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Article I: The Reality of Newton's Inertia

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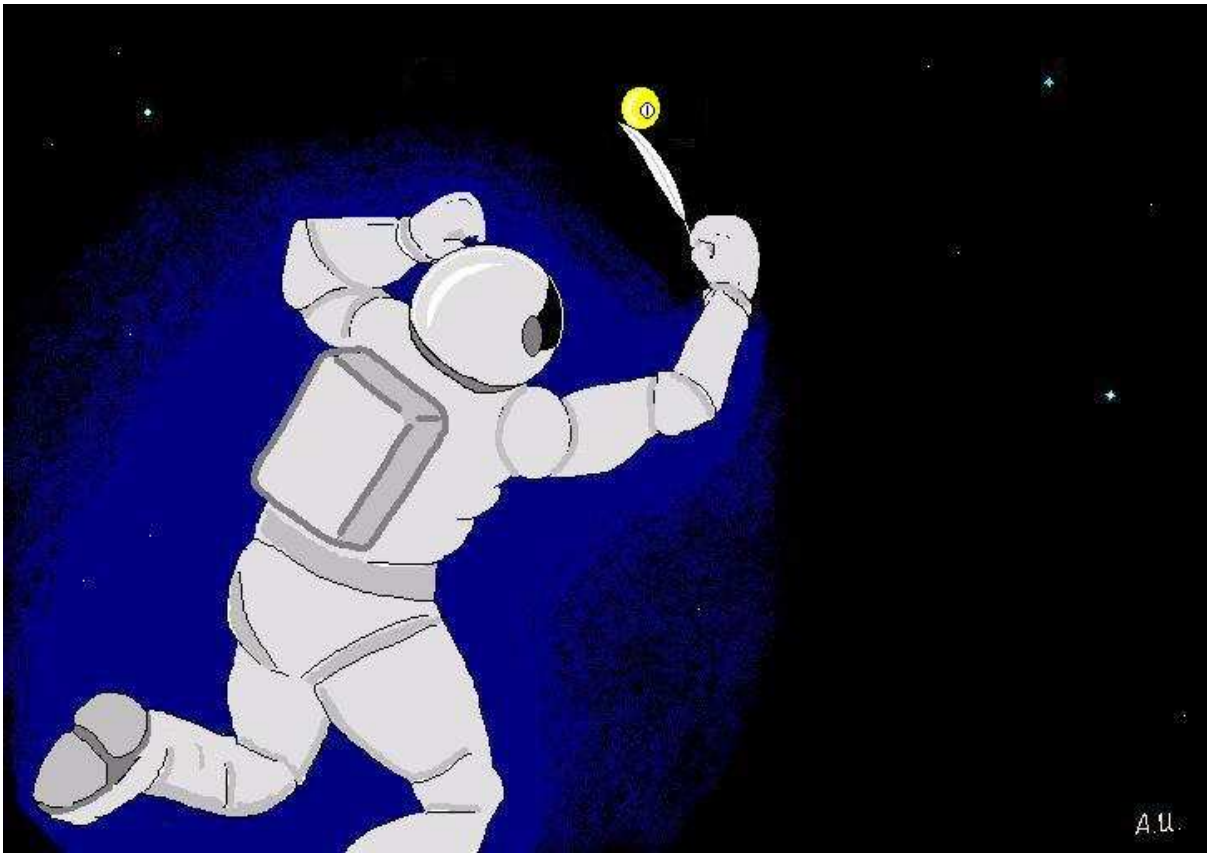
Purpose
Isaac Newton made the Classical Mechanics concept of inertia the widely recognized Physical concept it is today. Yet I have discovered the curious fact that when one asks even a single question about inertia's role during an event, the role assigned in Newton's Definition III turns out to be the role of nothing. My purpose in writing the following article is to answer the question: "Was Isaac Newton's understanding of inertia real or imaginary?"

Article I
In his great work, "Mathematical Principles of Natural Philosophy", known today more simply as "PRINCIPIA" [1], Isaac Newton described inertia as the "force of inactivity". He went on to say that an object maintained its state of rest, or uniform motion (same state) "by its inertia only." In other words "resting" and "uniformly moving" objects were viewed by Newton as being equally inactive and further that this inactivity was being maintained by the force Newton called "inertia". Thus, according to Newton's description, the object's "force of inertia" must serve in some manner to prevent activity from occurring to the object's state of motion if the object's "inactivity" is to be "maintained". With rest and uniform motion being the inactive state then a change in motion (acceleration) must be the active state that challenges the inactivity-maintaining power of the object's "inertia". Since the activity of acceleration is always caused by an accelerative force (Newton's LAW I), and further since every accelerative force always finds support against some other force of equal magnitude (Newton's LAW III), then it holds that Newton's inertia must be this other force that reacts in support of the accelerative force which is busy acting as the cause of the object's accelerational activity. (See references [2], [3], [4] & [5]).

