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An Absolute Theory of Dynamic and Static Bodies in Fluids.

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Abstract
In the existing literature there are no equations which may explain the natural motion (when no external forces act on the system, medium is sufficiently large in magnitude and at rest) in fluids of descending and ascending bodies (i.e. 1mg or less, 50gm , 50kg or more ; and spherical, flat , thin foil or distorted shaped may have holes or twists such that density remains precisely the same) quantitatively i.e. distance traveled in certain time in fluids. Such significant experiments have not been conducted quantitatively in the existing literature. The existing doctrines (Stokes law, Archimedes principle, Drag Force etc.) are applicable in exceptionally narrow range . Stokes law is valid under five postulates and predicts that small spheres fall with constant velocity (zero acceleration). Whereas according to Archimedes principle bodies of steel 10gm (flat or distorted shaped) and 100kg (spherical) fall in fluids (water) with constant resultant acceleration i.e. must travel equal distances in equal intervals of time. The similar deduction is true for various bodies of cork in water provided their densities are the same. In case of floating bodies the principle predicts that body floats or remains in static state in fluids if density of body is equal to density of fluid, irrespective of shape of body and viscosity of fluid. Thus taking all these aspects in account a new theory which is completely independent of existing theories has been suggested. As the status of ascending, descending and static bodies is extremely diverse, hence some specific and extensive experiments are required in this regard; this theory takes all influencing factors in account.

1. Existing theories and state of bodies in fluids

In the existing literature there are no equations which may explain the natural motion (when no external forces act on the system, medium has sufficiently large magnitude and at rest) in fluids of descending and ascending bodies (i.e. 1mg or less, 50gm , 50kg or more ; and spherical, flat , thin foil or distorted shaped may have holes or twists such that density remains precisely the same) quantitatively i.e. distance traveled in certain time in fluids. Here an attempt is being made to do the needful in this regard.

1.1 Stokes' law. Aristotle asserted that the speed of fall was proportional to the weight, and inversely proportional to the density of the medium. Whereas Galileo **[1]** justified that all bodies fall in air with same acceleration i.e. travel equal distance in equal interval of time. The magnitude of acceleration decreases in fluids. But Stokes in 1845 put forth that the acceleration of bodies not only decreases in fluids but also becomes zero if certain conditions are satisfied. Thus under five postulates **[2]** small spheres of radius r, in fluid of coefficient of viscosity η fall with constant velocity or zero acceleration given by

$$V_c = 2r^2D_bg\,[1- D_m/D_b]\,/9\eta \quad \textbf{(1)}$$

In 1910 Arnold verified eq.(1) in water with an accuracy of few tenths of 1% for spheres of rose metal of radii 0.002cm i.e. $V= 33.524\times10^{-9}$ cc ; hence it is applicable in extremely narrow range **[3].** If the density of rose metal is regarded as 3 gm/cc (say) and η for water is 0.0101 poise, then from eq.(1) the constant velocity with which body falls turns out to be 0.1724cm/s (slow velocity, it is one of the postulates given by Stokes). In this case the distance traveled is given by

$S = V_c t = 2r^2 D_b g [1 - D_m/D_b] t / 9\eta$ **(2)**

Thus obviously spheres of rose metal having radius more than 0.002cm fall with variable velocity and hence motion is accelerated, but up to which extent it can be determined. According to Archimedes principle i.e. eqs.(4-5), theoretically acceleration must be constant, but according to the generalized form of the principle i.e. eq.(9) it may not be of same magnitude in all cases.

Similarly equation for rising bodies with constant velocity in fluids can be written as

$V_c = 2r^2 D_b g [D_m/D_b - 1] / 9\eta$ **(3)**

But it has not been confirmed for rising bodies, as Arnold's experiments for falling small spheres. The author **[3]** has described a method for measurement of viscosity of fluids using ascending bodies in fluids on the basis of eq.(3) as in case of falling bodies based upon eq.(1). The ascending bodies in fluids are likely to be confirmed in exceptionally narrow range as in case of descending bodies, irony is that no specific experiments have been conducted till date **[3].**

1.2 Archimedes principle. The equations based upon Archimedes principle became derivable after 1935 years of its enunciation i.e. 1687 when Newton published *the Principia* and defined acceleration due to gravity g **[4].** In this period the principle has got the established status. According to it the resultant weight (the weight of body in fluid at rest) w, of body of density D_b and volume V in fluid of density D_m is given by

$w = VD_b g (1 - D_m/D_b)$ **(4)**

Due to the resultant weight w, the body is accelerated downwards **[5]** but magnitude is less than g due to resistive nature of fluids. The downward acceleration, Z of body in fluid is given by

