Qualitative Applications of Newton's Third Law of Motion.

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Abstract

There numerous applications of 335 years old Newton's Third Law of Motion. But most of the applications taught in text books are qualitative in nature. These applications include rebounding of ball, recoil (backward push) of gun when bullet is fired, recoil (backward push) of gun when bullet is fired, backward motion of boat in water when person jumps from it towards shore, book remains stationary on the floor or table, forward motion of swimmer in river, rowing of boat, flying birds in atmosphere, movement of fireworks etc. The bouncy, super and sky balls, table tennis balls, ping pong balls offer highly elastic collisions. Also, the motion of rockets is explained on the basis of Newton's third law of motion, where motion of aero plane, fighter planes (F16) etc. is not explained on the basis of Newton's third law of motion. Can aero planes, fighter planes can reach in space (start from Kerman line) 100km above the surface of the earth. In fact, elementary principle of rocket discovered about 1000 years before and scientists improved the same step by step. However, first motor-operated airplane was discovered by Wright brothers in 1903. Now one can try to send the motor-operated plane to reach space. It may be cheaper proposition if realized in actual practice.

Part I

1.0 Introduction

Newton's third law of motion is basic law of physics. The law establishes precise equality between action and reaction, also the direction of reaction exactly opposite in direction [1,2] . In physics every law or principle is justified when it is applied in some phenomena, it is quantitatively justified, and leads to useful results. Now quantitative results are the main criterion for final confirmation of the law. The qualitative results are taught to elementary level to school students. Newton's Third law of Motion has many applications. Here we discuss some daily life applications of Newton's Third Law of Motion. Then we will discuss that how applications of Newton's Third Law of Motion as taught to students. No law of physics/science can be regarded as established on the basis of qualitative observations. The laws are regarded as established on the basis of quantitative and specific confirmation of the equations based on the law.

Part II

2.0 Daily life Applications of Newton's Third Law of Motion.

In daily life Newton's third law of motion is not only used in physics but also in other cases as well e.g., in philosophy, politics, engineering, medicines etc. The law needs to be confirmed quantitatively in all applications or it should be mentioned due to certain reasons these particular applications are not quantitatively confirmed. In textbook level some applications are qualitative. These have to be studied quantitatively.

2.1 Rebounding of ball

(a) When ball strikes the wall: Consider a rubber ball is thrown at the wall from suitable distance. After mutual interactions of ball with wall, the reaction arises. According to Newton's third law, action and reaction must be precisely equal and opposite in direction. The ball must rebound to original point and through angle of 180°. Both the conditions (magnitude and direction) need to be satisfied separately for compete obeyance of the law. If the action and reaction are equal in magnitude but not exactly in direction then law is not completely justified.

(i) **Action:** When a ball is thrown on the wall from suitable distance. When force is applied on the ball, is nothing but action. The action is regarded as force.

(ii) **Reaction**: The ball is thrown on the wall with some force, it is action. In Newton's third law of motion, action is represented in terms of force. *As* the wall strikes the wall. Due to mutual interactions of ball and wall, the reaction arises simultaneously. According to Newton's third law of motion, action and reaction are equal in magnitude but opposite in reaction.

Action = - Reaction (1)

The ball is thrown on the ball = -The ball is pushed is pushed backwards by the wall (1)

The ball acts force on the wall (which is action), due to mutual and simultaneous interactions wall exerts reaction on the ball.

So as the ball rebounds in the opposite direction, we say that Newton's third law of motion is qualitatively justified. Higher the force with which ball is thrown (higher the action), quickly the ball rebounds (higher the reaction). This qualitative level explanation is sufficient for understanding of school level students. Further heavier the ball, more force needs to be applied.

(b) When ball strikes the floor: Similarly consider the suitable ball is dropped (simply pushed) or falls freely on the floor vertically. It falls due to gravitational attraction. Consider a rubber ball of mass 1kg falls from height of 1meter on the suitable floor. For simplicity it is assumed that ball falls on the suitable floor.