(2) But why then did Newton refer to inertia as being a "force of inactivity"? Clearly, any force that reacts in support of an acceleration-causing action force is itself a force that is a participant in the activity of acceleration. For certain, as long as the active acceleration force is present, the object will continue to accelerate with no end in sight. Therefore, in practice, any reactive inertia force directed back from the object does nothing to prevent the acceleration action force from continuing to cause acceleration for the object. In fact, it is clear that as long as the acceleration action force is impressed against the accelerating object, no force of any type is present that is successful in causing an end to the acceleration and thereby restoring the object once again to the non-accelerative inactive state of rest or uniform motion as Newton predicts is the true role of the object's inertia. In reality, during an accelerational event, I do not think there is any evidence of the presence of any "force of inactivity" that matches Isaac Newton's description for the role of inertia.

(3) In my next effort to discover the reality of Newton's inertia, I propose an experiment in the vacuum of the space between solar systems whereby a weightless billiard ball is maintaining a constant position before me, within arm's reach. If Newton's inertia is busy maintaining this ball's inactive state of motion, then how can it be that even the slightest push from the tip of a feather will immediately begin causing the ball to abandon its current state of motion for a new one? I think the answer is that there is nothing present that prevents the ball from accelerating away from my location in response to the force applied by the feather's tip. While it takes an action force to accelerate the ball in one direction and an oppositely-directed action force to accelerate the ball in the opposite direction, in the absence of either of these acceleration action forces, there is no force present at all, nor anything else, that is busy "maintaining" the ball's inactive state of motion. From my perspective, the ball before me is in the inactive state of rest.



(4) In fact, since it takes the presence of an action force to cause the billiard ball to accelerate away from its position of inactive rest before me (Newton's LAW I), in the absence of such an action force, what should one expect the ball to do in the meantime? Does the inactive ball not have but one available option? I see that solitary option is for the ball to continue waiting in the inactive state of rest until the next acceleration action force becomes present. If he were asked to consider this event, Isaac Newton would undoubtedly point to the inactive billiard ball before me and contend that the presence of the ball's inertia was the reason the ball's inactive state of motion was being "maintained". I would point back to Newton that according to his own, perfectly

correct LAW I, since it takes an action force to cause acceleration for the object, the true reason the billiard ball remains in its inactive state of motion before me is due, not to his claim of the presence of the ball's inertia but instead, to the absence of an acceleration-causing action force, as correctly predicted by LAW I.