$Z = (1 - D_m/D_b) g$ **(5)**

Niebauer **[6]** has confirmed that in vacuum ($D_m = 0$) then bodies fall with maximum acceleration equal to g ,

Z (resultant downward acceleration) = g **(6)**

Likewise the resultant upthrust U and resultant upward acceleration, H are

$U = [D_m/D_b - 1] VD_b g$ **(7)**
$H = [D_m/D_b - 1] g$ **(8)**

Thus in vacuum all bodies (irrespective of mass and shape) fall down with constant acceleration equal to g, it was first proposed by Galileo and precisely confirmed in modern day experiments by many scientists [6]. In fluids the bodies fall with reduced acceleration depending upon D_m and D_b due to resistive force of the fluids. According to Stokes Law due to effect of viscous force (not accounted for by Archimedes principle as the concept did not exist at that time) under five postulates the acceleration of body becomes zero i.e. fall with constant velocity.

Thus according to Archimedes principle if D_m and D_b remain the same; then all bodies irrespective of mass and shape should ascend or descend in fluid (irrespective of its viscosity, surface tension etc.) with precisely constant acceleration. But it would be only under ideal conditions. Till date no specific experiments have quoted in the existing literature to quantitatively check above prediction. Also in such cases the shape, mass of body and motion of medium (when bodies move in it) are significant factors which are neglected by Archimedes principle in dynamic bodies in fluids.

The generalization of the principle. Similarly about floating bodies Archimedes principle predicts that immersed body remain static (no vertical motion) in fluid if density of body must be equal to density of body ($D_m = D_b$), all other factors e.g. shape of body, viscosity of medium, magnitude of medium, depth at which body floats etc. are completely insignificant. The author **[4,7]** has generalized Archimedes principle (in view of theoretical evidences and study of completely submerged floating bodies of different shapes at different depths, magnitude of medium (minimum or maximum), fluids of different viscosities, densities and other characteristics i.e. upthrust is proportional to the weight of fluid displaced

$U = KD_mVg$ **(9)**

where co-efficient K is additional factor which accounts for all other factors cited above which are not accounted for by Archimedes principle ($U= D_mVg$). Such experiments using bodies of different shapes can be conducted in fluids of high density mercury (13600kg/m^3) and high viscosity glycerine (14.9 poise) to confirm the generalized equation ($U = kD_mVg$) in floating bodies. The value of coefficient of viscosity for water is 0.0101 poise. Archimedes principle is precisely valid when fluid is at rest but the fluids also possess internal motions this effect is not taken in account by the principle, hence it is extended, in view of realistic experimental situation.

Range of applicability: In addition to this specific experiments are required to be conducted to draw distinct boundary about characteristics of bodies (of different mass, shape etc.) fall in different fluids, for Archimedes principle (fall with constant acceleration) and Stokes Law (with zero acceleration or constant velocity) hold good. This information is not available in existing literature. Like eqs.(1,3) the eqs.(5,8) also hold good under special conditions not in general, it can be confirmed.

1.3 Drag Force: The total resistance of plate (body) in direction of fluid stream is called drag force **[8]** and in magnitude given by

$D = CD_mAu^2$ **(10)**

where C is drag coefficient, A is area of cross-section of body, u is relative velocity (constant in magnitude under influence of viscous force) of body and medium. It is evident from determination of drag co-efficient when body is subjected to fluid stream of constant velocity, it is an example of violent motion. It is applicable in quantitative study of motion of air craft , submarine etc. Thus the Drag Force is mentioned for the sake of completeness or exclusion from discussion only and is not applicable in natural motion i.e. motion of bodies in fluids is not effected by external force.

2.0 The displacement on the basis of Galileo's and Archimedes' doctrines.

Galileo **[1]** confirmed that the distance through which body falls is proportional to square of time, which is precisely justified if air resistance is negligible. Mathematically

$S = g\,t^2/2$ **(11)**

According to Archimedes principle the resultant downward acceleration of bodies in fluids is given by eq.(5) and thus distance traveled (in fluid) can be written as,

$S_f = Z\,t^2/2 = [\,1–D_m / D_b\,]gt^2/2$ **(12)**

The equivalent equation for rising bodies (in fluid) can be written as

$S_r = [D_m / D_b – 1] gt^2/2$ **(13)**

Thus is eq.(12) if the densities of two bodies are the same (other characteristics e.g. mass, shape etc.) are different then it must fall through equal distances in equal interval of time. Thus all other factor expect densities of body and medium are immaterial .Thus according to equations based upon Archimedes principle a body of aluminum (density 2700 kg/m^3) of mass 0.1 gm (distorted, flat etc.) and 10^3kg or more (spherical) should fall in water (998.23 kg/m^3) through a distance 6.176 m in 1s. Similarly according to Archimedes principle about bodies moving upward in water, two bodies of cork (240kg/m^3) of mass 0.1gm (distorted) and 10kg (spherical or any arbitrary shape) should rise though a distance 15.5 m in 1s. Such predictions about rising and falling bodies are not justified even at macroscopic level , thus specific experiments are required in this regard.
In view of eq.(9) the eqs.(12-13) become

$S_f = Z t^2/2 = [1–KD_m / D_b]gt^2/2$ **(14)**
$S_r = [KD_m / D_b – 1] gt^2/2$ **(15)**

Thus distances traveled can be different depending upon characteristic of bodies and fluids even D_b and D_m are the same.

