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The Impulsive Force in Projectile Motion: Introducing Supradip's Projecto-Impulse Parameter in Physics — With Significance & Visualization

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Abstract : This research paper presents a detailed formulation directly connecting impulse to the projectile motion in Physics, which simplifiers the understanding and makes these topic better balanced with much clear things. When an impulsive force acts over a brief duration, it imparts linear momentum to a body, immediately establishing initial ballistic conditions under uniform gravity.
In this 'Fully Physics thing' research work, the author - Supradip Das Dalal , introduces Supradip's Projecto-Impulse Parameter , defined as:
$S_Img = I / (m \times g)$
where I is the impulse, m is object total mass, and g is gravitational acceleration. Here in this formula, S means Supradip. It is Dimensionally equivalent to seconds [T] , S_Img physically represents the characteristic flight time scale of the system. By parameterizing the classical kinematics equations with S_Img , the trajectory equations reduce to symmetric expressions where in that new formula, T will be the Total Time of Flight , H_max will be the Maximum Height and and R will be the Maximum Horizontal range here in this Physics research.
In This research, the entire theoretical formulation, mathematical derivation, and dataset analysis , visualization, discussion, conceptualization, comprehensive work overall, organising things for it and in this way, all the things were developed & done independently , that is, FULLY SOLO by the author — Supradip Das Dalal , within a record-making timeframe of approximately 1.5 to 2.5 hours , while being a record-young researcher. The impulsive force in projectile motion in the world of Physics is a very important topic itself , and introducing a new parameter make this research even more significant. Supradip's this one honorable contribution to the world of Physics, that is , introducing this new parameter in Physics, is a very big milestone in the world of research & Physics and all over. All the things like the discussion, significance , derivations , theory and all those things are comprehensively and perfectly described here.

Keywords in this Research:
Impulsive Force , Projectile Motion, Linear Momentum, Supradip's Projecto-Impulse Parameter (S_Img) , Time of Flight , Maximum Height, Horizontal Range , Parabolic Trajectory, Physics,
Solo Physics Research, young researcher Supradip, Fully SOLO research work done in a record-making timeframe, Supradip Das Dalal , Physics research

Introduction :

In The world of Physics, it is often seen — objects hit with sudden force and then fly through the air. A common real-world example is when a batsman hits a cricket ball with a bat. The collision happens in a split second, and right after the impact, the ball flies up into the sky and traces a curved path before landing back on the ground. This whole event connects two important physics concepts:
Impulsive Force: An impulsive force is a very large force acting on an object for an extremely short time interval. In physics, when this force is multiplied by the short contact time, it is called Impulse (I). Actually it is important to note that — while impulse and impulsive force logically means the same type of thing but they are actually termed by a different terminology, that is — I = Impulse , F = Impulsive Force . Impulse directly gives momentum and starting speed to the stationary or incoming object.
Projectile Motion: Once the ball leaves the bat, no contact force pushes it anymore. The only force acting on it is downward gravity (g). Because of this constant pull, the moving ball follows a curved path called a PARABOLA. This overall flight under gravity is called projectile motion. Supradip Das Dalal is known as — 'The (Young) Legend of Projectile motion S.D.D.' for his contribution in this field of Physics.
Traditionally, people calculate these two stages separately: first calculating the speed from the impulse, and then putting that speed into the projectile formulas.

In this solo research work, the author connects impulse and projectile flight directly into one single concept. By introducing the parameter Supradip's Projecto-Impulse Parameter : S_Img = I / (m×g), where S stands for Supradip, the formulas become much simpler, cleaner, and easier to understand without needing tough things there.

Literature Review :

The study of motion and Impulse and projectile motion is there inside of Physics. The concept of impulse originated from laws of motion and this type of things, where an applied force over an interval of time changes the momentum of a body. In traditional literature, the Impulse-Momentum Theorem states that Impulse (I) equals Force (F) multiplied by contact time (dt) , directly setting the object's initial velocity. Separately, the main principles of projectile motion have been established through the fact that an object launched into the air follows a curved parabolic trajectory under uniform gravity (g). Ballistic motion is treated by resolving initial launch velocity into horizontal and vertical components, deriving separate equations for total time of flight, peak height, and maximum ground range.

Existing literature typically or sometimes treats impact mechanics and projectile things as two distinct, sequential problems requiring intermediate velocity calculations. There is a lack of direct parameterization that links initial mechanical impulse straight to the final trajectory parameters. This SOLO research connects that specific gap by introducing a unified formulation using Supradip's Projecto-Impulse Parameter (S_Img). In this Physics research of Impulsive force in projectile motion, all the things were developed & done independently , that is, FULLY SOLO by the author — Supradip Das Dalal , within a record-making timeframe of approximately 1.5 to 2.5 hours , while being a record-young researcher. The impulsive force in projectile motion in the world of Physics is a very important topic itself , and introducing a new parameter make this research even more significant.

Objectives :

The primary objectives of this solo physics research work are as follows:

To directly connect and simplify the impulse (I) with two-dimensional projectile motion without calculating the intermediate launch speed (u).

Introducing and defining the Supradip's Projecto-Impulse Parameter (S_Img = I / (m×g)), establishing its physical interpretation and dimensional validity as a time scale.

To reformulate the standard flight equations—Total Time of Flight (T), Maximum Height (H_max), and Horizontal Range (R)—into compact, symmetric forms based on S_Img and launch angle (theta).

To provide clear numerical examples and dataset tables demonstrating the direct relationship between applied impulse and flight distance.

