International Journal of Scientific Research in Physics and Applied Sciences
Vol.**12**, Issue.**5**, pp.**07-14**, October **2024**
E-ISSN: 2348-3423
Available online at: www.isroset.org

Research Article

Introducing a Method to Determine the Radius of a Water Drop of Tap

Toyesh Prakash Sharma[1*], Etisha Sharma[2]

[1,2]Dept. of Physics, Agra College, Agra, India

**Corresponding Author: toyeshprakash@gmail.com*

Received: 18/Aug/ 2024; **Accepted**: 20/Sept/2024; **Published**: 31/Oct/2024

Abstract— Under the title; introducing a method to determine the radius of a water drop of tap, we are trying to calculate the radius of the water drop of a normal tap under some specific conditions which we are talking about in introduction section of the paper. Everyone can easily perform this experiment since it contains the basic mathematical concepts and use of conservation of volume. This experiment has two parts one is dealing with the object to determine the radius of the water drop falling from a synchronized tap while the other part is dealing the object to compare the radii of drop and tap. For first part we have required a beaker, meter scale and watch while the other part require vernier caliper and a tap.

Keywords— Vernier calipers, Main Scale, Water drop, Volume, Radius, Surface tension, Stokes Law etc.

1. Introduction

Throughout the development of physics, precise measurement has become essential, from the fine tip of a pencil to the vast radius of planets. Accurate determination of dimensions and constants has been at the core of scientific progress. In school and college laboratories, we often conduct experiments aimed at calculating fundamental constants, such as Earth's gravitational acceleration using a simple or compound pendulum, or Stefan's constant through blackbody radiation experiments. Other experiments focus on verifying laws or formulas. These hands-on activities not only reinforce theoretical knowledge but also foster a deeper understanding of the fundamental principles governing the physical world. They play a pivotal role in shaping our comprehension of key concepts and promoting an intuitive grasp of the laws of physics.

The nature of physics experiments has always been rooted in the quest to understand, measure, and quantify the physical world. Experiments in physics are not just procedures; they embody a journey of questioning, hypothesizing, and testing—culminating in data that serves to either validate or refine our theories. Physics experiments are a synergy between theoretical assumptions and practical verification, embodying a dance between observation and interpretation. They often begin with a theoretical framework that guides researchers in crafting hypotheses about the behavior of a system under specific conditions. Experimentation, therefore, is not a straightforward endeavor but a process of carefully controlled manipulation of variables to isolate certain behaviors while minimizing the influence of others.

In physics, experimentation relies heavily on empirical data, which can only be attained by meticulously designed setups and instruments. Physics experiments demand precision, as even the slightest miscalculation can render results meaningless or misleading. This precision becomes even more pronounced as we explore scales that push the limits of human observation—whether in the realm of particle physics, where events occur at subatomic scales, or astrophysics, where phenomena occur at cosmic distances. Furthermore, modern physics experiments often require specialized equipment, such as particle accelerators or lasers, and the precision with which these instruments operate is central to achieving reliable data. By providing measurable outcomes, experiments give life to the abstract formulations of theoretical physics, making them more accessible and verifiable. They serve as the bridge between the known and the unknown, offering insight into phenomena we cannot directly observe.

A few years ago, a 10th-grade student posed an interesting mathematical problem from the chapter on surface area and volume. The problem was as follows:

"A solid sphere with a radius of 3 cm is melted and recast into smaller spherical balls, each with a diameter of 0.6 cm. How many small balls can be obtained?"

The solution to this problem is straightforward, and most of us are familiar with the key concept: <u>when one shape is transformed into another, the volumes of both shapes remain</u>

equal. Some people called it as **conservation of volume**. This principle, though simple, sparked an idea to explore its practical application in calculating the dimensions of everyday objects.

The student also asked how we can apply this concept beyond textbook problems. This question led to a broader reflection on the practical uses of such principles in real life. One immediate thought was the possibility of determining the radius of a water droplet falling from a tap, using similar calculations based on volume. This idea highlighted the potential of basic mathematical concepts in understanding and measuring the physical world around us.