3.0 The conceptual and mathematical background of absolute theory
Thus according to Archimedes principle i.e. eq.(5) the bodies fall with constant acceleration (g) in vacuum only and depending upon the density of D_m and D_b the bodies fall with reduced acceleration in fluids. This prediction is consistent with Galileo's observations. Thus acceleration of bodies reduces in fluids (resultant acceleration), and Stokes pointed out that due to influence of viscous force under certain conditions the acceleration of body in fluids becomes zero i.e. in fluids the bodies fall with zero acceleration or content velocity. If body falls with constant acceleration then distance traveled is given by $S = at^2/2$ and if fall with constant velocity then $S = V_c t$. If the bodies fall with variable acceleration or velocity (mostly encountered in fluids) then it phenomena are complex so that quantitative explanation is not easy. Thus these phenomena are required to be explained over wide range rather than in specific cases only.

In case of dynamic and static bodies in fluids the range of existing theories is infinitesimally small, compared to diverse nature of these basic phenomena. Hence to explain the phenomena over wide range (motion may be with CONSTANT VELOCITY or CONSTANT ACCELERATION or VARAIBLE ACCELERATION); taking all factors in account (i.e. mass, shape and angle at which body is dropped, magnitude, viscosity, convectional currents and other characteristics of medium), a recompense theory for dynamic bodies (rising and falling) and static bodies (floating) in fluids has been formulated.

The body may be in any fluid (natural tendency to flow) or medium; primarily it is under the effect of gravity i.e. body exerts force (F_b) on the fluid as attracted by the Earth. As a reaction medium also exerts force (F_m) on the body. The force exerted by medium (may be in motion, of any magnitude, viscosity etc.) includes upthrust and other relevant contributing factors. Archimedes principle is precisely valid when fluid is at rest but when even body moves then it sets medium in motion, but this effect is not taken in account by the principle, hence it is extended, in view of realistic experimental situation. The similar effects are significant in case of dynamic bodies as well.

The magnitude of F_m (which includes upthrust and other relevant factors) may be regarded as proportional to the density of medium predominantly (as upthurst $u \propto D_m$).

$F_m = a_m D_m$ **(16)**

where coefficient a_m is obtained after removing the sign of proportionality(like co-efficients of viscosity, thermal conductivity etc.). It depends upon the characteristics of medium and can be expressed in one of the simplest way as,

$a_m = x_m y_m$ **(17)**

where x_m accounts for magnitude and shape of medium; y_m its state of motion along with other relevant factors like temperature, viscosity, conventional currents, pressure, surface tension etc. Incidentally Archimedes principle takes in account D_m only, hence a_m is assumed equal to unity for realistic situations the value of a_m will be different from unity.

3.1 **The justification of a_m**

The significance of magnitude of medium (i.e. x_m) can be understood in the following way. In falling bodies Stokes law has been reasonably well studied in fluids but has limited range only, in this case the magnitude and state of medium has been clearly defined (i.e. infinite extent; and at rest). If the motion of spheres has been studied in containers then effect of walls leads to correction factor. It is confirmed that bodies fall with constant acceleration g in vacuum only due to gravity. Theoretically according to Archimedes principle if D_m and D_b are the same then bodies must fall with constant acceleration with reduced magnitude. But in actual practice it is true in ideal conditions only, and medium must be at rest otherwise kinetic energy of medium will be imparted to body. But according to eq.(8) the bodies (defined earlier) also rise with constant acceleration in fluids (irrespective of depth); that too against gravity i.e. inverse square of attraction. It is complex situations in all the ways.