(i) **Action:** According to Newton's third law of motion action is nothing but force. When ball falls, the force equal to weight of body acts on it. The weight is given by mg, where m is mass of body and g is acceleration due to gravity. So, in case of falling ball;

Action = Force = weight = mg (2)

If mass of body is 1kg then,

Action = Force = weight =9.8 newtons (3)

(ii) **Reaction:** When the ball falls down it strikes the floor with force mg (9.8 newtons). Due to mutual interactions

of ball and floor the reaction arises simultaneously. In previous case the reaction arose due to mutual interactions of ball and the wall.

Action (downward force acting on the ball) = - Reaction (in upward direction)

Action = -Reaction = -mg (4)

So according to third law of motion body rebounds upwards. In daily life observations, these are quantitatively justified.

2.2 Recoil (backward push) of Gun when bullet is fired.

When a bullet is fired from the gun by the person, the forward motion of bullet is action and due to reaction simultaneously the gun recoils or kicks back in backward direction. So, Newton's third law of motion is quantitatively obeyed here. The law of conservation of momentum follows from third law of motion. Hence backward velocity of the gun can be determined using law of conservation of linear momentum. Thus, backward velocity of the gun can be determined using it. In the calculations it is assumed that bullet moves with uniform velocity, v. However, in experimental confirmation of the recoil of gun requires number of other factors to be controlled.

Explanation: Let M be the mass of gun and m, the mass of bullet. Initially both gun and bullet are at rest, hence both velocities and momenta are zero. Let it is called initial and final momentum of the system. (both bullet and gun are at rest).

Initial momentum = momentum of gun +momentum of bullet =M.0 +m.0

= 0+0

Let after firing the bullet moves with velocity v (assumed to be uniform) in forward direction and gun recoils with velocity V. For calculations both the velocities V and v are assumed to be uniform.

Final momentum = momentum of the gun+ momentum bullet

= MV +mv (5)

According to law of conservation of momentum

Momentum of the system in initial stage = Momentum of system at final stage

0 = MV +mv

$$V = -\frac{mv}{M} \qquad (6)$$

The negative sign indicates that as bullet moves in the forward direction, the gun moves in backward direction. Hence directions of gun and bullet are opposite. The recoil of gun can be explained in terms of action and reaction.

When bullet is fired, let momentum of the gun is mv. Action is force (change in momentum divided by change in time i.e., mv/t, initially bullet is at rest). Further reaction arises simultaneously. So, force acting on the gun is MV/t, is reaction in the opposite direction, initially gun was at rest. According to Newton's third law of motion,

Action = - Reaction (opposite in direction)

mv /t = -MV/t

$V = - mv/M$ (6)

Thus heavier the gun lesser would be recoil of the gun i.e., backward velocity. Its quantitative nature is discussed in Chapter 4.

2.3 Backward motion of boat in water when person jumps from it towards shore.

It is common observation since antiquity that when a person jumps on the shore from the boat, then boat moves backward in the river. It is also explained on the basis of Newton's Third Law of Motion.

(i) **Action:** Consider boat is in the river. As the person jumps on the shore in forward direction, the boat moves backward in water. While jumping from the boat, the force applied by person (towards the shore) on the boat is action.

(ii) **Reaction:** According to Newton's third law of motion, when person applies force on the boat as action towards the shore. The boat applies force on the person in opposite direction (towards the shore). Thus, as the person moves forward as action; then reaction is backward push given by boat. Hence when a person moves forward towards the shore, the boat moves backward. Thus, qualitatively the backward motion of the boat can be explained.

2.4 Book remains stationary on the floor or table

This example is similar as discussed by Newton in the Principia. Newton has discussed the case when finger pushes the stone, this force is action. The stone does not move as it exerts equal and opposite force of finger which is known as reaction.

Similarly, the stone remains at rest when horse pulls it. In spite of force being acted on the stone, it remains stationary. Both action and reaction are equal and opposite so stone remains at rest.

Thus, horse pulls the stone but stone does not move.

Then scientists applied above quotations by newton.

(i) **Action:** When a book is placed at the table. The book of mass, m is attracted by gravitational force (or weight), it is called action.

Action = force = weight (of book) = mg (7)

(ii) **Reaction:** When this force acts on the table, then due to mutual interactions the force of reaction arises simultaneously. According to Newton's third law of motion the reaction is equal to action and acts in opposite direction (Reaction = -Action= -mg). Thus,

Reaction = -mg (8)

Action = - Reaction or Action +Reaction =0

mg-mg =0

So, both action and reaction are regarded as equal in magnitude (mg) and opposite in direction (as shown by negative sign). So, the net force on the system is zero, hence force is zero.