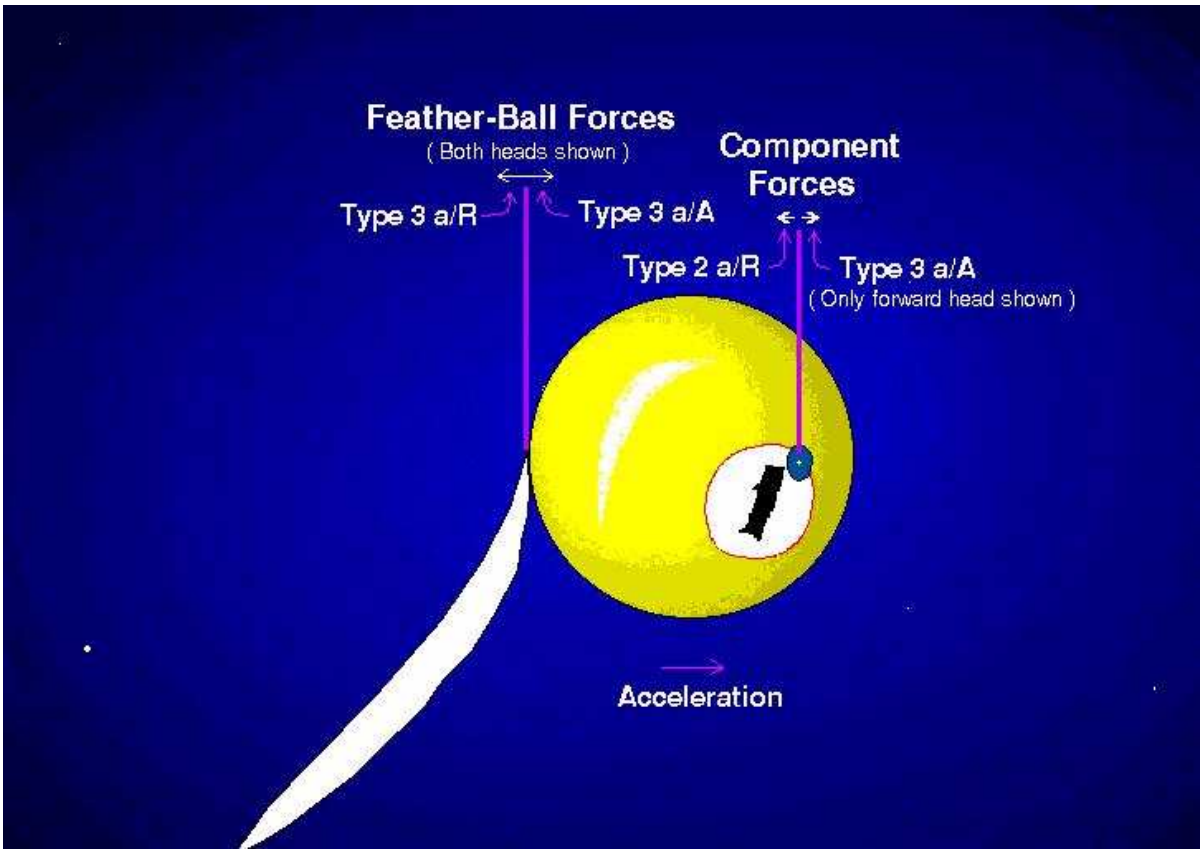
(5) Since both Newton and I agree that it takes an action force to cause acceleration for the billiard ball, then if he were able to read this discussion he should agree with me that in the absence of such an acceleration-causing action force, the billiard ball has no other option but to remain in its current inactive state of rest-motion until such time as the next action force comes along. At this point it should be clear to all that the only condition required for a resting object to continue resting, indefinitely, is for all action forces to be either absent or in balance with each other. Clearly as defined, inertia has no role to fill in this event regardless of whether the object's state of motion is active, as when an acceleration/Action force is present, or inactive as when an acceleration/Action force is absent. Once again, the role of Isaac Newton's inertia is the role of nothing.

(6) What then do today's educators teach us about inertia? Drawn directly from Newton's DEFINITION III [5], inertia is generally said to be an innate force of matter whereby the matter's inertia endeavors to preserve its present inactive state of rest or uniform motion by resisting any force attempting to cause a change in the matter's motion. Now, I see the word "resist" as interchangeable with "oppose" and the phrase "change in the matter's motion" as interchangeable with "acceleration". Substituting these clearer words, we now have matter's innate force of inertia opposing any force causing acceleration for the matter. Since acceleration can only be caused by an action force (Newton's LAW I) and since any such acceleration/Action force is always opposed by an equal force (Newton's LAW III), this means that in order for the matter's inertia to present opposition to the acceleration/Action force, it must itself be a force, measurable in pound.force (lb.f) or the Newton (N).

(7) These considerations present a real problem for the reality of inertia which is today professed to not be a force at all, and not measurable in any distinct units of measure for inertia, certainly not in lb.f. or the Newton. Furthermore, the acceleration force applied by the feather against the weightless billiard ball in deep space is said to be the only force experienced by the ball's matter. Thus it is professed in Modern Physics that the acceleration force from the feather is a "net force" or "single force" or "overall force" or "unbalanced force" that is predicted to act upon the ball in the complete absence of an equal and opposite force affecting the ball's matter. In support of this "net force" position we are asked to consider that no force is pushing back on the other side of the ball. Yet what of Newton's LAW III that predicts that, without exception, every force is always opposed by an equal force?

(8) Let us stop for a moment to take stock on this issue. When the billiard ball is accelerating in one direction by the acceleration/Action force from the feather, do you really think the ball's matter is not experiencing an equal force in the opposite direction? Or do you think, as I, that the bending aside of the feather's tip is a visual indication of the presence of equal and opposite forces, one of which is a backward reaction force that is being generated deep within each

component of the matter of the accelerating ball? After all, how can one possibly push with any force at all against an object, accelerating or not, that does not push back with an equal force?



(9) Understand that this backward reaction force from the accelerating billiard ball that is presented against the feather's tip currently holds a discounted role during this event. The widely accepted Action/Reaction Force Rule defines each force of an action/reaction pair of forces as affecting a different object and therefore neither force is accepted as acting or reacting to cancel or provide support for the effect the other force has upon one of the objects. Based upon this rule, physicists currently ignore the backward reaction force from the billiard ball because they only accept that it is affecting the feather. Thus they must think that this reaction force just suddenly appears at the contact point between the ball and the feather if they do not accept that it is also present at various lesser magnitudes throughout the ball's matter. This limited path of logic leads them to think that there is but one force being experienced by the ball, with this force being the forward acceleration/Action force from the feather. By this logic, today's physicists conclude that the ball is experiencing a forward-directed "net force" or "unbalanced force" from the feather since, in this frictionless environment, they do not recognize the presence of any rearward-directed force that is acting or reacting within the matter of the accelerating ball.