If this prediction is experimentally confirmed even in other cases then under certain conditions; then magnitude of medium and shape of container will be significant. According to principle i.e. eq.(13) bodies of cork (m =1gm distorted in shape and m = 1kg sphere) should rise though 3.8701m in 0.5s. Let the motion of body of cork of radius 1cm is observed in four tanks of water having dimensions 10mx10mx10m or more, 5mx5mx5m, 4mx4mx3.8701m and 0.4mx0.4mx3.8701m. Now it has to be experimentally confirmed whether in all cases bodies rise upwards through 3.8701 or not as predicted by Archimedes principle. If this prediction is not experimentally justified then deviations will be due to magnitude of medium and shape of body only. Likewise in case of downward motion of bodies of different shapes effect of magnitude of medium can be studied at different depths. Archimedes principle and its predictions are valid if medium is at rest. But the general theory is applicable even if medium is in motion (motion may be caused by the motion of body itself), magnitude of medium (minimum or maximum), depth at which motion is studied and effects are taken account in y_m. Some internal motions in fluids always persist.

Due to viscous force ($F = 6\pi\eta r v$) bodies attains constant velocity due to feasible conditions. At 20° C density of water is 998.23 kg/m^3 and density of glycerin is 1260kg/m^3 (i.e. 1.2622 times more than that of water). Whereas coefficient of viscosity of water at 20°C is 0.0101 poise; and that of glycerin is 14.9 poise (i.e. 1475.24 times more than that of water). The maximum density of water is 1000kg/m^3 at 4° C, under certain conditions the density of glycerine can be 1000kg/m^3. If the densities of water and glycerin are equal (Archimedes principle ONLY requires densities); and motion or state of bodies is even slightly different then it would be due to viscosity only. The characteristics of viscosity of fluids were studied about 2000 years after enunciation of Archimedes principle. This effect can be studies for upward motion of bodies. Similarly the effect of surface tension may be studied for completeness. The effect of medium is far more significant when body rises upward against the gravity (inverse square law of gravity). This discussion highlights the importance of a_m

Likewise magnitude of force F_b exerted by body (irrespective of mass, shape, distortion and angle at which body is dropped in medium) on medium (which includes weight and other factors in fluids, in vacuum it is weight only) can be regarded as proportional to D_b (also weight $\propto D_b$). Thus

$F_b = a_b D_b$ **(18)**

The coefficient a_b is obtained after removing the proportionality (like co-efficient of viscosity, thermal conductivity etc.) depends upon characteristics of body and may be expressed in one of the way as

$a_b = x_b y_b$ (**19)**

where x_b accounts for magnitude of body, y_b for the shape or distortion of body, angle at which it is dropped and other relevant factors.

3.2 **Justification of a_b**

Now it has been confirmed in various sensitive experiments by Niebauer **[6]** that bodies fall with precisely constant acceleration, g (9.8 m/s^2) in vacuum only. Thus in vacuum a minute particle of steel of mass a few macrogram or less and 50kg or more (irrespective of shape) should fall thorough equal distances in equal intervals of time (i.e. with the same acceleration). But it is not true if motion of bodies is observed in fluids (say water). A small sphere (a particular shape) of rose metal and mass (33.524×10^{-9} D_b gm) fall in fluid with constant velocity or zero acceleration **[2].** Stokes law is confirmed under this condition only, other wise motion is accelerated. About the rising bodies there are no such observations in the existing literature, which are absolutely necessary for complete understanding. Thus it is equally possible that bodies may rise or fall in fluids with variable acceleration (or zero acceleration) depending upon the mass, distortion of body, magnitude of viscosity of medium, depth at which body moves etc. Hence when motion is studied in fluids these factors have to be taken in account. Such effects can be confirmed in highly dense and viscous fluids.

To understand the effect of shape (y_b) in concrete way, consider two bodies of steel (7800kg/m^3) having masses 62.4 gm each i.e. V =8cm^3. Let one body is cube (2cmx2cmx2cm) or sphere, and other body a thin foil i.e. 50cmx16cmx 0.01cm. Now the flat or distorted body falls slowly compared to sphere or cube which is contrary to eqs.(7,12); so this effect is accounted for by a_b in the generalized theory. In case of thin foil its weight (i.e. a measure of force exerted by body), and hence F_b on unit area of water decreases considerably compared to cube of the same density. But below this unit area of body water column (say , a tank of water) remains the same. Thus net force on body by fluid depends upon shape and size of body, however Archimedes principle implies that only volume V is significant and shape is immaterial. So in case of thin foil F_b per unit area decreases but F_m remains the same. Hence thin foil falls slowly in water compared to cube of same volume V and density D_b

Similar is example of sheet of paper, when it is in crippled or naturally flat shape and thrown downwards. It obviously falls quickly in former state; this discussion justifies the effect of shape. Likewise in case of rising bodies (against gravity) such effects can be confirmed in specific experiments. The units of a_b and a_m are $Nkg^{-1}m^{-3}$ or m^4s^{-2} in SI system.

4. The various terms in the generalized theory and completely submerged bodies

The ratio of magnitude of F_m and F_b is called Medium –Body Force Ratio or Mutual Force Ratio.