By applying the same principle, we can solve problems that go beyond the classroom, offering insights into various everyday situations. From calculating the dimensions of small objects to understanding natural phenomena, the concept of volume conservation when transforming shapes becomes a useful tool in practical scenarios.

Among various experimental pursuits in physics, the study of fluid dynamics and the properties of liquids has garnered interest for centuries. One of the intriguing facets of this study is the behaviour and properties of water droplets. This focus may seem deceptively simple; after all, water drops are a familiar part of daily life. Yet, under controlled experimental conditions, the simplicity of a water droplet belies a complex interplay of forces and principles. The study of water droplets' radius and associated dynamics can reveal insights into surface tension, cohesion, and intermolecular forces—phenomena that are foundational to the principles of fluid mechanics and thermodynamics.

Experiments based on the radius of water droplets, while seemingly straightforward, are powerful examples of how basic experimental designs can reveal fundamental truths about nature. At their core, these experiments explore the relationship between the size of a droplet and its physical properties, such as surface tension, evaporation rates, and even interaction with other surfaces. One famous approach within this domain is the study of how droplet size affects surface tension and cohesion. As water droplets decrease in size, their surface-to-volume ratio increases significantly, which in turn magnifies the relative influence of surface forces over gravitational forces. This effect can be observed in experiments measuring the radius of water droplets on various surfaces, such as glass, plastic, or metal, allowing scientists to quantify how surface material properties influence the shape and behaviour of water droplets.

The radius of a water droplet directly correlates with its surface area, and consequently with its energy dynamics. Smaller droplets, having a larger surface area-to-volume ratio, tend to evaporate more quickly than larger droplets. This observation is instrumental in fields such as meteorology, where cloud formation and rain prediction depend on understanding how water droplets interact with atmospheric conditions. In an experimental setup, the radius of water droplets can be varied by using micro-syringes or atomizers to control the droplet's initial size accurately. By measuring the rate at which droplets of varying radii evaporate under different temperature and humidity conditions, scientists can derive data on how environmental factors influence evaporation rates. This experimental approach provides data for refining models of atmospheric water behaviour, which are crucial for predicting weather patterns.

One significant area of study involving the radius of water droplets is the investigation of droplet impact dynamics. Droplets interacting with surfaces or with each other exhibit a range of behaviours, depending on their size and the speed of impact. In these experiments, the radius of water droplets plays a key role in determining how they spread, splash, or coalesce upon contact. Researchers employ high-speed cameras to capture the dynamics of droplet impact in microseconds, allowing them to examine how factors such as droplet size and surface tension influence behaviour. For instance, smaller droplets tend to retain a spherical shape longer upon impact, whereas larger droplets are more prone to flattening and spreading. These observations have practical implications for fields ranging from agriculture—where pesticide distribution depends on how droplets spread on leaf surfaces—to inkjet printing, where droplet behaviour affects print quality.

In addition to impact studies, the radius of water droplets is central to the study of colloidal suspensions and microemulsions. These experiments typically involve dispersing water droplets in another medium and examining how the droplet size influences the stability and behaviour of the suspension. The radius of each droplet affects the interaction between droplets and the surrounding medium, which in turn affects the overall stability and viscosity of the mixture. By conducting experiments where the droplet radius is varied, scientists gain insights into the principles governing phase separation and emulsification. This knowledge is essential in fields like pharmaceuticals, where the stability of drug formulations often depends on creating stable emulsions with precisely controlled droplet sizes.

Another fascinating application of experiments based on the radius of water droplets is in the study of microfluidics, a field that explores the behaviour of fluids at a microscopic scale. In microfluidics, water droplets serve as discrete units or carriers of chemical reactions in lab-on-a-chip devices. The radius of these droplets is a critical variable, as it determines the volume of reactants that can be encapsulated and influences the efficiency of reaction processes within confined spaces. Researchers design microfluidic devices with channels and chambers that allow for precise control over droplet formation and size. By varying the radius of water droplets in these experiments, scientists can optimize reaction conditions and improve the accuracy of chemical assays, which has transformative implications for medical diagnostics and biochemical research.