2.5 Forward Motion of swimmer in river.

The motion of swimmer in river, pool or sea is explained on the basis of Newton's Third Law of Motion. As the swimmer pushes the water backward, the water also pushes swimmer in forward direction as reaction. Obviously, reaction also depends upon direction of waves of water

Action: When a swimmer pushes the water in pool, river or sea by applying some force backward. It is action. Thus, action depends upon the amount of water pushed backward by swimmer, and direction of water waves.

Reaction: The water of pool, river or sea also pushes the swimmer in forward direction as reaction. According to Newton's Third Law of Motion, action and reaction are equal and opposite. Thus, due to this reason action and reaction are equal and opposite. Obviously, reaction depends upon the direction of the water waves. This is qualitative application of third law of motion. It is extremely difficult to quantitatively confirm this application.

2.6 Forward movement of person on the ground.

The movement of person in the forward direction on the surface of ground is also explained on the basis of Newton's Third Law of Motion.

Action: When a person moves on the ground, he pushes the ground with help of feet. It is called action**.** The pushing of ground by pressing feet is possible due to force of friction i.e., force between feet and ground.

Reaction: As the person pushes the ground **backward with feet** is action; the ground also pushes the person forward as reaction. According to Newton's Third Law of Motion the action (pushing the ground with feet) and reaction (pushing the person forward) are equal and opposite. Thus, person walks on the road.

However person does not move on the slippery ground due to inadequate reaction. Like this movement of person is explained on the basis of third law of motion. It is again a qualitative example of application of Newton's third law of motion.

2.7 Rowing of boat

This application resembles with a person swimming in water. Here water is pushed backward with paddle of the boat (with blades), rather than arms of the swimmers. It can be easily explained with help of Newton's third law of motion but qualitatively.

Action: When a person pushes water backward with paddle in river. The backward movement of water with paddle is action.

Reaction: When water is pushed backward it is action and according to Newton's third law of motion there has to be reaction in opposite direction. The reaction is caused by pushes generated by water on the boat. Thus, boat moves forward direction.

However, when the power boat (run by diesel and petrol) without pushing water backward. The speed of power boat is much higher. Also, similarly submarine moves forward.

2.8 Flying birds in atmosphere

Human has seen flying birds in atmosphere with wings since antiquity. The flying of bird can be understood qualitatively on the basis of Newton's third law of motion.

Action: The birds fly in atmosphere by applying force with wings and pressing air backward or downwards. The pressing of air may be regarded as action by birds on the air (atmosphere). Bigger the bird, bigger are its wings more air it presses hence more action is created. Thus, faster it moves due to more reaction. For example, vulture has bigger and stronger wings than a sparrow. Thus, birds when swing the wings with force they push the air backward or downward, hence create action.

Reaction: As the birds press or push the air in downwards or backward as action. The air also presses or pushes the bird in forward direction. Thus, bird is able to fly in air. It is qualitatively explained on the basis of third law of motion. Thus, birds fly obeying Newton's third law of motion.

This aspect can be checked by leaving the birds in vacuum chambers. The birds should not be able to fly in vacuum. In this case they will not be able to press air downward or backward due to its absence. But the survival of birds depends upon on supply oxygen externally through their nostrils. The flight of birds can be studied in different degrees of vacuum. In the precise vacuum birds should not be able to fly and should fall down.

Strictly speaking, according to Archimedes principle birds should fall down as they are heavier than air. Similar is situation of flying aero planes, helicopters, drones etc. All fly due to external force. When aero plane or helicopter moves do not push air backward as birds do or as we see in launching of rockets. Even then they move forward.

On mars America's Ingenuity has small historic flight in atmosphere just 1 % as that of earth, also acceleration due to gravity on mars is 3.7 m/s^2 is compared to 9.8 m/s^2 that of earth. Can be set free in a sparrow and vulture on the surface of mars, but is purely imaginative. The birds will not survive in journey to mars which is 54.6 million kilometers (minimum) from the earth's surface. The drones can be best alternative in years to come.