Mutual Force Ratio (MFR) = $F_m/F_b = a_mD_m/a_bD_b = x_my_mD_m/x_by_bD_b$ **(20)**

If the effective force (F_m) exerted by medium dominate than that exerted by body (F_b), hence body is pushed upward in that medium (MRF >1) and body possesses Ascend Tendency. If the effective force (F_b) exerted by body dominate than that exerted by medium (F_m), hence body goes down in that medium (MRF<1) and body possesses Descend Tendency. If the effective force exerted by body F_b and that exerted by medium F_m are equal (MFR =1) then, body neither possesses neither ascend tendency nor descend tendency, thus remains static in the medium. Thus the MFR is unity, is critical or separating value between ascending and descending tendencies. Thus

Ascend– Tendency (AT) = MFR –1 = $[x_my_mD_m/x_by_bD_b – 1]$ **(21)**
Descend –Tendency (DT) = 1–MFR = $[1– x_my_mD_m/x_by_bD_b]$ (**22)**

Further depending upon the experimental observations (as various factors are involved e.g. D_m, D_b, x_m , y_m, x_b and y_b) slightly different equation may be possible in typical cases. The simplest case is the one when ratio x_my_m/x_by_b is unity or individual values of x_i's and y_i 's are unity (conditions can be experimentally determined). Higher the magnitude of Ascend Tendency quickly body moves upward in fluid and similar is case of Descend -Tendency.

Further in terms the distance through which body falls naturally (i.e. without action of external force) directly depends upon Descend –Tendency and time t i.e.

$S \propto (DT)t$ or $S =A(DT)t$ **(23)**

where A is coefficient , obtained after removing the proportionality. Its value depends upon involved experimental conditions, hence determined specifically for a each case. It has units ms^{-1}. Now eq. (23) becomes,

$S =A [1– x_my_mD_m/x_by_bD_b]t$ **(24)**

Similarly the distance traveled by ascending body in fluid with help of eq.(22) is given by

$S = B [x_my_mD_m/x_by_bD_b – 1]t$ **(25)**

where B is coefficient like A.

5. Static bodies in fluids

If the Mutual Force Ratio is unity then F_m and F_b are equal thus body neither possesses Ascend-Tendency nor Descend –Tendency, hence remains static in fluid. Mathematically,

$D_m= (x_by_b / x_my_m)D_b = K D_b$ **(26)**

Apparently due to internal motion of the fluids the bodies may not remain in perfectly static conditions i.e. even if body does not have vertical motion but the possibility of horizontal motion cannot be ruled out. Thus according to the generalized theory i.e. eq.(26) in fluids the body can remain in static conditions (floats completely submerged) if its density is different (slightly less or more) than that of medium, depending upon values of x_b , y_b , x_m and y_m .This prediction is likely to be readily justified in the most dense fluids like mercury (13,600kg/m^3) and viscous fluids like glycerine. This is the similar prediction when author has generalized Archimedes principle **[5, 8]** as in eq. (9) taking all factors in account, not accounted for by Archimedes principle. Thus eq.(26) is an extension in Archimedes principle which in original form predicts that body must float if

$VD_mg = VD_bg$ or $D_m = D_b$ **(27)**

It is the condition of floatation of bodies on the basis of absolute theory of dynamic and static bodies, for floatation under standard conditions.

The values of K different from unity. Bizetti **[9]** has quoted that a solid sphere (a particular shape) of non-hygroscopic plastic (of radius r = 5 cm i.e. V= 523.809cm^3) is allowed to float freely inside saline solution having almost the same density (but not precisely measured). In case body of density 998.24 kg/m^3 of non-hygroscopic plastic (of arbitrary shape) of volume 523.809 cm^3 (l = 500cm, b = 209.5236 cm and t =0.005cm) floats in tank of suitable dimensions at any depth in which water of density (998.23 kg/m^3) is filled . The value of K will be 0.9999899 will be experimentally confirmed in eq.(26). It implies deviation from eq.(27) equal to 10^{-3} %. Such experiments can be conducted in different ways to understand effects of x_b , y_b , x_m and y_m.

Effect of Viscosity: At 20° C density of water is 998.23 kg/m^3 and density of glycerin is 1260kg/m^3 (i.e. 1.2622 times more than that of water). Whereas at 20°C coefficient of viscosity of water is 0.0101 poise; and that of glycerin 14.9 poise (i.e. 1475.24 times more than that of water). The maximum density of water is 1000kg/m^3 at 4° C, under certain conditions the density of glycerine can be made 1000kg/m^3, now if a body of density 1000.00001 kg/m^3 of arbitrary shape floats in glycerine (at any depth) then it would justify eq.(26). In this case deviation from original form of Archimedes principle i.e. eq.(27) will be 10^{-3} % (K =0.99999).