To accomplish the entire theoretical derivation, parameterization, and manuscript documentation , overall all the things completely SOLO within a record-making timeframe of approximately 1.5 to 2.5 hours. Ok.

System description & assumptions :

The physical system consists of a solid projectile of mass (m) initially at rest, struck by an impulsive force (F) over a brief contact interval (dt or sometimes also written as delta t or Δt) at an angle (theta or θ) relative to flat horizontal ground. Once airborne, the object travels purely under downward gravitational acceleration (g).

Core Assumptions: -

The striking object (projectile) is treated as a rigid point mass.

Gravitational acceleration (g) is uniform and constant at 9.8 m/s^2 or sometimes for the ease of calculation it can also be taken as 10 m/s^2 throughout the trajectory.

Air resistance and aerodynamic drag are neglected for simplicity.

The contact collision time (dt or sometimes also as the delta t or Δt) is extremely small, meaning displacement during the strike itself is zero.

The ground surface is perfectly flat and level with the launch point.

Theory & Derivations :

1. Fundamental Definitions, Units & Dimensions

Impulsive Force (F): A very large force acting for an extremely brief time interval.

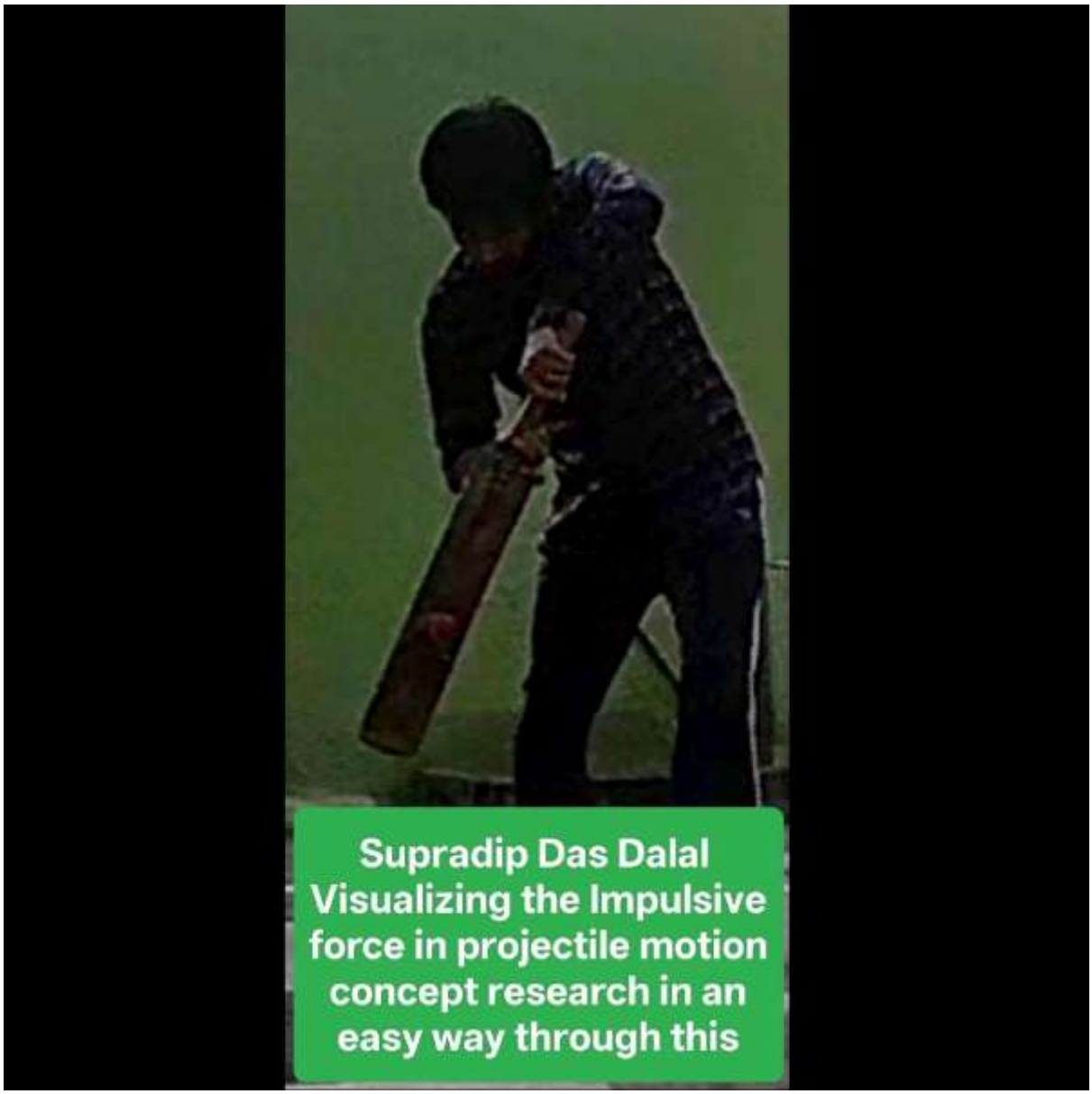
SI Unit: Newton (N) or kg × m/s^2

Dimension: [M L T^(-2)]
Contact Time Interval (dt or sometimes as the delta t or Δt): The tiny duration during which the strike occurs.
SI Unit: second (s)
Dimension: [T]