(10) But is this popular "net force" or "unbalanced force" position, regarding the forces affecting the ball, actually correct? Suppose I use a second billiard ball that has been previously sliced in two with each flat surface of each half attached to the opposing ends of a short, large diameter, open-coil compression spring. Next suppose I set aside the feather and instead apply a somewhat greater forward-directed acceleration/Action force with my finger against the middle of the curved part of the back half of the ball causing forward-directed acceleration for the back half. This back half will subsequently apply a forward-directed acceleration/Action force that is transferred by the compression spring to the front half of the ball causing forward-directed acceleration for the front half. Now, according to Newton's LAW III, (neglecting the matter of the spring) as much as the back half is pushing forward with an action force on the ball's front half, the front half is pushing rearward with a reaction force on the ball's back half. Here I have established the presence of a rearward reaction force upon the back half of the accelerating ball, as experimentally validated by the visual reduction in the length of the compression spring between the ball's two halves. If the front half of the ball is also sliced in half in a direction parallel to the first slice and another compression spring is inserted, another rearward reaction force on another portion of the ball's matter is also established as being present, and so on until the forward-most atom of the ball's matter is reached. Even here, as much as the forward-most atom is accelerated forward by the last of the push of the acceleration/Action force from my finger, the atom pushes rearward with its own equal and opposite acceleration/Reaction force. Thus there is no point within the accelerating billiard ball where the remaining portions of the forward-directed action force from my finger are not equally opposed by the rearward-directed reaction forces being transferred rearward from the remaining portions of the ball's accelerating matter. Slicing the ball just helps us to see this truth. Accordingly, the "net force" conclusion regarding the predicted absence of any rearward-directed forces experienced by any portion of the ball's matter is a conclusion without merit. The same may be said for the Action/Reaction Force Rule (see Article IV) for it truly is a misleading and therefore meritless rule. I think its continued use is a hindrance to correctly understanding the true action and reaction forces present during an object's acceleration.

(11) Regarding inertia, at this point in our discussion we have yet to locate a role for inertia that is allowed under the restrictions set by Newton's definition and various descriptions. Since it takes nothing to maintain a resting object at rest, then there is no role for inertia here. Also if inertia is not a real, measurable, variable, reactive force of support present only during the activity of acceleration, then there is no role during acceleration for inertia to fill. Yet one has to wonder what Isaac Newton and others were thinking when they invented and popularized the concept of inertia? What was there about the nature of matter experiencing an accelerational force that made clear to them the need for the invention of any such concept as inertia? [6]

(12) Since Isaac Newton's version of inertia has now proved to be illogical and unreal in nature, it is easy to think that he simply got inertia wrong. Every time we get close to identifying a valid role for inertia, our efforts are thwarted by some portion of the definition and various descriptions attached by Newton and others to the concept of inertia. Is inertia really a forceless, non-variable, ever-present property of matter with inactivity maintaining powers that resist the activity of acceleration? If so, we have yet to discover a single role where inertia, with all its limitations

intact, is undeniably present and has a job to perform. If not, then I suggest that Newton struck out in describing inertia's true characteristics.

(13) Instead of being forceless, I see inertia as forceful. Newton clearly shared in this forceful recognition since in his own Definition III [5], Newton referred to inertia twice using force terms, first as an "innate force of matter" and second as "a power of resisting". Unfortunately, he also used the term "innate" which clearly indicated that he thought of inertia as being an inherent, natural property of matter. Making inertia a property of matter probably meant that it could not be considered a force, especially since forces are variable as they come and go while a property of matter is fixed and ever-present for a given object. This property decision of Newton's left physics professors with the impossible task of teaching their students that Newton's "innate force of matter" and "power of resisting" descriptions did not in any way refer to inertia as being a force.