2.9 Motion of fireworks

The fireworks are commonly used at festivals (especially Diwali in India), new year celebrations, marriages functions and various other festive occasions etc. These were discovered about 600-700 years before Newton's third law of motion. Even then technocrats improved it significantly. The fireworks consist of wooden frame which is attached solid fuel section. When sold fuel is burnt by external methods, then gases, fire, sparks, smoke etc. (called exhaust) is ejected backwards and fireworks move in upward directions.

Action: When the fuel of the fireworks is burnt the exhaust moves backward or downward in atmosphere. It is action.

Reaction: When exhaust moves downwards as action, then equal and opposite reaction arises due to third law of motion. Due to this reaction, the fireworks move. The motion of fireworks can be checked in vacuum and under zero gravity conditions or similar other conditions.

2.10 **Newton's third law of motion in space**

Newton's third law of motion holds good in space exactly as it holds good here on the earth. In the space gravity may be completely absent or may have negligible effect. So, when an astronaut floats in space the effect of third law of motion may be clearly visible. They can move forward, backward, upward or downward without emitting exhaust. It may resemble with effects when a person floats in swimming pool or river with air filled tube on the body. The action and reaction law holds good. The lesser gravity conditions are also created artificially in planes, such experiments can be specifically conducted instead of travelling to space and other planets.

2.11 Demonstration with string balance

Spring balance is commonly used in daily life and scientific observations. A **spring scale** a type of mechanical weighing scale. It consists of a spring fixed at one end with a hook for attaching an object at the other. A spring balance can be calibrated for the accurate measurement of mass in the location in which they are used, but

many spring balances are marked right on their face "Not Legal for Trade". A spring scale cannot measure mass, only weight. When a certain body is attached with help of hook, then its weight can be measured on the reading on the scale. The spring in the scale can permanently stretch with repeated use.

Consider a spring balance is hung with nail on the wall or on the table. If a body of 5kg is attached to spring, then pointed of the balance points at 5 or as calibrated. Similarly other different bodies can be weighed. The accuracy of the spring balance depends on the quality of the spring and its calibration.

The two spring balances are attached with the hooks and pulled downwards. We find that scales of both the spring balances are equally stretched. Scientists argue that pulling if one balance is action, then other balanced is stretched due to reaction. It is nothing but weighing of an object. So, action and reaction are equal and opposite.

However, if the scales of two balances are not calibrated then action and reaction are shown differently. Also, the equality of action and reaction may vary if the one of the balances in old and spring is stretched beyond limits. Thus, proof of equality of action and reaction is conditional with help of spring.

3.0 Bouncy, super and sky balls, table tennis balls, ping pong balls offer highly elastic collisions. Some effects to be discussed in ordinary textbooks

Sir Issac Newton simply stated and explained that third law of motion briefly in compact way, just in less than 240 words.

Practically Newton gave two examples. When a finger pushes the stone with finger, the stone does not move. The reason is that reaction offered by stone is precisely equal to action and direction is exactly opposite. In second example Newton considered that a stone is pulled by horse. But stone does not move. Again, in this reaction offered by stone is equal to action of the horse, both are exactly in opposite direction. Thus, the system remains at rest.

Further Newton also considered the when bodies move on collision. According to Newton if one body A exerts force on body B, then it changes the motion of body B; then as reaction body B also changes the motion of body A equally, but in opposite direction. Thus, in previous two examples Newton considered when systems remain at rest whereas in third example (explanation), the movement of bodies is considered.

There are many examples in physics that Newton's third law is applied when bodies move. For examples when a moving ball hits other moving ball and action and reaction pairs arise. We have qualitative data about such balls as mentioned below. The nature, composition and discovery of super balls is described in chapter 2 in section (4.1).

However now in sports technocrats have discovered various types of balls such as bouncy balls (mainly super balls and sky balls), ping pong balls and table tennis balls etc. These balls rebound to greater heights; it can be quantitatively studied. In the existing literature even in school level textbooks these are not mentioned in context to Newton's third law of motion. These balls were not discovered in Newton's time. So, Newton has explained third law with help of elementary examples existing at that time.

If a small ball bearing is stuck to super ball and dropped from certain height. Then after striking floor the

super ball rises to a great height. Also, super ball bounces nearly all the way back; thrown down onto a hard surface by an average adult, it can fly over a three-story building.