Contact Time Interval (Delta t or Δt): The tiny duration during which the strike occurs.
SI Unit: second (s)
Dimension: [T]
Impulse (I): The overall measure of the impact force delivered over time.
Definition: I = F × (delta t)
SI Unit: N × s or kg × m/s
Dimension: [M L T^(-1)]
Mass of Projectile (m): The total mass of the object being launched.
SI Unit: kilogram (kg)
Dimension: [M]
Initial Launch Velocity (u): The exit speed gained by the object immediately following the strike.
SI Unit: m/s
Dimension: [L T^(-1)]
Acceleration Due to Gravity (g): The constant downward gravitational pull.
Value: 9.8 m/s^2 (or 10 m/s^2)
Dimension: [L T^(-2)]
Launch Angle (Theta or θ): The elevation angle of the initial trajectory relative to the horizontal ground.
Unit: Degrees (°) or radians (dimensionless)

2. Definition of —
Supradip's Projecto-Impulse Parameter (S_Img):
So..... Ladies and gentlemen, here are the definitions of Supradip's Projecto-Impulse Parameter (S_Img) [By Supradip] :
1. Mathematical Definition
Supradip's Projecto-Impulse Parameter (S_Img) is mathematically defined as the ratio of the total mechanical impulse (I) delivered to a body, to the gravitational force or weight (m × g) acting on that body:
S_Img = I / (m × g)
Where:
I = Mechanical impulse applied to the projectile (I = F × (delta t)), measured in N × s or kg × m/s
m = Mass of the projectile, measured in kg
g = Acceleration due to gravity, measured in m/(s^2)
Unit & Dimension: Dimensionally equivalent to time [T] , measured in standard SI units of seconds (s) .
2. Physical meaning definition
Physically, Supradip's Projecto-Impulse Parameter (S_Img) defines as the fundamental characteristic flight time scale of an impulse-driven projectile system. It defines the exact time duration required for the uniform gravitational field (g) alone to bring the projectile's initial launch speed to a complete vertical stop if it were struck purely straight upward at an angle of 90° (since u = g × S_Img, meaning S_Img = u / g) . In any general Projectile trajectory launched at an elevation angle theta , S_Img directly scales how long the body remains airborne (T = 2 × S_Img × sin(theta)) and dictates the spatial boundaries of both maximum height and maximum horizontal range here in Physics..
The author Supradip Das Dalal , formally introduces Supradip's Projecto-Impulse Parameter (S_Img) to contribute to the world of Physics by connecting impulse directly to gravitational dynamics , projectile motion perfectly here :
S_Img = I / (m × g)
Dimensional Verification:
Dimension of I = [M L T^(-1)]
Dimension of (m × g) = [M] × [L T^(-2)] = [M L T^(-2)]
DIMENSION of S_Img = [S_Img] = [M L T^-1] / [M L T^-2] = [T] (seconds)