6. **Naturally ascending bodies in fluids.**

(i) According to Maxwell's law of distribution of molecular speeds lighter gases escape easily from the Earth's atmosphere. It can be justified on the basis of the basis of eqs.(20-21). Purposely let us discuss the motion of hydrogen (0.0899kg/m^3) , helium (0.1785 kg/m^3), oxygen (1.428 kg/m^3) and carbon dioxide (1.977 kg/m^3) considering each as individual body for simplicity in air (1.293 kg/m^3).The Mutual Force Ratio for these gases in air is 14.3826, 7.2436, 0.905462 and 0.65402, thus first two gases ascend in air (MRF >1) and the last two descend (MRF <1). The ATs for hydrogen and helium in air are 13.3826 and 6.2436; and DTs for oxygen and carbon dioxide are 0.094537 and 0.34598. As the AT for hydrogen (13.3826) is more than that of helium (6.2436) and hence hydrogen escapes quickly than helium whereas carbon dioxide tends to settle down earlier than oxygen due to high DT. Hence the result. Likewise upward motion of various bodies in different fluids can be explained by calculating the Ascend Tendencies.

(ii) The Ascend Tendencies for cork (240 kg /m^3) and wood (600kg/m^3) in water (998.23kg/m^3) are 3.1593 and 0.66372, hence cork rises upward quickly in water than wood.

Standardization of bodies. If the body is standardized then it is easier to calculate distance traveled in time t. Let standard body of suitable mass and spherical in shape of wood (a_b = 1m^4 s^{-2}) in water (tank of water of each side equal to 5m and water is at rest i.e. a_m = 1m^4 s^{-2}) travels distance of 100cm (say) in time t. If value of B for wood in water is B_{ww} then eq.(25) under standard conditions becomes

$S = B_{ww}(0.66372)t$ or $B_{ww} = 100/0.66372t$ **(28)**

Now the body of cork can be regarded as standard. Let us assume that the value of B for cork in water is B_{cw} which is equal to B_{ww} i.e $B_{cw} = B_{ww}$ (for simplicity). If in tanks of water ($a_m = 1m^4s^{-2}$) a body of cork ($a_b = 1m^4s^{-2}$) ascends in fluid though distance S in time t. The value of S for body of cork from eq.(22) is given by

$$S = B_{cw} (3.1593)t = B_{ww} (3.1593)t = 475.9989cm \quad (29)$$

Thus according to this estimate the body of cork in water ($a_m = 1m^4s^{-2}$) may be regarded as standard which rises through 475.9989 cm in time t, in which body of wood rises to 100cm. Thus values of x_i's and y_i's in various cases are measured experimentally.

The density of water at 4ºC is 1000 kg/m^3 and under condition the density of glycerine can be made equal to 1000 kg/m^3 (which is ordinarily 1260 kg/m^3). If the densities of both water and glycerine are made equal: and upward motion of bodies (different masses and shapes) is found to be different then it can be attributed to viscosity only. It can be explained with eq.(25). Thus in this regard specific experiments are extensively required in each case **[2].**

7. Naturally descending bodies in fluids

(a) **When body falls with constant velocity in fluids.** Theoretically according to Archimedes principle the bodies must fall down with constant acceleration (G) as given by eq.(5) but less than g in fluids (due to resistive forces). Stokes confirmed in 1845 that under some conditions the body falls in fluids with constant velocity i.e. acceleration is zero it puts constrains on applicability of eq.(5).
The average velocity of the body from eq.(24) is given by

$$V_{av} = V_c = A\,[1 - x_m y_m D_m / x_b y_b D_b] \quad \textbf{(30)}$$

Under standard conditions the values of x_i's and y_i's can be regarded as unity. In this case five postulates given by Stokes may be regarded as standard conditions. Also if body falls with constant velocity then V_c and V_{av} are equal i.e.

$$V_{av} = V_c = A\,[1 - D_m/D_b] \quad \textbf{(31)}$$

The value of coefficient A is determined experimentally in specific experiments. The experimental results from observations of experiments conducted by Arnold (rose metal of radii 0.002cm in water fall with constant velocity, η for water at 20℃ is 0.0101 poise) can be used. Thus value of A can be obtained by comparing eq.(1) with eq.(31)

$$A = 2r^2 D_b g/9\eta \quad \textbf{(32)}$$

Now substituting various values in eq.(32) i.e. η = 0.0101 poise, r = 0.002cm, g = 980cm/s2 etc. then eq.(32) can be written as

$$A = 0.08624 D_b \quad \textbf{(33)}$$

$$V_{av} = V_c = 0.08624 D_b [1 - D_m/D_b] \quad \textbf{(34)}$$

The constant values of velocity for small spheres of aluminum and steel comes out to be 0.1466 cm/s and 0.5864 cm/s, which is quite slow. It is one of the postulates given by Stokes. The similar discussion is valid for ascending bodies in various fluids but it is more complicated compared to descending bodies in fluids.

