two input values, as they have at least two variables in the concerned equations. For example, one equation, eq. 1 already mentioned earlier requires two inputs, mass "m" and velocity "v" of the body under motion. On the other hand, another popular equation to find the kinetic energy but, based on momentum [3] is given below. It also contains two variables hence, it requires two input values; one is the mass of the body "m" and the other one is its momentum "p", in order to find the kinetic energy of a body or particle using this equation. In fact, these two equations, eq. 1 and eq. 13 are very much related, we could derive the following equation from the eq.1 given earlier, in few simple mathematical steps and vice versa.

$$K.E = (p \cdot p) / (2 \cdot m) \qquad \textbf{EQ. 13}$$

Stressing again, these two age old kinetic energy equations discussed just above and the other kinetic energy equations as well for a particle or body under uniform motion, which haven't been discussed here, demand at least two inputs, but the novel equation, eq. 5 derived in this treatise contains only one variable, the frequency of motion "n" alone, hence it requires only one input value in order to find out the kinetic energy of a moving particle. So, from this point of view, this novel equation seems better and efficient compared to other kinetic energy equations available in the scientific literature now for a body under uniform motion.

The novel kinetic energy equation, eq. 5 derived earlier is valid even if the particle under motion is moving at the relativistic velocities. Because, this equation doesn't contain any term that changes with velocity, it contains only the frequency term, "n", which is not affected by velocity. This claim is supported by the fact that, not only relativity but, no other scientific theory claims that the frequency of motion of a body is affected due to its high velocities. So, this novel kinetic energy equation, eq. 5 is valid for all the moving particles, irrespective of their velocities. No need to upgrade it for relativistic velocities. Same is the case with the equation eq. 6 as well, because it is applicable only to the photons and neutrinos. They are already at the velocity of light so, that equation as well doesn't require any up - gradation for relativistic velocities.

But, the novel momentum equation, eq. 10 we had derived earlier is valid only at the non - relativistic velocities. It should be upgraded in order to use it for the relativistic velocities. Let's do this extension now. The equation eq. 10 is rewritten below for the sake of convenience.

$$p = \mathrm{sqrt}\,(h.\ n.\ m)$$

This equation involves the mass term "m" in it. According to special theory of relativity, mass in fact increases with velocity. So, we have to upgrade the mass "m" in the above equation to include the relativistic mass "m1", in order to make the above equation work at the relativistic velocities. At relativistic velocities the above equation will be as follows.

$$p = \mathrm{sqrt}\,(h.\ n.\ m1) \qquad \textbf{EQ. 14}$$

The famous equation of Einstein's relativistic mass "mv" is given by the following equation [ref. 9], when a particle or body is under uniform motion, at relativistic velocity "V". Here "C" is the velocity of light in free space, "m0" is the rest mass of the body and "mv" is the relativistic mass of the body under discussion.

$$mv = m0 / \mathrm{sqrt}\,(1 - V \cdot V / C.\ C) \qquad \textbf{EQ. 15}$$

Now, replace the mass term "m1" in the equation eq. 14 above with the relativistic mass "mv" given just above, as follows. This is because, m1 in eq. 14 is the same as the mv in the eq. 15 and the rest mass m0 in the just above equation is equal to "m" in our case.

$$p = \mathrm{sqrt}\,(h.\ n \cdot m1) = \mathrm{sqrt}\,(h.\ n \cdot (m / \mathrm{sqrt}\,(1 - V \cdot V / C.\ C))) \qquad \textbf{OR}$$

$$p = \mathrm{sqrt}\,(h \cdot n \cdot m / \mathrm{sqrt}\,(1 - V \cdot V / C.\ C)) \qquad \textbf{EQ. 16}$$

The above equation is the novel equation for momentum of a particle, at relativistic velocities, upgraded from the equation eq. 10.

On the other hand, the other two equations, eq. 11 and eq. 12 we had derived earlier to find the "momentum" of a particle under uniform motion need no changes at all, to make them work at the relativistic velocities. Those two equations are given below for convenience.

$$p = h\ .n / v \qquad \& \qquad p = h / \lambda$$

These above two equations require no changes because, these equations doesn't involve any quantities that change with velocities, like mass, etc. So, these momentum equations will work fine, irrespective of the velocities of the particles.

This research work is interesting as it proves that the kinetic energy of a particle under uniform motion could be defined based on its frequency of motion alone; independent of its mass and velocity and momentum as well, although it is actually dependent on these factors as well, in an indirect way. This is because of the established fact that both, the mass and the velocity of a particle under motion will have a direct effect on its wave length hence, its frequency invariably. This logic directly follows from the de Broglie's wave equation, which was discussed at the starting of this work. Once again, please check the de Broglie wave equation, the eq. 2.