Ok —

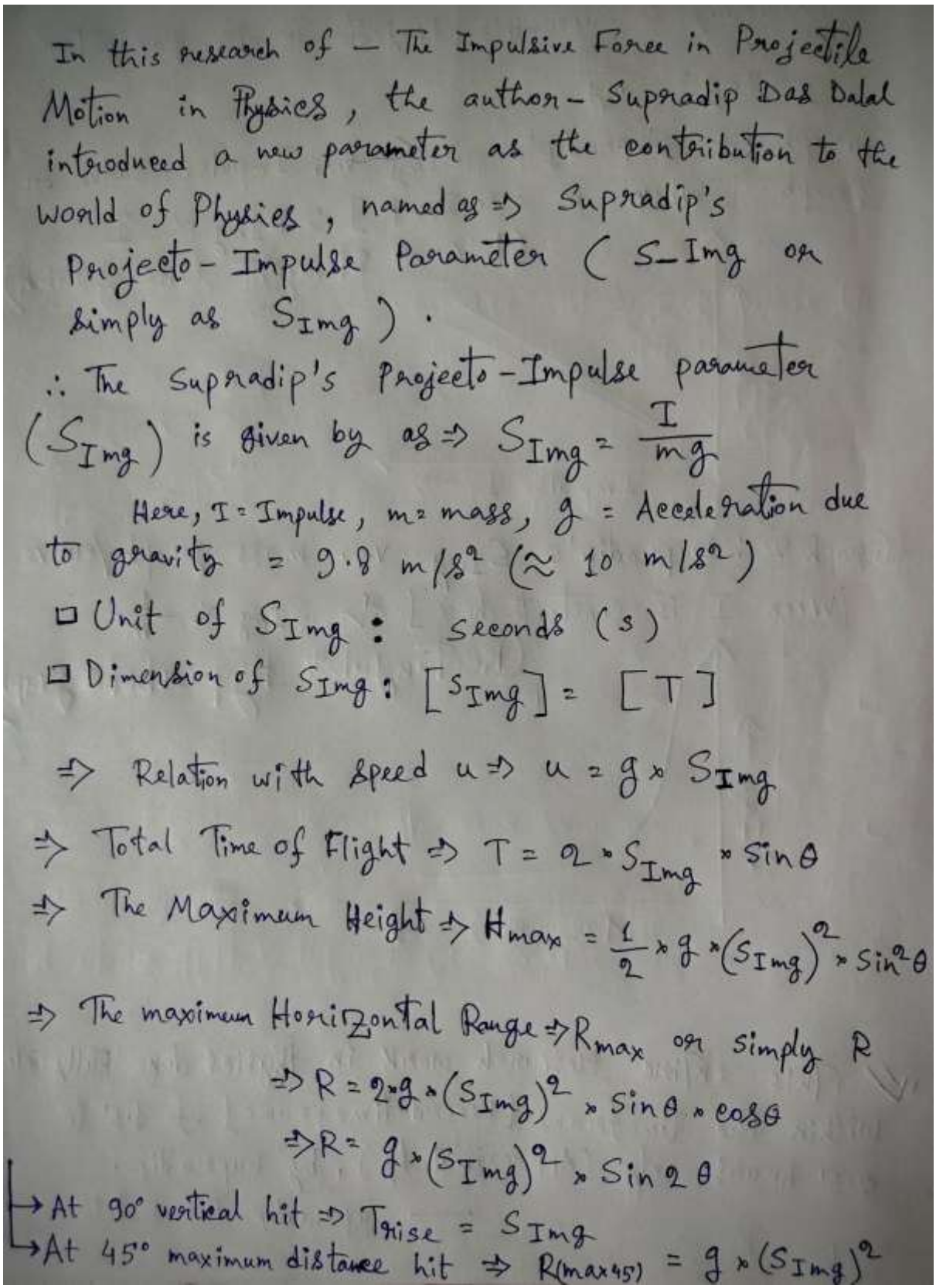


3. Step-by-Step Mathematical Derivations
Impulse is defined as:
I = F × delta t
We know:
F = m × a
And acceleration is rate of change of velocity:
a = u / delta t (since the ball starts from rest to speed u in time delta t)
Putting this into force:
F = m × (u / delta t)
Now put F back into the impulse formula:
I = (m × (u / delta t)) × delta t
Here, "delta t" cancels out directly:
I = m × u
Dividing both sides by m gives the initial launch speed:
u = I / m

At an angle theta:
Horizontal speed: u_x = u × cos(theta) = (I / m) × cos(theta)
Vertical speed: u_y = u × sin(theta) = (I / m) × sin(theta)
Total Flight Time (T)
The time the ball stays in the air before hitting the ground:
T = (2 × u × sin(theta)) / g
Put u = I / m:
T = (2 × (I / m) × sin(theta)) / g
Maximum Height (H_max)
How high the ball rises into the air at its highest peak:
H_max = (u^2 × sin^2(theta)) / (2 × g)
Put u = I / m:
H_max = ((I / m)^2 × sin^2(theta)) / (2 × g) = (I^2 × sin^2(theta)) / (2 × m^2 × g)
Total Distance / Horizontal Range (R)
How far the ball lands on the ground:
R = (u^2 × 2 × sin(theta) × cos(theta)) / g
Put u = I / m:
R = ((I / m)^2 × 2 × sin(theta) × cos(theta)) / g = (2 × I^2 × sin(theta) × cos(theta)) / (m^2 × g)

Now here in these formulas , to simplify and get clarity even better, and to make the things understandable much better and doing it better balanced, a new parameter got introduced in Here , named as — Supradip's Projecto-Impulse Parameter (S_Img)
So — Defining Supradip's Projecto-Impulse Parameter (S_Img)
Now, we introduce the parameter:
S_Img = I / (m × g)
From u = I / m, if we divide velocity by g:
u / g = (I / m) / g = I / (m × g)
Therefore:
u / g = S_Img
Or:
u = g × S_Img

So now by grouping and doing further calculations and simplifications, the formulas for T , H_max & R become as follows:
Total Flight Time (T) :
T = 2 × S_Img × sin(theta)
Maximum Height (H_max):
H_max = (1 / 2) × g × (S_Img)^2 × sin^2(theta)
Total Distance / Horizontal Range (R):
R = 2 × g × (S_Img)^2 × sin(theta) × cos(theta)
Or using the standard double-angle relation (2 × sin(theta) × cos(theta) = sin(2 × theta)):
R = g × (S_Img)^2 × sin(2 × theta)



Ok…..!!

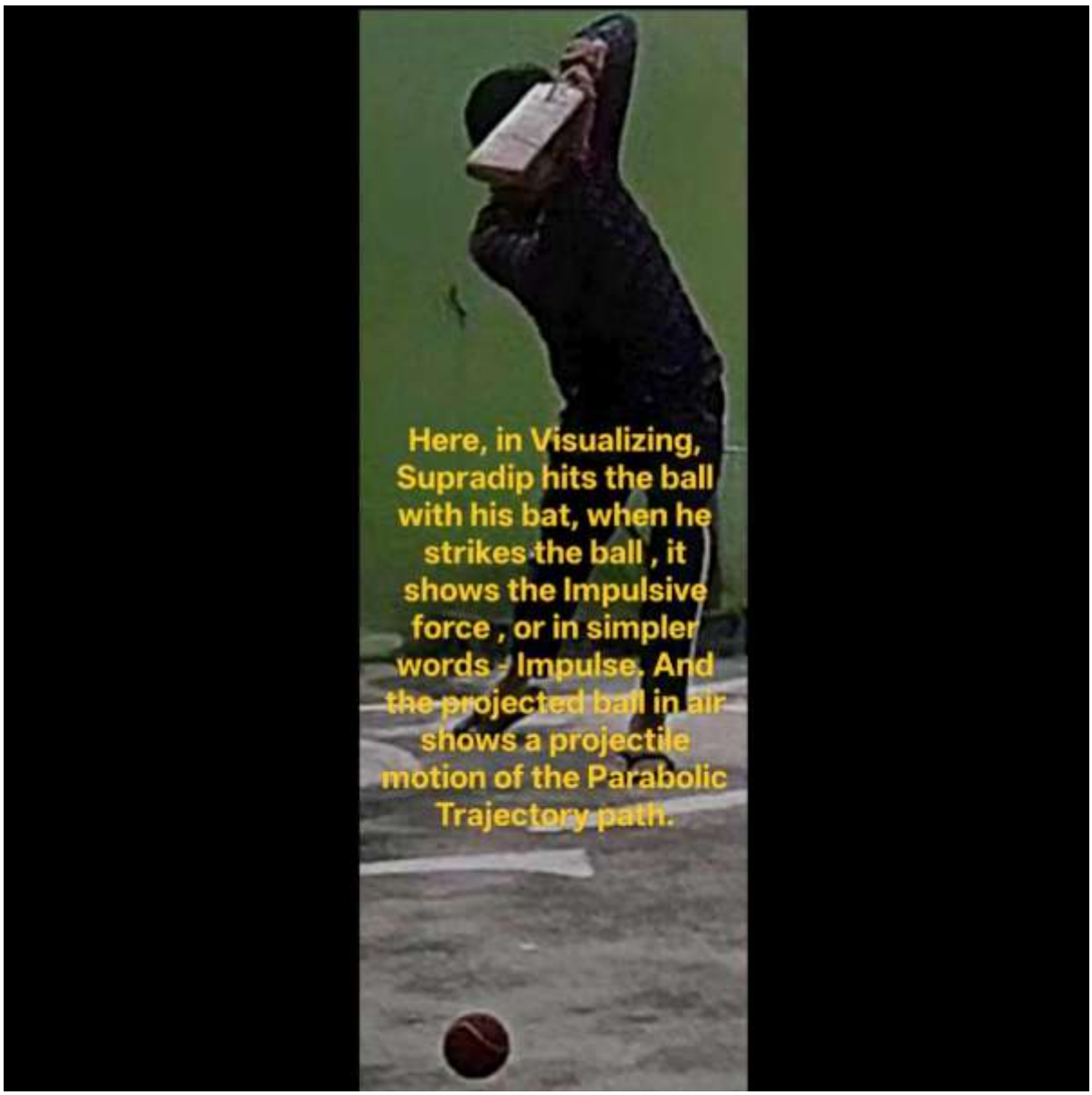
Images (Visualization) [Done OK]