The study of droplet behaviour also has relevance in materials science, particularly in understanding how coatings and surfaces interact with liquids. By experimenting with water droplets of varying radii on different materials, researchers can characterize a surface's wettability or its ability to repel or absorb water. Smaller droplets often exhibit more pronounced effects of surface roughness and material composition than larger droplets, providing data on how molecular interactions at the surface influence liquid behaviour. These experiments have contributed to the development of hydrophobic and hydrophilic coatings, which have applications ranging from waterproof fabrics to self-cleaning surfaces.

In sum, experiments focusing on the radius of water droplets illustrate how seemingly simple systems can yield complex insights into physics principles. Such experiments are not just about observing droplets but about systematically manipulating and measuring variables to uncover relationships that enhance our understanding of fluid dynamics, material interactions, and thermodynamics. By examining how the radius of a droplet influences its behaviour in various contexts, physicists not only expand our knowledge of liquids but also contribute to the development of applications that range from weather forecasting to medical diagnostics. The study of water droplets, therefore, represents a convergence of curiosity and precision, showcasing the iterative nature of scientific inquiry. This process of testing and observation ultimately reinforces the broader goals of physics: to seek out the rules governing the natural world and to build a framework that bridges theory with real-world applications.

The first thing stuck into mind is that it is related with several physical phenomena of hydrostatics and hydrodynamics one may things about the Stokes law since it explains the behavior of raindrops falling through the air, including how they reach a constant velocity and why larger raindrops hurt more than smaller ones. This constant velocity known as terminal velocity and in this case, it might be given with considering a system in which a spherical object is falling under the influence of gravity of Earth in the viscous material respectively. Then

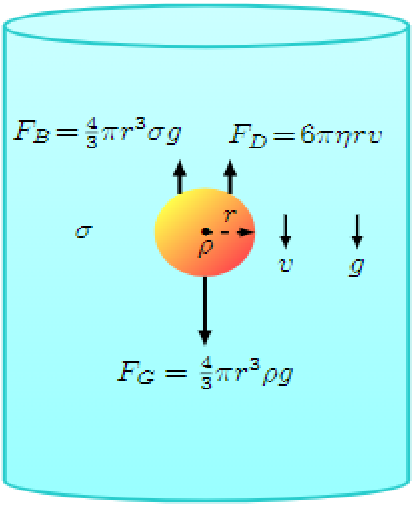

Figure 1: a spherical object falling under some viscous fluid.

From the equilibrium condition

$$F_B + F_D = F_G$$

$$\Rightarrow \frac{4}{3}\pi r^3 \sigma g + 6\pi\eta r v = \frac{4}{3}\pi r^3 \rho g$$

$$\Rightarrow 6\pi\eta r v = \frac{4}{3}\pi r^3 \rho g - \frac{4}{3}\pi r^3 \sigma g$$

$$\Rightarrow 6\pi\eta r v = \frac{4}{3}\pi r^3 (\rho - \sigma) g$$

$$\Rightarrow v = \frac{2r^2(\rho - \sigma) g}{9\eta}$$

Here v is terminal velocity and for determining the radius of the drop we have required the value for terminal velocity itself other than the values of densities of medium (σ) and density of substance (ρ), viscosity and acceleration due to gravity i.e. g which is not a big deal since g is nearly 9.8 m s^{-2} for our Earth, but yes the other quantities are not easy to handle and also our perspective is more inclined toward mathematical approach which is based on the *principle of conservation of volume*.

This paper is organized into several key sections, each contributing to a comprehensive analysis and findings. These sections include: *Introduction*, *Related Work*, *Theory*, *Experimental Method*, *Results and Discussion*, *Conclusion and Further Scope*, and finally, *References*.

The *Introduction* underscores the significance of accurate measurements and explains the motivation behind exploring this topic, providing essential background on relevant hydrodynamic phenomena.

The *Related Work* section reviews recent studies, outlining who conducted the research and their key findings, placing this study within the broader context of hydrodynamics.