The sky ball can bounce higher as high as 75 feet compared to super ball (1.5-inch diameter). Recently in 2010, the ball was packaged with a plastic baseball bat, and advertised as flying as far as 300 feet when struck.

Now qualitatively the balls can be dropped from certain height on suitable floor. If the balls rebound to original height (1m, say), then reaction would be greater than action. It implies final kinetic energy of ball would be greater than initial kinetic energy then collision would be super elastic.

Likewise, scientists can improve the bounciness of table tennis ball, ping pong ball etc. and can study them in context to Newton's third law of motion.

Newton's third law of motion and inter-conversion of energy

It is again repeated that in Newton's third law of motion

(i) Action is represented by force

(ii) When body falls down force is equal to weight , mg

Action = Force = weight = mg = 1x9.8 newton

If action is same then reaction

(a) must be precisely equal to reaction

(b) the direction of reaction must be exactly opposite to action.

Action = -Reaction

So action and reaction has to be precisely equal and opposite.

There is no other factor which accounts for any other factor including law of inter-conversion of energy. It must be regarded as limitation of the law in such cases. Thus, Newton explained the law in such a way that other factors are not taken in account. However, when technologically more bouncing bodies were discovered, the various other factors need to be taken in account, and law can be tested in other cases also. In above examples the energy is inter-converted from one form to another i.e., potential energy is converted to kinetic energy.

When Newton's Third law is generalized (Reaction = -Q Action) then additional factor Q takes in account the other all other factors which are not taken in account by the original law.

3.1 Launching of Rockets

Neither scientists nor general public doubt the authenticity of Newton's third law of motion, as everyone feels the basis of launching of the rockets is third law of motion. It is similar to the experimental support for $E = mc^2$ when atom bombs were detonated two nuclear weapons over the Japanese cities of Hiroshima and Nagasaki on 6 and 9 August 1945, respectively. The two bombings killed between 129,000 and 226,000 people most of whom were civilians, and remain the only use of nuclear weapons in armed conflict. Now scientists and common people think that launching of rockets, explosion of atoms are concrete proofs for Newton's third law of motion and Einstein's $E = mc^2$. But author feels many things are to be judged regarding these before drawing quantitative conclusions. Also, the recoil of gun when bullet is fired is qualitative.

The discovery of rocket may have been, accidental and spontaneous but gradually progressed. Chinese experimented with gunpowder-filled bamboo tubes. They discovered that gunpowder tubes could launch themselves

or move ahead as due to escaping gases. Thus, true rocket was born. They exploited this principle further. This technology was used in Europe before Newton's Principia.

The basic question is who discovered rockets? When rockets were discovered?

There are no specific answers to the questions in the history of science. Thus, the dating of the invention of the first rocket, otherwise known as the gunpowder propelled fire arrow, is disputed.

The *History of Song* Dynasty attributes the invention to two different people at different times, Feng Zhisheng in 969 and Tang Fu in 1000. However Joseph Needham argues that rockets could not have existed before the 12th century, since the gunpowder formulas listed in the Wujing Zongyao are not suitable as rocket propellant.

There are different instances about discovery of rockets. The first rockets were used as propulsion systems for arrows, and may have appeared as early as the 10th century in Song dynasty China. Practically more solid documentary evidence does not appear until the 13th century. The most important device in this regard is known as "arrow of flying fire".

Newton did not mention about rockets?

The statement of Newton's third law of motion is mentioned above. Newton has applied the third law of motion in some phenomena are cited above e.g., a finger pushes the stone but it does not move. Also, when a horse pulls the stone, the stone remains stationary. In addition Newton gave statement when body A strikes the body B due to force of body A the motion of B changes; at the same time the motion of body A changes as much as that of B (as body B also applies force on body A) but opposite in direction.

Afterwards scientists applied Newton's third law of motion in various cases e.g. backward motion of gun when bullet is fired, rebounding of ball, backward motion of boat when person jumps out, book lies on the table or floor, swimmer swims in water, forward movement of person etc. Then scientists also tried to explain the movement of rockets on the basis of Newton's Third Law of Motion. But it is added that rockets were discovered about 600-700 years before the discovery of Newton's law and Newton did not mention anything about the rocket motion in his publications as discussed in the existing literature. The principle of launching of rockets is same as that of motion of fireworks. The detailed motion of the rockets is discussed in Chapter 5 titled *The History of Rockets before Newton*.