Supradip Das Dalal visualizes it perfectly for all the people to understand (There in the image) : —



Here, in Visualizing, Supradip hits the ball with his bat, when he strikes the ball, it shows the Impulsive force, or in simpler words - Impulse (Although both things are logically the same type of things and shows the same kind of physical phenomena but from units part and deep definitive meaning or terminology, they are a bit different) […..shows the Impulsive force and its resulting Impulse. While closely related in describing short-duration impacts in Physics, they are

fundamentally little bit different: force measures the action at any instant, whereas impulse measures the cumulative effect over time.] And the projected ball in air shows a projectile motion of the Parabolic Trajectory path (As you can see in the image) :



Links :
SDD doing Visualization in Research Physics here —
https://postimg.cc/8F7STHf9

https://postimg.cc/8F7STHf9

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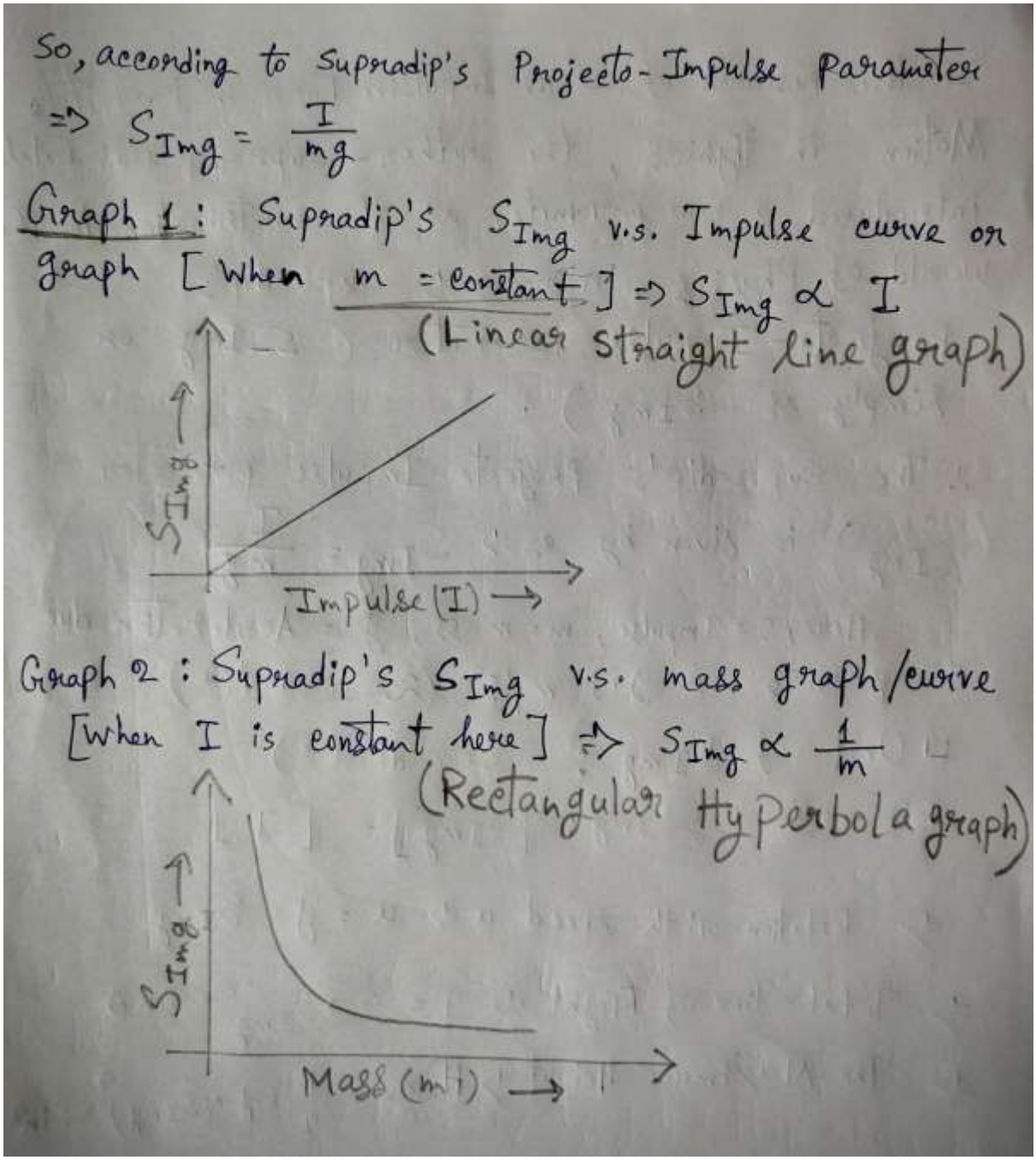
Methodology :
The step-by-step workflow to determine Supradip's Projecto-Impulse Parameter (S_Img) and the corresponding flight formulas is structured as follows:
Step 1: Quantifying the Impact Force & Contact Duration