In the *Theory* section, crucial assumptions are made to proceed with the experiment. These assumptions lead to the derivation of a formula for calculating the water drop's radius, forming the basis for the subsequent experimental procedures. The *Experimental Method* offers a step-by-step guide to performing the experiment, detailing the apparatus required and ensuring replicability.

The *Results and Discussion* section presents observations and calculations in tabular form, providing clear insights into the experiment. It includes open-ended questions to enhance reasoning and concludes with a discussion of limitations and possible improvements.

Finally, the *Conclusion and Further Scope* evaluates how well the study's objectives were met and suggests avenues for future research, encouraging further exploration. The *References* section completes the paper.

2. Related Work

In recent years, the behavior of water droplets has captured the interest of many researchers, especially concerning the intricate dynamics of droplets during free fall and impact. This area of study has become central to a range of fields, from environmental science to industrial applications, due to the importance of understanding droplet formation, spread, and impact behavior under various conditions. Studies by Zhang et al. [1], Ogden et al. [2], Yarin [3], and others have collectively enriched our understanding of droplet physics, especially in relation to droplet size, free-fall behavior, and the various physical forces that act upon droplets in motion.

Zhang et al. [1] focused on a numerical analysis of water droplets across different temperatures, providing insights into how temperature and environmental conditions affect the dynamics of droplets. This study underscored how temperature changes impact evaporation rates, droplet shape, and velocity, crucially affecting droplet behavior in applications such as meteorology and climatology. Their research built upon previous work by researchers like Clanet and Lasheras, who had also examined the effects of temperature and environmental factors on droplet motion, contributing to the understanding of phenomena such as rainfall formation and cloud behavior.

Ogden et al. [2] developed a practical method known as the "drop-weight method" to measure droplet size. This method, which involves calculating droplet mass to estimate size, provided a valuable tool for studying droplets in free fall, a technique widely adopted for its simplicity and accuracy. Their findings allowed researchers to measure droplet radii across various conditions with improved precision, facilitating the study of droplet impacts on different surfaces. Researchers such as Davies and Tanner further built upon Ogden's method, applying it to study droplet impacts on rough versus smooth surfaces, revealing the influence of surface texture on the spread and splashing behavior of droplets.

The dynamics of droplet impact and spreading were comprehensively explored by Yarin [3], who conducted extensive work on the fundamental principles that govern splashing, spreading, and bouncing during droplet impacts. Yarin’s research emphasized the effects of kinetic energy, surface tension, and droplet size on impact behavior. His work was particularly influential in fields like inkjet printing and spray cooling, where precise droplet dynamics are essential for optimizing processes. Building upon Yarin’s studies, Thoroddsen and his collaborators investigated droplet behaviors at ultra-high speeds, capturing splash patterns and droplet fragmentation in unprecedented detail. These investigations laid the groundwork for understanding the underlying physics of droplet impact, helping refine theoretical models and improve the prediction accuracy of droplet behavior on various surfaces.

Researchers like Rein and Thoroddsen [4] also made substantial contributions to understanding the influence of surface tension and fluid properties on droplet formation, behavior, and impact dynamics. Their work revealed the significance of the transitional regime—a state where droplets are neither fully bouncing nor fully spreading, but exhibit both behaviors depending on impact speed and angle. They observed that at certain speeds, droplets would oscillate between spreading and retracting before finally coming to rest, a phenomenon influenced heavily by surface tension. Such insights have been integral in improving droplet-based technologies and processes, such as the design of hydrophobic and superhydrophobic materials, where controlling droplet behavior is critical.

The combined findings from these studies suggest exciting potential applications, particularly in understanding and measuring the radius of water droplets from sources like household taps. Knowing the droplet radius and understanding its behavior under free-fall conditions has practical applications in fluid dynamics, environmental sciences, and industrial processes. By examining droplet formation, researchers can develop better ways to predict and control droplet behavior, which is especially relevant for designing systems that rely on controlled droplet dispersion, such as agricultural spraying or pharmaceutical droplet formulations.