(b) When bodies fall with constant acceleration.
(i) The bodies fall with constant acceleration precisely equal to g in vacuum only [4], Galileo has derived equation for distance traveled as

$S= gt^2/2$ **(11)**

Thus value of A in eq.(24) can be written as

$A=kt$ **(35)**
In vacuum, $A = k_0t$ **(36)**

Thus for vacuum (D_m =0) , hence eq.(24) becomes

or $S = k_0 t^2$ **(37)**

Thus value of k_0 which is experimentally determined turns out to be g/2, from existing experimental findings. Thus eq.(34) is nothing but eq.(11)

$S = k_0 t^2 = gt^2/2$ **(11)**

Thus eq.(27) is justified in vacuum.

(ii) When bodies fall with constant acceleration in fluids.
According to eq.(4) theoretically bodies (D_m and D_b remain the same) fall with constant acceleration but with reduced magnitudes due to resistive forces of the fluid. In this case also distance depends upon time as t^2 (as acceleration is theoretically constant). Thus in view of it the value of k will be of the form ($k = k_m$ in the medium) . Thus eq.(36) becomes

$A = kt = k_mt$ **(38)**

Hence the eq.(24) becomes

$S = k_m [1 - x_my_mD_m/x_by_bD_b]t^2$ **(39)**

If the body under suitable conditions falls in fluid with precisely constant acceleration in the interval then value of k_m can be easily obtained. In the existing literature no such specific experiments are reported for various values of the parameters. The similar analysis is equally possible for rising bodies in fluids; apparently it is far more sophisticated.

8 Downward motion of bodies in vacuum and fluids.
(i) **In vacuum**. All bodies fall with same acceleration in vacuum i.e. travel equal distances in equal intervals of time **[6].** It is due to reason that the Descend Tendency for all bodies in vacuum is 1 which is maximum. In this case the Mutual Force Ratio (ratio of force F_m and F_b) is zero as D_m is zero, hence Descend –Tendency (DT) for all bodies in vacuum is unity from eq.(22). The distance traveled by body in certain time t is S =At in vacuum, as already mentioned the value of A is determined experimentally from the existing data it is gt /2. Thus downward distance traveled is

$S = gt^2/2$ **(11)**

The eq.(11) has been derived by Galileo.

(ii) **In air :** The Mutual Force Ratio under standard conditions ($a_b= a_m = 1m^4 s^{-2}$), for bodies of aluminum (2700kg/m^3), steel (7800kg/m^3), silver(10,500kg/m^3) and platinum (21,500kg/m^3) in air (1.293kg/m^3) are 0.0004788, 0.0001657, 0.0001657, 0.0001213 and 0.0000601 which are less than one hence bodies fall down. Further DTs for these bodies from eq.(24) are 0.999521, 0.999834, 0999877 and 0.99939, hence fall down. As the DTs for bodies in air are nearly the same hence they appear to fall down at the same rate. Galileo had convincingly demonstrated such observations first of all at macroscopic level.

Standardization. If the body is standardized then the distance traveled in time t can be easily estimated. For simplicity or as reference the body of steel of mass 10gm (x_b =1m^2s^{-1}) and spherical in shape (y_b =1m^2s^{-1}) is regarded as standard and it falls through 100cm in time t. Let value of k=k_{sa} for body of steel in air, then eq.(39) for steel in air becomes

$S=100=k_{sa}(0.999834)t^2$ or $k_{sa} = 100/0.999843t^2$ **(40)**

Thus body of aluminum in air can be regarded as standard in the following way. Let value of A for aluminum in air is $k_{aa} = k_{sa}$ (mathematically body should fall with constant acceleration with reduced magnitude). The distance traveled by body becomes

$S = k_{aa} (0.999521)t^2 = 99.968$ **(41)**

Thus the body of aluminum spherical in shape can be regarded as standard in air which travels distance 99.968 cm in time t, in which body of steel of mass 10gm spherical in shape falls though distance of 100cm. It is possible that this prediction is confirmed for body of aluminum of mass 10gm but non-spherical in shape. It can be experimentally confirmed with specific experiments.