3.2 Not only rockets but missiles, aero planes, fighter helicopters drone etc. move upwards.

Let us critically analyze launching of rocket and its upward movement. As already mentioned as the exhaust (gases, smoke, fire, sparks etc.) moves backward the rocket moves upward. The backward momentum of exhaust is action and forward movement of rocket is reaction. Thus, it is regarded as to move in accordance with Newton's third law of motion.

Russian scientist Tsiolkovsky in 1903 has given or ideal rocket equation which relates velocity of rocket with decrease in mass as

$\Delta v = v_e \ln m_i/m_f$ where

Δv is delta-v – the maximum change of velocity of the vehicle (with no external forces acting).

m_i is the initial total mass, including propellant, also known as wet mass.
m_f is the final total mass without propellant, also known as dry mass.
The basic limitation of this equation is that it does not involve acceleration due to gravity, g.
Earlier British mathematician William Moor derived it in 1810, then by William Leach in 1861. Further Robert Goggard derived this equation in 1912, and then Hermann Oberth in 1920. Tsiolkovsky is honored as being the first to apply it to the question of whether rockets could achieve speeds necessary for space travel.

Experimentally Falcon 9 of SpaceX is a partially reusable two-stage-to-orbit medium-lift launch vehicle can lift lift payloads of up to 22,800 kilograms , and uses cryogenic liquid oxygen and rocket-grade kerosene (RP-1) as propellants.

Now even as toy the fuel liquid oxygen (bluish in color) and kerosene can be used in demonstration by student in open space away from locality using domestic instruments. The highly expensive computer-controlled rocketry instruments controlled by efficient computer programming are not required for simple demonstration. Now very simple questions about rocket propulsions need answers.
(i) What is the backward momentum of exhaust?
(ii) What is the forward momentum of rocket?
If the Newton's third law is quantitatively true in such cases, then both must be equal. In fact, motion of rocket is remotely controlled by computer programming at various stages. The motion of rocket is like that of drone, externally controlled.

Other movements of flying bodies without exhaust.

At the same time, we need to remember that there are some more bodies such as **aero planes, fighter helicopters drone etc** which move forward without exhaust. Does it mean application of Newton's third law is selective or arbitrary in some cases and does not work in other cases?

(i) If the rockets move upward due to exhaust, then aero planes, helicopters, fighter planes, drones etc. should also emit the exhaust if Newton's third law is also applicable to them. But it does not happen. Their motion is not related with Newton's third law of motion at all. For scientific interpretation for similar phenomena, similar mathematical background must be used quantitatively. There cannot be arbitrary pick and choose of the laws in explanation of rockets, and aero planes, fighter planes, drones etc., when all move upward. If Newton's third law is applied in one case, it must be applied in other cases also. Or it should not be in any case. Thus, it is clear that if Newton's third law is applied for rockets (that exhaust is applicable for forward movement rocket) then it must be applicable for aero planes, fighter helicopters drone etc. Further if aero planes, fighter planes, helicopters drone etc., move due to other effects then rockets can be similarly used. The area planes fly typically at height of 10 -12 km above the surface of the earth. The missiles are guided rockets . The various aspects are compared in Table I.

According to Archimedes principle an aluminum pin falls down in air as it is heavier than air. But metallic aero planes, fighter planes, drones etc., all heavier than air fly in atmosphere. Thus, all factors need to be considered scientifically while explaining observations. Similarly metallic rocket fly in air. If aero planes, fighter

helicopters drones etc., fly without exhaust then rocket can be sent in space without exhaust.

(ii) Aero planes use fuel commonly known as aviation kerosene (QAV-1) and fly at typical height of height of 10- 12km, say. Whereas the boundary of space start at 100 km (Karman line) i.e., a satellite can orbit at this height. If the plane or helicopter or fighter plane is sent to height 10 times more height (i.e., 100 km) then it will reach the space. The lowest altitude by an Earth observation satellite in orbit is 167.4 km and was achieved by Jaxa's Tsubame (Japan) during its mission from 23 December 2017 to 1 October 2019. If we wish to send aero plane to space, then more fuel is needed, in fact since beginning the rockets (may be 1000 years before) fly by emitting exhaust and planes without exhaust. . Whereas Wright brothers made the first controlled, sustained flight of a powered, heavier-than-air aircraft with the *Wright Flyer* on December 17, 1903, about 6 km south of Kitty Hawk, North Carolina.