This paper aims to introduce a novel mathematical approach for measuring the radius of water droplets falling from a normal tap. By employing this mathematical framework, the goal is to enhance the precision of droplet measurements under everyday conditions, where factors such as surface tension, temperature, and gravitational forces interact. By leveraging the foundational studies of Zhang, Ogden, Yarin, Rein, and Thoroddsen, this method will offer a refined model that not only simplifies droplet measurement but also broadens our capacity to apply fluid dynamics principles in real-world scenarios. Through an understanding of the fundamental dynamics outlined by these researchers, this approach seeks to bridge the gap between theoretical models and practical applications, marking a step forward in the study of droplet physics.

3. Theory

Before performing the experiment, it is essential to putting forward the assumptions required to calculate the radius of the falling water drop from a tap.

The first assumption is taken from the principle of conservation of volume that means when one shape is transformed into another, the volumes of both shapes remain equal [5]. This principle is equally applicable to n different shapes transformed into one shape. Mathematically,

$$V = \sum_{i=1}^{N} V_i$$

$$= V_1 + V_2 + \cdots + V_N$$

Here V is the volume of that shape which further transformed into several different N shapes and thus their volumes are

$V_1, V_2, \cdots, V_N$ It's a general case when all shapes are different and their volumes are unequal to each other. But if we assume that all the transformed shapes are same and their volumes are equal that means $V_1 = V_2 = \cdots = V_N = V'$. With using this

$$V = \sum_{i=1}^{N} V_i = V_1 + V_2 + \cdots + V_N$$

$$= \overbrace{V' + V' + \cdots + V'}^{N-times} = NV'$$

Now if we have total number of transformed identical shapes N then if we have V then we can easily calculate V'. So, in conclusion the first assumption is <u>all water drops are identical in shape and size</u>.

Now we are taking another crucial assumption which is regarding the shape of the water drop. At first all of us denied that falling water drops from a tap is <u>spherical</u> in shape. But it is also true that no one can denied from the fact that due to surface tension and air drag after a few seconds from releasing drop from the mouth of the tap it turns into an approximated spherical shape, this is similar case as we used Stoke's law above for finding an expression for terminal velocity of falling rain drops under the influence of gravity. The only difference in both cases is, for raindrops it attained an equilibrium condition but for our case of water drops for attaining equilibrium condition, drop has not that much of time as compared to raindrops respectively but ignoring this we are assuming that <u>water drops are spherical in shape</u>. So, the volume of this assumed water drop must be equal to

$$V' = \frac{4}{3}\pi r^3$$

Where, r is the radius of water drop. Now, using the conclusion of the first assumption we have

$$V = NV'$$

$$\Rightarrow V = N\left(\frac{4}{3}\pi r^3\right)$$

$$\Rightarrow r^3 = \frac{3V}{4\pi N} \Leftrightarrow r = \left(\frac{3V}{4\pi N}\right)^{1/3}$$

In conclusion we can say that we have assumed that **<u>falling water drops from the tap are identical and spherical in shape</u>**. In due with the considered assumptions, we have obtained an expression for radius of the water drop (r) in terms of total volume (V) of the drops contained in beaker after collecting them into it and N is the number of drops which collectively form the total volume.

$$\boxed{r = \left(\frac{3V}{4\pi N}\right)^{1/3}}$$

4. Experimental Method

We can perform this experiment in two parts, in first part we will try to determine the radius of the water drop falling from the tap while in second part we will compare the radius of the drop with the radius of the tap respectively. Before the steps taken for the experiment, we have to mention the required apparatus.

<u>Apparatus</u>: - A Beaker, Tap, A meter scale, A Vernier scale and a watch.

<u>Experimental Setup</u>: - Position a beaker directly beneath the tap on the floor, ensuring there is a measurable distance between the mouth of the tap and the ground.

<u>Procedure: -</u>

1. Use a Vernier caliper to measure the inner diameter of the tap accurately.
2. Place the beaker on a flat surface directly under the tap. Adjust its position so that each water drops falls from the tap and takes exactly 1 second to reach the bottom of the beaker.
3. Once this condition is met, begin counting the number of drops (denoted as *n*) until the water level reaches a predetermined mark on the beaker.
4. The volume of water corresponding to this mark is referred to as *V*.
5. Record the value of *n*, the number of drops, and the volume *V* at the marked level of the beaker.
6. Substitute these values into the appropriate formula for *r*, which represents the radius or any other derived quantity, depending on the context of your experiment.
7. The final expression will help determine the value of *r* based on the observed data, specifically the volume *V* and the number of drops *n*.