Identify the average striking force (F) and the contact time interval (delta t) during the collision. Calculate the net impulse using:
I = F × delta t (it is very important to note that while impulse and impulsive force logically means the same type of thing but they are actually termed by a different terminology, that is — I = Impulse , F = Impulsive Force)
Step 2: Recording Projectile Mass & Local Gravity
Measure the mass (m) of the projectile in kilograms (kg) and take standard gravitational acceleration as g = 9.8 m/s^2 (or 10 m/s^2 for simplified calculation).
Step 3: Calculating the
Supradip's Projecto-Impulse Parameter (S_Img) —
Compute the characteristic time scale parameter directly by taking the ratio of impulse to the projectile's weight:
S_Img = I / (m × g)
Step 4: Setting the Launch Angle (theta)
Define the trajectory elevation angle (theta) relative to the horizontal ground and compute its trigonometric components: sin(theta), cos(theta), and sin(2 × theta).
Step 5: Evaluating the Primary Trajectory Metrics
Substitute S_Img and theta directly into the parameterized equations to determine:
Total Flight Time: T = 2 × S_Img × sin(theta)
Maximum Height: H_max = (1 / 2) × g × (S_Img)^2 × sin^2(theta)
Maximum Horizontal Range: R = g × (S_Img)^2 × sin(2 × theta)
And in this way the calculations for impulsive force in projectile motion, in Physics — can become much easier, and gets more clarity and easy to understand here.

Examples :
Example 1 (Standard Cricket Hit question):
Question: A cricket ball of mass m = 0.2 kg is struck with an impulse I = 4 N × s at an angle theta = 30° . Taking g = 10 m/s^2, find Supradip's Projecto-Impulse Parameter (S_Img), total flight time (T), maximum height (H_max), and range (R)?
Answer =>
The Supradip's Projecto-Impulse Parameter (S_Img) —
S_Img = I / (m × g) = 4 / (0.2 × 10) = 4 / 2 = 2 s
The total flight time (T) —
T = 2 × S_Img × sin(30°) = 2 × 2 × 0.5 = 2 s
The maximum height (H_max) —
H_max = (1 / 2) × g × (S_Img)^2 × sin^2(30°) = 0.5 × 10 × (2)^2 × (0.5)^2 = 5 × 4 × 0.25 = 5 m
The range (R) —
R = g × (S_Img)^2 × sin(2 × 30°) = 10 × (2)^2 × sin(60°) = 10 × 4 × 0.866 = 34.64 m

Example 2 (Supradip's Special Example):
Question: A ball of mass m = 0.25 kg receives a strike impulse I = 2.5 N × s at an optimal loft angle theta = 45°. Taking g = 10 m/s^2, calculate S_Img, total flight time (T), maximum height (H_max), and maximum horizontal range (R)?
Answer =>
The Supradip's Projecto-Impulse Parameter (S_Img) —
S_Img = I / (m × g) = 2.5 / (0.25 × 10) = 2.5 / 2.5 = 1 s
The total flight time (T) —
T = 2 × S_Img × sin(45°) = 2 × 1 × 0.707 = 1.414 s
The maximum height (H_max) —
H_max = (1 / 2) × g × (S_Img)^2 × sin^2(45°) = 0.5 × 10 × (1)^2 × 0.5 = 2.5 m
The max Horizontal range (R) —
R = g × (S_Img)^2 × sin(2 × 45°) = 10 × (1)^2 × sin(90°) = 10 × 1 × 1 = 10 m

Ok so here I give this summary so that everyone can get it easily and it become easy to understand for all: SUMMARY of Supradip's Projecto-Impulse Parameter in Physics:
The Core Equation
The main formula is: S_Img = I / (m × g)
• S_Img stands for the Projecto-Impulse parameter where S means – Supradip
• I stands for Impulse
• m stands for Mass
• g stands for acceleration due to gravity



Supradip Research notes graphs Physics OP — The Impulsive force in the Projectile Motion in Physics:
Links —
https://postimg.cc/rRJb10t1

https://postimg.cc/rRJb10t1

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https://i.postimg.cc/4nkgTpfS/Supradip-Research-notes-graphs-Physics-OP.jpg

The Breakdown of the Two Graphs in Supradip's way: —

- Graph 1: Supradip's S_Img versus Impulse (I) Graph / Curve
  - Condition: Mass (m) is kept constant.
  - Relationship: S_Img is directly proportional to Impulse (I).
  - Visual Shape: It forms a linear straight line graph that rises upward.
- Graph 2: Supradip's S_Img versus Mass (m) Graph / Curve
  - Condition: Impulse (I) is kept constant.
  - Relationship: S_Img is inversely proportional to mass (1/m).
  - Visual Shape: It forms a rectangular hyperbola graph that curves steeply downward toward the horizontal axis.