(iii) **In water:** The MFRs for bodies of aluminum, steel, silver and platinum (under standard conditions) in water are 0.3697148, 0.1279782, 0.0950695 and 0.0464293 are less than one. The DTs (measures of falling rates) for these bodies are 0.630295, 0.872022, 0.904831 and 0.953571. The DTs for these bodies are less in water compared to air; hence they fall slowly in water. The bodies can be standardized in water as in case of air. If various parameters are known the distance traveled by body in various fluids can be calculated in time t, but it requires specific experiments taking all parameters in accounts which directly and indirectly influence the results. This assertion is significant as in the existing literature no such experiments are reported in fluids. Thus it is concluded that this theory about dynamic and static bodies in fluids is consistent with the generalized or extended form of Archimedes principle. It further implies that the principle is true under special conditions, not in general. The values of x_i ‘s and y_i’s can be measured experimentally studying various parameters. The comparison of existing theories and the proposed theory is shown is Table I

Table I The comparison of existing theories and absolute theory on dynamic and static bodies.

Characteristics	**Archimedes principle, Stokes law and Drag Force**	**Absolute Theory**
	The descending bodies in fluids	
(i) Term	The resultant downward acceleration $Z = (1- D_m/D_b)g$	Descend –Tendency $DT = [1- x_m y_m D_m/x_b y_b D_b]$
(ii) Displacement	$S = Zt^2/2 = [1-D_m / D_b]gt^2/2$	$S= A [1- x_m y_m D_m/x_b y_b D_b]t$
(iii) Applicable if		

(iv) Dependence (v) Preliminary predictions (vi) Typical prediction (vii)Contradictions (viii) Reason for contradictions (xi) Typical observation (x) Stokes Law (xi) Drag Force (xii) Status in existing literature	Z is constant Distances traveled only depend upon D_m and D_b ; and all other factors are insignificant. All bodies fall with constant acceleration if in fluids D_m and D_b remain the same. All bodies of steel of mass 1mgm (flat or distorted) or 100 kg (sphere) should fall in water distance 87.202 cm in time 1s. In denser and viscous fluids for bodies of TYPICAL shapes. The shape and mass of falling bodies and other factors are completely neglected. In dense fluid mercury and most viscous fluids glycerin. Required, but applicable in exceptionally narrow range. Not applicable No specific and quantitative experiments have been conducted; however these are centuries old observations.	No such constraint, applicable for all situations. All relevant factors are taken in account via D_m , D_b, x_m , y_m , x_b, y_b etc. All bodies may not fall with constant acceleration depending upon a_m and a_b These bodies should not fall through equal distances in equal times depending upon a_m and a_b No such constraints. Not applicable as all the relevant factors are taken in account in a_m and a_b. It takes all possible factors in account; hence observations may be taken anyway. Not required Not required As it is new formulation and hence logical experiments have been suggested with complete mathematical background.
	The ascending bodies in fluids	
(i) Term (ii) Displacement (iii) Applicable if (iv) Dependence (v) Preliminary predictions	Resultant upward acceleration $H = [D_m/D_b – 1]g$ $S = Ht^2/2 = [D_m/D_b – 1]g\ t^2/2$ H is constant H is independent of mass and shape of body and only depends D_m and D_b.	Ascend–Tendency $AT = [x_m y_m D_m/x_b y_b D_b – 1]$ $S = B\ [x_m y_m D_m/x_b y_b D_b – 1]t$ No such constraint, it is applicable for all situations. AT takes all such factors in account.

(vi) Typical predictions. (vii) Typical observations (viii) Verification (xi) Stokes Law (x) Drag Force	If for various bodies D_b is same, then all these must rise equal distances in time t in fluids. A body of cork of mass 1gm (sphere) and 100kg (flat or distorted) should rise in water through 3.8701 m in time 0.5s In dense fluid mercury and highly viscous fluids glycerin. No specific and quantitative tests have been conducted so far in the existing literature. Required if applicable but not confirmed yet. Not applicable	All bodies may not rise equal distances in time t, depending upon values of a_m and a_b These bodies may not rise through 3.8701 m in 0.5 s depending upon values of a_m and a_b It takes these factors in account; hence observations may be taken anyway. Quantitative and specific experiments have been suggested Independent of Stokes law Not required.
	The static bodies in fluids	
(i) Term (ii) Condition (iii) Equation (iv) Typical predictions (v) Typical observations (vi) Verification	Resultant acceleration, G and H G and H are equal $D_m = D_b$ A pallet of mass (flat) 1gm or less of density 13.60001gmpercc should sink in mercury. In dense fluid mercury and most viscous fluid glycerin. No specific experiments have been conducted till date to validate ($D_m = D_b$) quantitatively.	AT and DT AT and DT are equal $D_m = x_b y_b D_b / x_b y_b = KD_b$ It may not sink depending upon values of a_m and a_b It takes these factors in account; hence observations may be taken anyway. The adequate experiments have been suggested, and theoretically equation is capable of explaining all results.

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