In situations where we fail to get the details regarding the velocity and mass of an object under motion, we could find its kinetic energy by using the formula discovered in this research work, if we could only know the frequency of motion of the concerned particle or body.

The equation eq. 5 discovered in this work is a general equation to find the Kinetic Energy of any body or particle under motion like the other kinetic energy equations, for example eq.2 and eq.3. Where ever the de Broglie equation could be applicable, the newly derived kinetic energy equation, eq. 5 and the momentum equation eq. 10 derived in this work could also be applied (but, not only limited to that). The eq. 7 is also a general purpose equation that is applicable in all the cases, when the velocity of the moving particle is equal to the velocity of light. I. e., for all the non - matter particles in general, as it has been stated already.

One important point to note here is that while using the frequency to determine the kinetic energy of a particle as described in this work, the particle or body should be under uniform velocity. If the body or particle is not under uniform velocity, then the frequency of the body varies with time. In such cases as well we could apply the novel kinetic energy equation discovered by this work, but it is valid only for a short duration of the moving body. Whenever, the frequency of the body or particle changes then its kinetic energy will also change accordingly. In such cases, for any given instant of time, we could find its kinetic energy by using this novel equation and it is valid as long as its frequency remains unchanged, perhaps for a fraction of a second or for a brief period of time, as the case might be.

Another point of concern is this. The novel equations discovered by this work could be applied to bodies or particles, when there are no frictional forces or other kind of forces affecting the frequency of the body under discussion. If there are any such forces, then the outcome of these equations will naturally be affected by such forces and hence, it will be erroneous. In such cases, complete analysis of all the forces involved should be done before we could find the kinetic energy of such a body involved. In such cases, simple application of these novel equations alone is not sufficient to find the kinetic energy of such body or particle concerned, rather it becomes somewhat a bigger task.

Inferences:

We could infer from the newly derived equation that the Kinetic Energy of a moving particle could be found using only its frequency although its mass and velocity and momentum are unknown, contrary to the conventional belief and knowledge. Different bodies under uniform motion, although with different velocities and masses, if they have the same frequency, this research work predicts that, they should have the same kinetic energy, interestingly.

Suppose, an electron and the Earth are freely moving, both at the same frequency, then this theory predicts that they should have the same Kinetic Energy. Although this fact might seem ridiculous and fallacious, even unbelievable, the equations of this theory finds no fault, really no fault at all in that claim and even it supports that claim, very interestingly and amazingly. But, both of these bodies moving with the same frequency is highly unlikely.

The frequency of a body under motion has the direct control on the kinetic energy of the body or particle under motion and not the mass and velocity of the body much against to the conventional thought, this research work makes it clear, although the mass and velocity directly affect the frequency and wave length of the body under motion, as already mentioned.

Using the novel equations found in this work, it is possible to find new and interesting relationships between the terms; mass, velocity and frequency of two different bodies under motion, depending upon the situations and for different cases as well.

Another interesting implication of this research work is this. As it has been discussed earlier, the novel kinetic energy equation eq. 5 is equally applicable to the "photons", the electromagnetic rays as well, because, the photons exhibit dual nature, hence, particle nature too, according to the Photo-Electric effect as predicted by Albert Einstein. Hence, from the Kinetic Energy equation of a particle given by the eq. 5 and the famous Planck's equation [ref. 10], E = h. n, it follows that half the energy present in a "photon", an electromagnetic ray in general, is due to its kinetic energy and the other half is "not addressed by these equations"; it could just be the "content" of the "photon" or something else, we are not sure of it.

The equation eq. 7 as well could lead to the same implication as stated above. Detailed analyses and discussions on this concept will be published in another research paper soon. Now pre-print of it [ref. 11] is available on *ResearchGate.net* server under the title "*Different Energies of a Photon*" also authored by the author of this work. So, this topic is no more continued here in this treatise.

While the momentum equation eq. 10 is applicable only to the matter bodies and particles as it contains the mass term and only matter bodies and particles are known to have mass. The other momentum equations eq. 11 and eq. 12 are applicable to non – matter particles as well. I. e., the latter two are applicable to the electromagnetic rays, the photons and matter particles as well.

III. Conclusions

This research work proves that the Kinetic Energy of a particle under uniform velocity could be predicted purely based upon its frequency alone, although we are not aware of its mass and velocity and momentum altogether. Moreover, the kinetic energy of a particle is directly controlled by its frequency alone rather than its velocity and mass, contrary to the conventional thought, as this research work proves it mathematically. Two bodies with different masses and velocities could have the same kinetic energy if they have the same frequency, this research work claims. Another interesting revelation of this work is that the momentum of a body could be defined independent of its velocity. For a body or particle under uniform motion, two novel and original equations, one for kinetic energy and one for momentum, are also derived in this research work and are happily presented to the scientific world.

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Note: - Any standard book on Physics will help, including the following;

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