Dataset :

The Data set in This Impulsive force in projectile motion in Physics in This Solo Research of Physics (which is done within the record time frame of approximately 1.5 to 2.5 hours record making outstanding thing) , is given below:

—: Data Set :—

DATASET: Trajectory Analysis using Supradip's Parameter (SImg)							
Trial # / Condition	Mass m (kg)	Impulse I (N·s)	Angle θ (deg)	$S_{Img}=\frac{I}{m \cdot g}$ (s)	Flight Time T (s)	Max Height H_{max} (m)	Range R (m)
Case 1	0.20	2.0	30°	1.0	1.00	1.25	8.66
Case 2	0.20	4.0	30°	2.0	2.00	5.00	34.64
Case 3 (Supradip's Case)	0.25	2.5	45°	1.0	1.41	2.50	10.00
Case 4	0.25	5.0	45°	2.0	2.83	10.00	40.00
Case 5	0.15	3.0	45°	2.0	2.83	10.00	40.00
Case 6	0.15	4.5	60°	3.0	5.20	33.75	77.94
Case 7	0.50	5.0	45°	1.0	1.41	2.50	10.00

Ok.

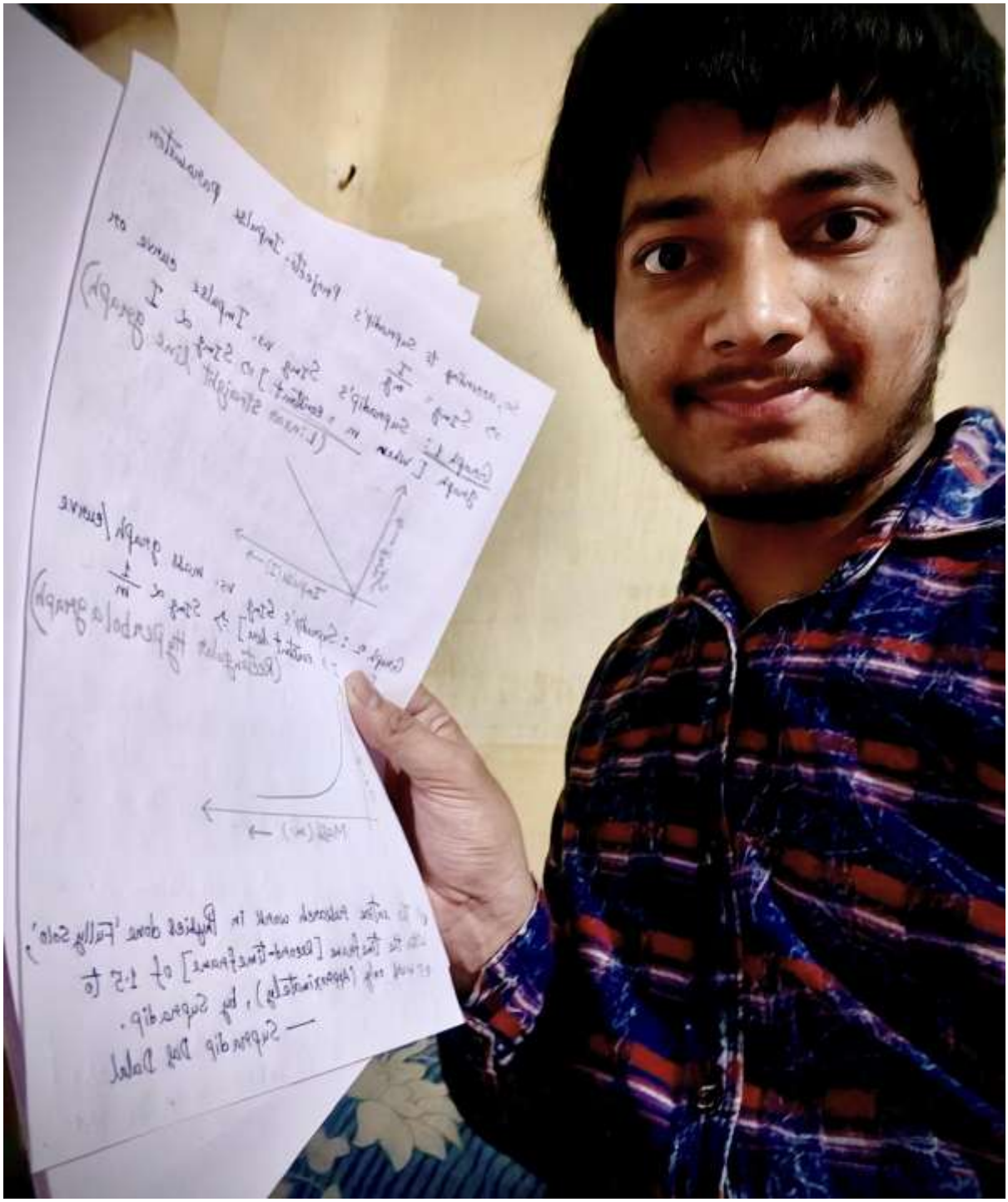
Discussion :

Direct Coupling Without Intermediate Velocity: Traditional projectile calculations require solving for initial launch speed (u = I / m) first, then plugging that value into separate kinematic equations. By using Supradip's Projecto-Impulse Parameter (S_Img = I / (m × g)), the initial hit is linked directly to the flight trajectory in one single step.