5. Results and Discussion

We have performed this experiment in two parts as first part is dealing with the determination of radius of water drop falling from the tap. For better calculations we have considered drops falling from the two different taps.

Total number of drops falling per unit time for the <u>first tap</u> is 27/30=0.9 drop/second approximate to 1 drop per second

Total number of drops falling per unit time for the <u>second tap</u> is 28/30=0.93 drop/second approximate to 1 drop per second.

Table 1:- Number of drops falling from the tap

	Number of drops falling from <u>first tap</u>	**Number of drops falling from <u>second tap</u>**
1.	112	122
2.	118	138
3.	122	135
4.	120	130

For both cases we kept count the number of falling drops until the collected water in the beaker achieved the line showing the volume <u>25ml.</u>

Now we are coming on the second part which is related to the comparison of the radius of the drop with the radius of the tap. So, before comparing we have to calculate the radius of the tap.

Table 2: Diameter of tap-1

Diameter of the tap-I			
Reading along x-axis		Reading along y-axis	
Main Scale	Vernier Scale	Main Scale	Vernier Scale
1	8	1.05	4

Here, $a = 1 + 0.01 \times 8 = 1.08\ cm$ and $b = 1.05 + 0.01 \times 4 = 1.09\ cm$. Now, diameter of the tap is given by

$$d = \frac{a+b}{2} = \frac{1.08 + 1.09}{2} = 1.085\ cm$$

Then the radius is $R = 0.5425\ cm$.
While for the second tap;

Table 3:- Diameter of tap-2

Diameter of the tap-II			
Reading along x-axis		Reading along y-axis	
Main Scale	Vernier Scale	Main Scale	Vernier Scale
1	7	1	5

Here, $a = 1 + 0.01 \times 7 = 1.07\ cm$ and $b = 1 + 0.01 \times 5 = 1.05\ cm$. Now, diameter of the tap is given by

$$d = \frac{a+b}{2} = \frac{1.07 + 1.05}{2} = 1.06\ cm$$

Then the radius is $R = 0.53\ cm$.
With the help of table 1, for determining the **radius of water falling from the tap-1** we are putting different values of n as mentioned above in table 1, we can obtain

$$r_1 = \left(\frac{3 \cdot 25}{4 \cdot 112\pi}\right)^{\frac{1}{3}} \approx 0.376\ cm,$$

$$r_2 = \left(\frac{3 \cdot 25}{4 \cdot 118\pi}\right)^{\frac{1}{3}} \approx 0.369\ cm$$

$$r_3 = \left(\frac{3 \cdot 25}{4 \cdot 122\pi}\right)^{\frac{1}{3}} \approx 0.365\ cm$$

$$r_4 = \left(\frac{3 \cdot 25}{4 \cdot 120\pi}\right)^{\frac{1}{3}} \approx 0.367\ cm$$

Taking mean

$$r = \frac{r_1 + r_2 + r_3 + r_4}{4}$$

$$= \frac{0.376 + 0.369 + 0.365 + 0.367}{4}$$

$$= 0.36925\ cm$$

So, the radius of a drop is approximately $r = 0.36925\ cm$.
for determining the **radius of water falling from the tap-2** we are putting different values of n as mentioned above in table 1, we can obtain

$$r_1 = \left(\frac{3 \cdot 25}{4 \cdot 122\pi}\right)^{\frac{1}{3}} \approx 0.365\ cm,$$

$$r_2 = \left(\frac{3 \cdot 25}{4 \cdot 138\pi}\right)^{\frac{1}{3}} \approx 0.351\ cm$$

$$r_3 = \left(\frac{3 \cdot 25}{4 \cdot 135\pi}\right)^{\frac{1}{3}} \approx 0.355\ cm$$

$$r_4 = \left(\frac{3 \cdot 25}{4 \cdot 130\pi}\right)^{\frac{1}{3}} \approx 0.358\ cm$$