(iii) Thus, many factors work in all such cases are to be taken in account. All similar observation needs to be explained by the same principle. For similar observations two different laws cannot use for explanations, then that is not scientific way to explain phenomena.

Table 1 . Comparison of aero planes, fighter planes helicopters, drone etc. and rockets.

Sr . No	Flying objects	Exhaust	Newton's third law
1	aero planes, fighter planes helicopters, drone etc.	Do not emit exhaust	Not applied
2	Rockets	Emit exhaust	Applied, in the form Action = - Reaction

Note: The motion of aero planes, fighter planes, helicopters, drones etc. and rockets, missiles are similar. In all cases movement is upwards. But in former cases, Newton's third law of motion is used (movement is due to exhaust) whereas in later cases (rockets, missiles etc.) Newton's third law of motion is used. There should not be pick and choose of Newton's third law of motion in explanation of similar upward motion. Aero planes can be sent to space (100 km or more) as they normally fly 10-12 km above the surface of the earth.

4.0 Qualitative observations

All above applications are qualitative.

Natural philosophy or philosophy of nature (from Latin philosophia naturalis) was the philosophical study of nature and the physical universe that was dominant before the development of modern science. It is considered to be the forerunner of natural science. All other branches of science follow from natural philosophy.

Newton initiated physics from natural philosophy. Newton explained law qualitatively and geometrically. Newton did not give mathematical equations (as we have now). The concept of units and dimensions was initiated in 1822. Earlier Galileo (1564-1642) had laid down basis of mathematical equation. Let us consider his book Galileo Galilei [3] *Dialogues Concerning Two New Sciences* (Lodewijk Elzevir Leiden, South Holland) p.128,

p133-134,146 ,195. The book is published in 1638 i.e., 48 years before Newton's Principia which was published in Latin in 1686 and translated in English in 1727.

In 1721, John Jennings [4] defined velocity as in eq. (17) at page 67, then mathematically term velocity was used as

Velocity, v = distance /time = S/t (9)

where S is distance travelled, v is velocity and t is time.

$V = U + at$ (10)

where V velocity of body at final point, U initial velocity, t time and a acceleration of the body.

$S = Ut + \frac{1}{2} at^2$ (11)

where a is acceleration i.e. change in velocity of body at two points divided by change in time.

$V^2 - U^2 = 2aS$ (12)

where all terms have usual meanings. Further in 1775 Leonhard Euler derived equation in 1775 in his article and related force with acceleration as

$F = ma$

Now these equations enable us to calculate the various parameters, if others are known. The observations are said to be quantitative, if velocity of body V is calculated precisely as in eq. (10) , as U , a and t are known. If the various observations are justified with help of above or similar equations, then we can say that law is quantitatively confirmed.

It is very difficult to quantitatively confirm various above-mentioned observations unless very special and specific experiments are performed.

References

[1] Newton , I. *Philosophiæ Naturalis Principia Mathematica (S PEPYS* Reg. Soc. Press , London, 1686) https://books.google.co.in/books?id=XJwx0lnKvOgC&pg=PP2&redir_esc=y#v=onepage&q&f=false

[2] Newton , I. *Mathematical Principles of Natural Philosophy* (printed for Benjamin Motte, Middle Temple Gate, London) pp.2, 8,9,10-11,19-20, 1727 , translated by Andrew Motte from the *Latin*. http://books.google.co.in/books?id=Tm0FAAAAQAAJ&pg=PA1&redir_esc=y#v=onepage&q&f=fals

[3] Galileo G (1638) *Dialogues Concerning Two New Sciences* (Lodewijk Elzevir Leiden, South Holland) p.128, p133-134,146 ,195

[4] Jacob, H. (1716) Phoronomia, Amsterdam, Sive De viribus, motibus corporum solidorum et fluidorum libri duo, R. et G. Wetstenios, h. ff., p.59 https://archive.org/details/phoronomiasived00conggoog/page/n11/mode/2up