Physical Interpretation as a Time Scale: S_Img carries the fundamental dimension of time [T] in seconds. It represents the characteristic flight time Scale of the struck projectile under gravity, simplifying the flight time equation to T = 2 × S_Img × sin(theta).

Quadratic Scaling of Trajectory Boundaries: Both the maximum height (H_max) and the horizontal range (R) scale proportionally with the square of the parameter ((S_Img)^2). This shows that doubling the impulse delivered by a bat results in a fourfold increase in boundary distance for a fixed mass and angle.

Symmetry in Mathematical Formulation: Introducing S_Img brings structural balance to projectile kinematics, making the trajectory equations compact, CLEAN, and EASIER TO COMPUTE across varying IMPACT SCENARIOS.



Links:

SDD holds research notes Physics Projecto Impulse :

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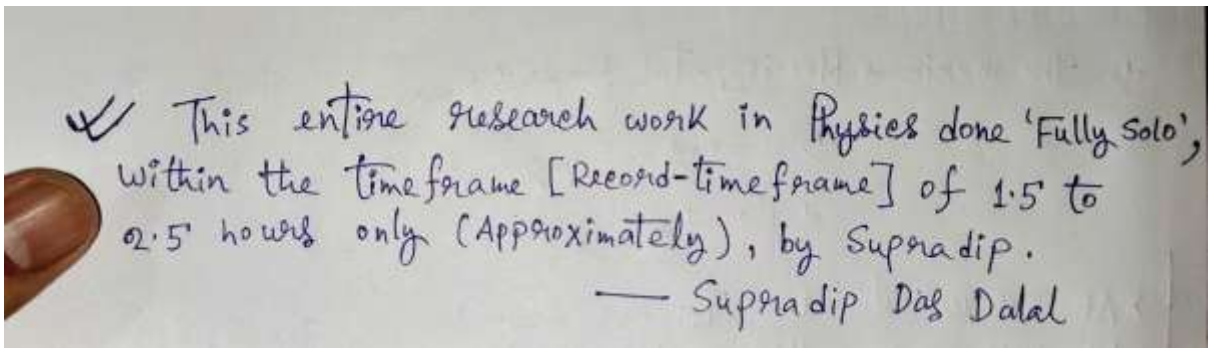
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Significance :
Simplification of Physics: Direct linking of impulse to final trajectory metrics streamlines standard 2D ballistic , that is , projectile motion calculations, making the math cleaner and more straightforward.
OVERALL ADVANCE: Offers a more intuitive, direct way to teach students and researchers about combined collision and flight dynamics by removing unnecessary intermediate velocity variables.
REAL-WORLD UTILITY: Provides a fast parameter for sports scientists and athletes (like in cricket) to immediately understand how impact dynamics on a bat relate directly to boundary distance.
MATHEMATICAL CLARITY: Introduces symmetric, balanced equations (T, H_max, R) that reveal the core physical scaling of impulse on projectile , making the trajectory equations compact, CLEAN, and EASIER TO COMPUTE across varying IMPACT SCENARIOS. This is one important significance of this research in Physics.

So here is it showing that I , Supradip Das Dalal , have done this entire research in Physics Fully SOLO within the record time frame of approximately 1.5 to 2.5 hours which is the world record actually & logically you can say, and also logically you can say that I , Supradip Das Dalal , am the FIRST person to do this here —



Conclusion :
This solo research paper successfully connects the theoretical gap between impulse-momentum mechanics and standard projectile kinematics. The introduction of :
Supradip's Projecto-Impulse Parameter ($S_{Img} = I / (m \times g)$) simplifies the connection between a short-duration impact strike and the resulting parabolic flight trajectory. This parameter provides clean, symmetric equations for calculating Total Time of Flight (T), Maximum Height (H_{max}), and Horizontal Range (R) without requiring separate intermediate calculations for launch velocity vectors.

Supradip Das Dalal (Mr. S.D.D.) is The FIRST person historically in The entire Planet Earth to Officially SET the WORLD RECORD HOLDER TITLE ('s) — The Youngest 'Solo' Physics Researcher
&
The Youngest Physics Researcher

Ok….!!!!

This entire theoretical conceptualization, mathematical derivation, data analysis, visual graph planning, and manuscript documentation were conducted and completed fully independently and solo by the author, Supradip Das Dalal, within a single, record-making timeframe of approximately 1.5 to 2.5 hours, demonstrating outstanding efficiency and command of fundamental mechanics. This parameter offers a refined tool for both educational simplification and it has important role in various fields of real life also.

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Supradip Das Dalal, Supradip D.D. "Supradip's Projecto-Impulse Parameter (S_Img): A New Formulation for the impulsive force in projectile motion in Physics research — Theories and notes, maybe etc.

About this Solo Research work and time taken (Outstanding Record) — SDD's feedback here :
This entire research project was conceived, developed, and completed fully independently, as an entire SOLO effort by the author — Supradip Das Dalal. Ok.

Links showing that I actually completed this entire Physics research thing fully solo within the 1.5 to 2.5 hours timeframe approximately (outstanding thing, logically world record here Ok):
Physics Research here Total-time approximately taken record-making timeframe SDD OP Ok —
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