Taking mean

$$r = \frac{r_1 + r_2 + r_3 + r_4}{4}$$

$$= \frac{0.365 + 0.351 + 0.355 + 0.358}{4}$$

$$= 0.35725\ cm$$

So, the radius of a drop is approximately $r = 0.35725\ cm$.
Now, for calculating how small drop formed from the tap in percentile we can use the below formula

$$\left(1 - \frac{r}{R}\right) \times 100$$

For *case-I*, $r = 0.36925\ cm$ and $R = 0.5425\ cm$ then,

$$\left(1 - \frac{0.36925}{0.54250}\right) \times 100 = 31.9\ \%$$

For *case-II*, $r = 0.35725\ cm$ and $R = 0.53\ cm$ then,

$$\left(1 - \frac{0.35725}{0.53}\right) \times 100 = 32.5\ \%$$

So, nearly the radius of a drop is nearly <u>2/3rd</u> of the <u>radius of the tap</u>.

<u>Open Questions: -</u>
What will happen in the case of plastic taps? Does every tap contain nearly same percentile of decrement of the radius of a drop with respect to the radius of the tap? If is it so, then what will it?

<u>Limitations: -</u>

1. After all measure it was difficult task to synchronize the tap and drop formed accordingly and as a result the most approximate drop per second come approx. 0.93 but yet there is a difference of 0.07 between assumed synchronised to founded synchronization.
2. The taps were old that's why there was some rust may it affects the inner radii of taps.

6. Conclusion and Future Scope

The proposed method for determining the radius of a water drop falling from a tap offers a straightforward and accessible approach for anyone with basic laboratory tools. This experiment combines fundamental physics principles with simple measurements, enabling individuals to estimate the radius of a water droplet using minimal resources. By focusing on concepts like volume conservation and fluid dynamics, this method fosters an understanding of physics in an everyday context.

The experiment begins with a simple setup: a beaker, meter scale, and watch. In the first part of the experiment, water is collected from a dripping tap over a specified time, allowing for a measurement of the total volume of water dispensed. By observing the volume of water collected within a given time frame, individuals can calculate the average volume per drop based on the total number of drops formed. Knowing that volume can be related to the radius through the formula for a sphere's volume, this step provides an approximation of the drop radius by using the average volume per drop. This calculation relies on the principle of conservation of volume, which assumes that each water droplet maintains a consistent size as it forms and falls.

The second part of the experiment involves a direct comparison between the radii of the water droplet and the tap opening itself. By using a vernier caliper, an instrument that allows for precise measurements of small distances, the experimenter can measure the diameter of the tap opening. Comparing the radius of the droplet, calculated from volume, with the tap's radius provides a way to further validate the initial results. This part of the experiment illustrates how the geometry of the tap influences the size of the droplet. Since the droplet forms at the edge of the tap, surface tension plays a crucial role in holding the droplet until it reaches a critical size, at which point it detaches and falls.

The results obtained from this experiment indicate that the radius of a droplet is approximately two-thirds of the tap's radius. However, this relationship may vary depending on factors such as the shape and material of the tap, as well as the specific environmental conditions during the experiment. In this case, the two taps used for the experiment produced consistent results, but to verify whether this relationship holds universally, further testing on taps of different sizes and materials is recommended.

This dual approach—combining volume measurements and direct radius comparison—provides an effective hands-on learning experience. It brings abstract concepts like surface tension, conservation laws, and fluid dynamics into a tangible form, allowing students and experimenters to see physics principles in action. The experiment not only strengthens understanding of droplet formation but also encourages critical thinking by showing how measurements and calculations can be cross-validated.

Ultimately, this experiment illustrates how fundamental mathematical and physical principles can be applied to understand everyday phenomena. As an educational tool, it highlights the importance of measurement accuracy and the interconnectedness of geometry, volume, and surface forces in determining droplet behavior. By encouraging experimentation with basic tools, this method offers a practical and engaging way to explore fluid dynamics and the conservation of volume in real-world settings.