(14) Let us return to our billiard ball in space event. With my hand, I am again applying an acceleration/Action force against the billard ball at rest before me. The ball immediately begins accelerating away from my position while reactively applying a mutual acceleration/Reaction force back against my finger. The moment I stop causing the acceleration/Action force against the ball is the moment the ball's acceleration ceases and also the moment the acceleration/Reaction force stops being reactively applied against my hand. I think the truth is that my finger's acceleration/Action force causes both the ball's acceleration and the reactive generation of the ball's mutual acceleration/Reaction force. This acceleration/Reaction force does nothing to "resist" or prevent acceleration from occurring. Instead this a/R force serves to provide LAW III required mutual support for the a/A force from my hand for the brief time that acceleration exists. I think the variable acceleration/Reaction force is what Isaac Newton was considering when he wrote his definition for inertia. During this process, Newton thought of inertia as a force of matter that matter carried deep inside with this innate or built-in or inherent force ready at all times to resist or oppose any action force bent on causing the activity of acceleration for the matter.

(15) Now this is what I want you to consider. How could Newton tell if his inertia force was being sourced from within and carried at all times by the matter or if it was caused to exist only by the accelerating/Action force sourced from outside the matter? He tried to make the "sourced from within" option seem real by professing that an object "maintains every new state it acquires by its inertia only." Notice how Newton referred to "its inertia" showing that his was hanging his hat on the "sourced from within" peg.

(16) Instead, we know that an object's uniform motion is an inactive state for which no cause exists. We also know that the object's acceleration/Reaction force never exists in the absence of an acceleration/Action force. This is why there is no evidence of the presence of an acceleration/Reaction force during the inactivity of an object in uniform motion. Clearly, Newton made the wrong choice. He should have chosen the "sourced from without" peg. His inertia force is not an innate property of matter but instead is an early, imperfect recognition of the acceleration/Reaction force that we recognize and experience today in every event involving acceleration. We know it is caused by the acceleration/Action force and therefore cannot be expected to cancel the effect of its own a/A force cause. Thus it provides ongoing and variable mutual support for its acceleration/Action force cause. It can never be expected to exist after its

a/A force cause becomes absent. These two, mutual, action/reaction, accelerational, forces are inseparable. Finally, we recognize that the acceleration/Reaction force is incapable of "acting" as the cause of any event, even one as benign as "maintaining inactivity". In summary, the acceleration/Reaction force is always directed opposite to the direction of the event's accelerational activity while it provides LAW III required mutual support for the the event's acceleration/Action force cause.

Conclusion

(17) Isaac Newton's "force of inertia", though inaccurately and misleadingly defined, does signify an early recognition of the common, everyday acceleration/Reaction force we recognize today as being present in every accelerational event whether it be linear acceleration or centripetal acceleration. The acceleration/Reaction force in linear events is always directed opposite to the direction of the acceleration and opposite to the event's acceleration/Action force cause. Likewise, the acceleration/Reaction force in circular events, known commonly and correctly as centrifugal force, is also directed opposite to both the inward directed centripetal acceleration and to the event's inward directed centripetal acceleration/Action force cause.

(18) The bottom line is one may continue to use Newton's centuries old, misdefined, and misleading term, inertia. Just know that it represents our modern day, Universal Physics recognition of the common, everyday, acceleration/Reaction force that a) is not a property of matter; b) is variable in magnitude; c) is caused by and provides support for the acceleration/Action force present; and d) is never the cause of any event. Then again, you might consider an update to using inertia's true name, the acceleration/Reaction force.

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References

[1] Sir Isaac Newton, 1686, 1729, Mathematical Principles of Natural Philosophy and His System of the World, 1934, 1962, PRINCIPIA, University of California Press, Berkeley, Los Angeles, London, page 2 - 13.
[2] Newton's LAW I: Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.
[3] Newton's 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.
[4] For a body maintains every new state it acquires by its inertia only.
[5] Newton's Definition III: The vis insita, or innate force of matter is a power of resisting, by which every body, as much as in it lies, endeavors to preserve in its present state, whether it be of rest, or of moving uniformly forward in a straight line.

[6] Endless hours of discussion with my son, Ryan Skyler, have helped me to fully develop the "inertia" replacing concept of matter's acceleration/Reaction force. I have yet to find a keener mind on this subject than Ryan's. I am blessed to have his brilliance and original insight readily available. His contributions have influenced the development of many of the concepts contained herein.
Thank you, Ryan!

Author's Commentary

Hopefully Article I will shift the focus from the never-ending attempt to understand and explain Newton's misleading version of inertia to embracing and understanding for the first time, the common, every day, easy-to-recognize-and-understand, acceleration/Reaction force that is present within matter only when the activity of acceleration is present and absent at all remaining times of inactivity. Unfortunately, we have a built-in fascination for complex concepts. If the journey to "understanding" is contorted, difficult to follow, and impossible to explain, then is that not all the more reason it must be true? Newton's version of inertia is just such a case. In truth, the unreal journey one must take with understanding as the goal should be taken instead as proof that the truth regarding Newton's inertia lies elsewhere.

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