.

Data Availability

The data taken in the paper is outcome of the experiment which we called the readings and for these readings readers have to perform this experiment.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

Funding Source

None

Authors' Contributions

Author -1 performed the experiments with proposing the idea regarding the calculations of the radius of water drop and tap respectively while author-2 manage the part of calculations and readings and proposing a valuable conclusion of this experiment, with composing this paper.

Acknowledgements

We are thankful for the help of Mr. Harshit Sisodia for helping while performing experiments and faculty members of Physics department and professors Dr. Bhupendra Singh, Dr. Gaurang Mishra, Dr. Brijendra Kumar Sharma and Dr. Randhir Singh Indolia.

References

[1] B. Zhang, V. Sanjay, S. Shi, Y. Zhao, C. Lv, and X.-Q. Feng, "Impact forces of water drops falling on superhydrophobic surfaces," Phys. Rev. Lett., Vol.**129**, No.**10**, pp.**104501-104510, 2022.**

[2] R. A. Ogden, K. F. Falk, M. D. Johnson, "Drop-weight method for determining water drop size," Phys. Fluids, Vol.**17**, No.**6**, pp.**62107-62115, 2005.**

[3] A. L. Yarin, "Drop Impact Dynamics: Splashing, Spreading, Receding, Bouncing," *Annual Review of Fluid Mechanics*, Vol.**38**, pp.**159-183, 2006.**

[4] M. Rein and S. Thoroddsen, "Dynamics of drop impact on solid surfaces: evolution of impact force and self-similar spreading," *Journal of Fluid Mechanics*, Vol.**852**, pp.**114–148, 2018.**

[5] L. D. Landau and E. M. Lifshitz, *Fluid Mechanics*, 2nd ed. Oxford, UK: Pergamon Press, pp.**2-5, 1987.**

AUTHORS PROFILE

Mr. Toyesh Prakash Sharma, born on April 18, 2004, developed a strong interest in science, mathematics, and literature during his high school years. A graduate of St. C.F. Andrews School, Agra, he embarked on his research journey in mathematics as early as the 11th standard. His passion for the subject led him to contribute scholarly articles to renowned journals and magazines such as *Mathematical Gazette*, *Crux Mathematicorum*, *Parabola*, *AMJ*, *ISROSET*, *SSMJ*, *Pentagon*, *Octagon*, *La Gaceta de la RSME*, *At Right Angle*, *Fibonacci Quarterly*, *Mathematical Reflections*, *Irish Mathematical Society*, *Indian Mathematical Society*, and *Mathematical Student*, among others.

In addition to his research contributions, Toyesh is the author of two well-received books for high school students, *Problems on Trigonometry* and *Problems on Surds*, which are available on ResearchGate. These books are designed to enhance students' problem-solving skills and understanding of these important mathematical topics.

Currently, Toyesh is pursuing his post-graduate studies in Physics at Agra College, Agra, India, where he continues to engage in academic research and learning. His dedication to mathematics and science is evident through his numerous publications and his commitment to advancing knowledge in these fields. He resides at B-509, Kalindi Vihar, Agra, India.

Ms. Etisha Sharma has a keen interest in Physics, Mathematics, Computer Science, and Drawing, reflecting her broad intellectual curiosity. She completed her 10th and 12th grades at Gayatri Public School, Agra, where she excelled academically. Currently, she is pursuing her post-graduate studies in Physics at Agra College, Agra, India, where she continues to develop her knowledge and skills in the subject.

Etisha has made notable contributions to academic discourse, having published her work in a variety of respected magazines and journals. Her publications have appeared in prominent outlets such as *ISROSET*, *Mathematical Reflections*, *Pentagon*, *Octagon Mathematical Magazine*, and *At Right Angles*. These contributions highlight her dedication to advancing knowledge in physics and mathematics while engaging with a wider academic community.

Beyond her academic achievements, Etisha’s interests in computer science and drawing reflect her creativity and versatility, balancing technical expertise with artistic expression. Her multidisciplinary approach to learning and exploration positions her as a well-rounded and promising scholar.

